UNCERTAINTY IN ADVANCED SERVICES: A SERVICE NETWORK ACTORS' PERSPECTIVE

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Doctor of Philosophy

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Thesis Abstract

As manufacturers increasingly move towards offering guaranteed outcomes in advanced services to remain competitive, they face a complex web of uncertainties that can threaten their ability to deliver on these promises. The study expounds on *how uncertainty impacts advanced services innovation from a service network actors' perspective*. The scope of this study extends to the perspective of broader service network actors due to their active involvement in advanced services. These actors include both internal and external stakeholders. The study aims to address the following research questions:

RQ1: What uncertainties arise for internal stakeholders of a manufacturing firm when innovating advanced services?

RQ2: What uncertainties arise for external stakeholders of a manufacturing firm when innovating advanced services?

RQ3: What are the likely implications of these uncertainties for internal and external stakeholders of a manufacturing firm when innovating advanced services?

The research adopts a multiple-embedded case study design. The network perspective sets the boundaries for the phenomenon. Organisational Information Processing Theory is used to develop a research framework that guides the data collection. Data is collected from 3 cases of manufacturers and 16 embedded cases involving customers, distributors, and technology suppliers by interviewing 50 participants. The analysis presents insights through detailed within-case narratives and cross-case findings.

The findings underscore various uncertainties faced by internal and external stakeholders grouped into different categories under organisational, relational, technical, and environmental domains. The implications of these uncertainties are thoroughly examined. The study makes substantial contributions to various literature streams and advances knowledge in the multi-actor context. The research bridges the gaps in existing literature and offers new insights into the uncertainties in advanced services.

The study also makes significant contributions to practice by guiding firms to understand uncertainties at early development stages, enhancing collaboration among internal and external stakeholders, and improving long-term strategic planning for advanced services.

Keywords: servitization, advanced services, outcome-based solutions, uncertainty, service network actors

Dedication

My grandfather and the family

Your trust in me more than I do!

Your encouragement for never settling down for less!

Your strength of letting me go miles away and live for myself!

Your endless support!

Your unconditional love and countless blessings!

This is for you!

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Publications

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Beltagui, A., **Rathi, D.**, and Dusane, S., (2024). *From supplier to orchestrator: Developing advanced service strategies for distributors.* Paper presented at the Spring Servitization Conference, Tilburg, Netherlands.

Momeni, B., **Rathi, D.,** Raddats, C., Bigdeli, A., (2024). *Upstream collaboration models in digital service innovations.* Paper presented at the Spring Servitization Conference, Tilburg, Netherlands.

Adler, L., Ebel, M., **Rathi, D.**, & Gebauer-Drechsel, H. (2024). *Design Principles for Product-Service Software-System Innovation for Healthcare Manufacturers*. In T. Bui (Chair), Paper presented at the Hawaii International Conference on System Sciences, Honolulu, HI.

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Abbreviations

SSP	Services Supporting Products
SSC	Services Supporting Customers
PSS	Products-Service System
S-D	Service Dominant
AS	Advanced Services
SNA	Service Network Actors
OEM	Original Equipment Manufacturer
VOC	Voice of Customers
ES	Engineering Services
RQ	Research Question
OIPT	Organisational Information Processing Theory
IPN	Information Processing Needs
IPC	Information Processing Capabilities
CT	Critical Theory
Capex	Capital Expenditure
Opex	Operational Expenditure
EaaS	Equipment-as-a-Service
AI	Artificial Intelligence
SLA	Service Level Agreements

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1. INTRODUCTION

This study explores the impact of uncertainties when innovating advanced services, focusing specifically on the perspective of Service Network Actors (SNA). This chapter provides an overview of the research topic and outlines the motivation behind the study. The chapter begins by providing context, explaining how manufacturers increasingly compete through advanced services by providing guarantees on the outcome of the products. This shift in focus underscores the importance of understanding the complexities of advanced services, serving as the primary motivation for this research. The subsequent section discusses the specific topic of uncertainties in advanced services from the perspective of SNA. Following this, the chapter highlights the research gaps and outlines the research questions this study aims to address. Finally, the chapter concludes by presenting the structure of the thesis.

1.1 Background & Motivation: Competing through Advanced Services

Basic product-service offerings are insufficient to distinguish manufacturers in today's highly competitive environment. As servitization increasingly reshapes the industry, organisations are moving beyond the traditional sale of products and basic services (section 2.1). Advanced services have emerged as a key differentiator, centred around outcome-based solutions and performance guarantees that cater to customers' evolving needs (Baines et al., 2024a; Ng et al., 2013; Visnjic et al., 2017). Unlike traditional sale models, the notion of delivering 'outcomes' has greater potential, both as a means of competitive strategy and to drive innovation and growth (section 2.1.3). This concept is drawing increasing attention in both academic research (section 2.2) and industry practice (Table 2).

Advanced services hold profound strategic significance in transforming manufacturers' operations and generating long-term value for their customers (section 2.2). By offering tailored services that guarantee the delivery of the desired outcomes, such as enhanced product performance and reliability, manufacturers can move beyond transactional relationships to forge lasting partnerships with their customers (Datta, 2020; Kamp and Parry, 2017; Saccani et al., 2014). A key strategy is fostering long-term contractual commitment between manufacturers and customers (Sjödin et al., 2019), as exemplified by Thales' training and simulation solutions. Thales offers an integrated solution that includes 24/7 services such as engineering, maintenance, supply, IT & logistics support. It ensures each system is operational throughout every mission-critical moment across a 25-year life cycle contract (section 2.1.3). Thus, advanced services facilitate customer-centricity by developing customised solutions, tailored investments in each provider-customer relationship, transparency of operations, high levels of trust and information exchange, leveraging advanced technologies, increased innovation, and financial outcomes (Baines and Lightfoot, 2013b; Burton et al., 2016; Dyer et al., 2018; Schroeder et al., 2020; Sjödin et al., 2016a; Visnjic et al., 2017).

In conclusion, the adoption of advanced services represents a critical frontier for manufacturers striving to maintain a competitive edge. However, this strategic shift is not without its challenges. Advanced services are inherently complex, presenting significant commercial and operational risks

for manufacturers (Hou and Neely, 2018; Sousa and da Silveira, 2019; Ziaee Bigdeli et al., 2018). The dynamic nature of these services and the responsibility to deliver guaranteed outcomes impose significant liability on manufacturers, requiring careful management and strategic oversight. This research, therefore, seeks to understand and unpack the intricacies of advanced services.

1.2 Research Focus: Uncertainties in Advanced Services

The research focuses on examining uncertainties and their implication when innovating advanced services (section 2.4), specifically from the perspective of service network actors (SNA) (section 2.3). As discussed in the previous section, advanced services differ significantly from conventional product-service offerings due to their complexity and the need to guarantee outcomes rather than merely providing products or basic services. To understand this complexity, Chapter 2 reviews the literature surrounding value mechanisms in advanced services (section 2.2), the role of SNA in advanced services provision (section 2.3), and the inherent uncertainties in advanced services innovation (section 2.4). This comprehensive review helps establish a framework using Organisational Information Processing theory (OIPT) to guide the empirical investigation in later chapters (Chapter 3).

As manufacturing firms increasingly move towards delivering outcomes through advanced services that generate greater customer value, it is vital to understand how firms create, capture, and deliver value to their customers (Martin et al., 2019; Osterwalder, 2010). These underlying mechanisms manufacturers employ to leverage the potential of advanced services in the market (section 2.2). First, value creation describes how the provider and customer collaborate to generate shared value (section 2.2.1). Value capture is the next critical element, which involves understanding how firms secure the financial and non-financial return from the value created (section 2.2.2). Lastly, value delivery is the process by which firms ensure that the intended value is delivered to the customers (section 2.2.3). This is aligned with the service-dominant logic, which emphasises the importance of interaction among different actors for successful value delivery (Lusch et al., 2010).

Manufacturers rarely operate in isolation when designing and delivering advanced services; instead, they rely on a broader network of actors (section 2.3). The successful innovation of advanced services requires collaboration with these service network actors (SNA) to engage in value co-creation processes (Grönroos and Voima, 2013; Sklyar et al., 2019b; Zolkiewski et al., 2023), thereby facilitating the effective delivery of advanced services to customers (Chesbrough, 2011; Kamalaldin et al., 2021; Randhawa et al., 2018). The service network actors involve both internal and external stakeholders who jointly contribute by providing the necessary resources, sharing expertise, and aligning their objectives (section 2.3.1). The extant literature extensively discusses the roles and successful collaboration, ranging from organisation-wide integration within the manufacturer (section 2.3.2), to collaboration between manufacturer-customer, manufacturer-distributors, and manufacturer-technology suppliers in co-creating and delivering value (section 2.3.3). However, the involvement of these actors introduces additional complexity in advanced services innovation.

It has been argued that complexity gives rise to uncertainty (Kreye, 2018). Uncertainty is higher in advanced services than in base or intermediate services (section 2.4.1). This higher level of uncertainty in advanced services can be attributed to various factors, including the complexity of integrating products and services (Mourtzis et al., 2018), the dynamic nature of customer needs and expectations (Benedettini and Neely, 2018; Zou et al., 2018), the reliance on technology and digitalization (Schroeder et al., 2020; Sklyar et al., 2019a), increased competition (Zolkiewski et al., 2023), and the involvement of service network actors (Parida and Jovanovic, 2022). While uncertainty has long been studied in various fields, its application and exploration in services and servitization have recently gained attention (Durugbo and Erkoyuncu, 2016; Ramirez Hernandez and Kreye, 2021; Rexfelt and Hiort af Ornäs, 2009; Vinhas, 2023). The literature review identifies key sources of uncertainty in advanced services, which include organisational, relational, technical, and environmental (section 2.4.3). The research examines these four uncertainty types in advanced services (section 2.4).

1.3 Summary of the Research Gaps

The literature review chapter identifies three significant gaps that this study investigates (section 2.5). Accordingly, three research questions are proposed to explore how uncertainties impact advanced services innovation from the perspective of Service Network Actors (SNA). Despite the growing body of research on uncertainties in servitization, there remains a lack of comprehensive investigation on uncertainties specific to advanced services (**Gap 1**). This lack of focus represents a critical gap in the literature, as advanced services involve a higher level of uncertainty that may differ from base or intermediate service types. This has not yet been thoroughly examined in the literature (section 2.4). **Gap 2** concerns the limited research from a broader SNA perspective. While previous studies have primarily focused on uncertainties at the individual firm level, within dyadic relationships such as between manufacturers and customers, or triadic relationships such as manufacturers, customers and suppliers, there is a lack of attention on the broader network (Erkoyuncu et al., 2011). This involves multiple interconnected internal and external stakeholders such as customers, distributors, and technology suppliers. **Gap 3** focuses on the underexplored implications of these uncertainties in innovating advanced services. Although uncertainties are acknowledged, research has yet to explicitly investigate how they impact advanced services innovation.

Building on these identified gaps, the study proposes the following research questions:

RQ1: What uncertainties arise for internal stakeholders of a manufacturing firm when innovating advanced services?

RQ2: What uncertainties arise for external stakeholders of a manufacturing firm when innovating advanced services?

RQ3: What are the likely implications of these uncertainties for internal and external stakeholders of a manufacturing firm when innovating advanced services?

The subsequent section discusses the research design and method employed to conduct the study.

1.4 Summary of the Research Design

The literature review (Chapter 2) reveals three gaps leading to three research questions, as illustrated in Figure 1 below. The present study takes a broader Service Network Actors (SNA) perspective to examine uncertainties that arise for internal (individuals in manufacturing firms) and external stakeholders (customers, distributors, and technology suppliers) and their implications when innovating advanced services. Based on Organisational Information Processing Theory (OIPT), a theoretical framework is developed in Chapter 3 that serves as a data collection protocol

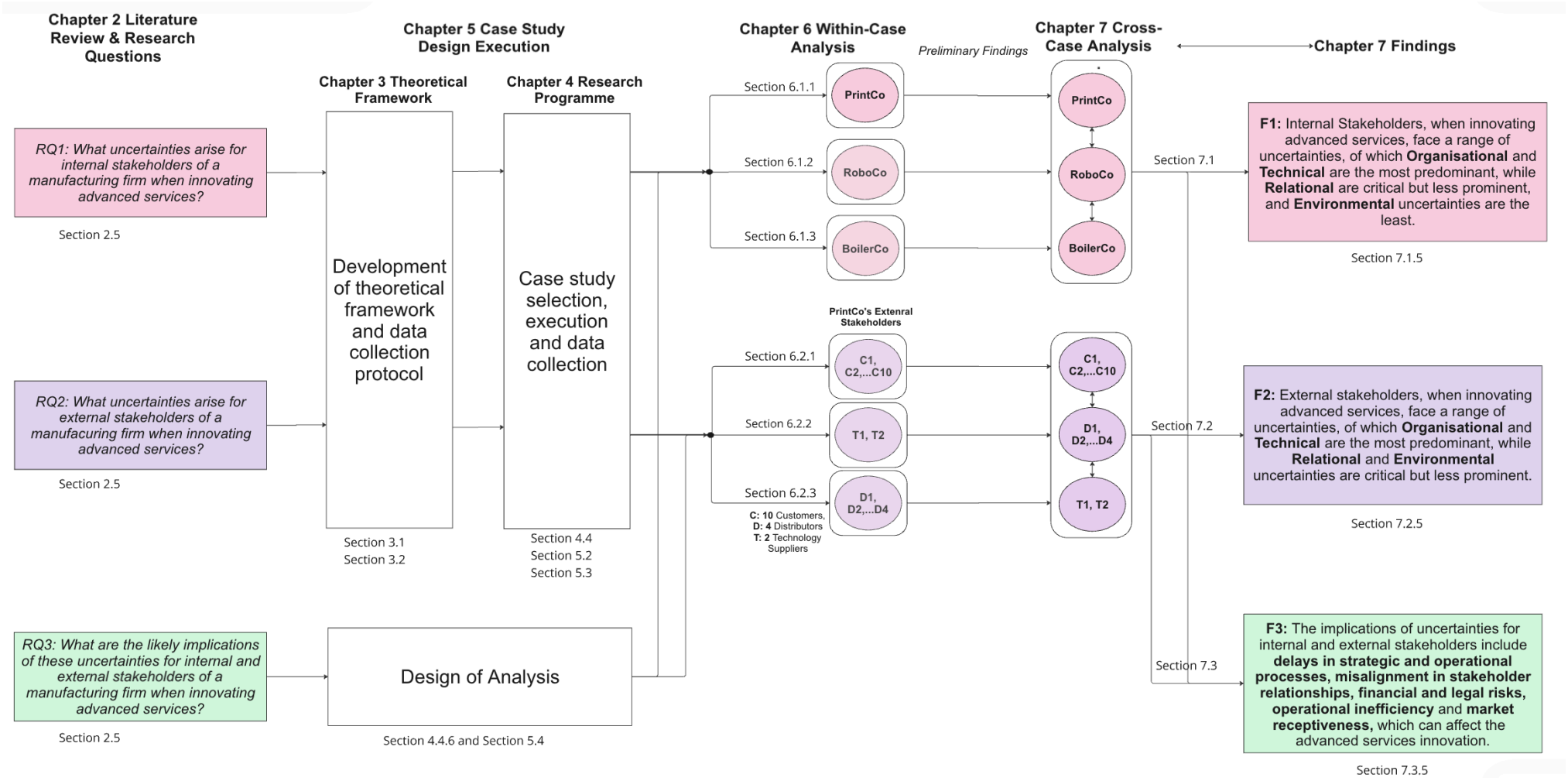

Figure 1: Research Design

The internal and external stakeholders of a manufacturing firm represent an embedded setting within the network, making embedded case studies particularly suitable for investigating complex phenomena and exploring multiple perspectives within a business system (Scholz and Tietje, 2002) or network. This study is grounded in an interpretivism paradigm (section 4.1.2), which takes a more subjective approach to exploring uncertainties in advanced services. Serving an exploratory purpose (section 4.2.2), the research employs a multiple-embedded case study design to address the proposed research questions (section 4.3.2).

Data collection spans 3 primary cases of manufacturers (PrintCo, RoboCo, and BoilerCo), which serve as key exemplars for examining internal stakeholders' uncertainties (section 5.2.1). Case PrintCo, which had access to external stakeholder data, includes 16 embedded cases involving 10 customers (C1-C10), 4 distributors (D1-D4), and 2 technology suppliers (T1 and T2) (section 4.4.4). The data is drawn from both primary and secondary sources (section 4.4.5). The study adopts an abductive approach to the analysis of the data, combining both deductive and inductive reasoning (section 4.2.1). A detailed, step-by-step analytical process is executed to ensure a rigorous examination and interpretation of the data (section 4.4.6).

Chapter 5 provides a brief overview of all the 19 cases, summarised in tables, along with the execution of the data collection and analysis process. It outlines the key characteristics of the cases, presents participant information for data collection and develops a research codebook to facilitate the data analysis. Chapter 6 presents a within-case analysis, focusing on the internal stakeholders of the three manufacturer cases (PrintCo, RoboCo, and BoilerCo) and external stakeholders involving customers (C1-C10), distributors (D1-D4), and technology suppliers (T1 and T2). These embedded cases provide key network perspectives that supplement the analysis and deepen the understanding of uncertainties in advanced services. This is followed by a cross-case analysis (Chapter 7), identifying broader patterns and themes across all the cases. The cross-case findings are synthesised to address the study's research questions and present the key insights and contributions of the research.

1.5 Research Findings & Contributions

This study addresses the research questions by thoroughly analysing the uncertainties that emerge when innovating advanced services, spanning organisational, relational, technical, and environmental domains identified from the literature. While previous studies have acknowledged the challenges posed by uncertainties, this research bridges the first gap by specifying and categorising these uncertainties within the context of advanced services

The analysis of individual cases involving internal stakeholders of manufacturing firms revealed distinct categories and a range of uncertainties across these uncertainty types (section 6.1). Through cross-case analysis, this study identifies both similarities and differences across cases, demonstrating that internal stakeholders encounter a range of organisational, relational, and technical uncertainties when innovating advanced services, with environmental uncertainties being less prominent. This analysis addresses the first research question (section 7.1).

Similarly, the individual analysis of external stakeholders uncovered a range of uncertainties, grouped into distinct categories under the four uncertainty types (section 6.2). The subsequent cross-case analysis highlights that external stakeholders primarily face organisational and technical uncertainties, while relational and environmental uncertainties are less pronounced, addressing the second research question (section 7.2).

The implications of these uncertainties were examined through both within-case and cross-case analysis of internal (section 6.1) and external stakeholder (section 6.2) cases. This analysis reveals that these uncertainties have several implications, affecting service development timelines, resource management, cost efficiency, strategic decision-making and several others for internal and external stakeholders alike when innovating advanced services. These findings address the third research question (section 7.3). The key contribution of this research is its in-depth examination of uncertainties in advanced services (Durugbo and Erkoyuncu, 2016; Goh et al., 2015; Kreye, 2019; Poeppelbuss et al., 2022; Ramirez Hernandez and Kreye, 2021) their implications (Ahmet Erkoyuncu et al., 2014; Ramirez Hernandez and Kreye, 2021) (section 9.2.1). The study's findings have some overlap of these uncertainties with existing literature but also unveiled new, specific uncertainties in advanced services across organisational, relational, technical, and environmental domains. Existing literature has highlighted a high level of technical uncertainty in advanced services (Kreye, 2018). Notably, organisational and technical uncertainties were found to be more prevalent across both internal and external stakeholders compared to other types of uncertainty types.

Furthermore, while The key contribution of this research is its in-depth examination of uncertainties in advanced services (Durugbo and Erkoyuncu, 2016; Goh et al., 2015; Kreye, 2019; Poeppelbuss et al., 2022; Ramirez Hernandez and Kreye, 2021) and prior studies have underscored the importance of a multi-actor perspective in advanced services (Parida and Jovanovic, 2022; Reim et al., 2019; Story et al., 2017), much of the literature remains focused on dyadic (manufacturer-customer) (Raddats et al., 2017; Ulaga and Reinartz, 2011), triadic (manufacturer-customer-intermediaries) (Bastl et al., 2019; Karatzas et al., 2016) or supply chain relationships (Datta, 2020). This research advanced theoretical understanding by examining a broader network of actors including manufacturers, customers, distributors, and technology suppliers within service network—an area that has been underexplored in the literature (section9.2.2). By doing so, this study sheds light on the interdependencies between these actors and their role in influencing uncertainties when innovating advanced services. Additionally, this research integrates the Organisational Information Processing Theory (OIPT) in the context of advanced services, thereby contributing to the servitization literature and the broader discourse on Information Systems (IS) within complex organisations (section 9.2.4).

In practice, this study offers valuable insights for manufacturing firms seeking to explore and innovate advanced services (section 9.3). It provides guidance on key considerations when engaging with SNAs (section 9.3.2) and emphasises the importance of involving both internal and external stakeholders from the early stages of advanced service development. Furthermore, the study highlights the significant implications of various uncertainties for internal and external stakeholders

when innovating advanced services, suggesting that manufacturers should integrate robust strategies and develop capabilities to effectively navigate these uncertainties (section 9.3.3).

1.6 Thesis Structure

This thesis is structured into nine chapters, each contributing to the main topic, as illustrated in Figure 2 below. Chapter 1 introduces the research, outlining the background and motivation for studying advanced services. It also defines the research topic and provides a brief overview of the entire research, including the gaps, methods, and contributions, offering the reader a roadmap for the thesis.

Chapter 2 presents a comprehensive literature review. The review centres on the servitization journey, advanced services, value mechanisms, and the roles of service network actors. It also examines the nature of uncertainties in advanced services and highlights the gaps that this research aims to address. Chapter 3 provides a theoretical lens for the basis of a framework that informs the analysis, offering a way to examine uncertainty.

Chapter 4 outlines the research methodology, including the research paradigm, abductive approach, exploratory purpose, theoretical propositions, case study design approach, and data collection and analysis plan. Chapter 5 details the case descriptions, pilot studies, and development of the research codebook, preparing the ground for the empirical analysis.

The within-case and cross-case analyses are described in Chapters 6 and 7, presenting the study's findings on uncertainties across different cases in Chapter 7. Chapter 8 discusses these findings in light of the literature and theoretical framework. Finally, Chapter 9 concludes the thesis by summarising the research contributions, identifying limitations, and outlining potential avenues for future research.

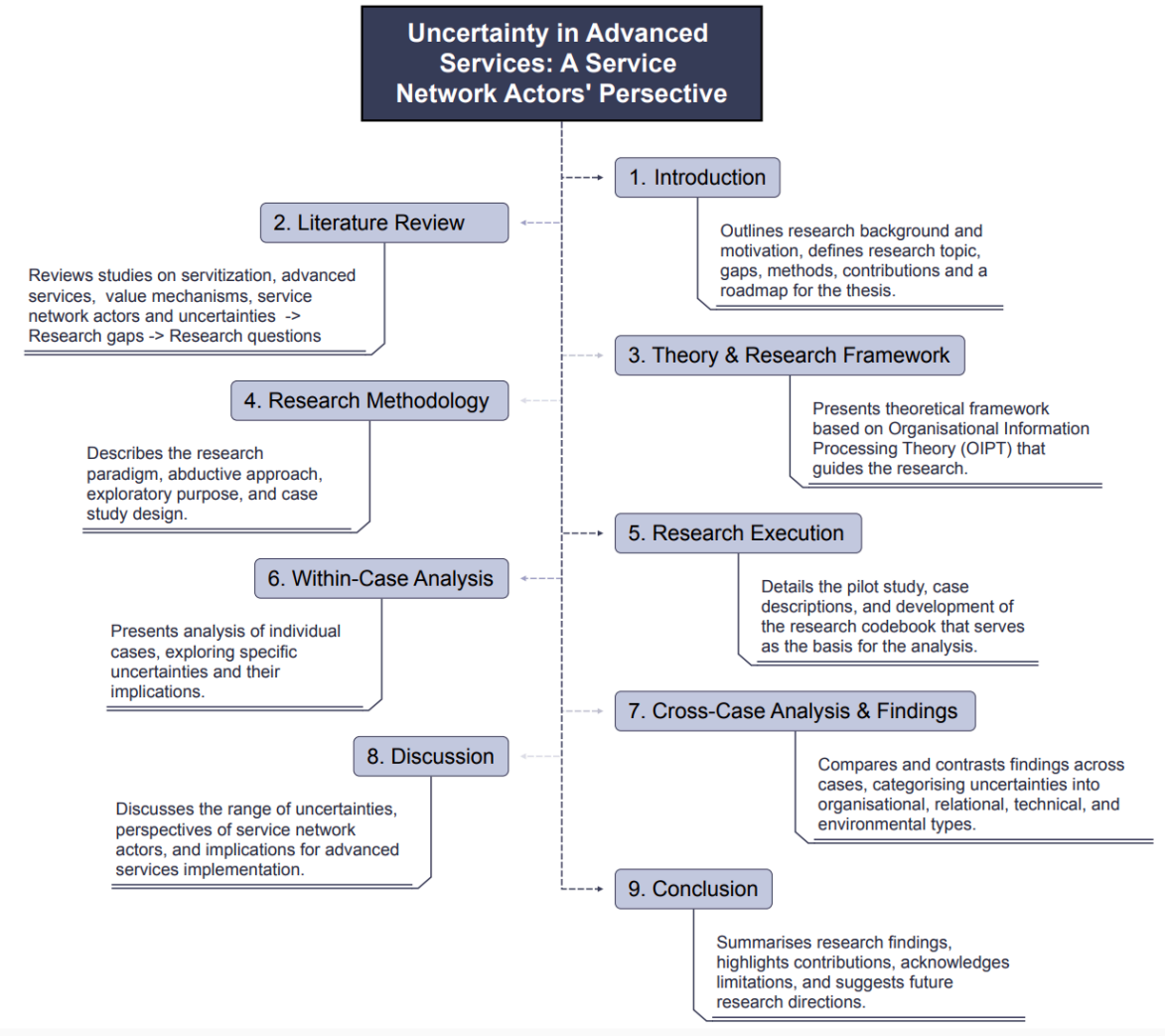

Figure 2: Structure of the thesis

2. LITERATURE REVIEW

This chapter provides a comprehensive review of existing literature relevant to the concepts of 'servitization', 'advanced services', and 'uncertainties', highlighting the key themes, insights, and gaps that inform the direction of this research. First, an overview of servitization and service classification is presented with an introduction to advanced services (AS) and illustrative examples (section 2.1). Second, the chapter discusses the three mechanisms—value creation, value capture and value delivery that manufacturers employ to leverage the potential of advanced services in the market (section 2.2). Third, the collaboration and role of various service network actors (SNA), including internal and external stakeholders (customers, distributors, and technology suppliers), in the value creation and delivery are discussed in detail (section 2.3). Fourth, the concept of uncertainty is introduced, and the different typologies are discussed, which form the focus of the present study (section 2.4). Finally, research gaps are identified, leading to the formulation of research questions this study aims to answer (section 2.5).

2.1 Servitization: Classification and Introducing Advanced Services

This section introduces the concept of servitization (section 2.1.1) and provides a brief on service classification (section 2.1.2). As the study primarily focuses on advanced services, section 2.1.3 defines advanced services and provides leading industry examples.

2.1.1 Servitization: Definitions, Evolution, and Advantages

The significance of servitization has now been widely acknowledged across both academia and industry. The definition of 'Servitization' has undergone varied interpretations within scholarly discourse. Its inception can be traced back to Vandermerwe and Rada (1988) when it was defined as bundling 'products and services' to add more value to the core business. Over time, servitization has been seen through the lens of the business model, referring to the transformation from products and basic support services to the provision of advanced services (Baines and Lightfoot, 2013b; Kohtamäki et al., 2019a). In this research, servitization is understood following this definition of business model transformation.

Servitization has gained prominence in both academia and industry, driven by macroeconomic trends and industry shifts. The quantity of peer-reviewed scholarly papers on servitization has increased steadily over the years- 22 from 1991 to 2000, 100 from 2001 to 2010 (Lightfoot et al., 2013) and more than 2000 articles from 2010 to 2023. This rise of servitization research has significantly impacted various literature streams, including service marketing, service management, operations management, strategic management, marketing, supply chain management and others (Baines et al., 2017; Chirumalla et al., 2023; Kamp and Parry, 2017; Lightfoot et al., 2013; Martín-Peña et al., 2019; Wang et al., 2023a; Zolkiewski et al., 2023). According to the report of Neely (2008), more than one-third of manufacturing companies have adopted servitization. Factors such as globalization, digitalization, and changing customer expectations have accelerated the adoption of servitization strategies among manufacturing firms.

The adoption of servitization strategies offers numerous benefits for manufacturing firms, driving both strategic and operational advantages. By doing so, manufacturers can differentiate themselves in the market and create numerous opportunities for growth (Latonen and Akpinar, 2019; Luoto et al., 2017; Neely, 2008). This has led companies to increasingly move towards integrating services into their products or transitioning to a fully service-based business model as a viable means to generate greater value. Manufacturers foster closer, long-term relationships with customers and gain a deeper understanding of their specific needs, facilitating continuous provider-customer interactions (Bastl et al., 2012; Oliva and Kallenberg, 2003). Several manufacturers tap into a recurring and incremental revenue stream that leads to profitability and economic stability (Benedettini et al., 2017; Brax, 2005; Gebauer and Friedli, 2005; Spohrer and Maglio, 2008). Furthermore, servitization acts as a catalyst for innovation and value co-creation (Baines et al., 2009; Gebauer and Friedli, 2005; Iriarte et al., 2023).

Simultaneously, customers stand to gain numerous benefits from servitization. One of the most significant benefits is access to integrated solutions that comprehensively address complex needs (Baines et al., 2007). It brings a higher degree of customisation for customers and increased quality. Servitization improves operational efficiency and productivity for customers by leveraging manufacturers' expertise (Baines and Shi, 2014; Vandermerwe and Rada, 1988). For example, British Airways sought cost reductions and increased efficiency through services. Servitization provides customers with increased flexibility and agility that helps them to adapt to changing market conditions and evolving demands. Such offerings enhance customer satisfaction levels and transfer risk from customers to manufacturers (Baines et al., 2007). Additionally, customers now emphasise the outcome of their purchase and look for greater value (Ulaga and Kohli, 2018; Zolkiewski et al., 2023). All these benefits have led manufacturers to compete increasingly through a servitized business model and customers to seek greater value from manufacturers.

2.1.2 Service Classification: Base, Intermediate and Advanced Services

Understanding the variety and scope of services is critical to analysing how firms transition from product-centric to service-centric models. Various service classifications have been proposed in the extant literature across different disciplines to categorise the different types of services that manufacturing firms can offer. These classifications help comprehend that not all services are identical and illustrate how services can build upon each other to create more complex and integrated offerings. Some of the notable classifications are discussed below.

For example, within the marketing and the strategic management literature, Mathieu (2001) introduced a classification distinguishing between Services Supporting Products (SSP) to Services Supporting Customers (SSC), which several scholars have adopted (Antioco et al., 2008; Baines et al., 2017; Gebauer and Friedli, 2005; Kindström, 2010). Ulaga and Reinartz (2011) extended this approach by introducing a two-dimensional taxonomy that combined SSP-SSC classification with input-based and output-based services. Another commonly proposed classification in the area of

sustainability and strategy is product-oriented, use-oriented and result-oriented services (Mont, 2002; Tukker, 2004).

Scholars in the service management literature streams have also developed their own classifications. Oliva and Kallenberg (2003) distinguished between transaction-based and relationship-based, while Gebauer et al. (2010) proposed five service categories: customer service, basic service, maintenance service, R&D-oriented service, and operational services. In operations literature, Baines and Lightfoot (2013a) introduced base, intermediate and advanced services classification, which provides a structured view of service progression in manufacturing firms. From the strategic management stream, Cusumano et al. (2015) classified services into smoothing and adapting services (which complement products) and substitution services (pay-per-use basis).

While these classifications provide valuable insights, many of them are interrelated (Raddats and Kowalkowski, 2014). Some studies suggest that close relationships with customers serve as a prerequisite for more integrated, process-oriented, and output-based services. This interconnection has led scholars to argue that many existing taxonomies align with the SSP-SSC classification (Raddats et al., 2019). This study adopts the *base, intermediate* and *advanced services* classification by Baines and Lightfoot (2013a) because it provides a clear, structured, and progressive view of how manufacturers transition toward servitization, as shown in Figure 3 below. Unlike other taxonomies, this classification is particularly pertinent for this study as it explicitly connects service complexity with operational and business model changes (Bustinza et al., 2015; Galvani et al., 2022; Jovanovic et al., 2023; Martin et al., 2019; Paschou et al., 2020; Schroeder et al., 2020; Sjödin et al., 2020b; Ziaee Bigdeli et al., 2017; Ziaee Bigdeli et al., 2018) . Furthermore, it aligns well with empirical observations in servitization literature, offering a robust framework for understanding the evolution of service offerings in industrial contexts.

These three service categories have been further expanded into eight steps, known as the ‘service staircase’ (Baines et al., 2024a). It provides a detailed understanding of where different services fall into these categories, as illustrated in Figure 3 below.

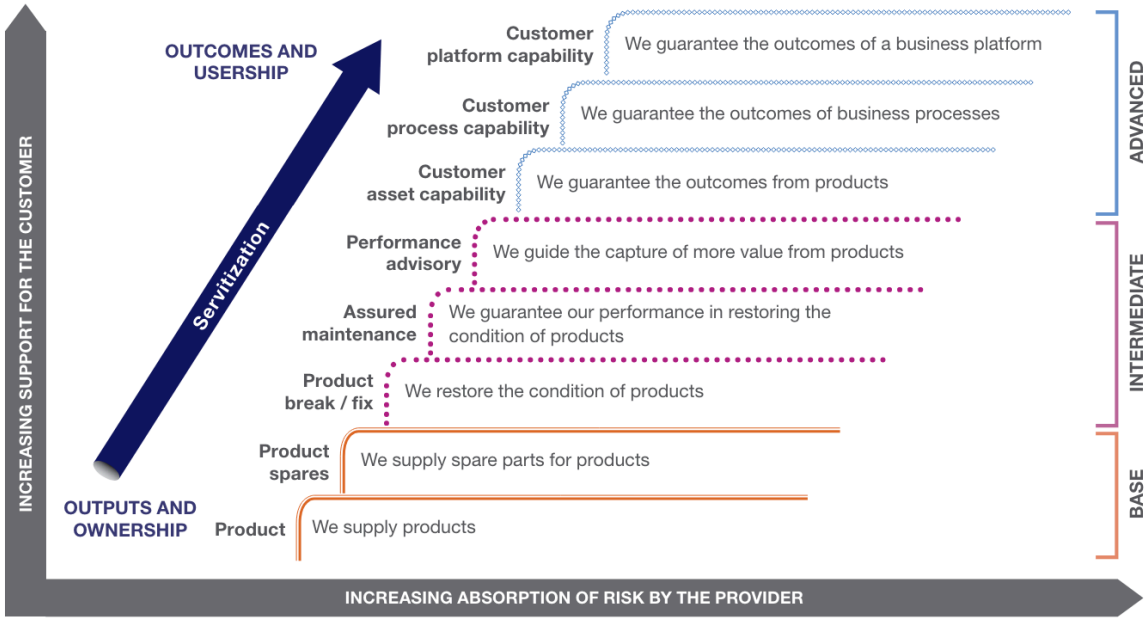

Figure 3: Service Staircase (Adapted from Baines et al. (2024a))

Each step represents different levels of service offerings, indicating the responsibilities undertaken by manufacturers on behalf of their customers from outputs and ownership to outcomes and usership (Annarelli et al., 2019; Baines et al., 2024a). As one progresses up the staircase to address customer issues, the manufacturer gradually combines and integrates products and services (Reinartz and Ulaga, 2008). This progression may lead to greater responsibilities and increased value in return for the manufacturer (Baines et al., 2024a). The staircase presents the evolution of servitization, outlining how manufacturers transition from product provision to delivering outcomes derived from the product. The following paragraphs provide a more detailed explanation of this classification.

Base services are typically offered on manufacturers' production expertise and primarily include providing products and spare parts to uphold the operational integrity of the equipment (Baines and Lightfoot, 2013a; Goffin and New, 2001). These services hold a notable revenue stream for manufacturers and often generate higher profit margins (Cohen et al., 2006) than tangible products. The main outcome for the manufacturers is to own the equipment, and the maintenance is carried out at the customer facilities.

Intermediate services are oriented towards maintaining and optimising product functionality throughout its operational lifespan, including scheduled maintenance and overhaul services (Baines and Lightfoot, 2013a). These services are often conceptualised as lifecycle service offerings as manufacturers strive to offer support for sustained functionality of their equipment across its entire lifecycle (Rabetino et al., 2015). Intermediate services represent a significant facet of service potential, complementing spare parts with a range of supplementary services (Visnjic et al., 2018) such as scheduled maintenance, technical helpdesk, installation, operator training, monitoring product condition, and others (Baines and Lightfoot, 2013a).

Advanced services (AS) represent a pivotal aspect of servitization. They go beyond the normal product-service offerings. Unlike base and intermediate services, which primarily focus on maintaining product functionality, AS epitomises an evolution towards result—or outcome-oriented solutions for customers (Baines and Lightfoot, 2013a). AS would integrate the product and services to offer a solution that primarily focuses on addressing the individual needs of customers through guaranteed outcomes.

Having outlined the classification of services, this study focuses particularly on advanced services. The decision to look at AS in this study is grounded in their transformative potential, which is marked by distinctive features and far-reaching implications compared to conventional base and intermediate service offerings. Additionally, the notion of delivering 'outcomes' has greater potential and is gaining more attention (section 2.1.3) in both research and practice. The following section explains the concept of AS by exploring characteristics and implications for firms embarking on the advanced services journey.

2.1.3 Advanced Services: Definition, Forms, and Examples

Advanced services (AS) have been defined in various ways. For instance, AS refers to a comprehensive integration where the service combines competencies and processes that supplement the physical product. The integration extends the manufacturer's operations to include the customers, thereby meeting their unique needs for an extended period (Baines and Lightfoot, 2013a; Garcia Martin, 2020). Ziaee Bigdeli et al. (2018: 315) in their study described advanced services as 'a complex bundling of product and service offerings, which often includes: (i) revenue payments structured around product usage; (ii) performance incentives (e.g. penalties for product failure when in service); and (iii) long-term contractual agreements (e.g. spanning five, ten or fifteen years) and cost-down commitments'. AS not only provide ownership of a product but also a complete solution comprising both products and services linked to its performance (e.g., pay-per-performance) and usage (e.g., pay-per-use) (Iriarte et al., 2023; Zheng et al., 2019).

Recently, AS have been defined as an 'integrated products-service system (PSS), that when used, delivers outcomes that directly align with value creation and capture processes within a customer's own organisation' (Baines et al., 2024a: 38). The present study operationalises advanced services following this definition. An outcome is the result or consequence of an action or activity. The provider is entitled to guarantee the delivery of the outcome (Musson et al., 2019; Ng et al., 2013; Visnjic et al., 2017). These outcomes are usually offered in the form of value propositions that are co-created with customers. In general terms, value proposition underlines the outcome rather than specifying how it is delivered (Jovanovic et al., 2019; Kim et al., 2007). Based on the agreed outcome, the contracts are thus formed, often referred to as outcome-based or pay-per-outcome contracts.

As illustrated in Figure 3, the three steps at the top of the staircase represent three distinct forms of AS outcomes: a product, a business process, or a business platform (Musson et al., 2019). Table 1 below provides details of these outcomes with relevant examples.

Table 1: Forms of outcomes (Adapted from Musson et al. (2019))

	Asset	Business Process	Business Platform
Focus	Manufacturer's products as an asset within their customer's operations	Business process of the customer within which the product sits	Customer's business model, of which the product is an enabler
Typical offering	Machine as an outcome	Business process as an outcome	Business platform as an outcome
Example of outcome	Improved machine reliability, availability and performance i.e., guaranteed product outcome	Improved operation, reduced disruption to production i.e., assurance of production	Enabling the customer to make new value propositions to its own customers i.e., flexible production facility

Manufacturers are obligated to have a higher degree of commitment throughout the contracted cycle (Oliva and Kallenberg, 2003; Tukker, 2004). Moreover, based on the agreed outcome independent of the product, all risks and liabilities fall under the manufacturers' umbrella due to uncertainty and a lack of control over customer usage experiences. The literature provides several successful industry examples of advanced services. Some of the prominent ones are presented in Table 2 below.

Table 2: Industry examples of advanced services

Example Firm	Advanced Services Offering	Description
Alstom Transport	'Total Train-Life Management'	transport solutions (e.g. train availability) for everyday service for a 20-year life cycle contract (Bustinza et al., 2015; Davies, 2004)
Thales Training and Simulation	'Training and Simulation Solution'	an integrated solution that includes 24/7 services such as engineering, maintenance, supply, IT & logistics support, that ensures each system is operational throughout every mission-critical moment across a 25-year life cycle (Thales, 2024)
Rolls-Royce Aerospace	'Total Care'	an integrated solution that combines the jet engine with performance monitoring services and charges customers a fixed pay per flying hour basis (Bustinza et al., 2015)
Xerox	'Managed Print Services (MPS)'	combines printing equipment with maintenance services and charges customers for the usage of the product-service-bundle (i.e. pay per print or pay per use) (Ziaee Bigdeli et al., 2018)
MAN Truck	'Pay-per-Kilometre'	an integrated solution combining truck, maintenance and driver management services and charged for the use i.e., distance driven (Ziaee Bigdeli et al., 2018)
Siemens Healthineers	'Managed Equipment Services (MES)'	a comprehensive solution combining equipment installation, maintenance, upgrades, and performance monitoring over a period of 10-25 years (Zeithaml and Brown, 2014)
ABB	'ABB Ability connected services'	customised solution that identifies asset performance issues and offers remote support, condition monitoring, and asset health services (Bustinza et al., 2015)

Philips	'Light as a Service' or 'Pay per lux'	customised solution where the company takes full ownership of the product and offers performance, maintenance of the installed base or upgrades, flexible and personalised lighting (Lighting, 2020)

In summary, delivering 'outcomes' has greater potential for enhancing value for manufacturers and customers. The section provided an overview of servitization and the classification of services and introduced AS with several prominent industry examples. Furthermore, academics have a growing interest in making advanced services a distinct field of research. The following section will explore the mechanisms of advanced services in detail.

2.2 Advanced Services Mechanisms: Value Creation, Capture, and Delivery

As manufacturing firms increasingly move towards delivering outcomes through advanced services that generate greater customer value, it is important to understand how firms create, capture, and deliver value to their customers (Martin et al., 2019; Osterwalder, 2010). This section discusses the underlying mechanisms of value creation, value capture, and value delivery that manufacturers employ to leverage the potential of advanced services in the market.

2.2.1 Value Creation: Co-creational Activities, Customer-centricity and Tools

Value creation describes how the provider and customer engage in a collaborative process to generate shared value (Lenka et al., 2017). In this process, the starting point for a firm is to identify the value to be created (O'Cass and Ngo, 2011; Payne and Frow, 2005). To do so, firms define a value proposition that states the desired outcome to be delivered (Baines et al., 2024b). A value proposition is often conceptualised as a hypothesis formulated by a company regarding the tangible and intangible benefits that could be collaboratively created and tailored to meet the specific needs of customers (Iriarte et al., 2023; Lusch and Vargo, 2014).

Formulating a value proposition requires collaborative and continuous engagement between manufacturers and customers to maximise mutual value (Wood and Godsiff, 2021). This mutual value can be labelled as *value co-creation* (Aarikka-Stenroos and Jaakkola, 2012; Kohtamäki and Partanen, 2016; O'Cass and Ngo, 2011). Service-Dominant (S-D) logic explicitly states that "the customer is always a co-creator of value" (Vargo and Lusch, 2008: 7). It involves a dialogue process wherein the manufacturer and customer engage in value-creation activities (Rabetino et al., 2015; Sjödin et al., 2020b; Sjödin et al., 2016b). This collaboration leverages the exchange of the manufacturer's expertise and the customer's operational insights, which is critical in delivering outcomes with higher use value aligned with the customer's specific needs. It allows for better exploration of opportunities.

In addition to co-creation, firms often focus on utilising data to develop advanced service offerings, like detecting machine errors or finding patterns in larger datasets that can help improve performance (Jovanovic et al., 2022). Continuous customer engagement in the co-creation process ensures the value proposition is relevant and tailored to their needs. Scholars have examined the practices and

activities to develop value propositions, including customer-centric approaches, tools and techniques, and the involvement of multiple actors, which are further discussed below.

A customer-centric approach is crucial when thinking about AS (O'Cass and Ngo, 2011; Salonen, 2011). Customer-centricity in AS context is defined as "organisation supports the customer directly and works to create, capture and deliver outcomes either at the level of the customers' assets, business processes or business platform"(Baines et al., 2024a: 78). This approach fosters a more sustained and close collaborative relationship with customers, emphasising the alignment of incentives, distribution of responsibilities, and integration of innovation processes.

To achieve this, manufacturers need to have a deeper understanding of their customer base and pain points. This understanding serves as the foundation for designing effective value propositions. Manufacturers need appropriate approaches, tools, and a mindset to co-create value propositions with customers and other stakeholders (Sjödin et al., 2020b). They can organise workshops or brainstorming sessions with customers to generate and refine new service concepts (Iriarte et al., 2023). Research suggests that companies go through the Voice of Customers (VOC) activities with the help of interviews or site visits to understand their pain points, which can lead to new opportunities (Bååt and Jabraouti, 2023; Musson et al., 2019). These approaches can be applied to map and visualise the value proposition with customers and internally within the organisation (Kindström, 2010). By embedding these practices, manufacturers can design highly tailored customer-centric advanced service value propositions that align with customer expectations and desired outcomes. .

The creation and co-creation of value requires the collaboration and involvement of multiple service network actors (Akaka et al., 2013; Grönroos and Voima, 2013; Lusch et al., 2010; Reim et al., 2019; Sörhammar et al., 2021; Zolkiewski et al., 2023), including internal and external stakeholders (Nguyen et al., 2022; Pezzotta et al., 2017). Thus, firms cannot create value on their own. The involvement and collaboration with internal and external stakeholders in the value creation are further discussed in section 2.3.

2.2.2 Value Capture: Pricing Strategies, Revenue Models, Financial Benefits

Value capture refers to the process of securing the return (financial and non-financial) from the value created and distributing those profits among the involved actors within the process (Chesbrough et al., 2018; Dyer et al., 2018; Sjödin et al., 2020a). Chesbrough et al. (2018) argue that value is derived from the provider's ability to capture the value generated by the efforts of other actors in the subsequent phases of the process. Therefore, it is essential to consider how value can be effectively captured in alignment with the value creation process. The literature has widely discussed this alignment of value creation and capture (Eloranta et al., 2019; Foss and Saebi, 2018; Ritala et al., 2013; Sjödin et al., 2020b). In AS, understanding the value capture mechanism is crucial for ensuring that firms can extract a fair return on investment for the value they provide to customers through effective pricing models and strategies.

Firms must develop an effective pricing model that captures value in advanced services, which often differs from traditional product-based pricing. Various pricing models are popular in advanced

services, such as subscription-based (Bressanelli et al., 2018; Meeuwissen et al., 2000), pay-per-use-based (Gebauer et al., 2017; Heinis et al., 2018; Ziaee Bigdeli et al., 2018), or pay-per-outcome-based (Arioli et al., 2024; Baines et al., 2024b; Nguyen et al., 2022).

Subscription-based pricing involves customers paying a recurring fee at regular intervals for access to a product or service (Bressanelli et al., 2018). Customers typically have unlimited access to the product or service during the subscription period. For example, Netflix offers a subscription-based pricing model where customers pay a monthly fee for unlimited access to its streaming platform. Users can watch as many movies and TV shows as they want within their subscription period without additional charges.

Pay-per-use-based pricing involves customers paying based on the extent or amount of their product usage and availability without purchasing the product (Cusumano et al., 2015; Gebauer et al., 2017). The pricing is directly tied to the level of consumption regardless of the outcomes achieved, and customers are charged accordingly. For example, GE utilises a pay-per-use model for its aviation services, charging customers a fixed hourly fee based on the performance of jet engines (Fischer et al., 2012). This model allows customers to pay for the actual usage of the engines.

The outcome-based pricing model involves pricing contingent upon the achievement of the outcome. Customers pay based on the successful attainment of the desired outcome rather than the quantity or duration of usage. So, as discussed in section 2.1.3, AS can be offered in three different forms, taking the example of Xerox's model, where the outcome pertains to a product (a printer), process (a print room), or a business platform (document management). In the pay-per-use model, the customer would be charged based on the quantity of copies produced. Meanwhile, in outcome-based, Xerox could guarantee printing efficiency.

Determining the appropriate pricing for AS is quite challenging in practice. Manufacturers must develop pricing strategies and models to monetise the benefits of AS effectively. It requires continuous engagement with the participating actors in the value creation and capture process. Therefore, the value capture mechanism is pivotal in successfully monetising value created through advanced services.

2.2.3 Value Delivery: Processes, Systems, Infrastructure, and Channels

Value delivery describes how a firm organises its processes and activities to deliver the promised value to the customer (Burström et al., 2021; Parida et al., 2019). While the value creation phase involves co-creating a value proposition to align the customers' needs and expectations, the delivery phase shifts the focus to operationalising the value proposition to deliver the desired outcome. An efficient and effective provision of advanced services requires attention to implement various strategies, each contributing uniquely to the overall service delivery process. These are further discussed in detail below.

Manufacturers must establish a robust *service infrastructure* (Oliva and Kallenberg, 2003), a foundational requirement for an efficient AS provision. Such infrastructure is the backbone for seamless service delivery, facilitating efficient operations and enhancing responsiveness to customer

demands. This infrastructure must exhibit a service culture, physical facilities, effective product modifications, refining business processes to support service integration, digital technologies, deployment of people and skills, and collaboration with external stakeholders (Baines and Lightfoot, 2013a; Baines et al., 2024c; Neely, 2008; Oliva and Kallenberg, 2003; Parida and Jovanovic, 2022; Priya Datta and Roy, 2011; Raddats et al., 2014; Reim et al., 2019; Schroeder et al., 2020; Ziaee Bigdeli et al., 2018) to maintain and monitor service operations.

Service culture is particularly significant when the organisation's strategic focus shifts towards advanced services (Neely, 2008; Salonen, 2011; Story et al., 2017). Story et al. (2017) suggest in their study that senior managers hold the key to promoting cultural change by repositioning the business model among all stakeholders through strategic planning. The study also highlights the significance of identifying and resolving potential obstacles, such as procedural bottlenecks and reward systems, that might impede the implementation and growth of the new service-oriented culture.

Product modifications emerge as a crucial aspect of the successful delivery of advanced services. It involves integrating service considerations into the product design to further develop the products (Baines et al., 2017; Story et al., 2017; Ziaee Bigdeli et al., 2018), enabling ease of maintenance, monitoring and customisation to adapt to evolving customer needs. This strategic approach ensures that products are not merely commodities but enablers of value creation throughout their lifecycle.

Refinement of *business processes* is crucial so that firms can adapt to evolving customer needs, better optimise resource allocation, proactively manage the overall product, and facilitate seamless coordination among service delivery functions (Baines and Lightfoot, 2013a; Gebauer et al., 2012; Ziaee Bigdeli et al., 2018). By doing so, manufacturers can boost operational efficiency and sustain ongoing value creation and capture (Baines et al., 2024c).

Digital technologies emerge as another critical imperative for efficient AS delivery. Various technologies and tools, including IoT, predictive analytics, cloud computing, and several others, act as core enablers for delivering AS (Ardolino et al., 2018; Schroeder et al., 2020). Manufacturers can harness digital innovations to reduce personnel by optimising service operations and enhancing service quality. The integration of these technologies into the service delivery processes extends manufacturers' visibility of their assets, from monitoring to promptly responding to problems (Baines and Lightfoot, 2013a), driving greater value for customers.

Moreover, the *deployment of people and skills* fosters a culture of service excellence, which is indispensable for the effective delivery of advanced services. The necessary skills required may vary depending on the role within the business. Baines and Lightfoot (2013a) in their research suggested a differentiation between front-office and back-office staff deployment in delivering advanced services. For instance, the technical skills of a Condition Monitoring Technician may be more critical to monitoring an occurring fault compared to relationship-building skills for an Account Sales Manager. Investing in personnel with the necessary skills and expertise and introducing various training programs can better align the workforce with the service infrastructure. Section 2.3.2 further

elaborates on the specific roles and involvement of internal stakeholders within the business in advanced services innovation.

Lastly, *collaboration with external stakeholders* is pivotal in delivering desired outcomes in advanced services to customers. Manufacturers must take an open and collaborative approach with partners to provide advanced services to customers successfully (Chesbrough, 2011; Kamalaldin et al., 2021; Parida and Jovanovic, 2022; Randhawa et al., 2018; Reim et al., 2019; Visnjic et al., 2018). By forging strategic partnerships, manufacturers can expand their service offerings and access specialised expertise. The next section (section 2.3) further discusses the specific role and collaboration of service network actors in the value creation, value capture and value delivery process.

In summary, a successful AS provision entails value creation, capture, and delivery processes. The co-creation of value propositions with customers and leveraging collaborative partnerships are essential for designing outcomes that meet evolving needs. The alignment of the value capture mechanisms ensures the effective monetisation of AS for businesses. Manufacturers can foster strategic partnerships that enhance their capabilities, which ensure an efficient and effective provision of advanced services, driving value creation and customer satisfaction.

2.3 Service Network Actors: Manufacturer, Customer, Distributor, and Technology Supplier

The previous section looked at how value is created, captured, and delivered in the context of Advanced Services (AS) by emphasising the significance of co-creation, pricing strategies and several elements required to deliver advanced services. Value creation and delivery in advanced services rely heavily on the collaboration and coordination of a range of Service Network Actors (SNA). Manufacturers, customers, technology partners, distributors, and other stakeholders play essential roles in co-creating, capturing, and delivering value throughout the service lifecycle. Understanding how these actors interact and collaborate is critical for optimising service performance, enhancing customer satisfaction, and driving the success of advanced services in the market. This section discusses the specific role of internal and external stakeholders and their collaboration to provide AS successfully.

2.3.1 Global Service Network

Prior studies have viewed networks through various lenses, such as value networks (Lusch et al., 2010), business networks (Hedvall et al., 2019), service systems (Brozović and Tregua, 2022; Ng et al., 2012), service networks (Gebauer et al., 2013; Weigel and Hadwich, 2018), and service ecosystems (Vargo and Akaka, 2012). While these concepts have distinct foundations, the literature also indicates a degree of overlap and interchangeability in their use (Brozović and Tregua, 2022; Sawatani, 2019).

“A value network is a spontaneously sensing and responding spatial and temporal structure of largely loosely coupled value proposing social and economic actors interacting through institutions and technology, to: (1) co-produce service offerings, (2) exchange service offerings, and (3) co-create

value" (Lusch et al., 2010: 20). "A service system is a network of agents and interactions that integrate resources for value co-creation" (Ng et al., 2012: 417). "A service ecosystem is a relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange" (Vargo and Akaka, 2012: 207). "Business networks are characterized by reciprocal relationships of more than two firms. These business networks represent an intermediary organizational form between market transactions and vertical integration" (Weigel and Hadwich, 2018: 255). A service network is a loosely connected group of upstream suppliers, downstream market channels, and additional service providers (Basole and Rouse, 2008; Gebauer et al., 2013).

This study employs the term 'service network' in the context of advanced services, as it best captures the collaborative relationships between different actors and establishing a global service network essential for servitization (Shipilov and Gawer, 2020; Williamson and De Meyer, 2012). Successful servitization requires manufacturers to collaborate with these service network actors (SNA) in value co-creation processes (Akaka et al., 2013; Grönroos and Voima, 2013; Ranjan and Friend, 2020; Sklyar et al., 2019b; Zolkiewski et al., 2023) and to facilitate the effective delivery of advanced services to customers (Chesbrough, 2011; Kamalaldin et al., 2021; Parida and Jovanovic, 2022; Randhawa et al., 2018; Visnjic et al., 2018). This global service network comprises various actors, which can be internal or external to the organisation (Poeppelbuss et al., 2022). The term "actor" refers to any participant in actor-to-actor exchanges creating mutual value (Vargo and Lusch, 2016). These actors involve manufacturers, customers, suppliers, partners, and distributors, extending beyond the organisational boundaries of manufacturers (Kothandaraman and Wilson, 2001; Parida et al., 2015; Reim et al., 2019; Sakao et al., 2009a).

Studies have highlighted the alignment of the global service network (Parida and Jovanovic, 2022) while also providing insights into the specific roles of network actors in advanced services. For instance, scholars have identified various dimensions of role differentiation based on the context, such as value creation processes in the provider sphere, partner sphere, and joint sphere (Grönroos and Voima, 2013), delivering services through internal (in-house), external partners or both (hybrid) (Kowalkowski et al., 2011) internal and external alignment, i.e. customer and service supplier network (Alghisi and Saccani, 2015), internal (manager, manufacturing and maintenance staff) and external stakeholder (customers and suppliers) engagement in AS (Nguyen et al., 2022).

In the present study, Service Network Actors (SNA) in advanced services are classified as internal stakeholders (within the manufacturer's organisation) and external stakeholders (customers, suppliers, and distributors). The joint efforts and coordination of these stakeholders within the network are essential for mutual value creation, capture and delivery of AS. These stakeholders' groups provide a framework for understanding their respective roles and interactions within the global service network, which will be further discussed in detail in the following sections.

2.3.2 Internal Stakeholder Collaboration

The significance of internal stakeholders has been highlighted in the service innovation literature. Internal stakeholders "bring different knowledge and competencies to the innovation process which could facilitate creativity, learning and knowledge development for innovation" (SChILLING and Werr, 2009: 32). Organisation-wide integration, engagement, and mobilisation of internal stakeholders from different departments (cross-collaborations) are promoted through service innovation (Fay et al., 2006; Hull, 2003). Scholars in servitization literature have recently begun to focus on internal employee integration and their involvement in various service functions.

The engagement and involvement of internal stakeholders entail significant importance in advanced services. Internal stakeholders hold customer proximity (Kreye et al., 2015; Vandermerwe and Rada, 1988), facilitating close interaction to understand their specific needs better. They encompass service-centric capabilities (Sampson and Froehle, 2006), allowing them to manage various service functions effectively. Additionally, their extensive technical and engineering knowledge (Baines et al., 2013) helps keep up with evolving technological trends. Internal employee buy-in and engagement are core enablers in the servitization strategy (Pana and Kreye, 2023).

Firms can leverage the employees' involvement and expertise, which helps in the value-creation process (Andreassen et al., 2016; Solem et al., 2022; Steen et al., 2011) and effectively delivers value-driven outcomes to the customers (Baines et al., 2013; Boukis, 2019; Gummerus, 2013; Vargo and Lusch, 2004). Internal stakeholders must engage and accept value propositions (Ballantyne and Varey, 2006). This step marks a significant milestone in the overall value creation process (Frow et al., 2014), serving as an initial juncture to secure buy-in from internal stakeholders regarding the envisioned value to be developed and delivered. Therefore, playing a critical role in evaluating the feasibility and practicality of advanced services within the existing organisational framework.

A few studies have looked at the internal stakeholder perspective in servitization. For instance, an internal ecosystem view in AS (Baik et al., 2019; Hullova et al., 2019; Sklyar et al., 2019b), the importance of internal stakeholders in value creation and co-creation (Boukis, 2019; Pezzotta et al., 2017), service capabilities development for internal employees (Jovanovic et al., 2019; Pagoropoulos et al., 2017; Valtakoski and Witell, 2018), skills and deployment of people for an effective advanced services delivery (Baines et al., 2013), and the internal employee integration and responses to service transition (Pana and Kreye, 2023). The active participation of internal stakeholders and their early input helps identify additional service opportunities that align with the firm's strategic objectives.

Despite the proven benefits of internal stakeholders' involvement, research shows only isolated cases of their integration and broader perspective on AS. The involvement of internal stakeholders in the early AS process allows their expertise to be leveraged from the beginning, but this has yet to be fully explored. The following section explores the collaboration and role of external stakeholders in advanced services.

2.3.3 External Stakeholder Collaboration

As previously indicated, advanced services value propositions are more focused on bringing value to the customers' business operations; nevertheless, a sole focus on the manufacturer limits the depth in which the phenomenon can be explored. Arguably, focusing only on the manufacturer can contribute to development but less to delivering AS. Therefore, the collaboration of manufacturers with external stakeholders such as customers, partners, suppliers, and distributors plays a pivotal role in both co-creation and value delivery processes (Parida et al., 2015; Reim et al., 2019; Sakao et al., 2009a). This study examines manufacturers' collaborations with individual actors, including *customers, technology suppliers, and distributors* within the service network, to understand their integration and specific roles in advanced services.

Manufacturer-customer collaboration

Research on advanced services emphasises collaboration and interdependencies between manufacturers and customers in co-creating value propositions (Vaittinen and Martinsuo, 2019; Windahl and Lakemond, 2010). Customers are no longer passive recipients but proactive participants in the value co-creation process (Agrawal and Rahman, 2015; Marco-Stefan Kleber and Volkova, 2017; Payne et al., 2008; Pinho et al., 2014). They are critical in co-creating the advanced services value proposition and are involved in the process rather than just collaborating (Lenka et al., 2017; Sjödin et al., 2016b). Furthermore, firms can develop compelling value propositions that rely on customer input (Vargo and Lusch, 2008). Manufacturers can leverage customer involvement to better understand their needs and expectations (Hakanen et al., 2017), enabling them to effectively tailor advanced service offerings.

Scholars have highlighted the significance of customers as value co-creators and providers as value facilitators (Ruiz-Alba et al., 2019; Vargo and Lusch, 2008). Through a dialogue process, both manufacturer and customer engage in co-creational activities (Sjödin et al., 2020b; Sjödin et al., 2016b), contributing their expertise, knowledge, and ideas to the design and customisation of advanced services. Carbonell and Rodriguez-Escudero (2014) underscored the significance of customer involvement and leveraging customer data in new service development. Moreover, AS require a high degree of value co-creation with customers, which in turn creates a positive influence on servitization (Ruiz-Alba et al., 2019).

Extensive research has been conducted on the benefits of involving customers in the value-creation process of advanced services. Also, high emphasis has been placed on engaging customers throughout the entire service lifecycle, from ideation to implementation (Vargo and Lusch, 2008). This ensures effective value creation and delivery. Despite the proven benefits of the manufacturer and customer collaboration in value creation, most studies focus on the manufacturer's perspective, and only a few have been seen through the customer lens (Sjödin et al., 2017; Tuli et al., 2007; Windahl, 2015). It becomes critical to understand how customers respond to manufacturers on advanced services and their collaboration in the entire value creation and delivery process. Additionally, there

is a need for researchers to focus on capturing customer insights, as well as their opinions and preferences in advanced services.

Manufacturer- supplier collaboration

A growing body of research indicates that manufacturers' effective transition to providing advanced services depends not only on their own capabilities but also on their ability to collaborate with suppliers and partners such as technology suppliers within the global service network (Parida and Jovanovic, 2022; Randhawa et al., 2018). These technology suppliers could be software providers, cloud platform providers, or data integrators (Momeni et al., 2023a).

Advanced services necessitate precise measurement of outcomes and performance, often entailing real-time monitoring and control of products (Kohtamäki et al., 2019b). To achieve the desired outcome, organisations deploy advanced technologies and systems capable of offering comprehensive and continuous product monitoring (Baines and Lightfoot, 2013b). Various technologies, such as machine learning (Cong et al., 2022), the Internet of Things (IoT) (Schroeder et al., 2020), big data analytics and cloud computing (Gaiardelli et al., 2021), are all enablers of advanced services (Iriarte et al., 2023). For this, manufacturers establish long-term partnerships with external technology suppliers that offer and integrate these advanced technologies to measure outcomes in real-time and reduce operating costs. This study uses the term technology supplier instead of partner, as firms often do not establish partnerships in the early phases of AS.

Recently, a few studies have focused on the technology supplier perspective within servitization. For instance, Ferreira and Lind (2023) characterised three distinct supplier interfaces between manufacturers and IoT technology suppliers involved in digital servitization in their study. Rapaccini et al. (2023) investigated challenges in the digital servitization journey of SME firms and the contributions of knowledge-intensive business firms from the perspective of manufacturers and technology suppliers. The inter-firm collaborative configurations help to understand how the ecosystem actors, involving service and technology suppliers, interact with the manufacturer in digital servitization (Dalenogare et al., 2023). Smania et al. (2024) identified paradoxical tensions in the digital servitization ecosystem from a technology supplier perspective due to their significance in delivering smart solutions.

Despite the growing recognition of the significance of technology suppliers in servitization and advanced services, the existing literature remains limited in fully capturing their perspective. While the aforementioned studies provide valuable insights into the roles and challenges faced by technology suppliers, they need to examine these actors' unique dynamics and contributions within the context of advanced services. This underscores the need for further research to better understand the technology supplier's perspective on AS.

Manufacturer-distributors collaboration

Distributors play a critical role as intermediaries, serving as a bridge between manufacturers and end customers (Hullova et al., 2019; Reim et al., 2019) in the global service network. Customers are

increasingly demanding integrated, customised products and services that meet their complex needs, which in turn puts pressure on distributors to evolve and adapt to these changing customer demands (Hakanen et al., 2017; Parida et al., 2014). This increases manufacturers' dependence on distributors to reach and serve their target market effectively (Vázquez et al., 2005). Therefore, manufacturers and distributors must collaborate to facilitate the successful provision of advanced services to the end customers (Parida and Jovanovic, 2022).

Distributors often have a deeper understanding of specific customer needs because of their proximity to the customers' business (Hullova et al., 2019). This insight into customer needs enables distributors to provide valuable feedback and insights to manufacturers, helping them tailor their advanced services more effectively to meet customer requirements. In addition, distributors possess the expertise and resources needed to market and promote AS to end customers. Their knowledge of local market dynamics and customer preferences gives them a unique advantage in effectively positioning and selling these AS. This collaboration between manufacturers and distributors is crucial for leveraging their respective strengths and capabilities to achieve mutual success within the context of AS.

Studies have highlighted the role of distributors, who are often regarded as either manufacturer-owned or independent and operate as separate entities from manufacturers in facilitating the adoption and distribution of advanced services in the market (Hakanen et al., 2017; Hullova et al., 2019). The exchange of information and expertise between manufacturers and distributors can improve the design and provision of services (Baines et al., 2009). There are only a few studies that focus on the perspectives of distributors in servitization. These studies do not provide the viewpoint of distributors and their role in developing manufacturers' AS. This indicates the need for further research in this area.

In summary, this section emphasises the importance of global SNA, distinguishing between internal and external stakeholders. Each plays a crucial role in creating and delivering value in the service network. The section highlights the collaboration between manufacturers and these actors in AS. The following section describes the concept of uncertainty and its significance in this study.

2.4 Uncertainty in Advanced Services: Definition, Terminology, and Typology

This section explores uncertainty in advanced services, covering its concept, definitions, typologies and implications. This comprehensive overview provides an understanding of uncertainty and its relevance to the present study.

2.4.1 Uncertainty: Definition and Concept

Uncertainty has been defined in various ways in the academic discourse. Scholars have described it using related terms such as 'risk', 'conflict', 'ambiguity', 'equivocality', and 'turbulence' (Ibrahim et al.,

2022; Lipshitz and Strauss, 1997). Table 3 below lists some prominent definitions of uncertainty in the servitization literature.

Table 3: Definitions of uncertainty in servitization context

Definition	Context	Sources
the difference between the amount of information necessary to perform a task and the amount of information already available within the organization (Galbraith, 1974)	Antecedents and consequences of project communication during the new financial service innovation process	Lievens and Moenaert (2000: 49)
State of deficiency of information related to a future event	Addressing uncertainties of PSS for service development oriented towards value chain	Sakao et al. (2009b: 139)
any deviation from the unachievable ideal of completely deterministic knowledge of the relevant system (Walker et al., 2003)	Understanding sources of service uncertainties in cost estimation for an industrial PSS	Erkoyuncu et al. (2011: 1225)
availability of reliable information and knowledge when making an assessment of the future (Bernstein and Bernstein, 1996)	Uncertainty identification at the bidding stage of service contracts for industrial service delivery	Erkoyuncu et al. (2013: 6297)
the difference in the amount of information that is required to perform a task and the amount of information already possessed by the firm (Galbraith, 1974)	Mitigation of uncertainties of industrial service provision by supply chain	Durugbo and Erkoyuncu (2016: 532)
the lack of knowledge which arises from not definite, not known or not reliable information	Understanding uncertainty exposure in servitized triads and reduction strategies through organisational response	Kreye (2017a: 1722)
a potential deficiency in any phase or activity of the process, which can be characterized as not definite, not known or not reliable **(**Kreye et al., 2012)	Identification of uncertainty criticality arising during engineering (ES) service development at different supplier co-creation modes	Ramirez Hernandez and Kreye (2021: 410)

The definition of uncertainty is contingent upon its interpretation (Anderson et al., 2019; Van't Klooster and Veenman, 2021) within a specific context or situation (Thunnissen, 2003; Van Der Sluijs et al., 2005). Therefore, for the present research, **uncertainty** refers to "*the lack of knowledge (in any phase or activity) which arises from not definite, not known or not reliable information*" (Kreye, 2017b: 363). This definition is widely recognised and accepted in servitization literature.

The concept of uncertainty cuts across diverse disciplines. Its significance has been highlighted across domains such as engineering (Agrawal and Seshadri, 2000; Ayyub and Klir, 2006; Greves and Schreiber, 1995), environmental science (Linder and Williander, 2017; Millar et al., 2007), economics and finance (Al-Thaqeb and Algharabali, 2019; Dixit and Pindyck, 1994), psychology (Carleton, 2016; Tiedens and Linton, 2001), business and management (Lee, 2002), and several others. Within the area of business and management, uncertainty has been studied in strategy (Kaplan, 2008), operations (Lee and Dong, 2009), organisational behaviour (Bordia et al., 2004; Galbraith, 1974), entrepreneurship (McMullen and Shepherd, 2006), and innovation (Teece et al., 2016).

While the concept of uncertainty has long been studied in various fields, its application and exploration in the context of services and servitization have gained attention relatively recently (Durugbo and Erkoyuncu, 2016; Kreye, 2017b; Ramirez Hernandez and Kreye, 2021; Rexfelt and

Hiort af Ornäs, 2009; Vinhas, 2023; Xiao and Yang, 2008; Zhang et al., 2020). Mainly, studies have looked at the strategies to identify and mitigate/reduce/manage uncertainties. Advanced services guarantee the delivery of outcomes, and the revenue payments are based on the usage of the products, which introduces layers of complexities for manufacturers (Sousa and da Silveira, 2019; Ziaee Bigdeli et al., 2018). Kreye (2018) argued that complexity gives rise to uncertainty. The present study focuses on uncertainty due to its significance in services and its fundamental role in driving organisational behaviour (Galbraith, 1974) which is a critical aspect in servitization and advanced services.

It has been argued that uncertainty is higher in advanced services compared to base or intermediate services (Hypko et al., 2010). Specifically, “the degree of uncertainty is higher when the chain of events is longer, like in the first stages of the development process; conversely, the degree of uncertainty is lower in the final stage of the process, the chain of events being shorter” (Leotta et al., 2020: 616). Moreover, it has been argued that uncertainty requires the necessary knowledge or an estimate of the information (Leotta et al., 2020), which cannot be predicted in AS from the perspective of network actors.

2.4.2 Terminologies: Uncertainty, Risk, Complexity and Challenge

The literature typically addresses 'risk,' 'complexity,' 'uncertainty,' and 'challenge' as related concepts, yet views them from distinct and complementary perspectives. For instance, the terms 'uncertainty' and 'risk' have frequently been used interchangeably or perceived as related concepts. Some researchers have made efforts to differentiate the two concepts (Faro and Rottenstreich, 2006; Samson et al., 2009; Thunnissen, 2003). There has been a distinction where ‘risk’ pertains to situations involving measurable probabilities, whereas 'uncertainty' involves scenarios lacking such quantifiable metrics (Faro and Rottenstreich, 2006). It has been argued that uncertainty gives rise to risk (Samson et al., 2009). This shows that uncertainty and risk are two different concepts. The present research focuses on uncertainty over risk due to its critical role in decision-making processes in advanced services and its wide recognition in the servitization literature for over two decades now.

The terms ‘uncertainty’ and ‘challenge’ have been used interchangeably or closely related concepts. There hasn't been a direct distinction made between uncertainty and challenge. While uncertainty refers to a lack of knowledge or not known information, challenge refers to ‘(something of being faced with) something that needs great mental or physical effort to be done successfully and therefore tests a person’s ability’ (Dictionary, 1995). Uncertainty is more focused on a situation's unknown and unpredictable nature, while challenge is about obstacles or hardships. Uncertainty may become a challenge at later stages of a process when it requires action or decision-making. For example, when faced with uncertainty, individuals or organisations may need to navigate challenges to make informed decisions or take practical actions. Furthermore, uncertainty and challenge can interact with each other.

Servitization introduces new layers of complexity which gives rise to uncertainty for firms (Ziaee Bigdeli et al., 2017). The complexity in servitization means that firms often need to make decisions

in non-linear, evolving, heterogeneous and emerging contexts (Nilsson and Darley, 2006; Wasserbaur et al., 2024). Complexity usually stems from the interdependencies of multiple factors within a system, whereas uncertainty arises from the lack of knowledge of those interdependencies. Therefore, in the AS context, complexity introduces uncertainty, as discussed in the previous section. However, scholars primarily focus on the challenges, strategies or capabilities in providing advanced services (Gebauer et al., 2017; Parida et al., 2015; Reim et al., 2019; Selviaridis and Norrman, 2015; Zolkiewski et al., 2023). Uncertainty in advanced services is yet to be fully understood. The current research does not aim to view a challenge, risk or complexity as uncertainty; instead, it acknowledges that uncertainty can lead to challenges.

2.4.3 Typologies of Uncertainties

The literature suggests different ways to classify uncertainties. Research on uncertainty frequently focuses on uncertainty typologies as a basis for developing decision-support tools. Yet, there is no universally accepted typology. One of the most common classifications in decision-making literature proposed by Walker et al. (2003) is based on different dimensions, mainly *nature* of uncertainty (epistemic and aleatory), *level* of uncertainty (from deterministic to total ignorance) and *source* of uncertainty (application in the model). In the context of servitization, several scholars have derived their own classifications in the specific research context, often grounded in Walker's dimensions. Table 4 presents some prominent examples of these classifications in servitization literature.

Table 4: Typologies of uncertainties in servitization literature

Typologies/Categorisation	Rationale for Classification	Source
Customer uncertainty Competitors uncertainty Resources uncertainty Technology uncertainty	classification based on sources	Lievens and Moenaert (2000)
Knowledge Uncertainty Variability Uncertainty	classification based on the nature (Meijer et al., 2006)	Rexfelt and Hiort af Ornäs (2009)
Demand Uncertainty Supply Uncertainty	classification based on context (i.e., service delivery system)	Erkoyuncu et al. (2011)
Need Uncertainty Process Uncertainty Outcome Uncertainty	classification based on context (i.e. customer specific needs, co-creation process, and the performance outcome)	Ulaga and Kohli (2018)
Organisational Uncertainty Relational Uncertainty Environmental Uncertainty	classification based on sources	Kreye (2017a)
Organisational Uncertainty Relational Uncertainty Technological Uncertainty Environmental Uncertainty	classification based on sources within the context of management and services	Kreye (2018)
Organisational Uncertainty Relational Uncertainty Technical Uncertainty Resource Uncertainty Environmental Uncertainty	classification based on sources within ES context	Ramirez Hernandez and Kreye (2021)

Researchers often adapt uncertainty classifications to fit the specific context or practical application of their studies, leading to some typologies that are more generic and others that focus on specific

areas of uncertainty. Given the complexity of AS and the diverse nature of uncertainties they present, this research adopts a widely adopted classification based on emerging sources of uncertainty (Kreye, 2017a; Walker et al., 2003). In this context, sources refer to the origins or causes of uncertainty, which can stem from various actors, activities, or processes involved in creating, capturing, and delivering value. These sources are the underlying factors that contribute to the unpredictable or unknown elements within advanced services.

Typically, it has been argued that uncertainty tends to be higher in advanced services compared to base and intermediate (Hypko et al., 2010; Kamp, 2021). This higher level of uncertainty in advanced services can be attributed to various factors, including the complexity of integrating products and services (Mourtzis et al., 2018), the evolving needs for customisation and personalisation (Jovanovic et al., 2023; Mourtzis, 2016), the dynamic nature of customer needs and expectations (Benedettini and Neely, 2018; Zou et al., 2018), the reliance on technology and digitalization (Schroeder et al., 2020; Sklyar et al., 2019a), increased competition (Zolkiewski et al., 2023), and involvement of service network actors (Parida and Jovanovic, 2022). Based on these, four types of uncertainties can be further investigated in the AS context: *organisational, relational, technical,* and *environmental*. These are discussed below in the following sections.

Organisational Uncertainties

Organisational uncertainty refers to "the lack of understanding of firm resources by organisational members, which results in variations in organisational effectiveness and efficiency over time" (Kreye, 2022: 35). These resources can include equipment, capabilities, processes, knowledge flow, people, facilities, and others (Erkoyuncu et al., 2011). Organisational uncertainty emerges from within the organisation. It has been highlighted as the core challenge for manufacturers and one of the root causes for failure in servitization (Valtakoski, 2017). Organisational uncertainty tends to be higher in the start-up phase (Kreye, 2019), as firms often lack internal capabilities (Galbraith, 1974) and required knowledge and expertise in the development of advanced services.

It is clear from the definition what belongs to the organisational uncertainty type, and scholars have investigated various organisational uncertainties in the context of servitization and Engineering Services (ES)[1] that are internal to manufacturers. For instance, lack of understanding to define new functions and processes, reorganising internal structures, formulation of pricing strategies for new services, cost-conscious culture (Ramirez Hernandez and Kreye, 2021, 2022), job rotations and redefining roles (Kreye, 2018). Building on this foundation, internal resistance from sales and service departments, as well as constraints related to resource availability and understanding of execution processes, have also been identified as core organisational uncertainties. The transition towards a

[1]Engineering services (ES) are placed in the intermediate service type within the staircase model based on the case descriptions in the papers

new service provision culture (Fliess and Lexutt, 2019; Ng et al., 2013) has been highlighted as a core uncertainty. The lack of knowledge and skills to design an adequate level of service agreements (Harland et al., 2005) is due to the complexity of contractual agreements for advanced services. Certainly, these organisational uncertainties can interrupt manufacturers' development of services.

In the present research, organisational uncertainties will be examined based on the following facets: 1) organisational structure (Nudurupati et al., 2016) and change (O'Connor and Rice, 2013), 2) unfamiliar operational conditions (Arnold and Quelch, 1998), 3) processes and strategies (Nudurupati et al., 2016), 4) resources (Benedettini et al., 2015), and 5) organisational dynamism (Benedettini et al., 2015). By following this approach, organisational uncertainties can be differentiated from other uncertainty types.

Relational Uncertainties

Relational uncertainty refers to the 'inability to predict or explain partners' actions' (Kreye, 2017b: 366) in the service context. It stems from the lack of knowledge surrounding how the partner will behave or make decisions, such as changes in their priorities, strategies, conflicts, or level of commitment (Knobloch and Solomon, 1999) within the service relationship. As discussed in section 2.2, AS requires close collaboration with various network actors (Grönroos and Voima, 2013; Lusch et al., 2010; Parida and Jovanovic, 2022). Dependency and continuous engagement with customers, distributors, technology, and service providers are critical to the creation and delivery of advanced services (Reim et al., 2019). Additionally, the unpredictability due to the lack of trust between partners (Gölgeci et al., 2021) and the differences in the integrations of various partners (Li et al., 2023) is emphasised in the servitization literature. This close and dynamic inter-organisational relationship in advanced services (Story et al., 2017) leads to relational uncertainty.

Scholars have explored relational uncertainties in dyadic (Kreye, 2017b; Ramirez Hernandez and Kreye, 2021) and triadic (Kreye, 2017a) relationships in the servitization context. For instance, high relational uncertainty is observed during the initial stages of service interactions between manufacturers and customers (Kreye, 2017b). The author also highlighted the unidirectional nature of relational uncertainty in service dyads due to a lack of trust in sharing information from both ends. Ramirez Hernandez and Kreye (2021) highlighted how managing the coordination within the larger supplier network and the gap in the supplier capabilities led to high relational uncertainty for manufacturers in engineering services (ES) development. In advanced services, it becomes imperative to understand the relational uncertainties due to the high dependency on global service network actors.

Relational uncertainty will be examined based on the facets of 1) interdependency between manufacturer and customer (Kreye, 2019), 2) trust and commitment from partner (Kreye, 2017a), 3) interrelationship and involvement of multiple stakeholders (Hou and Neely, 2018), and 4) variation in customer demands (Hou and Neely, 2018).

Technical Uncertainties

Technical Uncertainty can be defined as a lack of knowledge surrounding significant changes in technologies (maturity and application) (Reim et al., 2020) and data (Durugbo et al., 2010; Hou et al., 2013) in product and service attributes. It is often used interchangeably with technological uncertainty. In the context of servitization, scholars have mainly examined technical uncertainty in relation to the use or integration of new technologies (Bhatti et al., 2024; Kreye, 2019). Firms often lack understanding in terms of what data is available (Erkoyuncu et al., 2011), whether the available data is accurate for the purpose, or the quality and reliability of the data (Huijbregts et al., 2001). Therefore, this study expands the scope of technical uncertainty from just technologies to understanding data-related uncertainties.

Technical uncertainty may arise from interactions of multiple technologies in the delivery of advanced services (Baines and Lightfoot, 2013b) and the use of technologies within the operational setup (Reim et al., 2016). The changes in manufacturers' capabilities such as expanding their technological infrastructure to facilitate data processing, analysis and interpretation to improve service performance (Ardolino et al., 2018; Ulaga and Reinartz, 2011)) can lead to technical uncertainty. Technical uncertainty has been studied in the context of servitization and ES development. For instance, Kreye (2018) argued that technical uncertainty is higher in performance-based services than in maintenance services. It arises from the manufacturers' dependency on performance monitoring and interactions with product technologies. Technical uncertainty can relate to the integration of product and service elements, lack of engineering knowledge to accurately measure the asset performance, and scoping of the services due to high customisation (Ramirez Hernandez and Kreye, 2022). Furthermore, Bustinza et al. (2022) proposes that both internal and external sources can lead to technical uncertainties. Externally, it can result from technological changes in the surrounding environment. In contrast, internally, it mainly arises from disparities between manufacturers' current technological capabilities and the required capabilities for product service innovation. However, technical uncertainty has not been examined extensively in the advanced services context, and current insights are mainly limited to technologies.

As discussed, technical uncertainties are linked to both technologies and data. Therefore, the present study examines it based on the following factors: 1) technological advancements (Reim et al., 2016), 2) interactions of new technologies with products (Melander and Lakemond, 2015), 3) ability to capture and interpret data from assets (Durugbo et al., 2010), and 4) development of product technologies.

Environmental Uncertainty

Environmental uncertainty can be defined as the lack of information surrounding changes or variability in the external environment of the organisation (Tung, 1979). The external environment comprises various factors, including competitors, legal regulations, changes in the markets, and availability of supply (Kreye, 2019). The degree of environmental uncertainty significantly influences organisations' intangible resources (Cheng and Krumwiede, 2017). Intense competition in the service

sector presents customers with numerous options (Wang et al., 2011) which in turn puts high pressure on manufacturers to further develop their offerings to stay competitive.

Environmental uncertainty has been examined by a few studies in the servitization literature. For instance, Ramirez Hernandez and Kreye (2022) their paper reflects on environmental uncertainty as a result of reluctance to share data due to legal settings, variations in the ownership rights affecting global service providers, and existing competitors' offerings in ES development. Zhang et al. (2020) in their study highlighted environmental uncertainty affects manufacturers' strategies and ability to transform towards servitization mainly due to external technological turbulence and increasing demand. It has also been argued that environmental uncertainty tends to be higher in servitized triads due to the cross-national setup for service provision (Kreye, 2017a).

As the literature points out, the current research will examine environmental uncertainty following these factors: 1) competition (Kreye, 2019; Ramirez Hernandez and Kreye, 2022), 2) legal regulations (London and Hart, 2004), 3) cross-country setup (Kreye, 2017a), 4) market fluctuations (Hypko et al., 2010), 5) supply availability (Chao et al., 2009) and 6) network actors' external environment.

The following section reviews the literature to identify specific gaps and formulate research questions for the present study.

2.5 Research Gap and Research Questions

The literature review provided a comprehensive understanding of AS (section 2.2), significance of SNA (section 2.3) and uncertainties (section 2.4). This section focuses on analysing the literature to identify specific gaps concerning uncertainties (section 2.4) and SNA perspective (section 2.3) in advanced services.

Existing research on uncertainty in advanced services

Uncertainty has been gaining increasing attention in the servitization literature, as discussed in section 2.4. Extant studies have focused on identifying various uncertainties or uncertainty types and mitigation strategies. Scholars have looked at uncertainties in different contexts, as shown in Table 5. For instance, Erkoyuncu et al. (2011) and Erkoyuncu et al. (2013) in their study have investigated uncertainties in industrial PSS cost forecasting and service delivery. Durugbo and Erkoyuncu (2016) focused on identifying strategies to mitigate uncertainties in industrial service operations. Furthermore, Zhang et al. (2020) analysed cost-benefit aspects of servitization under varying levels of environmental uncertainties and Ramirez Hernandez and Kreye (2021) examined uncertainties in different supplier co-creation modes within ES development. However, these studies predominantly do not specifically distinguish uncertainties based on the types of services.

Despite these contributions, there is a lack of comprehensive exploration of uncertainties specific to AS. This is because advanced services are inherently more complex than traditional PSS offerings (Kamp and Parry, 2017; Reim et al., 2015) as they require extensive customer interaction, an integrated network of actors (Kowalkowski et al., 2011; Story et al., 2017; Zolkiewski et al., 2023), advanced technologies and tools (Baines and Lightfoot, 2013b; Vaittinen et al., 2018), and several

other factors. This lack of focus on AS represents a critical gap in the literature, as advanced services involve a higher level of uncertainty that may differ from those in traditional servitization or PSS.

Service network perspective on advanced services

Another significant gap involves a network perspective on uncertainties in advanced services. Previous research has primarily focused on uncertainties at the individual firm level, within dyadic relationships such as between manufacturers and customers, or triadic relationships such as manufacturers, customers and suppliers. In dyadic manufacturer-customer interaction, relational uncertainties in service dyads in implementing service strategy (Kreye, 2017b), and the effect of service complexity on uncertainty during service operations in ES (Kreye, 2019) have been examined. While there have been a few studies exploring triadic relationships, these studies are limited and do not specifically address AS. For instance, Kreye (2017a) identified uncertainties and organisational responses in triadic service relationships.

As shown in Table 5, the literature lacks a comprehensive exploration of uncertainties from a broader network perspective (Erkoyuncu et al., 2011), particularly those involving multiple interconnected internal and external stakeholders such as customers, distributors, and technology suppliers (section 2.3). Moreover, the sources and effects of uncertainties vary significantly depending on the actors involved (Grote, 2009). Recently, Wang et al. (2023b) in their study further emphasised the need for research to understand the uncertainties faced by multiple actors in servitization, identifying this as an underexplored area. Understanding these uncertainties from the perspective of multiple actors in the service network is crucial in advanced services. These services typically require a high level of coordination and integration across the entire service network. This shows a significant gap in the literature, reinforcing the need to examine uncertainties from a network perspective in advanced services.

Table 5: Comparison of research on uncertainty across different network actors

Note: The table indicates that the existing research has not extensively looked at uncertainty in advanced services from a broader network actors' perspective

Actors	Context	Service Type[2]	Sources
Manufacturer	Cost forecasting, service delivery, supplier co-creation, ES development, cost-benefit analysis, and competitive bidding	Base, Intermediate, and Advanced Services (Availability)	Erkoyuncu et al. (2011), Erkoyuncu et al. (2013), Durugbo and Erkoyuncu (2016); Kreye et al. (2014), Ramirez Hernandez and Kreye (2021), Zhang et al. (2020), Ramirez Hernandez and Kreye (2022)
Dyad Manufacturer-Customer	Relational uncertainty, service complexity, uncertainty interaction and inter-organisational relationship	Base, Intermediate, and Advanced Services (Availability)	Kreye (2017b), Kreye (2018), Kreye (2019), Kreye (2022)

[2] The service classifications in Table 5 are interpreted based on the categorization within the referenced articles to align with the present study and may not precisely match their usage.

Triad Service Provider (Supplier)- Manufacturer (Buyer)- Customer	Effects of service complexity on uncertainty in ES	Intermediate Services	Kreye (2017a)
Network Technology supplier- Manufacturer- Distributor- Customer	***No Research***		

Implications of uncertainty when innovating advanced services

While it is critical to identify and understand uncertainties in AS, it is equally important to examine how these uncertainties impact AS innovation. The existing servitization literature primarily focuses on identifying uncertainties and proposing mitigation strategies. However, there is a limited exploration of their direct impact on operational and strategic aspects of service implementation. For example, Ahmet Erkoyuncu et al. (2014) developed a framework to manage the impact of uncertainty on cost at the bidding stage of product-service availability. Similarly, Ramirez Hernandez and Kreye (2021) explored the criticality of different uncertainty types in ES development. Understanding the implications of uncertainties is crucial because it shows how different uncertainties can influence the processes and overall strategic planning. Despite the acknowledged importance of managing uncertainties, there is a scarcity of research that explicitly examines the implications of these uncertainties when innovating advanced services. Therefore, there is a significant gap in the literature regarding the implications of uncertainties when innovating advanced services.

To bridge the identified gaps in the literature, this research aims to examine how uncertainties impact internal and external stakeholders when innovating advanced services. In order to address the gaps, three research questions are proposed:

RQ1: What uncertainties arise for internal stakeholders of a manufacturing firm when innovating advanced services?

RQ2: What uncertainties arise for external stakeholders of a manufacturing firm when innovating advanced services?

RQ3: What are the likely implications of these uncertainties for internal and external stakeholders of a manufacturing firm when innovating advanced services?

By focusing on internal stakeholders, RQ1 examines the uncertainties encountered within the manufacturing organisations. RQ2 shifts the focus outward, identifying the uncertainties external stakeholders, such as customers, distributors, and technology suppliers, face when engaging in advanced services. Finally, RQ3 seeks to understand the implications of these uncertainties for internal and external stakeholders. Collectively, these research questions aim to provide a holistic understanding of the uncertainties influencing the innovation of advanced services.

2.6 Summary

This chapter provided the contextual background of advanced services and the role of SNA, as well as details the concept of uncertainty in advanced services. It begins by providing a brief overview of the concept of servitization in section 2.1, followed by service classification and introducing AS with different examples from the literature.

Section 2.2 discusses the mechanisms of advanced services, focusing on value creation, value capture, and value delivery. Each mechanism is defined, offering a comprehensive understanding of their roles in the context of advanced services. Section 2.3 explores the roles of SNA in advanced services. It differentiates between internal and external stakeholders and highlights the significance of collaboration among manufacturers, customers, distributors, and technology suppliers.

Section 2.4 introduces and defines the concept of uncertainty within the context of AS. It elucidates related terminologies such as risk and challenges and categorises uncertainties based on their sources, providing clarity on the various forms of uncertainty prevalent in AS. Finally, section 2.5 identifies research gaps and formulates research questions to guide the study. These questions are tailored to address the identified gaps in the literature, setting the stage for further exploration and analysis in the subsequent chapters.

3. THEORETICAL FRAMEWORK

The literature review chapter detailed the concepts of advanced services, various mechanisms, the role of SNA, and uncertainties. These concepts and identified gaps in the literature form the basis for developing a theoretical framework to guide this research. This chapter presents the theoretical conceptualisation of the current research in the form of a research framework. The research framework integrates the concepts of advanced services and uncertainties.

The following section introduces Organisational Information Processing Theory (OIPT) as a theoretical basis for developing the framework. This chapter is divided into two main parts. The first part introduces the theory and details how OIPT has evolved over time within the literature. The second part presents the development of a research framework based on OIPT and provides an overview of its key constructs.

3.1 Organisational Information Processing Theory

3.1.1 Introducing OIPT

Galbraith (1974) first introduced organisational information processing theory (OIPT) to understand complex organisational design. It was later expanded to an inter-organisational dyadic level to assess buyer-supplier relationships (Bensaou and Venkatraman, 1995; Premkumar et al., 2005) and understand the supply chain level (Busse et al., 2017). The principle of the OIPT suggests that "*the greater the task uncertainty, the greater the amount of information that must be processed among decision-makers during task execution to achieve a given level of performance*" (Galbraith, 1974: 28). Information processing involves the collection, interpretation and integration of information (Tushman and Nadler, 1978). It has been argued that an organisation's internal information processing operations are affected by the level of uncertainty it perceives.

The concept of uncertainty is contingent as it can vary across different organisations (Li et al., 2021) and is core to the OIPT. Galbraith (1974) contended that when an organisation faces higher levels of uncertainty because of various factors such as technological advancements, performance standards, intensified competition, or the expansion of product lines, there is an increased need for information processing. The primary impact of uncertainty is to restrict an organisation's capacity to preplan or make decisions regarding activities before their implementation (Tushman and Nadler, 1978). Two main strategies were proposed to improve organisational performance: '*reducing the need for information processing*' or '*increasing the capabilities for information processing'* (Galbraith, 1974). Firms must find a *fit* between these two to achieve optimal performance. These constructs are central to the theory.

3.1.2 Evolution of OIPT

Over time, OIPT has evolved into a comprehensive framework, with scholars in various disciplines contributing to its development and refinement, building upon Galbraith's initial conceptualisation (Fan et al., 2017; Premkumar et al., 2005; Tushman and Nadler, 1978). It has been widely adopted as a theoretical lens for investigating areas within supply chain literature (Qrunfleh and Tarafdar,

2014; Saberi et al., 2019; Schoenherr and Swink, 2012; Swink et al., 2007). For example, the theory has been used to establish links between mass customisation and design strategies to reduce information processing needs (Trentin et al., 2012) and explore the information processing needs in the supply chain (Busse et al., 2017).

Recently, OIPT has been adopted in the servitization literature. For instance, Kreye (2017b) assessed service quality impact by identifying relational uncertainty and organisational responses in servitization. Kroh et al. (2018) examined how the performance impact of market knowledge becomes stronger with increasing degrees of servitization. Wei and Sun (2021) explored the effects of manufacturing digitalisation on firm performance. Similarly, Jat et al. (2023) investigated the impact of servitization on financial performance using OIPT to guide the research. Most of these studies within servitization have utilised OIPT to conduct quantitative research.

Despite its widespread application across various domains, the use of OIPT within servitization remains underdeveloped, particularly in the context of advanced services. This scarcity in the literature leaves significant gaps in our understanding of how information processing needs and capabilities influence the effectiveness of servitization strategies. Therefore, this study employs OIPT as a foundational lens to guide the research. In the following section, a research framework grounded in OIPT is proposed, along with an introduction to three core concepts integral to the theory.

3.2 Developing Theoretical Framework

Studies that aim to answer "how" and "why" questions often contribute to theory development (Voss, 2010). To effectively address these questions, it is crucial to first understand the fundamental concepts and how they interrelate. This study investigates *how uncertainties impact advanced services innovation from a service network actors' perspective* (section 2.5). Developing a theoretical framework is essential for this purpose, as it links these core concepts and provides a structured approach to guide the research, highlighting specific areas that need to be examined in depth (Miles and Huberman, 1994a).

The foundation of the research framework for this study is grounded in the guiding theory, illustrated in Figure 4 below. This framework has been developed with insights from various supply chain studies that examine multiple sources of uncertainty (Bensaou and Venkatraman, 1995; Premkumar et al., 2005). The three core concepts of the OIPT are — *Information Processing Needs* (IPNs), *Information Processing Capability* (IPCs), and *the fit* between the two to obtain optimal performance. These concepts are fundamental to OIPT and are commonly explored in other studies (Busse et al., 2017; Dalenogare et al., 2022; Kroh et al., 2018). In this study, the concept of IPNs is adopted and integrated to serve the specific research purpose. The developed framework guides the data collection for the research. The following section elaborates on the core concepts within the developed framework.

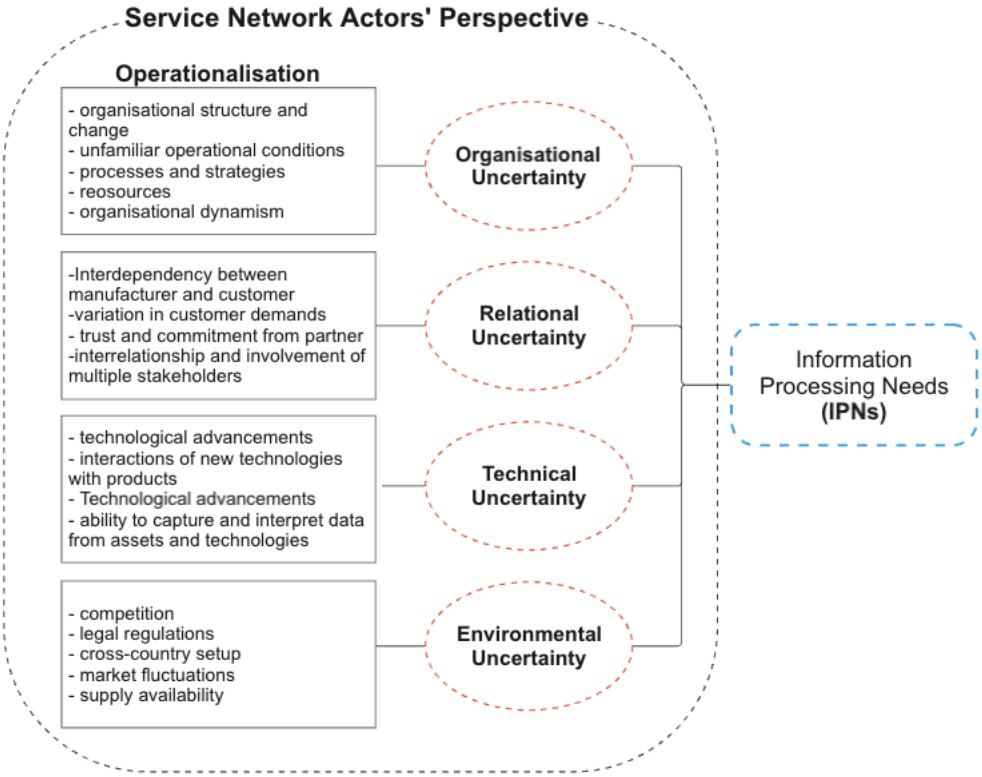

Figure 4: Research Framework

3.2.1 Information Processing Needs

Information Processing Needs (IPNs) refer to the extent of information an organisation requires to carry out any tasks and make informed decisions effectively (Galbraith, 1974). The amount and quality of information needed are influenced by the uncertainty the organisation encounters, which directly impacts the decision-making processes. Uncertainty often increases due to complexity (the presence of multiple factors) and dynamism (the degree of temporal change) (Busse et al., 2017; Duncan, 1972; Kreye, 2019). The greater the uncertainty, the higher the information processing needs of the organisation (Dutot et al., 2014).

Studies have examined various forms (or sources) of uncertainties which increase the demand for information processing. For instance, Bensaou and Venkatraman (1995) explored environmental, partnership and task uncertainty. Similarly, Premkumar et al. (2005) captured IPNs in the form of environmental and partnership uncertainty. These studies did not measure IPNs directly but instead took a holistic perspective that assesses different uncertainties first and, thereby, the IPNs. This research adopts a similar approach, positing that uncertainties must be examined first so that organisations can understand their IPNs. As discussed in the previous chapter (section 2.4.3), these uncertainties are categorised based on their sources into four types: *organisational*, *relational, technical* and *environmental*. To operationalise these uncertainties for the study, various factors were identified from the literature.

This study utilises the recognised approach of operationalising uncertainties based on the factors from the literature within a specific context (Kreye, 2018; Ramirez Hernandez and Kreye, 2021) (section 2.4.3). *Organisational uncertainties* will be examined under the facets of organisational

structure (Nudurupati et al., 2016) and change (O'Connor and Rice, 2013), unfamiliar operational conditions (Arnold and Quelch, 1998), processes and strategies (Nudurupati et al., 2016), resources (Benedettini et al., 2015), and organisational dynamism (Benedettini et al., 2015). *Relational uncertainties* will be assessed based on the interdependency between manufacturer and customer (Kreye, 2019), trust and commitment from partner (Kreye, 2017a), interrelationship and involvement of multiple stakeholders (Hou and Neely, 2018), and variation in customer demands (Hou and Neely, 2018). *Technical uncertainty* will be examined through factors such as the interactions of new technologies with products (Melander and Lakemond, 2015), technological advancements (Reim et al., 2016), and the ability to capture and interpret data from assets (Durugbo et al., 2010). *Environmental uncertainty* will be examined under facets including competition (Kreye, 2019; Ramirez Hernandez and Kreye, 2022), legal regulations (London and Hart, 2004), cross-country setup (Kreye, 2017a), market fluctuations (Hypko et al., 2010), and supply availability (Chao et al., 2009).

Rationale for OIPT

OIPT serves as a valuable theoretical foundation for this research, given its focus on the importance of uncertainties and information processing in organisational decision-making. The research framework, which includes IPNs captured in the form of uncertainties, is highly relevant to understanding the complexities of advanced services within service networks. While this study focuses explicitly on IPNs and does not examine IPCs or the fit between IPNs and IPCs, the theory still offers significant benefits.

The theory acknowledges that a company operates as an open social and economic system, carrying out business activities both within and outside its organisational boundaries (Thompson, 2017). It highlights the significance of differentiating between internal and external integration (Wong et al., 2011), as this study does by separating internal and external stakeholders within the service network for advanced services. Additionally, the theory has been primarily utilised in quantitative strategy within servitization (Dalenogare et al., 2022; Jat et al., 2023; Kroh et al., 2018; Li et al., 2021; Zhang and Qi, 2021), its application in qualitative has been less explored. Therefore, by employing OIPT as a qualitative theoretical lens, this research identifies and categorises uncertainties that arise in AS. The framework guides the data collection for the research. Once these uncertainties are known across the service network, manufacturers can better see where they need to acquire more information.

3.3 Summary

This chapter provides a comprehensive overview of the core concepts of OIPT and its evolutions within the literature. The theory suggests that the level of information processing needs an organisation faces is directly influenced by the degree of uncertainty in its environment. As uncertainty increases, the information processing needs also rise. In section 3.2, a research framework is developed based on the theory that incorporates core concepts, including

operationalising uncertainties based on the sources within the service network. It also provides the rationale and significance of utilising OIPT as a guiding theory for the current research. The following chapter describes the research methodology that explains the boundaries and a method to answer the research questions.

4. RESEARCH PROGRAMME

This chapter outlines the research methodology adopted for this study. It begins by identifying the research paradigm in section 4.1, which briefly explains the belief system underpinning the study. Section 4.2 discusses the research approach and purpose, showing how the research will be conducted. Section 4.3 details the research strategy and the methods to conduct the study. Finally, section 4.4 presents the case study design, elaborating on the theoretical propositions, as well as the data collection and analysis procedures employed. The key elements of the research methodology are summarised in Figure 5 below.

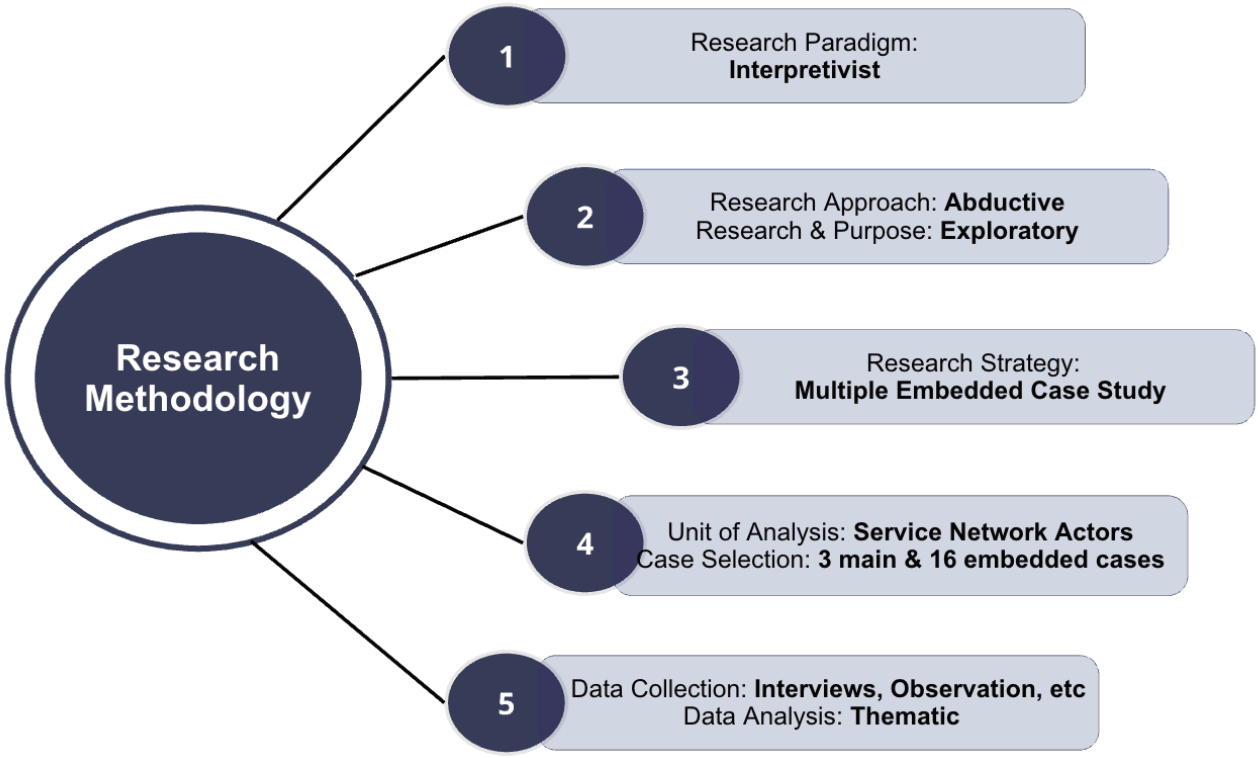

Figure 5: Research Programme (Author)

4.1 Research Paradigm

A research paradigm reflects the researcher's perspectives on the world they inhabit and the world they aspire to live in (Lather, 1986). It involves the researcher's beliefs about the fundamental nature of reality (ontology), the researcher's relationship to what is knowable (epistemology), and the researcher's ability to generate knowledge (methodology) (Guba and Lincoln, 1994). In organisational research, these underlying assumptions significantly influence the research approach that guides the study. Selecting an appropriate philosophical paradigm is crucial, as it shapes the researcher's worldview and helps in understanding the assumptions and limitations of the research.

Research paradigms have evolved, with the most commonly classified paradigms are 1) ***positivism,*** 2) ***interpretivism***, and 3) ***critical theory*** (Orlikowski and Baroudi, 1991). These paradigms and their corresponding epistemological and ontological positions are illustrated in Figure 6 below. Each paradigm is further examined to evaluate its relevance and applicability to this study.

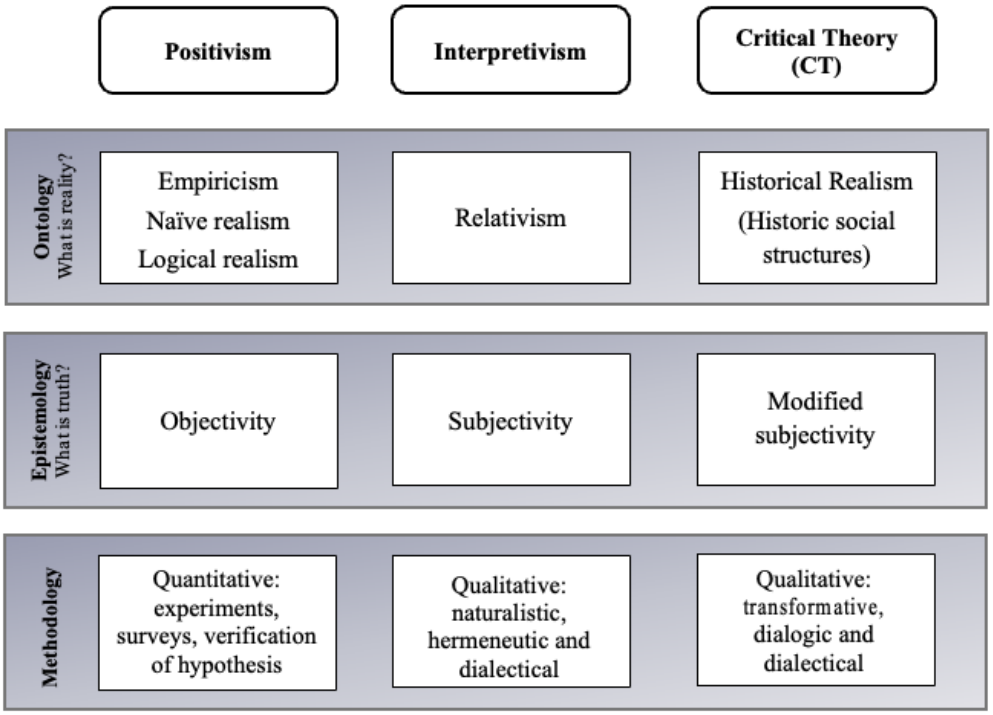

Figure 6: Research Paradigm (Ryan, 2018)

4.1.1 Positivism, Interpretivism, and Critical Theory

Positivism is based on the philosophical perspective of natural scientists, who use the visible reality within society to produce generalisations (Alharahsheh and Pius, 2020). This means that understanding real phenomena ontologically must always be grounded on measurement and evidence (Hammersley, 2012), independent of the observer. Positivist studies propose a hypothesis, epistemologically, which is tested with data, and if the analysis confirms the hypothesis, then it can be seen as an accurate representation of reality. This paradigm aids positivist researchers in thoroughly comprehending the objects using empirical testing and procedures, including sampling, measurement, surveys, and focus group discussions. This implies that the validity and reliability of the insights offered by positivist researchers may be of a high quality (Cohen et al., 2011). Most often, the data collection and analysis methods used in positivist research are quantitative.

Interpretivism research paradigm reinforces culturally produced and historically contextual interpretations of social life (Al-Ababneh, 2020). The interpretivism research paradigm has a distinct epistemology from positivism, taking a more subjective view. Interpretivists posit that reality is a socially constructed phenomenon shaped and perpetuated by social interaction on an ontological level (Orlikowski and Baroudi, 1991). Unlike positivists, who generalise theories, interpretive researchers engage with the organisational phenomena under study (Gioia and Pitre, 1990). Interpretivists get the perspectives of the individuals involved, generate descriptions, gain some insight, and draw conclusions. There is less concern regarding the repeatability or generalisability of explanations attributed to them by the participants (Orlikowski and Baroudi, 1991). An interpretivist is more likely to use a qualitative approach for data collection and analysis.

Lastly, *critical theory, also known as the* transformative paradigm (Al Riyami, 2015), and its ontology are rooted in relativism. The critical paradigm is primarily an emerging paradigm that focuses on social, cultural, and political concerns (Myers et al., 2013). Critical researchers deliberately embrace ethical, moral, and political norms to assess the circumstance and conduct their study while considering the societal, economic, political, and cultural context of particular research objects or events (Hammersley, 2012). In a similar manner to interpretivism, critical researchers may use qualitative and quantitative data collection methods.

4.1.2 Interpretivism: The Choice of Research Paradigm

An interpretivism paradigm is the most suitable research paradigm for achieving the current study's intended research aim. A more subjective approach is required to consider uncertainties due to their non-static nature and non-linear interactions in a service context (Erkoyuncu et al., 2011). Accordingly, the proposed research focuses on taking the perspective of service network actors (SNA) to examine uncertainties arising in advanced services and their impact.

Manufacturers employ value creation, value capture and value delivery mechanisms to leverage the potential of advanced services (section 2.2). Value is perceived as a construct shaped by human experiences, hence varying for each actor engaged within the global network for advanced services. This varying degree of engagement to generate value in advanced services increases the level of uncertainties in overall innovation. The interpretivism paradigm "generates alternative understandings of what goes on in project practice and how practitioners participate in and manage complex organisational arrangements" (Cicmil, 2006: 36) Therefore, an interpretivism paradigm acknowledges the subjective nature of uncertainties and diverse perceptions of actors to gain a more comprehensive and deeper exploration of the complex phenomenon under study.

Unlike positivism, the interpretivism paradigm acknowledges that the data collected and analysed cannot be easily generalised due to its dependence on the specific context of advanced services and diverse perspectives on uncertainties (Remenyi, 2002). Under the interpretivism paradigm, data will be collected through interviews and formal interactions between the researcher and informants. Informants are selected based on the assumption that individuals with a certain level of expertise are most capable of understanding the significance of the research (Rennie, 2001) and providing the necessary data.

The transformative approach of critical theory involves uncovering the historical frameworks that shape reality. Interpretivists seek to comprehend the natural settings in which individuals' realities unfold, aiming not to instigate social change from disparities but to lead action based on individuals' lived experiences. Adopting the interpretivism paradigm for this study can provide a deeper understanding of uncertainties in advanced services through collecting and interpreting qualitative data. This approach may lead to unique insights and conclusions, ultimately contributing to high levels of validity and trustworthiness in the data due to its basis on personal contributions and consideration of various variables (Myers, 2019).

4.2 Research Approach and Purpose

This section focuses on selecting a suitable research approach and purpose that aligns with the current research objectives.

4.2.1 Research Approach: Abduction

A research approach refers to the path of conscious scientific reasoning that guides the research process (Peirce, 1974). Three research approaches are commonly used: *deduction*, *induction,* and *abduction*. The following section briefly overviews the three approaches and discusses a suitable approach for the present study.

Deduction, Induction and Abduction

A *deduction approach* involves using an existing developed theory or hypothesis and the design of a research method to test and validate it (Trochim and Donnelly, 2001). It follows a systematic process that investigates the general to the specific, leading to the generalisability of findings. An *induction approach* starts with observation of specific phenomena or patterns and then developing a theory or hypothesis based on those observations. This approach provides a more in-depth understanding of the phenomenon under study and is less concerned with generalizability (Ragab and Arisha, 2018). On the other hand, an abduction approach involves a combination of induction and deduction (Kovács and Spens, 2005). The present research adopts an abductive research approach suitable for the current study's purpose, which is further discussed in detail below.

Choice of Research Approach: Abduction

Abduction is the most suitable research approach. It provides a form of creativity in research that enables the generation of new knowledge by iteratively integrating theoretical frameworks with emerging data to enhance both empirical and theoretical understanding (Andreewsky and Bourcier, 2000; Kovács and Spens, 2005). An abductive approach relies on examining a specific set of facts (Peirce, 1974). These facts are first sorted out to grasp the essence of the observed phenomenon, yet an immediate or satisfactory understanding may not be fully achieved (Åsvoll, 2014). Thereby acknowledging the significance of existing theories but also emphasising the value of collecting and analysing qualitative data to uncover new insights. This will lead to a more comprehensive and in-depth understanding of the research topic.

In the context of this research, the process begins deductively by applying the existing four uncertainty types in a theoretically developed framework (Kovács and Spens, 2005) (see section 3.2). By using this framework, the study ensures that the theoretical understanding of uncertainties is grounded in empirical investigation, allowing the interviews to be guided but not overly restricted. Following this, an inductive phase is employed where data collected from interviews is analysed to identify emerging patterns and themes which may refine or challenge the initial framework. This iterative process of deduction and induction enables the research to adapt and evolve. This study

aims to validate current knowledge and uncover new uncertainties by integrating theoretical insights with empirical data using an abductive approach.

4.2.2 Research Purpose: Exploratory

The research purpose refers to how the researcher plans to investigate in order to answer the research questions and achieve the objectives of the proposed research (Saunders et al., 2009). The commonly employed classification of research purpose in the literature comprises three main types: *exploratory*, *descriptive* and *explanatory*. The section below provides a brief overview of the three types and discusses the suitable purpose for the present study.

Exploratory, Descriptive and Explanatory

Exploratory research seeks to explore phenomena to generate new insights and better understand the research topic by asking questions (Robson, 2002). It intends to provide fresh perspectives when existing knowledge on the topic is limited. *Descriptive research* aims to describe a phenomenon or event, providing a detailed and comprehensive picture of the research topic. It utilises the existing knowledge and data to provide a detailed explanation of the occurrence of a particular phenomenon. *Explanatory research,* on the other hand, seeks to understand the causal relationships between variables and provides an explanation for why a particular phenomenon occurs (Saunders et al., 2009). It relies on a specific variable to determine an outcome, with the cause and effect being known beforehand without a confirmed relationship.

Exploratory: The Choice of Research Purpose

The present study serves the purpose of exploratory research. Several key considerations drive this choice. First, the global service network in the context of advanced services is complex and characterised by significant uncertainties. This area is relatively under-explored, as identified in the literature review (section 2.5). Exploratory research is well-suited for examining uncertainties, as it allows for a comprehensive exploration of phenomena that are not yet well understood (Stebbins, 2001). Secondly, given the uncertain and evolving nature of advanced services, a flexible research design is essential to adapt and refine research questions and methods as new information emerges (Reiter, 2017). This study aims to generate new insights into uncertainties in advanced services rather than confirming existing theories or knowledge. Finally, the phenomenon under study must be clearly defined to determine its boundaries of application (Barratt et al., 2011). In this study, the unit of analysis is the service network actors, providing clear boundaries and scope for the research (section 4.4.3). This focused perspective guides the formulation of interview questions and the collection of relevant data, ensuring a detailed examination of the interactions and roles within the service network.

4.3 Research Strategy

The research aims to examine uncertainties and their impact on advanced services innovation from the SNA perspective. It is crucial to adopt a suitable research strategy to answer the research

questions (section 2.5). Research strategy refers to the coherent set of methods, techniques and procedures to conduct the research (Verschuren, 2003). Research strategy can be classified according to their nature as qualitative or quantitative and based on type as grounded theory, ethnography, phenomenology, content analysis, and case study. This research employs a qualitative case study approach in line with the research questions, purpose, and the nature of the phenomena under investigation. The following section provides a detailed explanation and rationale behind the chosen research strategy.

4.3.1 Qualitative Study

A qualitative research strategy involves exploring a phenomenon within its natural setting to uncover and understand the world through interpretive methods (Denzin et al., 2006). The existing literature on uncertainties in servitization lacks a comprehensive understanding of how these uncertainties influence the innovation of advanced services, particularly from the broader perspective of service network actors (section 2.5). The literature suggests that qualitative research is particularly useful for exploring complex and contextual phenomena, allowing for an in-depth understanding of the experiences, perspectives, and meanings attributed to these phenomena (Yin, 2015). Studies on uncertainties are still evolving (Kreye, 2017a), necessitating a need for in-depth insight into the domain. Furthermore, integrating SNA introduces additional complexity within the context of advanced services (section 2.3). Qualitative strategy is used for knowledge and theory development by validating or challenging the existing theory or propositions (Flyvbjerg, 2006). This study employs information processing theory in the context of advanced services and develops a theoretical framework to guide the research (section 3.2). Therefore, for all these reasons, a qualitative strategy is highly suitable for examining uncertainties in advanced services and understanding them from the perspective of SNA.

Yin (1994: 13) defined case study as “an empirical enquiry that investigates a contemporary phenomenon within its real-life context”. Researchers can delve deep into the participants' experiences, perspectives, and behaviours in their natural settings through interpretive practices using a qualitative case study (Denzin et al., 2006). The three main reasons why the present study adopts a case study are discussed below.

“How” and “why” questions

Firstly, case studies are best suited to address research questions that begin with “how” and “why” to understand the phenomena understudy (Yin, 2009). Researchers seek to understand the reason behind why a particular phenomenon leads to certain outcomes. Similarly, how this phenomenon is employed to achieve a specific outcome. The present study combines the questions of “what” uncertainties are and “how” these uncertainties impact the innovation of advanced services (section 2.5). Addressing these questions would lead the researcher to a more comprehensive understanding of the phenomena and facilitate the development of broader theoretical statements regarding the patterns in the observed occurrence (Fidel, 1984).

Complex phenomena

Secondly, case studies are particularly useful when there is an in-depth exploration of complex phenomena in their real-life setting (Yin, 2009). Complex phenomena often involve multiple variables and intricate relationships between them (Priya, 2021). Advanced services require the integration of the SNA, involving both internal and external stakeholders. Case studies involve multi-perspective analyses, where the researcher considers the viewpoints of individuals involved and those of relevant groups and their interactions (Tellis, 1997). The exploratory nature of the research questions necessitates a thorough exploration of uncertainties from the perspectives of these actors within the network. Such circumstances may be particularly evident in embedded case studies (Yin, 2009), which is further discussed in the next section. A case study is well suited to capture this complexity and interplay between various factors and actors involved.

Contemporary phenomena

Thirdly, case studies are preferred when the researcher has limited influence over events, and the emphasis is on contemporary phenomena (Yin, 2009). This research aims to gather the perspectives of the SNA on AS. The objective of the study is to look at those firms that are planning to introduce advanced services within their business or are in their early stages rather than their past experiences in advanced services. This can be effectively addressed using a case study.

In summary, the above justifications demonstrate that a qualitative case study is the most suitable strategy for the present study. The following section provides a detailed description of the appropriate type of case study.

4.3.2 Multiple Embedded Case Study: The Choice of the Research Strategy

Yin (2009) proposed two types of case studies: *single* or *multiple, and* two variants of case study: *holistic* or *embedded.* Figure 7 illustrates the types of case studies in a 2 x 2 matrix adopted from Yin (2018) and integrated into the context of this research. The type of case study selection depends on the context, phenomenon or research questions (Yin, 2009). A multiple-embedded case study serves the exploratory purpose of this research. The below sections distinguish between holistic single and multiple case studies and embedded single and multiple case studies.

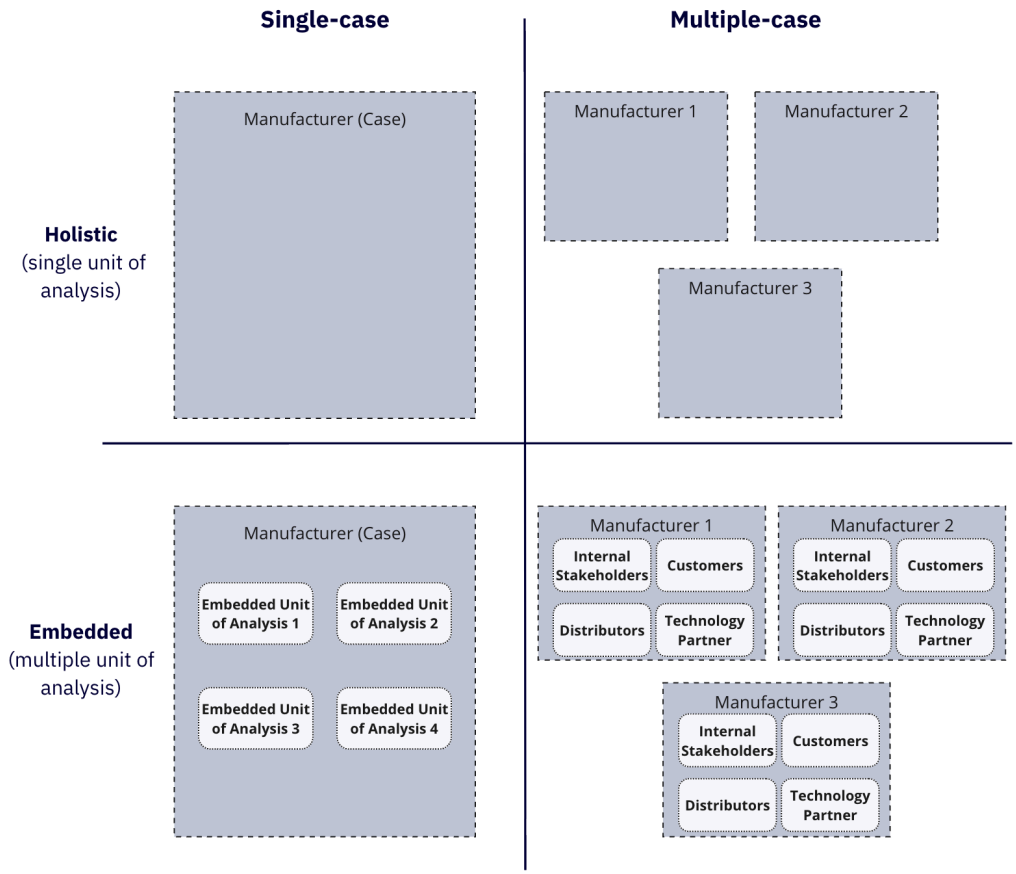

Figure 7: Types of Case Study (adapted from Yin (2018))

A *holistic single case study* focuses on a single entity or unit of analysis and aims to understand the entire phenomenon in its entirety (Yin, 2018). Such studies provide an in-depth analysis of a singular case and allow for a deep understanding of the complexities within that specific context of the case. A *holistic multiple-case study* involves analysing multiple cases or entities, allowing for comparison and contrast to reveal individual outcomes and patterns across the cases (Yin, 2018). In simpler terms, the same case study may contain more than a single case, as illustrated in the Figure 7 above. Multiple case studies are primarily carried out to follow the concept of replication, which may be exact if the cases yield similar findings or analytical if they yield contrasting findings (Yin, 2018).

An *embedded single case study* involves analysing multiple units or subunits within a single case, allowing for a more detailed examination of different aspects or perspectives of the phenomenon (Scholz and Tietje, 2002). In an embedded context, there is a focus on understanding the interconnections and interactions between the different units or subunits. An *embedded multiple case study* involves multiple cases, and each case contains multiple units or subunits of analysis (Yin, 2018). Embedded subunits can be *within* or *part of* the original case. Multiple embedded case studies consist of multiple units of analysis depending on the phenomenon and research questions.

Rationale for Embedded Multiple Case Study

The exploratory purpose and required Service Network Actors' (SNA) perspective in the present study make an embedded multiple case study a suitable research strategy. The holistic design is beneficial for gaining an understanding of the entire phenomenon as a holistic entity in which no

distinct logical subunits can be identified (Yin, 2018). The present study aims to incorporate a broader SNA perspective to identify uncertainties and their implications when innovating advanced services. As discussed in section 2.3, SNA consists of internal (individuals in manufacturing firms) and external stakeholders (customers, distributors, and technology suppliers). This represents an embedded setting within the network. Embedded case studies are particularly suited for investigating complex phenomena and exploring multiple perspectives within a business system (Scholz and Tietje, 2002) or network. For this study, the multiple embedded case study will allow to explore the logical replication that may arise across the SNA. Theoretical replications across multiple cases enhance the accuracy, credibility, and consistency of findings, resulting in stronger conclusions (Miles and Huberman, 1994a; Scholz and Tietje, 2002; Tellis, 1997; Yin, 2009).

The fourth quadrant in the Figure 7 above illustrates the embedded context of advanced services by integrating the internal and external stakeholders in the primary case of manufacturers. In this study, the primary emphasis is on the manufacturer cases, which serve as key exemplars, while the embedded cases provide supplementary network perspectives that enrich the overall understanding of the uncertainties in advanced services.

A few studies in servitization literature have used embedded case studies where individuals or business units within or part of the business are considered to support the current choice of strategy. For instance, Nenonen et al. (2014) used an embedded single case study of a manufacturer with two local business units to explore the image risks of servitization in the manufacturing industry and the interactions with service delivery partners. Avlonitis and Hsuan (2017) followed a multiple embedded case study using multiple units of analysis to understand the manifestation of modularity in service design. Vaittinen et al. (2018) explored the customers' readiness to adopt advanced services using three embedded customer cases of the focal manufacturing firm. A single case study with multiple embedded units (10 subsidiaries) was conducted to explore service capabilities by Jovanovic et al. (2019). Momeni et al. (2023b) integrated a single embedded case study using a triadic (manufacturer, internal and external salespeople, and customers) approach to understand the multi-actors' perspective and requirements in introducing smart services.

In summary, the research's exploratory purpose and embedded context suggest a multiple embedded case study to understand the uncertainties not only from different levels within the focal manufacturing firms but also to provide various perspectives from the broader network on AS. The following section describes the overall design process for the chosen multiple-embedded case study strategy.

4.4 Case Study Design

The research design guides the researcher's choice of data collection and approaches to data analysis to address the research questions and objectives of the study (Yin, 2009). This will explain 'why' and 'how' certain cases, data collection and analysis methods are selected. The research follows a case study design process proposed by Yin (1994):

- **Defining the Research Questions**: This step involves clearly stating the purpose of the case study and identifying specific research questions that need to be answered.
- **Theoretical Propositions**: This step identifies the theoretical propositions or framework that will guide the researcher in collecting and analysing data within the study's scope.
- **Unit of Analysis**: This involves determining the unit of analysis in the case study, which could be an individual, group, organisation, or society.
- **Case Selection Criteria**: In this, the researcher defines the case and determines the boundaries of the cases that will be included in the study based on their relevance to the research.
- **Data Collection Plan**: This step involves deciding on the qualitative methods (interviews, observations, document analysis, etc) and procedures (interview guide, consent, participants recruitment) to gather the relevant data to address the research questions.
- **Data Analysis Plan**: In this step, the researcher outlines the process for analysing the collected data, including methods and techniques for identifying patterns and themes in the data.

The following sections will provide details about these steps of the multiple embedded case study design used to conduct the study.

4.4.1 Research Questions

The first step of the design process is clearly defining the research question (Yin, 2009). The nature of the research questions clarifies the method and research design, as discussed in section 4.3.1. The researcher's theoretical assumptions are reflected through the research questions, influencing the decisions for sampling and setting boundaries for the analysis (Miles and Huberman, 1994a). In Chapter 2, the literature review revealed the gaps and concluded the study's questions to be addressed. Three research questions were formulated for this study:

RQ1: What uncertainties arise for internal stakeholders of a manufacturing firm when innovating advanced services?
RQ2: What uncertainties arise for external stakeholders of a manufacturing firm when innovating advanced services?
RQ3: What are the likely implications of these uncertainties for internal and external stakeholders of a manufacturing firm when innovating advanced services?

These questions seek to understand the uncertainties and their impact on advanced services innovation from SNA perspectives. The following section underpins the theoretical propositions for the study.

4.4.2 Theoretical Propositions

Once the research questions have been defined, it is essential to consider the theoretical propositions in the initial stage of the case-based research (Yin, 1994). Theoretical propositions are vital in

determining a study's expected dynamics. These propositions establish the connection between theoretical concepts and empirical observations, making it easier to explore the research questions systematically. Often, the researcher develops a theoretical framework that helps to focus the investigation, particularly relevant for conducting multiple case research due to its complexity (Miles and Huberman, 1994b).

This research is guided by a theoretical framework developed in Chapter 3. This framework is based on the established literature on uncertainty and is integrated within the research's context. It draws on Organisational Information Processing Theory (OIPT) as its foundation (Galbraith, 1974). OIPT has been widely adopted in servitization literature, as discussed in section 3.1.2 and the framework aligns with the objectives of the study.

4.4.3 Unit of Analysis

The unit of analysis is a crucial part of the case study design. In an exploratory case study, the unit of analysis defines the specific boundaries and scope of the study (Dubé and Paré, 2003). In simpler terms, it determines what will be studied and analysed (Yin, 2009). The unit of analysis can often be an entity like an organisation, a group, an individual, a society, etc (Neuman, 2007; Yin, 2009). Within the context of this research, which aims to explore uncertainties and their implications when innovating advanced services from the SNA perspective, the chosen unit of analysis is the **Service Network Actors (SNA).** This involves internal (manufacturer) and external (customer, distributors, technology partner) organisations who are all integral to AS, as discussed in section 2.3. Furthermore, within the manufacturer organisations, the study adopts a multiple embedded case study approach (section 4.3.2), where internal stakeholders from different departments (e.g., service managers, R&D teams, product managers, and sales) serve as sub-units of analysis. It is important to focus on the broader network actors, given the complexity and interdependency within the service network (Parida and Jovanovic, 2022; Reim et al., 2019; Story et al., 2017).

The rationale for this unit of analysis lies in the understanding that AS cannot be effectively implemented in isolation within the sphere of manufacturers (Baines and Lightfoot, 2013b; Ziaee Bigdeli et al., 2018). It involves continuous engagement and involvement of a network of actors, with each actor contributing uniquely to the value creation, capture and value delivery processes (section 2.3). These interactions are crucial in delivering successful outcomes to the end customer. Advanced services require a high degree of customisation to meet specific customer needs, as well as integration of various digital technologies and collaborative delivery models, which presents unique uncertainties and challenges (Baines and Lightfoot, 2013b; Zolkiewski et al., 2023). These uncertainties can arise from various sources and in different forms. By focusing on SNA, this study aims to capture a holistic view of how these uncertainties permeate through different layers of the network and influence advanced services innovation. Therefore, SNA, as the unit of analysis, aligns well with the study's objectives. It allows to examine these actors collectively to not only identify the specific uncertainties each actor faces but also how these uncertainties compound within the service network.

4.4.4 Case Selection

Case selection is “the primordial task of the case study researchers, for in choosing cases, one also sets out an agenda for studying those cases” (Seawright and Gerring, 2008: 294). This means carefully choosing cases that will provide a comprehensive and in-depth understanding of uncertainties in advanced services. The selection of the cases should align with theoretical propositions or research questions (Creswell and Creswell, 2017; Yin, 2009). This study follows a multiple embedded case study approach, focusing on different service network actors’ (SNA) and their interactions to examine uncertainties in advanced services. Multiple cases emphasise complementary aspects of phenomenon understudy (Eisenhardt, 1989). The embedded nature of the study allows for an in-depth exploration of multiple perspectives within each case, acknowledging that uncertainties emerge not only at the firm level but also through interactions among different actors in the service network. The following section provides details into the selection criteria of these cases.

Selection Criteria

To effectively capture uncertainties across organisational, relational, technical and environmental domains, selecting cases with distinct characteristics will allow for a thorough exploration of these variations. Conducting research in a case study often involves choosing cases based on firm characteristics essential for addressing the research question (Yin, 2009). The characteristics of the firms can include aspects such as size, industry, geographical location, organisational structure, performance, and others, as these can significantly influence the dynamics of advanced services. Other criteria for case selection in an embedded multiple-case study include the relevance of the cases to the research topic, their data availability and the firms' willingness to participate (Yin, 2018). This purposive sampling in qualitative research underscores the importance of selecting cases that provide rich, context-specific insights into the phenomenon under study (Bryman, 2016). For the present study, selecting cases with a clear connection to advanced services is crucial, ensuring that the research questions are effectively addressed and comprehensive data on uncertainties can be gathered.

Based on the research questions and strategy, this research is expected to focus not only on manufacturers planning to offer advanced services but also on the active involvement of external stakeholders embedded within the focal firms. Therefore, the case selection criteria for this study will include manufacturers that meet the following criteria:

- **Manufacturers’ knowledge and awareness of servitization**—Firms that offer some level of services (e.g., base and intermediate) and are aware of the servitization process.
- **Manufacturers in the early phases of the AS journey**—Firms that are planning to innovate AS and are at the exploration and engagement stage (Baines et al., 2020).

- **Manufacturers interacting with their service network actors for AS**—Firms that are planning to or are actively engaging with both internal and external stakeholders, including various departments/teams within the firm, customers, distributors, and technology suppliers.

To further elaborate on the second criteria of firms in the early stages of advanced services, Baines et al. (2020) proposed four stages to progress in servitization: *exploration, engagement, expansion* and *exploitation*. The exploration stage involves firms investigating and understanding the concept and implications of competing through AS to establish whether a viable opportunity exists. The engagement stage involves firms evaluating and demonstrating the potential of AS within the business until it gains acceptance. The last two stages involve scaling, innovation, and provision of advanced services. Thus, by focusing on the firms in the exploration and engagement stages, this research captures the uncertainties that arise during these early phases in AS. During these stages, firms try to actively explore and engage both internally and externally to gauge the viability and acceptance of AS among various stakeholders. This focus allows for a detailed examination of the specific uncertainties firms face as they navigate the initial stages of AS.

Selected Case- Recruitment

The chosen multiple-embedded case study strategy not only facilitates a detailed exploration of the uncertainties in AS but also allows for examining various sources from the perspectives of different actors. With the SNA being the unit of analysis, selecting cases where access to diverse actors is critical to the study. Three manufacturers were chosen for this study based on the above selection criteria. These firms are part of a partnership programme run by a research group based at the University, which aims to assist these firms in transforming their business models towards servitization.

The first manufacturer, Case PrintCo (section 5.2.1), provided not only financial support for this research but also access to their organisation and personnel for the entire period of this study. As a longitudinal case, data was collected over two years, allowing for periodic and follow-up interviews and continuous observation of the organisation's internal stakeholders. Longitudinal case studies not only support the generation of theoretical insights through the detailed examination of the case but also ensure comprehensive case analysis with the depth and quality of the research (Yin, 2009). The research group's partnership programme further facilitated access to the other two manufacturing firms, ensuring that they met the selection criteria and were willing participants in this study.

In line with the University's regulations, the selected cases of internal and external stakeholders of a manufacturing firm were sent an information sheet and a consent form as an official invitation to participate in the study. The information sheet provided a brief overview of the study, outlining its objectives and participants' rights (Appendix 6: Information Sheet). The consent form sought permission to conduct and record interviews and to use the collected data for the study's purposes (Appendix 7: Consent Form). Ethical guidelines were carefully followed throughout the recruitment process, ensuring confidentiality and emphasising that participation is voluntary. The inclusion of these individuals is crucial for the research, as their perspectives are key to exploring the impact of

uncertainties on advanced services from a broader network view. Their contributions are vital to addressing the research questions and fulfilling the objectives of the study.

Following this process, 19 cases involving both internal and external stakeholders were recruited. A total of 32 internal stakeholders from three manufacturing cases were confirmed to participate in the interviews. Ten customers, four distributors, and two technology suppliers from one of the manufacturer cases, PrintCo, consented to participate. These informants were selected for their extensive knowledge and ability to provide valuable insights into the research context (Rennie, 2001). However, external stakeholders from the other two recruited manufacturers could not participate. The primary challenge was coordinating with customers and distributors, which proved difficult due to their competing priorities and time constraints during the data collection process. Additionally, due to perceived risks, manufacturers were hesitant to involve technology suppliers at the initial stage. Efforts were made to reassure participants about confidentiality and the research benefits, but some hesitance remained. Section 5.2 in the next chapter details the specific cases and selected participants.

In this research, it was important to involve a significant number of participants from manufacturing companies. Generally, the necessary expert knowledge lies in the higher management positions directly involved in planning advanced services development. Not all the employees were engaged in advanced services within the business. Therefore, capturing a broader view is essential to not only gain a comprehensive understanding of uncertainties but also provide perspectives from other stakeholders on advanced services within the firm. This has proven beneficial for higher management in various ways, such as identifying knowledge gaps and areas, identifying key stakeholders across the firm for advanced services, and facilitating collaboration opportunities across different departments/teams.

To conclude, 3 manufacturer cases which act as key exemplars and 16 embedded cases involving customers, distributors, and technology suppliers were recruited for this study. A total of 50 participants across all the cases were interviewed as a source of primary data collection. The following section describes the plan and process of data collection in detail.

4.4.5 Data Collection Plan and Process

After selecting the cases and participant recruitment, the next step involves planning to collect data from these cases. This study employs a qualitative multiple-embedded case study, which involves collecting data through both primary and secondary sources to strengthen the substantiation of constructs for the verification of the obtained information (Yin, 2009). These sources include interviews, documentation, archival records, observations and physical artefacts. Each source of data serves as a puzzle piece that collectively enriches the researcher's knowledge and understanding of the phenomenon understudy (Baxter and Jack, 2008). The following section outlines the plan for collecting data from various sources for this study.

Primary Data Source: Interviews

The most commonly used primary data source in qualitative case study research is interviews (Stake, 2008; Yin, 2009). The purpose of the interviews is to allow the researcher to directly interact with participants and capture detailed information about their experiences, viewpoints and behaviours (Bryman, 2016). Interviews are a practical, usually economical, and efficient way to gain insights into the social context of the research participants. Interviews are chosen as the primary data collection method for this study due to the inherently subjective nature of uncertainties, allowing participants to provide rich and in-depth insights within the context of AS. This method is particularly effective in uncovering the complexity and experiences of individuals within organisations, facilitating a comprehensive understanding of uncertainties and their impact on AS innovation. Various studies on advanced services taking the SNA perspective have used interviews as a critical data source in case studies due to their effectiveness in capturing human behaviour and complex organisational dynamics (Parida and Jovanovic, 2022; Reim et al., 2019; Story et al., 2017).

Interviews can be unstructured (informal conversational interview), semi-structured (general interview guide approach), and structured (standardised open-ended interview) (Patton, 2002). An unstructured interview involves generating spontaneous questions based on the context during the ongoing interview. Semi-structured interviews have specific outlined questions as a fundamental checklist but allow for flexibility in exploring other emerging areas during the interactions with participants (Patton, 2002). Structured interviews include a set series of pre-planned questions to guide each participant through a consistent sequence (Patton, 2002). The level of adaptability is constrained to some extent based on the type of interview and proficiency of the interviewers.

Semi-structured interviews are employed in this study due to their flexibility and depth, making them particularly suitable for exploratory research purposes. This allows for a structured yet open-ended approach, where predefined questions guide the conversation while also providing the opportunity to probe deeper based on participants' responses. This flexibility is crucial for uncovering the complexities and uncertainties surrounding advanced services. Additionally, this interactive form of the interview allows the participants to express themselves freely (Kakilla, 2021). Numerous studies on advanced services and uncertainties have employed semi-structured interviews by highlighting their ability to gather comprehensive qualitative data and provide strong evidence to support this study’s data collection approach (Kreye, 2017a; Reim et al., 2019; Schroeder et al., 2020; Story et al., 2017; Zolkiewski et al., 2023).

In summary, the primary source of data collection for this study is semi-structured interviews. The evidence from the literature on advanced services and uncertainty, as well as the exploratory purpose of the study, support the choice of semi-structured interviews. However, certain constraints to semi-structured interviews must be considered when conducting them. For instance, language barriers or context-specific knowledge leads to insufficient or limited responses to the questions asked (Brinkmann, 2014). To address this challenge, the researcher will design an interview guide with anticipated responses specific to research questions and probes to maintain participant engagement throughout the process. The following section details the design of an interview guide for the study.

Interview Guide Design

The interview guide serves as a tool to provide the researcher with a predetermined list of questions that direct the interview and is primarily used as a memory aid to ensure that all the research objectives are covered (Hennink et al., 2020). As the present research employs a semi-structured interview approach, the questions within the interview are informal and can be customised based on the context and participant. The interview guide will help determine *what* questions to pose and in *which* sequence to ask them (Tracy, 2019). Before designing the interview guide, it is essential to have explicit knowledge and consideration of the research questions, literature review and theoretical framework. These resources can serve as a guidepost during interviews and aid in uncovering themes for further investigation. An interview guide is designed based on the research questions (section 2.5) and theoretical framework (section 3.2). This guide consists of two parts: an information sheet and a consent form that provides a brief overview of the research topic, which was sent before the interview **(see Appendix 6 and 7)** and a set of interview questions **(Appendix 5)** to direct the interview**.**

In developing the interview questions, this study follows a structured sequence comprising three types of questions: *generative, directive* and *closing* (Tracy, 2019). The interview begins with open-ended broad questions to establish a rapport and allow participants to express their thoughts and experiences freely (Generative questions). For instance, asking participants to describe their role within the business and their familiarity with advanced services can set the stage for later discussions. Then, more specific and focused questions are asked to gather detailed information on the research topic. These questions aim to uncover detailed insights related to organisational, relational, technical and environmental uncertainties in introducing AS within the organisation. Finally, closing questions wrap up the interview and allow participants to provide any final thoughts or insights. The interview guide also includes probes and follow-up questions to encourage participants to elaborate on their responses and provide more in-depth information. This way, the researcher ensures a comprehensive exploration of the research topic while maintaining a logical flow that facilitates in-depth and meaningful responses from participants.

Secondary Data: Direct Observations and Documentation

In addition to primary data collection through interviews, this study uses three secondary data sources to enhance the analysis and provide a broader context: direct observations, documentation, and archival records.

Direct Observation: Workshops and Meetings

The case study is expected to occur in a real-world setting, which provides an opportunity for direct observations (Yin, 2018). This research uses direct observation as a significant secondary data source, involving data collection through workshops and meetings. Observing the interactions, behaviours, and dynamics within these settings provides valuable insights into the research topic and can complement the information obtained through interviews (Yin, 2018).

Workshops conducted during this study involved interactive sessions with various stakeholders, offering real-time data on their interactions, behaviours and discussions around advanced services. In Case PrintCo, these workshops were based on customer segmentation, mapping out customer pains and gains, customer value proposition design, AS business model design, AS system requirements, and AS contract management process mapping. Some workshops were held in person, while a few others were online using the Miro board (section 5.3). In addition to workshops, there were weekly (for a year) and bi-weekly (for another year) meetings from Case PrintCo, which served as a consistent source of direct observation. These meetings involved planning and piloting of AS within Case PrintCo. These sessions were conducted online via Microsoft Teams; some sessions were permitted to be recorded for the study's purposes. In addition, several workshop sessions during the industry partnership roundtables hosted by The Advanced Services Group at Aston University were observed, which provided valuable strategic insights related to advanced services of the three cases, PrintCo, RoboCo and BoilerCo. Both workshops and meetings allowed the researcher to gain insights that might not be accessible through interviews alone, adding depth and context to the findings (Yin, 2018).

Documentation

Documentation constitutes another important secondary data source (Yin, 2009). This includes materials such as websites, presentations, reports, and other written records related to the organisations involved in the study. These documents provide background information, detail the companies' product and service offerings, present ongoing project presentations that are indirectly related to AS, and present the strategic context in which services are being developed. Reviewing these documents aids in understanding the organisational goals, processes, and external communication strategies related to AS.

4.4.6 Data Analysis Plan and Process

Data analysis involves organising and examining the collected qualitative data to draw meaningful insights and answers to the research questions (Yin, 2009). It is important to ensure the data is accurately interpreted to identify patterns, relationships and themes relevant to the study. Therefore, planning how the data will be organised and analysed is crucial. In research using the interpretivism paradigm, usually, the collection of data and analysis of the data is performed at a similar time (Neuman, 2007). An abductive approach to analysing the data and methods such as coding and thematic analysis are employed in this research.

Within Case and Cross Case Analysis

In qualitative multiple-case studies, two analysis steps are performed: *within-case and cross-case analysis* (Ayres et al., 2003; Barratt et al., 2011; Eisenhardt, 1989). The present study uses an embedded multiple case study strategy (section 4.3.2), therefore following the two-step process of analysis across the cases to generate findings. The *within-case analysis* involves examining individual cases in-depth to understand their unique characteristics and identify patterns and themes.

In this study, the first step involves conducting a within-case analysis, where internal stakeholders of the three manufacturer cases (section 6.1) and external stakeholders of the customers, distributors and technology supplier cases (6.2) will be analysed individually to identify key themes and patterns. To examine the third research question (RQ3) — *What are the likely implications of uncertainties for internal and external stakeholders when innovating advanced services?* — the analysis aimed to systematically identify these uncertainties through a comprehensive within-case analysis. Building on these uncertainties, the likely implications were inferred through an analytical interpretation process. This approach involved examining the nature and patterns of uncertainties to understand their plausible consequences for stakeholders. A detailed description of cases is provided in Chapter 5, followed by the data coded at the individual case level in Chapter 6.

The next step is cross-case analysis, which involves identifying shared characteristics within specific groups or categories to address the research question Voss (2010). The main idea is to compare and contrast these emerging patterns and themes across multiple cases to identify commonalities and differences and to explore the data further (Eisenhardt, 1989). By comparing how these uncertainties manifest across cases, the analysis reveals new patterns and causal mechanisms that may not be apparent within individual cases due to the lack of benchmark relationships for comparison (Miles and Huberman, 1994a; Yin, 2018). Visual representations, such as tables, are used to highlight similarities and differences, providing a clear and structured view of uncertainties and their implications. Chapter 7 provides cross-case analysis across all the cases and generates findings for the study by answering research questions.

Stages in Thematic Analysis

Thematic analysis is a technique for identifying, organising, analysing, describing, and reporting emerging themes derived from the collected data (Braun and Clarke, 2006). To conduct a thematic analysis, a three-step coding process, which includes open coding, axial coding, and selective coding, has been commonly utilised (Miles and Huberman, 1994a).

- **Open Coding** involves breaking down data into smaller units and assigning codes based on their contents. It begins at the onset of data collection when notes and other data sources are reviewed to identify essential terms, key concepts, or primary themes.
- **Axial Coding** involves organising and categorising the codes identified from the raw data into broader themes or categories. The focus is on finding connections between the codes to derive broader themes.
- **Selective Coding** involves refining and selecting the most relevant themes to the research questions and structurally relating them to the other categories. This will ensure that the analysis is focused on the emerged patterns from the data and that the research questions are addressed.

The study uses an abductive research approach, which allows for an iterative process of theory development and data analysis (Kovács and Spens, 2005). This approach will help researchers reshape the theoretical framework by moving back and forth between the theory and data based on

emerging insights (Dubois and Gadde, 2002). The theoretical foundation of this research is OIPT, and the developed framework can be reshaped using an abductive approach to data analysis.

Nowell et al. (2017) proposed a step-by-step procedure to conduct thematic analysis. For the purpose of this study, systematic thematic analysis is performed in four phases, as outlined below in Table 6.

Table 6: Step-by-step thematic data analysis (adapted from Nowell et al. (2017))

Data Analysis Phases	Sub-steps	Description
Data Structuring and Familiarisation	Initial Reading	- Organising primary and secondary data sources - Manually reading the entire data set to get an initial sense of content - Application of the theoretical framework to structure data collection (deduction)
	Note Taking	- Making notes of initial impressions and potential patterns - Annotating documents manually or using word processors
Initial Coding	Generating Codes	- Labelling chunks of data with codes across entire data set (**Open coding**) (induction) - Within case analysis - NVivo software to create and manage initial codes
	Reviewing Codes	- Review the codes to ensure key concepts and patterns in the data are captured - Reviewing codes within NVivo
Theme Development	Clustering Codes	- Grouping initial codes into broader categories that reflect meaningful patterns (**Axial Coding**) (Induction) - Within Case and Cross-case Analysis - NVivo to cluster codes into categories
	Preliminary Themes	- Identifying relationships and developing preliminary themes from broader categories (**Selective Coding**) (Abduction) - Within Case and Cross-case Analysis - Uncertainty conceptualisation framework to match identified uncertainties into different types
Representing Data	Presenting Findings	- Linking findings to the RQs - Presenting findings in the form of summary table

This study aims to investigate and interpret the data thoroughly by combining within-case and cross-case analyses with the three-stage coding process of thematic analysis. The NVivo software will aid in organising and coding the data. Once the initial coding is performed, elements of the theoretical framework are brought into account to cluster the codes into different uncertainty types and identify preliminary themes. An abductive approach enables a dynamic back-and-forth between theory and data, leading to a refined theoretical framework.

4.4.7 Quality of the Research

In qualitative research, it is important to ensure the quality of the research to maintain its integrity and trustworthiness. This study follows four criteria to ensure the quality of the conducted research: *Credibility, Transferability, Dependability,* and *Confirmability* (Lincoln, 1995; Shenton, 2004). These are further discussed below.

Credibility refers to the trustworthiness of the research findings (Lincoln, 1995). Brewer and Hunter (1989) suggest that combining different methods helps address their limitations and leverage their specific advantages. This study enhanced credibility by employing multiple strategies, such as triangulation, which involved comparing data from interviews, direct observations, and documents to identify consistent patterns and themes. Another form of triangulation could include using a diverse group of informants whose viewpoints and experiences can be cross-validated. This will lead to a comprehensive understanding of the attitudes or behaviours being studied (Shenton, 2004). This study brings the broader SNA perspective on uncertainties, ensuring that the viewpoints were validated across all the actors. In addition to triangulation, member checking was also employed to enable participants to review and provide feedback on the findings, ensuring their perspectives were accurately represented.

Transferability refers to the degree to which the research findings can be extended and applied to other contexts or populations (Merriam and Tisdell, 2015). This was addressed by providing a detailed description of the research context and participatory cases, as well as the setting and conditions under which the research was conducted. Such comprehensive descriptions allow other researchers to determine the applicability of the findings to different settings.

Dependability refers to ensuring the entire research process is logical, traceable and clearly documented (Merriam and Tisdell, 2015). For this study, the research design has been explained in detail by describing how the research will be conducted and executed. Furthermore, this research thoroughly documents the operational aspects of data collection and analysis. This will provide transparency and allow for the research process to be replicated and reviewed by others.

Confirmability refers to neutrality, where the findings are shaped by the participants and not researcher bias and objectivity of the research findings (Shenton, 2004). To ensure confirmability, the supervisory team continuously analyses and evaluates the study's findings. In addition, a report was provided to the cases to ensure the conclusions are free from researcher bias and subjectivity.

To summarise, this study employs various strategies to ensure and enhance the quality of the research. All the aforementioned criteria were considered and addressed to ensure the credibility, transferability, dependability, and confirmability of the study.

4.5 Summary

This chapter provided a comprehensive overview of the research methodology employed in this study. It began with selecting interpretivism as the philosophical paradigm guiding the research (section 4.1.2). The chosen research approach is abductive, and then clarifying the study serves an exploratory purpose (section 4.2).

The research strategy was described, focusing on the multiple embedded case study (section 4.3). Within the case study design, the choice of the SNA as the unit of analysis and its relevance to the study (section 4.4.3). Section 4.4.4 detailed the case selection criteria, resulting in the recruitment of 19 cases with 50 participants from internal and external stakeholders.

Section 4.4.5 covered the data collection methods, including semi-structured interviews as the primary source and secondary sources of data such as observations, documents, and others. The section also detailed the design of the interview guide. Subsequently, section 4.4.6 outlined the data analysis plan and process, describing the steps of thematic analysis to draw meaningful conclusions. Finally, the chapter concluded by detailing the steps taken to ensure the quality and rigour of the research (section 4.4.7).

5. CASE STUDY DESIGN EXECUTION

This chapter outlines the practical implementation of the multiple-embedded case study research design, including the actions taken to collect and analyse data after the planning phase. It begins by discussing the pilot study conducted with a manufacturing case, where the objectives of the pilot and the key findings are presented, along with any adjustments made to the main research design based on these insights (section 4.4). Following this, detailed case descriptions of the selected manufacturers, customers, distributors, and technology suppliers are provided to offer essential context and background for the subsequent analysis (section 5.3). The execution of the data collection is then explained in section 5.2. Finally, the chapter describes the execution of the data analysis (section 5.4). It explains the development of the codebook, with a particular emphasis on how the codes were created, defined, and systematically applied to the data. The codebook ensures transparency and consistency in the analysis, facilitating the interpretation of the findings.

5.1 Validating Case Study Design

A pilot study is a preliminary investigation conducted to refine the research design and data collection plan before the main study (Yin, 2018). By trialling a segment of the planned research, the pilot provides an opportunity to validate and adjust the design, ensuring the interview questions and procedures are well-suited to meet the research objective. This process is recommended as an essential step before carrying out the main study to reveal any inadequacies, ensuring that the subsequent research yields reliable and high-quality results (Yin, 1994).

5.1.1 Purpose of Validation

The main purpose of validating the designed case study is for the following:

- **Validate the understanding of IPNs and IPCs:** The pilot aimed to test the framework for understanding the Information Processing Needs (IPNs) and Information Processing Capabilities (IPCs), specifically digital and data capabilities, to ensure it aligned with the study's aim. This framework is illustrated in Figure 8 below.

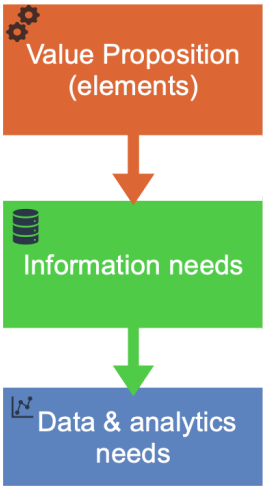

Figure 8: Initial framework to validate case study design

- **Test and refine the interview guide**: This involved assessing the clarity and relevance of the interview questions to ensure that they were appropriately structured to capture the necessary data.
- **Confirm the boundaries of the unit of analysis**: This step was crucial to ensure that the defined scope and unit of analysis are well-suited for addressing the research questions.

The pilot study was conducted with seven participants from different departments within Case PrintCo (Table 8). This provided the opportunity to assess the applicability of the research framework and ensure the relevance of the questions, focusing on the context of advanced services, information processing, and internal stakeholder perspectives.

5.1.2 Implications and Benefits of the Validation

The pilot revealed that identifying Information Processing Needs (IPNs) was more complex than initially expected. Participants demonstrated a lack of clarity regarding the overall concept of advanced services, which was relatively new to them. During the interviews, numerous information needs emerged, indicating that the initial framework was insufficient for capturing the complexity of these needs. This lack of structure highlighted the necessity for a more robust approach. Furthermore, it became apparent that without a clear understanding of the IPNs, it is challenging to capture IPCs.

Given that advanced services are a relatively new concept, understanding the IPNs is a crucial first step, as they directly inform the specific IPCs required to address these needs. In response to these challenges, it became apparent that using uncertainties as the lens through which to examine IPNs would provide a more structured and comprehensive approach. This approach has been previously used in studies (Premkumar et al., 2005). Uncertainties, by nature, drive IPNs and focusing on uncertainties allowed for a more structured and comprehensive way to capture the necessary data. This shift in focus allowed for a more detailed and accurate understanding of how IPNs arise. Therefore, the focus shifted towards identifying uncertainties rather than IPNs and IPCs.

Based on the insights from the pilot, the interview questions (section 11.5) and research framework (section 3.2) were refined to focus specifically on uncertainties, ensuring a more targeted and effective data collection process. The pilot confirmed that the selected unit of analysis, which focuses on both internal and external stakeholders, was feasible. This allowed for interviews across a wider range of stakeholders to provide a comprehensive view of the uncertainties in advanced services. The inclusion of external stakeholders ensured that the scope was sufficiently broad to capture their perspectives.

In summary, the pilot study was instrumental in refining the research design and data collection methods. It led to a significant shift in focus from IPNs and IPCs to uncertainties, which were found to be a more effective way of capturing the complexities within the case organisations. This foundational step laid the groundwork for the subsequent main study, ensuring its robustness and relevance.

5.2 Case Descriptions

This section provides a detailed description of the manufacturers, customers, distributors, and technology supplier cases involved in this study. All three manufacturing firms are in the early phases of advanced services (section 4.4.4). The descriptions provide essential background information on each case, including its context to advanced services and participants interviewed. A total of 50 participants were interviewed across all cases. To maintain clarity and ensure the confidentiality of both internal and external stakeholders, each participant was assigned an interview code.

5.2.1 Case Description of Internal Cases

This section provides a brief overview of the manufacturers' cases, including the company's background and its context in relation to advanced services. Table 7 summarises the three primary cases of manufacturers involving Case PrintCo, RoboCo and BoilerCo.

Table 7: Brief Overview of Manufacturer Cases

Case	Company	Size	Product Portfolio	Potential AS Offering	Participants Interviewed	Secondary Data Sources
PrintCo	Manufacturer of coding and marking printing equipment with full traceability solutions	3000+ across 120 countries	Product printing, case printing and labelling, consumables, sector solutions, serialisation, etc	Coding as a Service, potentially offering guarantees on their coding solution with a fixed price per code	17	Workshop observation, Weekly teams, meeting, website, documents, company website, LinkedIn
RoboCo	Industrial Automation Solutions	30,000+ across 110 countries	Automation Systems, Machine Safety Technology, Robotics,	Guarantee the performance of automation solutions.	9	Workshop observation, company website, LinkedIn

			Sensing, Machine Vision, Software, etc			
BoilerCo	Manufacturer of fuel-efficient steam and hot water boiler solutions	125+ across UK	Steam Boiler Solutions, Industrial Boiler Ancillaries, Hot Water Boiler, Heat Recovery & Waste Heat Boiler, etc	Steam as a Service, potentially offering guarantees on their steam and hot water boiler solutions	7	Workshop observation, company website, LinkedIn

A total of 33 participants were interviewed from the three manufacturer cases. Table 8 presents a summary of the interviewee roles, the department or team they are part of, and their years of experience within the business. Each participant has been assigned an interview code to ensure anonymity and allow cross-referencing during the analysis. The following sections provide further details of these cases.

Table 8: Summary of Key Participants from Manufacturer Cases

Case	Interview Code	Interviewee Role/Title	Team/Department/Division	Experience (Years) in firm
PrintCo	Intr1PrintCo	Director Services	Product Management	17
	Intr2PrintCo	Senior Product Manager	Product Management	4
	Intr4PrintCo	Service Manager	Sales	16
	Intr4PrintCo	Group Data and Analytics Director	IT	
	Intr5PrintCo	Data Analytics Manager for Engineering	IT	20
	Intr6PrintCo	Data Scientist	Technical	2
	Intr7PrintCo	Global Head of Pricing	General Management/Admin	14
	Intr8PrintCo	Group Pricing & Spares Manager	Group Pricing	18
	Intr9PrintCo	Head of UK Sales	Sales Management	12
	Intr10PrintCo	Group Customer Experience Programme & Change Manager	Customer Experience	6
	Intr11PrintCo	Group Customer Experience Programme & Change Manager	Customer Experience	4
	Intr12PrintCo	Programme Manager (Service and Automation)	General Management/Admin	1
	Intr13PrintCo	Area Sales Manager	Sales	7
	Intr14PrintCo	Product Manager (Services)	Portfolio Management & Advanced Services	5
	Intr15PrintCo	Senior Software Engineer	Product Management	4
	Intr16PrintCo	Business Development Manager	Product Management	14
	Intr17PrintCo	Head of Technical Service	General Management/Admin	9
RoboCo	Intr1RoboCo	Business Development-Global Account Management	Product Management	22
	Intr2RoboCo	Solutions and Service Manager	Sales	25
	Intr3RoboCo	Senior Manager	Sales	16
	Intr4RoboCo	R&D In-charge	R&D	30
	Intr5RoboCo	Industry Marketing Manager	Marketing	6

	Intr6RoboCo	Key Account Manager for Environmental Mobility	Sales	10
	Intr7RoboCo	Service Manager	Product Management	22
	Intr8RoboCo	Global Account Manager	Sales	34
	Intr9RoboCo	Project Manager Advanced Services	Product Management	25
BoilerCo	Intr1BoilerCo	Sales Engineer	Technical	
	Intr2BoilerCo	Business Support Engineer	Technical	4
	Intr3BoilerCo	Service Manager	Product Management	
	Intr4BoilerCo	Head of Sales	Sales	16
	Intr5BoilerCo	Commercial Director	General Management/Admin	11
	Intr6BoilerCo	Mechanical Electrical Project Manager	Technical	2
	Intr7BoilerCo	Technical Director	General Management/Admin	

Case PrintCo: Printing solutions

Case PrintCo is a global manufacturer of coding and marking printing equipment, employing over 3,000 people across 120 countries. The company specialises in digital printing and traceability solutions across various sectors, including food, beverage, life sciences, packaging, etc. Their diverse product technologies enable printing on everyday items such as cans, eggs, cartons, glass, trays, household goods, and more. In addition to its diverse product range, Case PrintCo offers various services, from base to intermediate. Base services include spare parts, warranties, and ad-hoc repairs, while intermediate services cover scheduled maintenance, inspections, and overhauls. Case PrintCo is in the early stages of moving from a traditional product and aftersales service model to the provision of advanced services. This strategic expansion is intended to secure a more stable, long-term revenue stream and enhance customer retention. Customers purchase products and services, such as hardware, software, consumables, training programmes, and maintenance services, separately. Through advanced services, Case PrintCo seeks to provide outcome-based solutions where payments are tied to performance metrics. This approach transfers the risks and responsibilities to Case PrintCo and supports customers by reducing errors, minimising downtime, and improving quality. At this stage, Case PrintCo is engaging with internal stakeholders, customers, distributors, and technology suppliers to understand the potential of advanced services for the business.

Case RoboCo: Industrial automation solutions

Case RoboCo is a global leader in industrial automation solutions founded in the 1930s. The company employs over 30,000 people across 110 countries. It provides integrated solutions that include sensing, control, safety, vision, motion, robotics, etc. They service various industries, including electronics manufacturing, life sciences automation, logistics and warehouse automation, automotive and electric vehicle manufacturing, and food and beverages. Beyond industrial automation, the company extends its expertise to electronic components, social infrastructure systems, healthcare, and environmental solutions. Case RoboCo offers a range of service portfolios, including repairs, training, safety, and robot services, as well as regular maintenance and support.

In the context of advanced services, Case RoboCo is exploring the potential to provide guaranteed outcomes to machine builders. Unlike OEMs, Case RoboCo may not directly offer guarantees to end customers at this stage. The company uses data analytics and AI for performance advisory services (intermediate services) to enhance machine uptime. Case RoboCo's long-term goal is to guarantee the performance of its automation solutions on production lines, where customers would pay on a fixed hourly basis. Case RoboCo is in the exploration and engagement phase, working to assess the feasibility of these advanced services and collaborating with internal stakeholders to understand the wider implications of such offerings.

Case BoilerCo: Steam and boiler solutions

Case BoilerCo is a manufacturer of industrial boiler solutions founded in the 1960s. The company specialises in the design and manufacture of fuel-efficient steam and hot water boiler solutions for various industrial applications. Case BoilerCo's advanced boiler-house technology is instrumental in minimising operational downtime, optimising fuel usage, and enhancing overall efficiency. Their service offerings cover the complete product lifecycle, including design, manufacturing, installation, ongoing servicing, training, and provision of spare parts, ensuring an integrated and comprehensive solution for customers. Case BoilerCo operates globally and has substantially contributed to reducing carbon footprints across various sectors.

In terms of advanced services, Case BoilerCo is exploring the potential to offer guaranteed outcomes centred around energy efficiency. Currently, the company provides intermediate services such as performance advisory and remote support for preventive and unplanned maintenance issues. Additionally, the company uses the operational data to provide reports and offer recommendations to customers, ensuring optimal product performance. As part of their move toward advanced services, Case BoilerCo is developing a "Steam as a Service" model, which aims to offer customers a solution based on performance rather than product ownership. Currently, Case BoilerCo is in the exploration and engagement phase, working closely with internal stakeholders to assess the feasibility and scope of these advanced service offerings.

5.2.2 Case Description of External Cases

Customer Cases (C1-C10)

This section briefly overviews the customers' cases, including the company's background and information about equipment and their interactions with Case PrintCo. Table 8 summarises the ten customer cases.

Table 9: Brief Overview of Customer Cases

Case	Company	Size	Product Range	Sites with Case PrintCo Equipment	Interaction with Case PrintCo	Secondary Data Sources
C1	Multinational Dairy Cooperative	-	Milk, Cheese, Butter, and other	21 global factory sites	Weekly or monthly calls, visits and emails,	Company Website, LinkedIn

			dairy-based foods		depending on the site	
C2	Multinational Beverage Producer	700,000+ across 200 countries	Soft Drinks, Water, Coffee and Teas	5 sites in US with 66 different products	Intermittent with once or twice every few months	Company Website, Articles, LinkedIn
C3	Multinational Consumer Goods Producer	34,000+ across 200 countries	Toothpaste, Toothbrushes, Cleaning Agents, Prescribed Products and Pet Food	10 sites	Intermittent with once or twice every few months	Company Website, Articles, LinkedIn
C4	Multinational Conglomerate	1 million+ across 100 countries	-	39 sites in 4 countries	Weekly or monthly calls, visits and emails, depending on the site	Company Website, Articles, LinkedIn
C5	Multinational Hot Sauce Producer	195 countries	Signature Hot Sauce and various related Condiments	1 site in US with 45 different products	Intermittent with once or twice every few months	Company Website, Articles, LinkedIn
C6	Multinational Food Manufacturer	100 countries	Cereals, Snacks, Yogurt, and Convenience Meals	10 sites in US with 200 different products	Weekly or monthly calls, visits and emails, depending on the site	Company Website, Articles, LinkedIn
C7	Multinational Conglomerate	3000+ across 70 countries	Skincare, Haircare, Health Supplements, and Pain Relief	14 global factory sites	Weekly or monthly calls, visits and emails, depending on the site	Company Website, Articles, LinkedIn
C8	Alcoholic Beverage Producer	30,000+ across 180 countries	Spirits, Beer, And Wine	3 sites in Scotland and England with 180 different products	Intermittent with once or twice every few months	Company Website, Articles, LinkedIn
C9	Multinational Personal Care Manufacturer	88,000+ across 120 countries	Skincare, Haircare, Makeup, and Fragrance Brands	63 global factory sites	Weekly or monthly calls, visits and emails, depending on the site	Company Website, Articles, LinkedIn
C10	Multinational Snack and Confectionery Industry	90,000+ across 150 countries	Cookies, Chocolates, Gum, Candy, Baked Snacks and Beverages	34 global factory sites with 660 different products	Weekly or monthly calls, visits and emails, depending on the site	Company Website, Articles, LinkedIn

A total of ten participants were interviewed from the 10 customer cases. Table 9 provides a summary of the interviewee's roles and their years of experience within the business. Each participant has been assigned an interview code to ensure anonymity and allow cross-referencing during the analysis. The subsequent sections provide further details of these cases.

Table 10: Summary of Key Participants from Customer Cases

Case	Interview Code	Interviewee Role/Title	Experience (Years) in firm
C1	Cust1	Packaging Innovation Manager	9
C2	Cust2	VP Technical Services	13
C3	Cust3	VP Global Packaging and Sustainability	18
C4	Cust4	Senior Manager in Engineering	6
C5	Cust5	Directors of Engineering	5
C6	Cust6	Principal Packaging Engineer	13
C7	Cust7	Head of Technical Parts	3
C8	Cust8	Supplier Performance Manager	14
C9	Cust9	Head of Maintenance and Project	18
C10	Cust10	Sourcing and Packaging Manager	14

Case C1: Dairy Cooperative

Case C1 is a multinational dairy cooperative founded in 2000 and owned by farmers. It ranks among the largest dairy producers globally, specialising in the production and distribution of various dairy products, including milk, cheese, butter, and other dairy-based foods. The company operates in numerous international markets, delivering high-quality and nutritious products. Case C1 strongly emphasises sustainability, committing to various environmental initiatives, promoting responsible farming practices and reducing its carbon footprint.

Case C1 is a significant multinational account for Case PrintCo, with a presence across 21 sites in different countries. The interaction between Case PrintCo and Case C1 varies by location and involves regular communication through calls, visits, and emails every week. Case C1 has also engaged in late-stage customisation with Case PrintCo to accommodate specific operational needs. Case C1 typically purchases all equipment upfront (Capex) rather than leasing, finding ownership more straightforward due to the complexities introduced by new leasing regulations.

Case C2: Beverage Producer

Case C2 is a large multinational corporation founded in the 1800s. It currently operates in 200 countries and employs over 700,000 people worldwide. The company specialises in the production, packaging, and distribution of a wide range of beverages. In addition to its own proprietary brands, Case C2 collaborates with partner companies to produce and distribute their beverages. With over 225 bottling partners across 900 manufacturing facilities, the company manages a portfolio of 200 brands and thousands of beverage products, including soft drinks, waters, coffee and teas, reaching approximately 2.2 billion consumers globally.

Case C2 is a large national account for Case PrintCo, using 66 different product technologies across five of its manufacturing sites, which are covered by service contracts in the US. However, only one of these sites has its equipment connected to the Cloud, limiting Case PrintCo's ability to monitor other equipment in real-time. The interaction between Case PrintCo and Case C2 occurs intermittently, once or twice every few months. While Case C2 has begun moving from the Capex to the Opex model (paying based on usage/results), the company still finds owning equipment more beneficial for cost control.

Case C3: Consumer Goods Producer

Case C3 is a major multinational corporation founded in the early 1900s. It currently operates in 200 countries and employs more than 34,000 people globally. The company specialises in the production, packaging, distribution and sale of oral care, personal care, home care and pet nutrition products. Case C3's products include well-known brands of toothpaste, toothbrushes, cleaning agents, prescribed products and pet food. The company has established a strong presence in both developed and emerging markets, driven by its commitment to innovation and high-quality products. Case C3 also collaborates with numerous partners to enhance its product offerings and to reach a diverse global consumer base, with a focus on sustainability and health.

Case C3 is a large multinational account that uses various product technologies across 10 of its sites, which are direct sales territories for Case PrintCo. The company uses a mix of leasing and purchasing equipment, with decisions based on the anticipated useful life of the equipment and relevance to ongoing operations.

Case C4: Conglomerate

Case C4 is a large multinational conglomerate founded in the late 1800s. It operates in over 100 countries and employs over 1 million people. It specialises across various business sectors, including steel, automotive, IT, infrastructure, chemical, consumer and retail, etc. The company is committed to sustainability and innovation, driving advancements in technology and infrastructure while focusing on long-term value creation for its stakeholders. Case C4's strategic partnerships and continuous investment in R&D are aimed at improving its competitive edge and delivering value through its wide range of products and services.

Case C4 is a global account for Case PrintCo, using various product technologies across 39 sites in 4 countries. One European site utilises cloud technology for product connectivity. Case C4 has a mix of Capex and Opex purchasing models that allow flexibility in managing equipment across production lines.

Case C5: Hot Sauce Producer

Case C5 is a multinational corporation founded in the late 1800s. It has grown its global presence in over 195 countries and territories worldwide. The company specialises in the production, packaging, and distribution of its signature hot sauce and various related condiments. Case C5 is dedicated to maintaining traditional production methods while innovating with new flavours. The company is committed to sustainability by following environmental practices and supporting local initiatives.

Case C5 is a large national account, operating a single manufacturing site in the US and utilising over 45 different product technologies. Some of these products are connected to the cloud. Case PrintCo and Case C4 interact periodically, once or twice every few months. Case C5 has opted for a leasing programme (do not own equipment) with Case PrintCo, facilitating easier long-term maintenance and management.

Case C6: Food Manufacturer

Case C6 is a major multinational corporation founded in the late 1800s. It operates in over 100 countries. The company specialises in the production, packaging, and distribution of a wide range of food products. Its product portfolio includes some of the world's most recognisable brands in categories such as cereals, snacks, yogurt, and convenience meals. Case C6 strongly emphasises innovation, sustainability, and quality, continuously developing new products that meet evolving customer needs. Case C6 has an extensive distribution network and strategic partnerships that ensure its products reach millions of households worldwide.

Case C6 is one of the large multinational customers, using 200 different product technologies across 10 sites in the US. Due to Case C6's global presence and diverse brand portfolio, it remains unclear how many other sites or countries actively use Case PrintCo's products. In the US, two sites have equipment connected to the cloud. The nature of interaction between Case PrintCo and Case C6 varies by site, with communication taking place through calls, visits, and emails on a weekly basis. Case C6 has a mix of Capex and Opex purchasing models for various equipment on their production lines. For certain suppliers, Case C6 maintains contracts with terms and conditions that include performance metrics like availability and uptime alongside penalties for underperformance.

Case C7: Healthcare and Skincare

Case C7 is a large multinational conglomerate founded in the 1970s. The company has expanded its reach in over 70 countries, employing more than 3000 people globally. It specialises in the production and distribution of various personal care and healthcare products of more than 20 brands. Its extensive product portfolio includes well-known brands in skincare, haircare, health supplements, and pain relief. Case C7 combines traditional wisdom with modern science to develop innovative products, focusing on eco-friendly practices and community development initiatives.

Case C7 is a large national account for Case PrintCo, using different product technologies across 14 sites. One of these sites has products connected to the cloud for real-time monitoring. The interaction between Case PrintCo and Case C6 varies by site, involving calls, visits, and emails on a weekly or monthly basis. Case C7 typically purchases all equipment upfront (Capex) rather than leasing, the business finds owning the equipment easier for cost control.

Case C8: Beverage Producer

Case C8 is a leading manufacturer of alcoholic beverages with over 200 brands. It was founded in the 1990s. The company operates in over 180 countries and employs more than 30,000 people globally. Case C8 has a diverse product portfolio, including renowned brands such as spirits, beer, and wine. The company strongly emphasises sustainability by prioritising eco-friendly practices and responsible drinking initiatives.

Case C8 is a national customer for Case M, using over 180 product technologies across 3 sites in Scotland and England. The interaction between Case PrintCo and Case C8 occurs once or twice

every few months. Case C8 is trailing a new purchasing model with one of the suppliers, where payment is based on output performance.

Case C9: Personal Care

Case C9 is a global leader in the beauty and cosmetics industry founded in the early 1900s. The company operates in over 150 countries and employs more than 88,000 people worldwide. It specialises in the manufacturing of a wide range of personal care products. Case C9's extensive product portfolio includes skincare, haircare, makeup, and fragrance brands. The company implements eco-friendly practices throughout its global supply chain network and promotes initiatives to reduce its environmental impact.

Case C9 is a large multinational account of Case PrintCo, using different product technologies across nine countries with over 63 global factory sites. The interaction between Case PrintCo and Case C9 varies by site, involving calls, visits, and emails on a weekly or monthly basis. Case C9 typically purchases all equipment upfront (Capex) rather than leasing, the business finds owning the equipment easier for cost control.

Case C10: Food Manufacturer

Case C10 is a global multinational corporation in the snack and confectionery industry, founded in the early 1900s. It operates in over 150 countries and employs more than 90,000 people globally. Its extensive product portfolio includes cookies, chocolates, gum, candy, baked snacks and beverages. The company places a strong emphasis on sustainability and customer preferences, driving continuous innovation through investments in technical centres and establishing a global network to enhance its product offerings.

Case C10 is among the largest multinational customers for Case PrintCo, using more than 660 product technologies worldwide across 34 sites. Many of these sites have over 220 products on lease agreements, supported by service contracts with Case PrintCo. Additionally, a majority of the sites use automation software provided by Case PrintCo.

Distributor Cases (D1-D4)

This section provides a summary of the distributor cases, detailing each company's background, key service offerings, and interactions with Case PrintCo. Table 10 presents an overview of the four cases of distributors and the details of the participants interviewed. The following sections provide further details of these cases.

Table 11: Brief Overview of Distributor Cases

Case	Company	Location	Key Offerings	Services provided	Interactions with Case PrintCo	Secondary Data Source
D1	Production and logistics	Norway	Automation solutions, tracking, marking,	Customer-centric services,	Quarterly reviews	Company Website,

	solutions supplier		labelling systems, robotics	technology solutions		Document, LinkedIn
D2	Coding and Marking Solutions Supplier	Nigeria	Coding and marking products	Operators' training, 24-hour technical support, spare parts availability	Quarterly reviews and reactive interactions (commercial, technical, logistics)	Company Website, Document, LinkedIn
D3	Printing Solutions Supplier	Kenya	Tailored solutions for various industries and materials	Emergency services, installation and training, 24/7 helpdesk, financing plans	Quarterly reviews and reactive interactions (commercial, technical, logistics)	Company Website, Document, LinkedIn
D4	Automation Solutions Supplier	Greece	Integrated automation solutions, robotics	EaaS model (equipment rental, support, spare parts), advisory services	Quarterly reviews	Company Website, Document, LinkedIn

Summary of Key Participants from Distributor Cases

	Interview Code	**Interviewee Role/Title**	**Experience (Years) in firm**
D1	Dist1	CEO	11
	Dist2	Customer Support Analyst	4
D2	Dist3	CEO	43
D3	Dist4	Operations Director	8
D4	Dist5	CEO	10

Case D1: Production and Logistics Solutions Supplier

Case D1 specialises in providing automation solutions for production processes for food, beverage, pharmaceuticals and other industries based in Norway. It was established 25 years ago and employs over 50 people. By partnering with leading global manufacturers, the company focuses on marking, tracking, production management, labelling systems, and robotics. Case D1's commitment lies in improving production environments through advanced technology and developing customer-centric services. Case PrintCo has quarterly reviews with Case D1.

Case D2: Coding and Marking Solutions Supplier

Case D2 is a distributor of coding and marking printing solutions based in Nigeria. It is a private limited liability company established 27 years ago. The company supplies a wide range of products and additional services to support its customers. These services include operators' training, technical support with a fixed response time of 24 hours, and spare parts and equipment availability as part of its after-sale services. Case PrintCo has quarterly reviews with Case D2 and many reactive interactions regarding commercial, technical, and logistic matters.

Case D3: Printing Solutions Supplier

Case D3 is a leading distributor of coding, marking, labelling, and digital printing solutions based in Kenya. They provide solutions tailored to diverse applications and materials, from products to pallets

serving various industries. The company was established over 25 years ago. In addition to the diverse product range, they provide flexible service solutions, including emergency services, free installation and training for operators, 24/7 remote helpdesk support, and customised financing plans to ensure clients maximise their production efficiency with minimal downtime. Case PrintCo has quarterly reviews with Case D3 and several other reactive interactions regarding commercial, technical, and logistic matters.

Case D4: Automation Solutions Supplier

Case D4 is one of the leading industrial groups based in Greece. They specialise in integrated automation solutions for the industrial packaging and supply chain sectors. The company was established over 35 years ago. They offer code printers, labelling systems, check weighers, and complete robotics solutions. The company provides a comprehensive range of high-value services. Their rental services integrate equipment, technical support, spare parts, and consumables, adhering to the Equipment-as-a-Service (EaaS) model. Additionally, they offer advisory services to support their clients further.

Technology Supplier Cases (T1, T2)

This section briefly overviews the technology supplier cases, outlining each company's background, the services they offer, and their relationship with Case PrintCo. Table 11 summarises the two cases of technology suppliers and the details of the participants interviewed. Further details on these cases are provided in the following sections.

Table 12: Brief Overview of Technology Supplier Cases

Case	Company	Industry Focus	Technology Provided	Services	Relationship with Case PrintCo
T1	Hardware and Software Solutions	Transportation, Energy, Automation, Healthcare	Edge computing platforms, IoT solutions, data management systems	Embedded hardware for connectivity, cloud interfaces, real-time performance monitoring	Supplier of IoT technology to Case PrintCo; potential for strategic partnership in future
T2	Cloud-based Software Applications	Manufacturing	Cloud-based software, IoT integration, data management	Cloud storage, data analysis, dashboard creation, workflow management	Supplier of cloud-based software to Case PrintCo's; potential for strategic partnership in future
Summary of Key Participants from Technology Supplier Cases					
	Interview Code	**Interviewee Role/Title**		**Experience (Years) in firm**	
T1	Tech1	Technical Sales Manager		8	
T2	Tech2	CEO		5	

Case T1: Hardware and Software Solutions

Case T1 specialises in the design and development of advanced hardware and software solutions for various industrial applications. Their offerings include edge computing platforms, IoT solutions, and data management systems, serving the transportation, energy, automation and healthcare sectors. The company has a strong focus on innovation and quality. Their expertise in embedded technology enhances operational efficiency and connectivity for their customers.

Case T1 provides cutting-edge IoT technology to Case PrintCo, enabling remote product monitoring. The solutions from Case T1 include a cloud interface and hardware that gathers and transmits performance data and alerts to the cloud. This allows Case PrintCo to diagnose potential issues, identify root causes, and offer remote customer support, significantly reducing the need for on-site engineer visits. Real-time data is captured and displayed on custom dashboards, allowing Case PrintCo to proactively maintain product performance and support customers in managing the equipment effectively, leading to reduced downtime. Case T1 and Case PrintCo had a basic supplier-buyer relationship. Due to the high cost of the attached hardware, Case PrintCo is currently exploring how this relationship can be converted to a strategic partnership as it moves towards offering advanced services.

Case T2: Cloud-based software applications

Case T2 is a leading provider of cloud-based software solutions, specialising in developing robust platforms for various manufacturing sectors. Their cloud-based application integrates with IoT platforms, offering standard user interfaces and back-end functions to support connected services for manufacturers. This allows businesses to leverage product data and increase value for their customers.

Case T2 provides a cloud-based, IoT-enabled digital system that is the backbone of Case PrintCo's connected services. The data collected through the IoT technology by Case T1 is transmitted to Case T2. Case T2's software manages data storage, analysis, workflows, and user interfaces, creating dashboards and visualisations that make data clear and actionable. This enables Case PrintCo to make informed decisions based on real-time data, improving service delivery and customer support. While Case T2 currently operates as a technology supplier to Case PrintCo, there is a potential for this relationship to evolve into a more integrated partnership. Case PrintCo is exploring ways to deepen its collaboration with Case T2 by aligning its objectives and future plans.

5.3 Executing Data Collection

This section outlines the process followed to collect primary and secondary data from the cases. The primary aim of the data collection was to obtain comprehensive insights into each case, using semi-structured interviews as the primary method. As detailed in the previous section, the case descriptions presented essential background information on the manufacturers, customers, distributors, and technology suppliers. A total of 50 participants across these cases were interviewed to gather insights related to uncertainties in advanced services.

Among these participants, some were based in the UK, while others were located globally across different countries. As a result, all interviews for primary data collection were conducted online via Microsoft Teams. As outlined in section 11.5, the interview guide was followed consistently across all interviews. Each interview session lasted between 45 and 90 minutes.

Given that Case PrintCo is part of a longitudinal case study, several in-person visits were made to the company over a two-year period in the UK. These visits allowed for contextual insights that complemented the interview data. Additionally, secondary data collection involved workshop observations in which some workshops were held in person, while others were conducted online using digital collaboration platforms such as Miro. The use of both in-person and online workshops, as illustrated in Figure 9, provided further triangulation of the data, reinforcing the depth and breadth of the insights gathered.

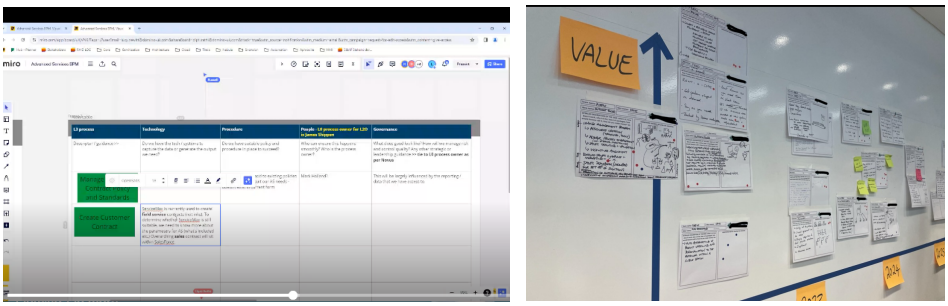

Figure 9: Direct Observation through Workshops

Moreover, over the two-year period, The Advanced Services Group at Aston University hosted various industry partnership roundtables. These roundtables involved all three manufacturing cases (PrintCo, RoboCo, and BoilerCo) and several other industry partners. These roundtables provided valuable strategic insights into the cases. The observed sessions were crucial for gathering data on advanced services, as participating manufacturers shared their insights and challenges during each roundtable.

All collected data, including participant information, workshop materials, recordings, and additional documentation from the cases, were securely stored in the University's cloud system to ensure compliance with data protection and confidentiality requirements. Secondary data was also used to obtain background information on the cases, their services, and relevant project documentation. Public sources, including company websites, were used to describe the cases. The following section provides a description of the individual cases.

5.4 Executing Data Analysis

This section outlines the practical implementation of the data analysis process. It explains how the data is coded, categorised, and interpreted to draw meaningful insights from the interviews and other data sources. A research codebook was developed to ensure consistency throughout the coding process and to facilitate within-case analysis.

Coding Process

The research followed the steps of thematic analysis to identify, organise, analyse, describe and report the emerging themes from the data (refer to Table 6). After the completion of data collection, all interview transcripts, workshop notes, and related documents were organised and manually reviewed to gain an initial understanding of the content. This preliminary review helped identify key patterns and areas of interest. All data were imported into NVivo, a qualitative data analysis software, to help organise and manage the coding process. The NVivo software facilitated the efficient management of data and ensured a systematic approach to coding.

Research Codebook

A research codebook was developed to serve as a structured guide for the coding of unstructured data, thereby ensuring consistency and reliability across the entire dataset. The codebook was informed by the theoretical framework presented in section 3.2. It allowed the identification and categorisation of different uncertainties within each type based on factors identified from the literature. The coding process followed an abductive approach, combining deductive (theory-driven) and inductive (data-driven) reasoning. This approach allowed for flexibility in identifying emerging patterns from the data while still grounding the analysis in theoretical constructs. The within-case analysis started with Case PrintCo, including its embedded cases (Case C1 and Case D1). Case PrintCo was selected as a reference point due to its early familiarisation during the pilot study, while the embedded cases were chosen to facilitate the researcher's understanding of coding across a range of SNA (the unit of analysis).

The codebook's structure is designed to categorise uncertainties into distinct types, enabling a systematic examination of how these uncertainties manifest in advanced services. Figure 10 below provides an example of the coding tree. It illustrates how specific example quotes from the data were organised into first order, second order, and third order codes (categories) and aggregate concepts (uncertainty types).

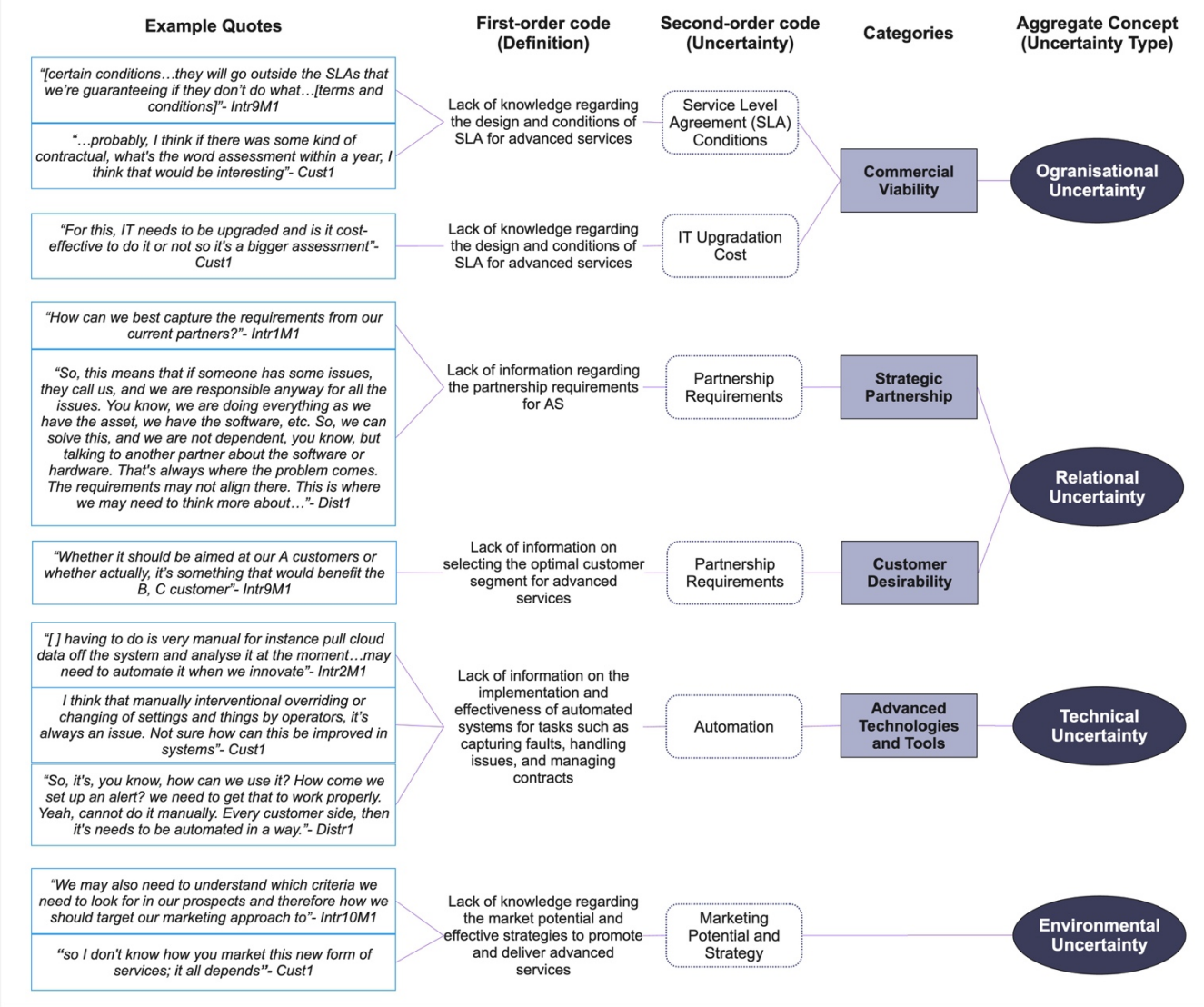

Figure 10: An example of the coding tree

This coding tree shows the progression from raw data (example quotes) to higher-level abstractions (uncertainty types), providing a clear view of the coding process. After this initial familiarisation with coding, the data were analysed following the same process in all the cases to identify patterns and develop insights. The aim was to capture all the uncertainties in the individual cases. A detailed description of the within-case analysis is provided in the next chapter.

In carrying out the analysis for RQ3, uncertainties were initially identified through the within-case analysis of each case. Following this, the likely implications were derived through an analytical interpretation of these uncertainties, considering their nature, patterns, and potential consequences. This interpretative process facilitated the examination of plausible outcomes that stakeholders might encounter, including operational inefficiencies, delays, misalignments, and rising costs. While not all the implications are directly evidenced in the data, they are grounded in a logical assessment of how identified uncertainties could affect internal and external stakeholders during advanced service innovation.

5.5 Summary

The chapter provided details on the execution of the research by outlining the practical steps taken to collect and analyse the data. It began with an overview of the pilot study conducted with Case PrintCo, which informed adjustments to the developed theoretical framework and the interview guide. Following this, the chapter provided a comprehensive background on each case. These descriptions provided essential context for understanding the diverse business environments and advanced services. Also, each case included a summary of the participants interviewed, presenting the necessary information. Following the case descriptions, the chapter discussed the execution of the data collection across the cases.

Finally, the execution of data analysis is discussed. The section outlined the thematic analysis process and the development of a research codebook, which facilitated the systematic coding and categorisation of uncertainties. The coding framework was structured to align with the theoretical framework, enabling an organised approach to identifying and interpreting key themes. The within-case analysis of Case PrintCo and its embedded cases provided a reference point for subsequent case analyses, ensuring consistency in the interpretation of data. The following chapter presents the final coding of the data obtained from the individual cases.

6. WITHIN-CASE ANALYSIS

This chapter presents a detailed analysis of the individual cases studied. Following an embedded multiple-case study design, the analysis is structured around the main manufacturing cases and the embedded cases involving customers, distributors, and technology suppliers. The research framework illustrated in section 3.2 is employed to analyse and categorise uncertainties specific to each type, i.e., organisational, relational, technical and environmental. Building on the coding process executed in the previous chapter (section 0), this chapter uses the research codebook to finalise the coding of the data for individual cases. This within-case analysis represents definitive coding, categorisation, and interpretation of the data from the cases. The thematic step-by-step process thoroughly analyses each case and lays the groundwork for the broader cross-case analysis in the next chapter. The chapter offers context-specific insights essential for drawing conclusions during cross-case comparisons.

The within-case analysis is structured in two sections. The first section focuses on analysing and identifying uncertainties faced by internal stakeholders in the three manufacturer cases: PrintCo, RoboCo, and BoilerCo. In each case, four uncertainty types are analysed. The second section focuses on analysing and identifying uncertainties faced by external stakeholders involving customers (C1-C10), distributors (D1, D2, D3, and D4), and technology supplier (T1 and T2) cases, providing a comprehensive exploration of uncertainties and their implications at the individual case level.

6.1 Internal Stakeholders Uncertainties

6.1.1 Case PrintCo

Organisational Uncertainty

In Case PrintCo, interviews with internal stakeholders identified several organisational uncertainties. Subsequently, these were grouped into *Internal Dynamics, Commercial Viability, and AS Scope & Understanding*. As described in the previous chapter, the analysis follows an abductive approach to identify and categorise uncertainties in each type (sections 4.4.6 and 5.4). Table 13 lists these uncertainties and provides their definitions.

Table 13: Organisational uncertainties apparent in Case PrintCo

Uncertainty Category	Uncertainty	Definition	Inferred Implications
Internal Dynamics	Culture and Mindset Change	Lack of understanding regarding the cultural and mindset shift towards AS	Less buy-in from stakeholders
	Roles and Responsibilities	Lack of knowledge about the specific roles and responsibilities for AS	Delays in strategic decision-making and development process
	Skillsets and Expertise	Lack of knowledge about the required skills and expertise for AS	Operational inefficiency
	People Training	Lack of understanding about the necessary trainings to deliver AS	Operational inefficiency, misalignment of customer

			expectations and increased costs
	Resources & Capabilities	Lack of understanding regarding the allocation and availability of resources and capabilities for AS	Delays in resource allocation and increased costs
	Organisational Structure	Lack of understanding about how to effectively organise the firm's processes, people and tools for AS	Delays in strategic decision-making
	Business System and Processes	Lack of understanding of the internal systems and processes required to facilitate AS	Delays in the development process and operational inefficiency
	Sales Team	Lack of certainty regarding the sales team's comprehension and their ability to effectively communicate and sell AS to customers	Misalignment of customer expectations and delays in the development process
	Dedicated AS Team	Lack of certainty about having a dedicated AS team within the business	Delays in the development process and strategic decision-making
Commercial Viability	Pricing Model & Strategy	Lack of information regarding the pricing strategies for AS	Delays in strategic decision making and development process, and market receptiveness
	Service Level Agreement (SLA) conditions	Lack of knowledge regarding the design and conditions of SLA for AS	Misalignment of customer expectations and delays in strategic decision making
	Financial Benefit	Uncertainty about the revenue generation potential from AS	Delays in strategic decision making and less buy-in from stakeholders
	Funding	Lack of certainty in securing the necessary funding for AS	Delays in decision making and less buy-in from stakeholders
	Legal & Commercial Risk	Lack of knowledge about the legal and commercial aspects of the SLA	Compliance issues and contractual disputes
AS Scope & Understanding	AS Knowledge & Understanding	Lack of definite knowledge and understanding about the overall concept of AS	Less buy-in from stakeholders and delays in the development process
	Value Proposition	Lack of understanding of the specific meaning and boundaries of the value proposition	Misalignment of customer expectations
	Service Guarantee	Lack of understanding about the feasibility of providing guarantees in AS	Operational inefficiency and delays in the development process
	Naming Conventions and Hierarchies	Lack of understanding about the definitions and terminologies used for AS	Less buy in from stakeholders

Internal Dynamics

The Internal Dynamics category captures uncertainties arising from the interplay between human and structural factors. Several uncertainties were identified and coded in this category, as summarised in Table 13 above. Organisational uncertainty often stems from internal resistance, misalignment in strategic priorities, and insufficient understanding or allocation of resources necessary for new initiatives within the business (section 2.4.3). These factors can create significant barriers to change, particularly when shifting from a product-centric to a service-centric business model.

In the context of Case PrintCo, a significant uncertainty relates to the **lack of understanding regarding the cultural and mindset shift towards advanced services**[3], as indicated by these statements from participants in Case PrintCo:

> *"So, the culture of the company, whether they want to change or not when it comes to offering advanced services"- Intr9PrintCo*

> *"I have an expectation that there will be resistance within certain teams because there's either a lack of understanding about why it's important for the business, why it would help us and or it's significantly complicating their life"- Intr2PrintCo*

Another critical uncertainty within this category is the **lack of understanding regarding the allocation and availability of resources and capabilities for advanced services.** Participants expressed that advanced services are new to them, and they are unaware of what is required to develop such services. Additionally, there is concern about whether the organisation currently possesses all the necessary capabilities to move forward, as highlighted by the participants:

> *"for advanced services development in [ ], there's been a lack of resource"- Intr2PrintCo*

> *"Against what capabilities we need going forward to help us achieve that and some other bits". -Intr1PrintCo*

These uncertainties have led to *a year-long delay*[4] in developing advanced services in Case PrintCo. Organisational culture plays a critical role in adopting new business models, and resistance to change can delay or complicate progress. Despite the company's offerings, including aftersales services, the prevailing culture remains predominantly product-centric, which led to *less buy-in from stakeholders* of Case PrintCo. Additionally, uncertainty surrounding roles and responsibilities within the organisation has led to confusion as participants were unsure of their specific contributions and how they aligned with the overall goals of advanced services. This caused *delays in strategic decision-making* for advanced services. Additional uncertainties within this category and supporting statements are detailed in **Appendix 1** (section 11.1).

Commercial Viability

The Commercial Viability category describes uncertainties surrounding the sustained profit-generating ability of advanced services in the market through a competitive pricing model. During the interviews, participants demonstrated a **lack of understanding regarding revenue generation from advanced services** in the long run. This uncertainty stems from the challenge of predicting

[3] The bold text within the paragraphs represents the definitions provided in Tables
[4] The end of the paragraph presents with the texts in italic highlighting the likely implications of uncertainties

whether advanced services will provide a consistent and profitable revenue stream. Participants questioned the value propositions, potential financial benefits, and the balance between generating additional revenue and reducing operational costs:

> *"What the likely financial benefit is to our company if we choose [ ] value proposition"- Intr2PrintCo*

> *"What value they're bringing commercially to the business that probably the earliest stages of advanced services from a concept"- Intr7PrintCo*

> *"Are we trying to gain extra revenue or are we trying to reduce bad cost?" and if it's both, sometimes you won't – you know, what's going to be the main driver, bad cost of not sending engineers to the site, improve the revenue of we'll get extra profitability plus customer spending more with us"- Intr9PrintCo*

Another significant uncertainty within this category is the **lack of knowledge regarding the design and conditions of service level agreements (SLAs) for advanced services**. SLAs are critical to the effective delivery of advanced services, as they establish the specific terms and conditions under which these services are rendered. Participants in Case PrintCo raised concerns about meeting the required standards, handling deviations, and the potential implications of failing to fulfil the agreed-upon terms:

> *"[certain conditions…they will go outside the SLAs that we're guaranteeing if they don't do what… [terms and conditions]"- Intr9PrintCo*

> *"What if the code is 1mm outside the product? How would that be penalised or set in the contract? -Field notes (Workshop)*

These uncertainties led to a *misalignment of customer expectations* and the overall *receptiveness of the market* and caused *delays in strategic decision-making*. **Appendix 1** (section 11.1) details additional uncertainties and supporting statements.

AS Scope & Understanding

The Advanced Services (AS) Scope & Understanding category captures the uncertainties related to the knowledge base and individual perspectives on the overarching concept of advanced services within Case PrintCo, as shown in Table 13. Some participants expressed a **lack of definite knowledge and understanding about the overall concept of AS,** while others possessed limited knowledge and held varying opinions:

> *"This is just a new concept, that we may have an opinion, but it's not a definite, so it's the lack of information that we have"- Intr1PrintCo*

> *"I'm not totally certain on this definition, but it's been talked about"- Intr5PrintCo*

Another significant uncertainty within this category is the **lack of understanding about the feasibility of providing guarantees in advanced services** within Case PrintCo. Several participants expressed concerns about this aspect, and increased resistance was observed during the interviews, particularly when discussing the implications and practicalities of the term guarantee, as highlighted in the statements:

> *"It's just too much to guarantee in advanced services, and I don't know if we should do that"- Intr7PrintCo*

> *"So, to guarantee the uptime. Now, quite how that would play out in reality. I don't know for certain."- Intr5PrintCo*

> *"It will be interesting to see, are we ever going to be able to offer 100% guarantee"- Intr9PrintCo*

The lack of a clear understanding has led to a *misalignment of customer expectations* and *delays in the development process* in Case PrintCo. Additionally, the uncertainty regarding service guarantees led to the implication of *operational inefficiency*. **Appendix 1** (section 11.1) provides details of other uncertainties and supporting statements from participants.

Relational Uncertainty

The relational uncertainty type describes the unpredictability of a partner's action regarding advanced services. Several uncertainties emerged and were grouped into *Customer Desirability* and *Strategic Partnership*. Table 14 summarises these uncertainties within Case PrintCo.

Table 14: Relational uncertainties apparent in Case PrintCo

Uncertainty Category	Uncertainty	Definition	Inferred Implications
Customer Desirability	Target Customer Segment	Lack of information on selecting the optimal customer segment for AS	Delays in the development process and strategic decision-making
	Customer Engagement	Lack of information on whom to and how to engage within customer organisation for AS	Erosion of trust and collaboration and delays in development process
	Staff Turnover on Sites	Lack of information about the rate of staff turnover on customer sites	Operational inefficiency and increased risk of service failure
	Customer Activities	Lack of information about the customer activities on production lines	Operational inefficiency and increased risk of service failure
	Customer Requirements	Lack of clear understanding about the specific requirements of the customer	Misalignment of customer expectations and delays in development process
Strategic Partnership	Potential Partnerships	Uncertainty about potential partners for AS and how to sustain these partnerships effectively	Erosion of trust and collaboration and increased strategic risk
	Partner Requirements	Lack of information regarding the requirements of partners for AS	Potential conflicts and delays in development process

	Supplier Equipment	Uncertainty about the equipment provided by third party suppliers and its integration with product technologies	Operational inefficiency and increased risk of service failure
	Distribution Channel as Middleman	Lack of knowledge regarding the distributors' perspective and role in AS	Delays in strategic decision-making

Customer Desirability

The category of Customer Desirability captures uncertainties related to understanding and engaging with target customer segments for advanced services. It focuses on the unpredictability surrounding identifying and interacting with potential customers, which is essential for effectively innovating advanced services. The participants' statements indicate a significant uncertainty within Case PrintCo is the **lack of information on whom to and how to engage within customer organisation for AS**. This is particularly critical because the foundation of advanced services relies on effective customer engagement, yet Case PrintCo struggled to adopt a customer-centric approach, as indicated by these statements from participants:

> *"It's always a question about whom to connect at the customer site..."- Intr2PrintCo*

> *"I think we're struggling to get customers to engage on that…"- Intr3PrintCo*

> *"We were initially thinking about a needs-based proposition, in that case, how a customer wants to interact with us. So, we talked about self-serve, we talked about consultative, we talked about outcome-focused, and we talked about partnership"- Intr11PrintCo*

Another significant uncertainty within this category, highlighted by several participants, is the **lack of information on selecting the optimal customer segment for advanced services.** This lack of clarity impedes the company's ability to strategically focus its resources and tailor its services to meet the specific needs of the most relevant customer segments. Given that Case PrintCo operates across multiple sectors and serves a diverse range of customer segments, identifying the most appropriate targets for these services becomes complex, as indicated in these statements by the participants:

> *"And so yes, there's some value in […] quality, but it might be for a particular segment and not for all"- Intr8PrintCo*

> *"Whether it should be aimed at our A customers or whether actually, it's something that would benefit the B, C customer"- Intr9PrintCo*

> *"Do we really personalise, you know, our services and products and target those industries based on what matters to them? Probably not, if at all."- Intr11PrintCo*

The category is identified as the primary source of uncertainty in Case PrintCo. The uncertainties led to the *misalignment of customer expectations* as manufacturers' emphasis remains on the product rather than the customer. Consequently, this misalignment leads to *customer dissatisfaction*, which can strain relationships and *erosion of trust and collaboration* between manufacturer and customer. **Appendix 1** (section 11.1) details these uncertainties under this category.

Strategic Partnership

The category Strategic Partnership describes uncertainties associated with external stakeholder collaborations to provide advanced services. Table 14 illustrates the range of uncertainties that emerged from the interviews within Case PrintCo. As highlighted in section 5.2.1, Case PrintCo has collaborated with various suppliers for software and hardware solutions. Participants expressed a significant uncertainty as the **lack of information regarding the requirements of partners for advanced services,** given the current informal collaboration model involving biannual meetings:

> *"How can we best capture the requirements from our current partners?"- Intr1PrintCo*

> *"What we are doing now is we're trying to ask them what their plans are, how do they see the future? What do they know about that might impact our joint ability to serve? But we haven't really made this a structured development process that involves them" - Intr2PrintCo*

Another significant uncertainty pertains to the **lack of knowledge of the distributors' involvement and mindset for advanced services,** which complicates the process of reaching end customers. Moreover, Case PrintCo was not initially aware that its distributors operate with their own advanced services business model, which complicates coordination and integration efforts with end customers, as highlighted in these statements:

> *"The other half of the world, we go through distribution, which again creates more complexity to us in the sense that we're a bit further away from the customer"- Intr2PrintCo (Field note)*

> *"I am not sure if we then deal with a middle person or plan to sell directly to end-user"- Intr9PrintCo*

> *"Our distribution channels are already offering advanced services, so I am not sure how we should deal with this"- Intr11PrintCo*

These uncertainties underscore the critical role of partners and distributors in the service network and highlight the complexities they introduce for Case PrintCo. This complexity impacts manufacturers' *strategic decision-making* on whether to involve distributors in AS planning. Additionally, if the partner requirements are not well understood, the misalignment of goals can lead to *conflicts* and *delay the development process*. **Appendix 1** (section 11.1) provides further details of uncertainties under this category.

Technical Uncertainty

The technical uncertainty type reveals several uncertainties related to the technological resources and data infrastructure essential for successfully innovating advanced services. These uncertainties are grouped into *Advanced Technologies and Tools and Technical Infrastructure,* as presented in Table 15 below.

Table 15: Technical uncertainties apparent in Case PrintCo

Uncertainty Category	Uncertainty	Definition	Inferred implications
Advanced Technologies and Tools	Technology Upgrades	Lack of understanding of the required technology upgradation to support AS	Operational inefficiency, increased costs and delays in development process
	Automation	Lack of information on the implementation and effectiveness of automated systems for tasks such as capturing faults, handling issues, and managing contracts.	Operational inefficiency, increased costs, and increased resistance to technology adoption
	Cloud Interface	Uncertainty about cloud connectivity for all the equipment	Delays in development process, increased costs and strategic risk
	Technical Requirements	Lack of knowledge about the technical requirements from technologies, systems and equipment to support AS	Operational inefficiency and delays in development process
	Delivery Tools & Systems	Lack of knowledge about specific tools and systems required to support and deliver AS	Delays in strategic decision-making and increased costs
	Product Reliability & Developments	Lack of information regarding product reliability and future product developments	Operational inefficiency, increased costs and customer dissatisfaction
	Target Product Technology	Uncertainty about selecting the target product technology to offer AS	Delays in strategic decision-making
Technical Infrastructure	Data Requirements	Lack of understanding about the required data to effectively offer AS	Delays in the development process
	Data Availability	Lack of information about the availability of the necessary data to support AS	Data silos and fragmentation and delays in the development process
	Data Interpretation	Lack of understanding of how to map data to specific needs and provide actionable insights	Delays in the developments process, increased risk of service failure and customer dissatisfaction
	Technical Development	Lack of information about ongoing and required technical developments in the data infrastructure	Delays in strategic decision-making and increased costs
	Product Connectivity	Uncertainty regarding the reliability of product connectivity for data retrieval	Operational inefficiency, increase strategic risk, and delays in the development process
	Behaviours around the Product	Lack of information about the impact of external factors on the production line due to the operation of other machines and operators	Operational inefficiency

Advanced Technologies and Tools

The category Advanced Technologies and Tools describes the uncertainties about specific tools and technological developments crucial for advanced services. A notable uncertainty within this category is the **lack of knowledge about specific tools and systems required to support and deliver advanced services.** The uncertainty is particularly pressing as these tools are crucial for day-to-day operations and for fulfilling service promises like uptime guarantees. Participants expressed concerns about the availability and adequacy of these tools:

> *"A lot of these things on having the tools established that will achieve and deliver that uptime guarantee, we don't know yet"- Intr5PrintCo*

"You have to have the capacity and the tools to do it remotely, which might involve augmented reality tools. I don't necessarily think we have all those in place at the moment."- Intr6PrintCo

Another significant **uncertainty about cloud connectivity for all the equipment** was highlighted by multiple participants. Currently, not all assets in Case PrintCo are connected to the cloud for real-time data retrieval, which presents a considerable issue, as indicated in these statements:

"…a bit unsure if advanced services will only be offered on a printer having a [ ] cloud interface on it that pulls out even more detailed information"- Intr7PrintCo

"…the other thing to think about is when we deliver our service, it's got to have cloud or not…" -Intr9PrintCo

Additionally, participants indicated that adopting new technologies and tools for advanced services may lead to *increased costs* due to the necessary adjustments and adaptations. These uncertainties result in *operational inefficiencies* and *strategic risk* in designing and delivering advanced services due to the continuous evolution of technologies and systems. **Appendix 1** (section 11.1) provides a comprehensive overview of additional uncertainties in this category.

Technical Infrastructure

The category Technical Infrastructure describes uncertainties related to the data infrastructure and technical developments required to support advanced services. A significant uncertainty in this category is the **lack of information about ongoing and required technical developments in the data infrastructure**. Participants highlighted concerns regarding whether the existing infrastructure is adequate for collecting and processing data:

"Is that infrastructure enough for you to collect the data, push it through the cloud, get it onto where you're monitoring?"- Intr4PrintCo

"We capture some of this data in order to know how hot things are getting and so forth so we can spot any weaknesses from that data. But the infrastructure is not designed necessarily for advanced services"- Intr5PrintCo

Another critical uncertainty that emerged during the interviews pertains to the **lack of information about the impact of external factors on the production line due to the operation of other machines and operators.** The equipment provided by Case PrintCo is positioned at the end of production lines and must interact with several other machines. Additionally, frequent operator shifts changes introduce further uncertainties in managing and mapping these interactions, as suggested in these statements:

"There are other behaviours that happen around the [ ] which we need to think about measuring or certainly guessing indication."- Intr2PrintCo

"The downtime occurring at the location without technician interference, customer contact, and tech support. It's unknown to us, invisible, we don't know. And there's a large portion of those points is not captured in any way"- Intr7PrintCo

During the interviews, participants extensively discussed the necessary technical developments to support advanced services. The focus was on articulating specific data requirements and determining how to utilise this data to provide actionable insights, both internally and for customers. Difficulties extracting actionable insights from data and understanding external factors can *delay the development process*, leading to an *increased risk of service failure*. Additionally, poor data interpretation can result in *customer dissatisfaction*, as customers may not receive the timely and accurate information needed to improve their operations. **Appendix 1** (section 11.1) provides details of additional uncertainties under this category.

Environmental Uncertainty

The environmental uncertainty type describes the unpredictability and complexity of external factors. In Case PrintCo, no specific sub-categories were formed under this uncertainty type due to the limited number of codes, as presented in Table 16. These uncertainties reflect the broader external influences impacting advanced services.

Table 16: Environmental uncertainty apparent in Case PrintCo

Uncertainty	Definition	Inferred Implications
Competition	Lack of information about the competitors and their AS offerings	Increases strategic risk
Marketing Potential and Strategy	Lack of knowledge regarding the market potential and effective strategies to promote and deliver advanced services	Market receptiveness, delays in strategic decision-making, increased risk of service failure
Sustainability	Uncertainty about the long-term sustainability and viability of equipment	Increased costs and operational inefficiency

The participants' statements indicate a significant uncertainty is **the lack of information about competitors and their AS offering**. This affects Case PrintCo's ability to understand its competitive landscape, as highlighted by participants:

"I don't think we've looked closely enough at our competitor's offering, but now I can see one or two similar moves, Then maybe not; it's not fully advanced, I guess. I haven't been able to see what their proposal looks like. What do their terms and conditions in there?"- Intr2PrintCo

"I'm not sure whether this has been thought of, but as we aren't the only people selling this equipment – we have competitors"- Intr9PrintCo

"And then from the Case A's, it's being the eyes and ears of the business in any competitor information…maybe get a sense that?"- Intr7PrintCo

This lack of competitor insight affects the formulation of effective strategies and competitive positioning. Without a clear understanding of competitor activities, Case PrintCo struggles to strategically position its advanced services in the market, leading to *market receptiveness*. Another notable uncertainty is the **lack of knowledge regarding the market potential and effective strategies for promoting and delivering AS,** as indicated by the participants in Case PrintCo:

> *"If we choose value proposition which is maybe an [ ]..then how big is the potential market for that"- Intr2PrintCo*

> *"We may also need to understand which criteria we need to look for in our prospects and therefore how we should target our marketing approach to"- Intr10PrintCo*

> *"From the marketing point of view, we will target particular sectors or even from a kind of a sales point of view. We think there's an opportunity in this sector in this part of the world. Therefore, we want ourselves or our teams to go after that in terms of their kind of prospecting role. Umm, but I think it's probably fair to say there's not really much more than that done"- Intr11PrintCo*

The lack of market insight affects Case PrintCo's ability to effectively target and engage with promising market segments, which could limit its overall market performance and adoption of advanced services. The participants' statements indicate **uncertainty about the long-term sustainability and viability of equipment**:

> *"I think we're not seeing much of a push from our customers because it's just a small part of their production line, and the whole area of sustainability is one that we do need to do a lot more work to understand where the potential benefits are that advanced services will deliver?"- Intr2PrintCo*

While this may not be considered a critical point in the early stages of designing advanced services, it could impact customers' *long-term strategic planning* as the importance of sustainability increases. Addressing sustainability will be essential for the continued success and reliability of advanced services in the future.

6.1.2 Case RoboCo

Organisational Uncertainty

In Case RoboCo's organisational context, interviews with internal stakeholders revealed a diverse range of uncertainties. Table 17 summarises these organisational uncertainties below.

Table 17: Organisational Uncertainties apparent in Case RoboCo

Uncertainty Category	Uncertainty	Definition	Inferred Implications
Internal Dynamics	Culture and Mindset Change	Lack of understanding regarding the cultural and mindset shift towards AS	Less buy-in from stakeholders

	Roles and Responsibilities	Lack of knowledge about the specific roles and responsibilities for AS	Delays in strategic decision-making and development process
	Skillsets and Expertise	Lack of knowledge about the required skills and expertise for AS	Operational inefficiency
	People Training	Lack of understanding about the necessary trainings to deliver AS	Operational inefficiency, misalignment of customer expectations and increased costs
	Resources & Capabilities	Lack of understanding regarding the allocation and availability of resources and capabilities for AS	Delays in resource allocation and increased costs
	Organisational Structure	Lack of understanding about how to effectively organise the firm's processes, people and tools for AS	Delays in strategic decision-making
	Business System and Processes	Lack of understanding of the internal systems and processes required to facilitate AS	Delays in the development process and operational inefficiency
	Sales Team	Lack of certainty regarding the sales team's comprehension and their ability to effectively communicate and sell AS to customers	Misalignment of customer expectations and delays in the development process
	Cross-Collaborations	Lack of certainty about the effectiveness and coordination of cross-departmental collaborations within the business	Lack of certainty about the effectiveness and coordination of cross-departmental collaborations within the business
Commercial Viability	Pricing Model & Strategy	Lack of information regarding the pricing strategies for AS	Delays in strategic decision making and development process, and market receptiveness
	Financial Benefit	Uncertainty about the revenue generation potential from AS	Delays in strategic decision making and less buy-in from stakeholders
	Funding	Lack of certainty in securing the necessary funding for AS	Delays in decision making and less buy-in from stakeholders
	Legal & Commercial Risk	Lack of knowledge about the legal and commercial aspects of the SLA	Compliance issues and contractual disputes
AS Scope & Understanding	AS Knowledge & Understanding	Lack of definite knowledge and understanding about the overall concept of AS	Less buy-in from stakeholders and delays in the development process
	Value Proposition	Lack of understanding of the specific meaning and boundaries of the value proposition	Misalignment of customer expectations

Internal Dynamics

The Internal Dynamics category captures uncertainties arising from the interplay between human and structural factors. During the interviews, a key issue in Case RoboCo was the company's traditional focus on product sales. Participants highlighted a significant uncertainty related to the **lack of understanding regarding the cultural and mindset shift towards advanced services**:

> *"First concern was the internal mindset, and we are still struggling because our mindset is of a product manufacturing company. I mean, we are not yet in the position to openly discuss and talk about services"- Intr2RoboCo*

"Trying to build a services business on the foundations of a product sales business is very difficult. In fact, I'll go as far as to say I think it is impossible"- Intr3RoboCo

"How long does it take to move from the yellow box to the X as a service? I really don't know; the differentiation point in this approach is not the evolution of the company but the mindset of the people. We have a problem too because we are moving forward from our comfort area"- Intr9RoboCo

Another critical uncertainty within this category is **the lack of certainty regarding the salespeople's understanding and mindset towards AS,** indicated by several participants in Case RoboCo**:**

"I think we need to modify the business in a very revolutionary way to get it. So how do we measure our salespeople?"- Intr3RoboCo

"But for services, you have to talk about the customer. And that's a different ball game, in that we have 1500 people in sales in Europe, so how can we change 1500 people? Who are the local champions in our sales organisation that want to embrace this idea of service and how to help them?"- Intr4RoboCo

The sales team presents a notable source of uncertainty as their acceptance of advanced services remains unclear within Case RoboCo. These uncertainties impact the strategic direction, implementation, and overall success of Case RoboCo's advanced services. Various other uncertainties were encountered during interviews, detailed in **Appendix 3** (section 11.3), along with supporting statements.

Commercial Viability

The category **Commercial Viability** describes the uncertainties surrounding the sustained profit-generating ability of advanced services in the market through a competitive pricing model. Participants expressed the **lack of information regarding the pricing strategies for AS:**

"It's a question of our value proposition and the business model to say how we price it. Do we just sell a one-term solution for which the customer installs it? Let me say one cost, do we ask him for a subscription?"- Intr1RoboCo

"The question that we still have is related to putting the right price on this service. I think our prices are very low, but we don't have any experience or comparisons that we can make. So, we don't have at least some local references to use to understand if we are choosing the right price. We are very low, so we can ask more in my perception, but that again is my perception. I don't think we have the data to say, OK, we are in the right price position"- Intr7RoboCo

Another significant uncertainty within this category, which several participants of Case RoboCo highlight, is the **lack of knowledge about the legal and commercial aspects of the SLA**. They voiced concerns about the confidentiality of intellectual property and aligning SLAs with customer business requirements for advanced services:

"Work out exactly where it is, where you have to convince the business then not just in terms of the development, but in terms of what the risk profile looks like, especially if you're a product business like us so, what's the business's appetite to take on that level of risk"- Intr3RoboCo

"Just trying to look further around the complexities of legal design inside the discussion with customers. Because it's IP confidentiality and sharing information to affiliates and a lot more topics around this legal side of the agreement, we don't know yet"- Intr8RoboCo

Given the emerging uncertainties, this category is crucial as it significantly impacts customers' willingness to purchase and the overall market success of advanced services. Additional uncertainties identified within this category and supporting quotes are detailed in **Appendix 3** (section 11.3).

AS Scope & Understanding

The Advanced Services (AS) Scope & Understanding category captures uncertainties related to the knowledge base and individual perspectives on the overarching concept of advanced services within Case RoboCo, as shown in Table 17. Two significant uncertainties emerged during the discussions with the participants. The first pertains to a **lack of definite knowledge and understanding about the overall concept of advanced services.** Participants in Case RoboCo exhibited misconceptions and varying opinions about advanced services, revealing a general lack of clarity among them:

"I mean the misconceptions the management had around the services or what services mean, and still to this day we are fighting, but with the concept that everything we provide to the customer, support and services are free or cannot be charged, that's something still not completely clear"- Intr5RoboCo

"We instruct the customer how to use the product in the best way. So, this is a consultancy, let's say, a basic service here. I don't know if this is correct or not. I think the [ ] has been classified as advanced because it doesn't depend on our product. So, you can make this assessment despite the installation of the customer."- Intr7RoboCo

Another notable uncertainty that emerged from the interviews was the **lack of understanding about the specific meaning and boundaries of the value proposition.** Some participants indicated a clear understanding and involvement in exploring two distinct value propositions. Conversely, others suggested that they were already providing advanced services, specifically performance advisory services (Intermediate services), where more misconceptions were observed:

"I don't know if people around Europe or in general terms in Japan they understand fully how the process is done, what's happening in, you know, when you design the value proposition, how is the customer journey and that side exactly fit in, I'm not quite sure"- Intr5RoboCo

"I can say that you have this bottleneck on this line, but also change and then go through something like pay-per-performance activity. We cannot, but we are not the direct seller because we provide the product components, not the machines. But pay per performance is something that may be achievable but still a big question mark."- Intr7RoboCo

These uncertainties significantly impact Case RoboCo's strategies for developing advanced services and its understanding of the potential benefits. This category is crucial as it highlights the complexities associated with advanced services and how the overarching concept aligns with Case RoboCo's organisational framework.

Relational Uncertainty

The relational uncertainty type describes the unpredictability of a partner's action regarding advanced services. Several uncertainties emerged and were grouped into *Customer Desirability* and *Strategic Partnership*. A summary of these uncertainties is presented in Table 18 below.

Table 18: Relational uncertainties apparent in Case RoboCo

Uncertainty Category	Uncertainty	Definition	Inferred Implications
Customer Desirability	Target Customer Segment	Lack of information on selecting optimal customer segment for AS	Delays in the development process and strategic decision-making
	Customer Engagement	Lack of information on whom to and how to engage within customer organisation for AS	Erosion of trust and collaboration and delays in development process
	Customer Mindset & Expectations	Lack of knowledge regarding the customer's mindset and expectations for AS	Misalignment of customer expectations and customer dissatisfaction
Strategic Partnership	Potential Partnerships	Uncertainty about potential partners for AS and how to sustain these partnerships effectively	Erosion of trust and collaboration and increased strategic risk
	Partner Requirements	Lack of information regarding the requirements of partners for AS	Potential conflicts and delays in development process
	Distribution Channel as Middleman	Lack of knowledge regarding the distributors' perspective and role in the AS	Delays in strategic decision-making
	System Integrators & Machine Makers	Uncertainty about the collaborations with system integrators or machine makers for AS	Erosion of trust and collaboration and increased strategic risk

Customer Desirability

The category of Customer Desirability captures uncertainties related to understanding and engaging with target customer segments for advanced services. The participants' statements indicate that a significant uncertainty within Case RoboCo is the **lack of information on whom to and how to engage within customer organisation for AS**:

> *"the first uncertainty is really how you clarify with the customer what a data-driven business model is really about"- Intr1RoboCo*

> *"how mature is the company and how mature is the person in front of me when I speak about a complex topic like advanced Services?"- Intr2RoboCo*

Additionally, since Case RoboCo operates as a component and automation solution provider rather than a machine manufacturer, participants expressed concerns about the **lack of knowledge regarding the customer's mindset and expectations for advanced services**:

> *"I think the main concern is really to understand where the expectations are and bring them to a realistic level because most projects, and I have seen many projects failing most projects failing because the expectations were not managed in the beginning"- Intr1RoboCo*

> *"We'll have to think about formulas and different formulas just to get an agreement with customers to build a common ground of expectations"- Intr2RoboCo*

In this context, customers may not be accustomed to engaging with services within an industry focused on component provision. Participants in Case RoboCo emphasised the need for effective storytelling and compelling narratives to communicate the value propositions of advanced services. These uncertainties highlight the importance of this category, as it influences the success of advanced service initiatives. The lack of customer-centricity impacts *customer buy-in* for advanced services, leading to *misaligned expectations* and *delays in the design process*.

Strategic Partnership

The Strategic Partnership category describes uncertainties associated with external stakeholder collaborations to provide advanced services. These uncertainties are detailed in Table 18 above. A significant uncertainty highlighted by participants in Case RoboCo is the **lack of information on whom to partner with and how the partnership can be best sustained**:

> *"So, it's basically a triangle, or maybe it can even be an end customer to multipoint companies because probably you need another supplier, somebody that has a certain software that is doing the same thing so that you have machine hardware as a service, automation as a service specific software as a service that you provide to that customer"- Intr1RoboCo*

> *"It's a bit uncertain to establish those new partnerships like with consultants, I don't know even consultants to this day; we still have very hesitant relationships with some consultants whilst, around the market, everybody else is doing it right"- Intr5RoboCo*

The importance of the Strategic Partnership category is underscored by the complexity of managing relationships with system integrators or machine makers in Case RoboCo. Participants in Case RoboCo highlighted the **uncertainty about collaborations with system integrators or machine makers for AS,** emphasising the complexity of dealing with those who have their own advanced service models:

> *"You can say that depending on the model, some of our system integrators, I think, are not distributors; they are rather more system integrators or machine makers. They have their own advanced service models which become far more complex"- Intr1RoboCo*

"It's been a bit of concern in terms of trying to establish those relationships into managing partners, partners being system integrators"- Intr5RoboCo

These partners have their own service business models, adding complexity to managing collaborative models for advanced services within Case RoboCo. The interviews revealed the critical role that strategic partnerships play in the value network, impacting the *strategic planning* and *implementation* of advanced services. The success of advanced services relies heavily on aligning these partnerships effectively. **Appendix 3** (section 11.3) provides further details of uncertainties under this category.

Technical Uncertainty

Within Case RoboCo, several uncertainties emerged under the technical uncertainty type, as detailed in Table 19 below. These uncertainties pertain to the technological and infrastructural aspects necessary for supporting and delivering advanced services.

Table 19: Technical uncertainties apparent in Case RoboCo

Uncertainty Category	Uncertainty	Definition	Inferred Implications
Advanced Technologies and Tools	Delivery Tools & Systems	Lack of knowledge about specific tools and systems required to support and deliver AS	Delays in strategic decision-making and increased costs
	Technology Upgrades	Lack of understanding of the required technology upgradation to support AS	Operational inefficiency, increased costs and delays in development process
	Automation	Lack of information on the implementation and effectiveness of automated systems for tasks such as capturing faults, handling issues, and managing contracts.	Operational inefficiency, increased costs, and increased resistance to technology adoption
	Product Reliability & Developments	Lack of information regarding product reliability and future product developments	Operational inefficiency, increased costs and customer dissatisfaction
Technical Infrastructure	Data Availability	Lack of information about the availability of the necessary data to support AS	Data silos and fragmentation and delays in the development process
	Data Interpretation	Lack of understanding of how to map data to specific needs and provide actionable insights	Delays in the developments process, increased risk of service failure and customer dissatisfaction
	Cybersecurity	Uncertainty about the adequacy of safety and cybersecurity infrastructure for data sharing	Increased risk of data breaches, compliance issues and erosion of trust and collaboration

Advanced Technologies and Tools

The Advanced Technologies and Tools category describes the uncertainties related to specific tools and technological development essential for advanced services. A significant uncertainty in this category is the **lack of knowledge about specific tools and systems required to support and deliver advanced services,** as indicated in these statements**:**

"But currently, we don't have that proper services platform, which means that we are not as quick as we would like just to implement the strategy because we are lacking some tools to do that, unfortunately"- Intr2RoboCo

"But also from the point of view of systems, sometimes the systems are not helping us to actually be and accrue the actual activities, all the invoicing and a lot of things on that side"- Intr5RoboCo

Participants of Case RoboCo also expressed a **lack of understanding of the required technology upgradation to support AS:**

"a lot of products we have today, for instance, machine controllers, that technology is 40 years old, so people forgot how that technology was introduced and why we should develop the technologies now"- Intr4RoboCo

Another significant uncertainty within this category is the **lack of information on the implementation and effectiveness of automated systems for tasks such as capturing faults, handling issues, and managing contracts.** Participants highlighted that the current systems are not equipped to handle these processes efficiently, resulting in a reliance on manual methods:

"But we don't have anything as a tool right now dedicated to contract monitoring and usage; it is still manual. So, it means that you have to manually insert all the information into the contract and also store what you promise in this contract manually in another system. So actually, the contract handling is manual, and that is not efficient."- Intr7RoboCo

Another significant uncertainty within this category indicated by one of the participants pertains to the **lack of information regarding product reliability and future product developments:**

"Should I make a different design to maximise the opportunities for servitization? So those are the things in my mind. But then when presenting the business case for investment to develop the technology or the product, this is a difficult story because there is so little success evidence in our company about services"- Intr4RoboCo

Existing systems at Case RoboCo are not purpose-built for advanced services and lack the capability to handle outcome-based contracts and associated conditions. This deficiency leads to *delays* and *increased costs*. Despite Case RoboCo's specialisation in advanced technologies and automation, immediate attention is needed to strategically upgrade systems and tools.

Technical infrastructure

The Technical Infrastructure category describes the uncertainties surrounding data infrastructure and technical developments that support AS. One notable uncertainty is the **lack of information about the necessary data to support advanced services:**

"[continuing conversation…then the second thing is what kind of data is available that is reasonable, easy to catch."- Intr1RoboCo

Another significant uncertainty is the **lack of understanding of how to map data to specific needs and provide actionable insights,** as highlighted by the participants:

"we need the data and be back and forth, to store them in order to be analysed and so on. And still, we don't have that possibility"- Intr2RoboCo

"How can we make their life easier? So, there's a lot of data on a lot of machines, but you need to have almost a PhD in data science to get information or value out of that data"- Intr4RoboCo

Furthermore, several participants of Case RoboCo expressed **uncertainty about the adequacy of safety and cybersecurity infrastructure for data sharing:**

"Even if we had a platform, we could not use it because they don't want to connect their machines for cyber security to the internet. So that is one of the main uncertainties"- Intr2RoboCo

"Many of the factories find it difficult to understand how to embrace cybersecurity on the factory floor; this is a big concern going forward"- Intr4RoboCo

These uncertainties have significant implications for Case RoboCo. They affect the delivery of advanced services, influence *strategic planning*, and cause several *delays* in implementation and the accuracy of information provided to customers, potentially leading to *penalties or breaches of contract*.

Environmental Uncertainty

The Environmental Uncertainty type describes the unpredictability and complexity of external factors. Within Case RoboCo, a few participants expressed **uncertainty about the long-term sustainability and viability of equipment:**

"even to get subsidies from the European Union or from local government, you have to fulfil some requirements regarding the energy efficiency, the sale of CO2 emissions and so on is a very big concern for many customers"- Intr2RoboCo

"how our solutions could be contributing to the customers, the reduction in greenhouse emissions or you know the net zero equation, that's the area where we can play a lot"- Intr5RoboCo

Another notable uncertainty is the **lack of knowledge regarding the market potential and effective strategies for promoting and delivering AS:**

"We struggle a lot to be recognised as a competent partner to do or to deliver services. So, we're kind of the new kids on the block, let's say."- Intr5RoboCo

These uncertainties significantly impact Case RoboCo's ability to formulate effective sustainability strategies and **market positioning**. Without a clear understanding of sustainability practices and market dynamics, Case RoboCo faces issues promoting its advanced services and gaining recognition as a competent service provider. This uncertainty affects the strategic direction and potential success of advanced services in the market.

6.1.3 Case BoilerCo

Organisational Uncertainty

The interviews with internal stakeholders in Case BoilerCo revealed several organisational uncertainties. Similar to other cases, these uncertainties were grouped into three distinct categories. Table 20 summarises these organisational uncertainties and their descriptions within the context of Case BoilerCo.

Table 20: Organisational uncertainties apparent in Case BoilerCo

Uncertainty Category	Uncertainty	Definition	Inferred Implications
Internal Dynamics	Culture and Mindset Change	Lack of understanding regarding the cultural and mindset shift towards AS	Less buy-in from stakeholders
	Roles and Responsibilities	Lack of knowledge about the specific roles and responsibilities for AS	Delays in strategic decision-making and development process
	Skillsets and Expertise	Lack of knowledge about the required skills and expertise for AS	Operational inefficiency
	People Training	Lack of understanding about the necessary trainings to deliver AS	Operational inefficiency, misalignment of customer expectations and increased costs
	Resources & Capabilities	Lack of understanding regarding the allocation and availability of resources and capabilities for AS	Delays in resource allocation and increased costs
	Organisational Structure	Lack of understanding about how to effectively organise the firm's processes, people and tools for AS	Delays in strategic decision-making
	Business System and Processes	Lack of understanding of the internal systems and processes required to facilitate AS	Delays in the development process and operational inefficiency
	Sales Team	Lack of certainty regarding the sales team's comprehension and their ability to effectively communicate and sell AS to customers	Misalignment of customer expectations and delays in the development process
	Dedicated AS Team	Lack of certainty about having a dedicated AS team within the business	Delays in the development process and strategic decision-making
Commercial Viability	Service Level Agreement (SLA) conditions	Lack of knowledge regarding the design and conditions of SLA for AS	Misalignment of customer expectations and delays in strategic decision making
	Funding	Lack of certainty in securing the necessary funding for AS	Delays in decision making and less buy-in from stakeholders
	Legal & Commercial Risk	Lack of knowledge about the legal and commercial aspects of the SLA	Compliance issues and contractual disputes

AS Scope & Understanding	AS Knowledge & Understanding	Lack of definite knowledge and understanding about the overall concept of AS	Less buy-in from stakeholders and delays in the development process
	Value Proposition	Lack of understanding of the specific meaning and boundaries of the value proposition	Misalignment of customer expectations
	Service Guarantee	Lack of understanding about the feasibility of providing guarantees in AS	Operational inefficiency and delays in the development process

Internal Dynamics

The category Internal Dynamics describes uncertainties arising from the interplay between human and structural factors. The interviews revealed several uncertainties falling under this category, as detailed in Table 20 above. A significant uncertainty pertains to the **lack of understanding of the internal systems and processes required to facilitate advanced services.** Participants highlighted that there is no standardised process for service design and delivery in Case BoilerCo:

> *"There's no SOP for how it is done. How it's managed? How is that time logged when people are connecting remotely?"- Intr2BoilerCo*

> *"One of the main sorts of unpredictable issues is, I guess, getting purchase orders, and so we can set jobs up because our process is not set"- Intr3BoilerCo*

> *"You know, better interaction internally as opposed to sort of, you know, siloed departments, which is not something you can afford to have if you were to offer this kind of uh, servitization model."- Intr4BoilerCo*

Another significant uncertainty that emerged from the interviews is the **lack of certainty about having a dedicated AS team within the business:**

> *"But at this moment, I think we're at that sort of division point, decide whether we invest in it and we build that department which can be dedicated to just let's say advanced services or servitization"- Intr2BoilerCo*

> *"But we may also look externally and build a sort of team that has a mixture of internal people and external people"- Intr5BoilerCo*

The formation of a specialised team for advanced services is deemed crucial by stakeholders for expediting tasks and processes. This uncertainty of a dedicated team has resulted in noteworthy *delays in decision-making* for advanced services in Case BoilerCo. Additional uncertainties identified within this category, along with supporting quotes, are detailed in **Appendix 4** (section 11.4).

Commercial Viability

The Commercial Viability category describes uncertainties related to the sustained profit generation potential of advanced services in the market. A significant uncertainty identified during the interviews pertains to the **lack of knowledge about the design and conditions of service level agreements (SLA) for advanced services:**

"So, I think, as you say, it's just how we're contracted, how we word it within the contract"- Intr1BoilerCo

"A simple contractual sale of plant and services to actually deliver in, I don't know, 5, 10, 15-year contract in a servitization model?"- Intr4BoilerCo

"So, how would you denote that we've got 100% uptime, but if they open a valve too fast or contaminate, then ah, what? What happens there with the charges?"- Intr6BoilerCo

These uncertainties can lead to *misalignment of customer expectations* and *additional delays* in delivery. The newness of advanced services within Case BoilerCo has resulted in an unclear understanding of contractual conditions and durations. **Appendix 4** (section 11.4) details additional uncertainties and supporting statements from participants.

AS Scope & Understanding

The category Advanced Services (AS) Scope & Understanding describes uncertainties surrounding the knowledge base and individual perspectives on the overarching concept of advanced services, as illustrated in Table 20. Some participants expressed a **lack of definite knowledge and understanding about the overall concept of AS,** while others possessed limited knowledge and held varying opinions:

"So, I'm sort of familiar, but not to an extent."- Intr1BoilerCo

"I'm honest. I've not come across advanced services that much, so yeah, it's quite interesting"- Intr3BoilerCo

"It's internally kind of new to us, so people like, what's this new way of doing thing?"- Intr5BoilerCo

"It's very difficult for internal people to understand an outcome-based model rather than just supplying something and walking away or just do it fulfilling the contract"- Intr7BoilerCo

Multiple stakeholders showed a **lack of understanding of the specific meaning and boundaries of the value proposition**. Discussions revealed varied perspectives on what constitutes a value proposition, with some stakeholders struggling to articulate the specific value propositions they could deliver:

"but I mean, one of the sort of propositions I suppose that we would give is and we talk a lot about our life cycle"- Intr3BoilerCo

"I think the first complexity that we have is defining clearly compelling value proposition"- Intr5BoilerCo

"we're still trying to figure out what the end value proposition is"- Intr7BoilerCo

Another significant uncertainty within this category where several participants demonstrated a **lack of certainty regarding the feasibility of offering guarantees in AS:**

> *"I think with every business the word guarantee is scary"- Intr1BoilerCo*

> *I think it's difficult to guarantee that they won't go down. Um, because there's a quite a few things that depend on what they're doing"- Intr3BoilerCo*

This category is pivotal as it highlights the complexities associated with advanced services and how the overarching concept aligns with Case BoilerCo's organisational framework. These uncertainties significantly influence Case BoilerCo's development of advanced services and its understanding of the potential benefits.

Relational Uncertainty

The relational uncertainty type describes the unpredictability of a partner's action regarding advanced services. Several uncertainties emerged, and they are grouped into two categories in Table 21 below.

Table 21: Relational uncertainties apparent in Case BoilerCo

Uncertainty Category	Uncertainty	Definition	Inferred Implications
Customer Desirability	Target Customer Segment	Lack of information on selecting the optimal customer segment for AS	Delays in the development process and strategic decision-making
	Customer Engagement	Lack of information on whom to and how to engage within customer organisation for AS	Erosion of trust and collaboration and delays in development process
	Staff Turnover on Sites	Lack of information about the rate of staff turnover on customer sites	Operational inefficiency and increased risk of service failure
	Customer Activities	Lack of information about the customer activities on production lines	Operational inefficiency and increased risk of service failure
	Customer Requirements	Lack of clear understanding about the specific requirements of the customer	Misalignment of customer expectations and delays in development process
	Customer Mindset & Expectations	Lack of knowledge regarding the customer's mindset and expectations for AS	Misalignment of customer expectations and customer dissatisfaction
Strategic Partnership	Partner Requirements	Lack of information regarding the requirements of partners for AS	Potential conflicts and delays in development process
	Supplier Equipment	Uncertainty about the equipment provided by third party suppliers and its integration with product technologies	Operational inefficiency and increased risk of service failure
	Distribution channel as middleman	Lack of knowledge regarding the distributors' perspective and role in the AS	Delays in strategic decision-making

Customer Desirability

The Customer Desirability category describes uncertainties about understanding and engaging with target customer segments for advanced services. A significant uncertainty identified within Case

BoilerCo is the **lack of information regarding the optimal customer segment to focus on for AS,** indicated in the statements:

> *"I don't think it wouldn't be the right solution for everybody, but for some of some of the bigger companies and even possibly even the small companies, it would be a good solution."***- *Intr1BoilerCo***

> *"Certain characters gelled with other people or different sectors. Because we have such a vast range of customer bases. You know, it's huge."- Intr4BoilerCo*

> *"The next thing is right, to whom are we going to propose this? Which customer?"- Intr5BoilerCo*

In Case BoilerCo, the primary customer segmentation has traditionally been based on product sales. Discussions revealed concerns about transitioning to a more service-focused customer segmentation due to the extensive customer base and strategic planning for advanced services. Another significant uncertainty within this category is the **lack of information about the customer activities on production lines**:

> *"But the caveat to it is always that it's all based on the customer looking after it, how they're supposed to, because otherwise the boiler will fail."- Intr3BoilerCo*

> *"I think one of the uncertainties that we sometimes have is the information that we're being given from the customer, what they do at the site and how they provide us with the actual details is kind of a big issue"- Intr5BoilerCo*

This category is particularly prevalent in Case BoilerCo as it significantly influences the design of advanced services tailored to understand the customer base and their specific needs. Additional uncertainties are detailed in **Appendix 4** (section 11.4).

Strategic Partnership

The category Strategic Partnership describes uncertainties associated with external stakeholder collaborations to provide advanced services. Participants expressed a significant uncertainty as the **lack of information regarding the requirements of partners for advanced services,** as highlighted in these statements:

> *"I'm not sure how that would work, obviously, because when we go when a third party comes to us, and they want to withhold the service contract"- Intr1BoilerCo*

> *"If we could continue that service, but it's still a bit granular at the moment, so it's partners, we could get better terms with them"- Intr2BoilerCo*

> *"But no, it is when there are multiple parties, it does become more complex because, you know, everybody's got their own kind of interest in the project and what they need to achieve and when they need to achieve it by, and it doesn't always marry up"- Intr3BoilerCo*

Stakeholders highlighted that understanding partner requirements is crucial for successfully delivering advanced services. The uncertainties in these partnerships may lead to misaligned expectations and potential conflicts, which could delay the overall planning and implementation of advanced services. Participants highlighted another significant **uncertainty about the equipment provided by third-party suppliers and its integration with product technologies:**

> *"we'll use certain suppliers for different parts. Um, so obviously, like, we will buy in, and then, you know, it might fail, and obviously, we can't. We're not able to offer that guarantee. It's not our product"- Intr3BoilerCo*

Similar to Case PrintCo and Case RoboCo, Case BoilerCo also operates through distribution channels and direct end customers. Participants expressed a **lack of knowledge regarding the distributors' perspective and role in advanced services:**

> *"That is a bit more complexity when it's kind of like, let's call it, a middleman. So, you know, we've got our customer, and they've got their customer and the boiler; how would this work when we think about advanced services? Should we involve them or keep them out of this?"- Intr3BoilerCo*

This category is significant as stakeholders emphasise the pivotal role played by partners and distributors within their value network. This impact extends to the *strategic planning* and *operational execution* of advanced services.

Technical Uncertainty

The Technical Uncertainty type reveals a few uncertainties within Case BoilerCo. These uncertainties are presented in Table 22 below. Case BoilerCo has recently integrated a new system to streamline data connectivity across various platforms. This technological shift will continue to contribute to the development of advanced services.

Table 22: Technical uncertainties apparent in Case BoilerCo

Uncertainty Category	Uncertainty	Definition	Inferred Implications
Advanced Technologies and Tools	Product Reliability & Developments	Lack of information regarding product reliability and future product developments	Operational inefficiency, increased costs and customer dissatisfaction
Technical Infrastructure	Data Availability	Lack of information about the availability of the necessary data to support AS	Data silos and fragmentation and delays in the development process
	Data Interpretation	Lack of understanding of how to map data to specific needs and provide actionable insights	Delays in the developments process, increased risk of service failure and customer dissatisfaction
	Cybersecurity	Uncertainty about the adequacy of safety and cybersecurity infrastructure for data sharing	Increased risk of data breaches, compliance issues and erosion of trust and collaboration

	Behaviours around the Product	Lack of information about the impact of external factors on the production line due to the operation of other machines and operators	Operational inefficiency

Advanced Technologies and Tools

The Advanced Technologies and Tools category describes the uncertainties related to specific tools and technological development essential for advanced services. A significant uncertainty within this category is the **lack of information regarding product reliability and future product developments,** as highlighted by the participants**:**

> *"It's a full circle itself as well because the product design needs to be right, and specifically when it comes to offering a guaranteed outcome, we may need to look at it more precisely"- Intr2BoilerCo*

> *"It's difficult because you do have people coming on like sort of wanting, almost wanting that reassurance of the reliability, and obviously you can only give it to them so far"- Intr3BoilerCo*

Stakeholders emphasised that current products require advanced technologies and additional features to support real-time performance monitoring. This necessity introduces *potential cost implications* and raises questions about the organisation's *readiness to absorb these costs*.

Technical Infrastructure

The Technical Infrastructure category presents uncertainties pertaining to data infrastructure and technical developments to support the provision of advanced services. While Case BoilerCo possesses the capability to capture potential data for advanced services, participants expressed a **lack of understanding of how to map data to specific needs and provide actionable insights:**

> *"I think before we can implement the advanced service, we need to understand the lifeline of all our components. We need to have a lot of data there to be able to monitor that, and I think we were able to do so. I just don't think we were monitoring it to be able to then provide this advanced service"- Intr1BoilerCo*

> *"We get a lot of data into the cloud. The question is how we use it and how we manipulate and make decisions from it. So that's kind of where we're struggling internally"- Intr7BoilerCo*

Participants expressed the **lack of information about the necessary data to support advanced services** if they choose a particular value proposition:

> *"In terms of looking at x as a service, the availability of the data. Do we even capture that data to deliver the value proposition? I am not quite sure"- Intr7BoilerCo*

Additionally, **uncertainty about the adequacy of safety and cybersecurity infrastructure for data sharing** was observed during the interviews:

"Certain customers do have concerns about cyber security. Some customers won't even allow their data to be transferred so, but then, if that is a concern, then that might be a decision to be made, I suppose." Intr4BoilerCo

Another critical uncertainty that emerged during the interviews pertains to the **lack of information about the impact of external factors on the production line due to the operation of other machines and operators,** as highlighted in the statement:

"So, for instance, like we could give them the best boiler in the world, but if their water treatment in their boiler is not correct. Eventually, they're gonna have problems"- Intr3BoilerCo

It is noteworthy that Case BoilerCo proactively implements a unified system, which represents a significant step towards resolving data-related uncertainties. As a result, not many new uncertainties have emerged under this category, though ongoing monitoring and adaptation will be essential to ensure the effectiveness of this system.

Environmental Uncertainty

The analysis of Case BoilerCo did not reveal any significant environmental uncertainty. This suggests that the case is in its early stages of considering external factors or that the organisation has not yet encountered substantial complexities related to market conditions, regulations, or broader industry trends. As a result, external pressures or changes may not have been a focal point in their current strategic or operational considerations.

6.2 External Stakeholders Uncertainties

6.2.1 Customer Uncertainties

Organisational Uncertainty

Several uncertainties emerged from the interviews with Case PrintCo's customers, grouped into three categories. Table 23 provides a summary of these uncertainties along with their definitions. These uncertainties are pivotal as they directly influence Case PrintCo's strategic planning and advanced services innovation.

Table 23: Organisational uncertainties apparent in Customer cases

Uncertainty Category	Uncertainty	Definition	Inferred Implications
Internal Dynamics	Labour Availability	Uncertainty regarding the availability of on-site labour	Increased costs
	Technical Team and Expertise	Uncertainty about the availability and expertise of technical personnel to manage technologies and systems	Increased costs and operational inefficiency
	People Training	Lack of understanding about the necessary trainings for AS	Operational inefficiency and increased costs

Commercial Viability	Pricing Model & Strategy	Lack of information regarding the pricing strategies for AS	Delays in strategic decision making and development process, and market receptiveness
	Service Level Agreement (SLA) Conditions	Lack of information about the design and conditions of SLA for AS	Misalignment of expectations and delays in strategic decision making
	Financial Benefits	Uncertainty about the revenue generation potential from AS	Delays in strategic decision making and less buy-in.
	IT Upgradation Cost	Uncertainty about the cost associated with technological upgrades	Increased cost and delays in development process
	Performance Benchmark	Lack of knowledge regarding the performance benchmark of equipment on production line	Operational inefficiency
AS Scope & Understanding	AS Knowledge and Understanding	Lack of definite knowledge and understanding about the overall concept of AS	Less buy-in and delays in the development process
	Value Proposition	Lack of understanding of the specific meaning and boundaries of the value proposition	Misalignment of expectations
	Service Guarantee	Lack of understanding about the feasibility of providing guarantees in AS	Operational inefficiency and delays in the development process

Internal Dynamics

The Internal Dynamics category describes uncertainties among Case PrintCo's customers, mainly related to human dynamics. Customers expressed significant **uncertainty regarding the availability of on-site labour,** which has led to *increased costs* for them:

> *"... so, underline operators, you know there's a lot of reduction in terms of personnel actually on the floor now; anything you can do to minimise?"- Cust1*

> *"Our biggest challenge is the uncertainty around technician availability when there's issues"- Cust2*

Customers emphasised the newness of advanced services and expressed **uncertainty about the availability and expertise of technical personnel to manage technologies and systems:**

> *"…like you can't just be one person being to know how all this works so you need to build a structure of team with technicians and programmers"- Cust5*

> *"…you need to make sure you have the talent to support the automation right, and often we struggle to get the right technical expertise within the business"- Cust9*

Customers highlighted that the existing technical expertise might not be sufficient to effectively support the evolving technological infrastructure necessary for advanced services, potentially leading to *increased costs* and *operational inefficiency*. One of the customers also indicated a **lack of understanding about the necessary training for advanced services:**

"It's more of the training of the people on how the property using them if you have a new guy do it and if they don't know how to do it properly, then it's causing issues, so it's about how can you train them"- Cust5

Uncertainties related to Internal Dynamics emerged as a prevalent category among customers of Case PrintCo, significantly influencing the broader development of advanced services across various dimensions. Additional uncertainties and supporting statements are detailed in **Appendix 2** (section 11.2)

Commercial Viability

The Commercial Viability category describes uncertainties related to the pricing model and financial benefits that advanced services can bring to their business. Several participants expressed **a lack of knowledge about the design and conditions of service-level agreements (SLA) for advanced services:**

"…probably, I think if there was some kind of contractual, what's the word assessment within a year, I think that would be interesting"- Cust1

"…um, service contracts, it's something that we always consider, and it would just depend on the terms of the service contract whether or not our plants would be interested in doing it"- Cust2

"If I think of it as a service contract, I will need to understand"- Cust3

During the interviews, customers highlighted the need for more detailed specifics regarding the SLA for advanced services from Case PrintCo. This uncertainty resulted in a *misalignment of expectations* and *subsequent delays* in development. Participants expressed another significant **uncertainty about the cost associated with technological upgrades** during the interviews**:**

"For this, IT needs to be upgraded and is it cost-effective to do it or not so it's a bigger assessment"- Cust1

"…need to spend money on setting up the infrastructure to connect this machine to the cloud plus then will cost us a ticket, I guess"- Cust4

This leads to *increased costs* and significant *delays in the development process* for Case PrintCo. Appendix 2 (section 11.2) details several other uncertainties that arose during interviews with Case PrintCo customers.

AS Scope & Understanding

The Advanced Services Understanding category describes the uncertainties that particularly focus on the knowledge and individual perspectives on the overarching concept of advanced services within customers. Several participants showed a **lack of definite knowledge and understanding about the overall concept of AS:**

"I think in principle it looks good, but I just need more information about those things cause OEM suppliers, so normally that's how it works, they have specific experiences that we then push back from them but then with that, there be some kind of supply or maintenance contract let's say where every whatever pair they come in just so quickly make sure it is working. So, it's a little bit disjointed in terms of how it's done"- Cust1

"We have a lot of service contracts; to be honest with you, I've never seen them framed this way. I don't quite understand this"- Cust3

"What the pay per x means the numbers behind, but yeah, like to see more details to see if it makes sense or not"- Cust5

Given the newness of advanced services, customers struggled to visualise the offering and understand the benefits it can bring to their business. Although Case PrintCo provided some examples of value propositions tailored to specific needs, participants expressed a **lack of understanding about the specific meaning and boundaries of the value proposition:**

"*You want to do pay per use but I don't know if you just need to do on it per hourly basis or something, I don't know. It's mentality really, I suppose"- Cust1*

"*What I would need to understand is you know how this compares to our current model right?****"-*** *Cust3*

"…well I mean, right now, I don't have an issue with Case PrintCo's [ ], so I don't think it is worth it" [Not seeing value in it]- Cust5

This uncertainty led to a *misalignment of their expectations* and *less customer buy-in* on the proposed value propositions. Another significant uncertainty is the **lack of understanding about the feasibility of providing guarantees in advanced services,** as indicated by the participants**:**

"In terms of the guaranteed outcome, I think that's good, you know, we want to know that the credibility ends up time that request is there and how would that be demonstrated, and then I'll see"- Cust1

"I would need more information on the guaranteeing uptime"- Cust2

"If we're doing coding as a service, the expectation would be that this thing performs, you know, 100%"- Cust6

This category is prevalent as it articulates the intricacies of advanced services, providing insights into customer's understanding and alignment of the concept within their organisational framework. The subsequent section provides an analysis of relational uncertainties.

Relational Uncertainty

The relational uncertainty type describes the unpredictability of a partner's action in the context of advanced services. From the customer's perspective, this uncertainty type is primarily associated with supplier collaboration and potential partnerships for advanced services.

Strategic Partnership

The category Strategic Partnership describes the uncertainties linked with the collaborations of suppliers and potential partnerships for providing advanced services. Several customers showed **uncertainty about potential partners for AS and how to sustain these partnerships effectively:**

> *"[highlighting some software names] …have bits of software that manage security; you probably need to understand who those partners and providers are somehow linked Case PrintCo with that as well, so it's a whole family"- Cust1*

> *"…somehow you need to, I don't know if you partner up with some really good security partner or something, then I think that would build confidence, so I don't know how you do that market, but that's key because you've got to think there's a lot of hackers now that are breaking into factories"- Cust 9*

> *"You know, we have been looking at as we look at new systems or, you know, replacement systems, you know, there are OEMs out there that are doing some things that are interesting"- Cust6*

Given that Case PrintCo customers operate within a complex ecosystem with multiple suppliers in their production line, the importance of this category is underscored by its influence on the customers' business capacity to establish effective collaborations with suppliers in their ecosystem. This category plays a pivotal role in shaping the dynamics of relationships and collaborations within the intricate network of suppliers. These partnerships with customers can pose a *strategic risk* for manufacturers by maintaining a complex ecosystem with various partners, potentially leading to *erosion of trust and collaboration*.

Technical Uncertainty

The technical uncertainty type reveals uncertainties related to the technological and technical infrastructure aspects crucial for advanced services provision. Table 24 provides a summary of uncertainties that emerged from the customer interviews.

Table 24: Technical uncertainties apparent in Customer cases

Uncertainty Category	Uncertainty	Definition	Inferred Implications
Advanced Technology and Tools	Technology Upgrades	Lack of understanding of the required technology upgradation to support AS	Operational inefficiency and increased costs
	Automation	Lack of information on the implementation and effectiveness of automated systems for tasks such as capturing faults, handling issues, and managing contracts	Operational inefficiency, increased costs, and increased resistance to technology adoption

	Delivery Tools & Systems	Lack of knowledge about specific tools and systems required to support and deliver AS	Delays in strategic decision-making and increased costs
	Technology obsolescence strategy	Lack of understanding regarding technology obsolescence strategies from suppliers	Increased costs
	Cloud Interface	Uncertainty about cloud connectivity for all the equipment	Delays in development process, increased costs and strategic risk
Technical Infrastructure	Cybersecurity	Lack of understanding regarding the alignment of safety and cybersecurity infrastructure for data sharing	Increased risk of data breaches, compliance issues and erosion of trust and collaboration
	Data Interpretation	Lack of understanding of how to map data to specific needs and provide actionable insights	Delays in the developments process, increased risk of service failure

Advanced Technologies and Tools

The Advanced Technology and Tools category describes uncertainties related to the required technological advancements and tools to support advanced services in customers' business operations. During the interviews, customers expressed a **lack of understanding of the required technology upgradation to support AS:**

> *"…like that would have the bits of IT which need to be upgraded, but not sure at this stage". - Cust1*

> *"I think we're looking for technology that can verify that the code is correct, I am not sure if Case PrintCo can offer something on that technology"- Cust2*

> *"We're investigating [specify technology] and other new technologies which are, to be honest, just a headache, we need to think how much… "- Cust3*

The uncertainty about required technology upgrades makes it difficult for customers to plan and invest in the necessary infrastructure. Another crucial uncertainty expressed by the participants pertains to the **lack of understanding regarding technology obsolescence strategies from suppliers:**

> *"…affected with the aftersales service the spare parts so that is why there has to be clear obsolescence strategy by the companies right now I don't know if Case PrintCo has a clear strategy in this value proposition"- Cust4*

> *"So, it's yeah that's kind of the technology obsolescence, which is important to think about, may have to see when I look at the agreement"- Cust5*

These uncertainties lead to *increased costs* for manufacturers and create *operational inefficiency*. These uncertainties impact the smooth transition and effective implementation of advanced services, leading to potential delays. **Appendix 2** (section 11.2) details other uncertainties within this category.

Technical Infrastructure

This category describes the uncertainties linked with the data infrastructure and technical readiness to support advanced services within the customer's business environment. A significant uncertainty

in this category is the **lack of understanding of how to map the data to the specific needs and provide actionable insights,** as indicated in the statements**:**

"They can interrogate with graphs and data that they can put into power BI, think that's the kind of situation at present, but I am not sure"- Cust1

"So that might be driving the technical challenges of aggregating the data, how do you map the larger chunks of it"- Cust3

Several participants expressed **uncertainty about the adequacy of safety and cybersecurity infrastructure for data sharing**:

"How do you prove that is super secure and that's the key…"- Cust1

"It's just very difficult with current cybersecurity requirements to get it all set up correctly, "the promise doesn't quite live up to the reality quite live up to the promise in terms of ease of access"- Cust2

"Cybersecurity issues, yeah, but it is a headache to get through, you know, the communication of it and getting it like behind our firewall is a bit of a pain" - Cust3

"Getting the information on the real-time scenario but once it is handed over to us, we will not give any data to the external parties"- Cust4

"If the security side from the data transfers can be acceptable and you know meet the company's kind of qualifications or specifications"- Cust6

A few of them pointed out the complexities of the numerous Non-Disclosure Agreements (NDAs) and stringent communication requirements within their business to ensure cybersecurity. This leads to an *increased risk of data breaches* and several *compliance issues,* which in turn *delays the development process*.

Environmental Uncertainty

The environmental uncertainty type describes the unpredictability and complexity of external factors. A few participants expressed **uncertainty about the long-term sustainability and viability of equipment:**

"the [ ] as a service what that reduction looks like and if you can demonstrate how you stand out with sustainability compared to the competition"- Cust1

"I would assume the energy is not that much; this is not the biggest energy sink"- Cust3

"how we can make our packaging more sustainable going forward is a big concern…"- Cust5

"but the sustainability would be like an I would say it's more of a factor and not the main factor, maybe it can be important at a later stage"- Cust6

While some participants expressed concerns about sustainability and its implications, others seemed less focused on this aspect, considering it secondary to other factors. These varied opinions suggest that while sustainability is a relevant consideration, it is not uniformly prioritised across Case PrintCo's customer base. Participants also expressed a **lack of knowledge regarding the market potential and effective strategies to promote and deliver advanced services:**

> *"so, I don't know how you market this new form of services; it all depends"- Cust1*

> *"it depends on the kids' cookies how the Franchise are attractive"- Cust4*

This range of opinions underscores the complexity of environmental uncertainty among Case PrintCo's customers, impacting *operational inefficiency* and leading to *an increased risk of service failure*. After examining the uncertainties from Case PrintCo's customers' perspective, the following section will identify the uncertainties faced by distributors.

6.2.2 Distributor Uncertainties

Organisational Uncertainty

The organisational uncertainty type reveals uncertainties within the organisational context of Case PrintCo's distributors. Table 25 summarises these uncertainties that emerged during the interviews with distributors.

Table 25: Organisational uncertainties apparent in Distributor cases

Uncertainty Category	Uncertainty	Definition	Inferred Implications
Internal Dynamics	Technical Team and Expertise	Uncertainty about the availability and expertise of technical personnel to manage technologies and systems	Increased costs and operational inefficiency
	Resources & Capabilities	Lack of understanding regarding the allocation and availability of resources and capabilities for AS	Increased costs
	People Training	Lack of understanding about the necessary trainings to deliver AS	Operational inefficiency, misalignment of customer expectations and increased costs
Commercial Viability	Pricing Model & Strategy	Lack of information regarding the pricing strategies for AS	Market receptiveness
	Service Level Agreement (SLA) Conditions	Lack of knowledge regarding the design and conditions of SLA for AS	Misalignment of customer expectations
	Financial Benefits	Uncertainty about the revenue generation potential from AS	Delays in strategic decision making
AS Scope & Understanding	Service Guarantee	Lack of understanding about the feasibility of providing guarantees in AS	Increased costs and operational inefficiency

Internal Dynamics

The Internal Dynamics category describes the uncertainties mainly associated with human factors. Participants expressed significant **uncertainty about the availability and expertise of technical personnel to manage technologies and systems:**

> *"It's been difficult to build an organisation with enough technical people. So, when the problem happens, there aren't enough technical people with the expertise there to support a glance"- Dist1*

> *"We want to extend back-office systems to technical helpdesk but need to discuss… need to overcome internal resistance such as not wanting to use own phone"- Dist5*

One of the participants showed a **lack of understanding regarding the allocation and availability of resources and capabilities for AS.** Despite being familiar with the outcome-based service model, distributors struggle with effectively managing and allocating resources due to the demanding nature of the business model, as indicated in the below statement:

> *"You know business concept because you have to be on your toes. Sometimes, we have fewer resources, so it's a resource-demanding business model. We struggle in that…"- Dist1*

Additionally, there is significant uncertainty regarding the **lack of understanding about the necessary training to deliver AS,** as highlighted in the statement:

> *Maybe we can remote control the people in the factory. It still requires that we give good training to the customers, but we will have a much better idea about what the problem is before we actually visit the customers."- Dist3*

Even though distributors recognise the value of outcome-based services, these uncertainties can lead to *misalignment of customer expectations* and *increased costs*. Consequently, these distributor-level uncertainties can compromise the overall effectiveness and market success of the advanced services offered by Case PrintCo.

Commercial Viability

The Commercial Viability category describes the uncertainties of the sustained profit-generating ability of advanced services in the market through a competitive pricing model. During the interviews, several participants demonstrated a **lack of information regarding the pricing strategies for advanced services**:

> *"So, I think the whole industry has a big concern because it's been, uh, maybe they don't increase the prices, but without taking the prices, it has been too long. I think the service coding service has been sold too cheap"- Dist2*

> *"The prices, of course, are always an issue, and I think even more so in Africa than it is in Denmark because the Capex is very high compared to the work or the labour"- Dist4*

Regional variations in pricing also emerged as a concern, highlighting the complexity of pricing strategies across different markets. Participants highlighted the **lack of understanding regarding revenue generation from advanced services** due to exchange rate fluctuations:

> *"We can't afford to have any profit wiped out because of the exchange rate fluctuations. And you've committed to reprice"- Dist2*

Furthermore, there was a **lack of knowledge regarding the design and conditions of service level agreements (SLAs) for advanced services**. This includes uncertainties about setting appropriate conditions based on regional differences, as indicated in the statement:

> *"And I don't know the margin because we have the same model for customers that are located close to us and also customers that could be far up north. So, I don't know if that's a challenge, but then it's more costly to travel far to change a controller on the machine than to drive for 20 minutes. Not sure if we need to set some conditions within our agreement"- Dist2*

The impact of these uncertainties on Case PrintCo is significant. Distributors often have their own pricing models and face uncertainties such as fluctuating exchange rates and regional pricing disparities, as highlighted in the supporting statements. This complicates the development of competitive pricing models for advanced services for Case PrintCo. These uncertainties *delay the strategic decision-making* and *development process* for Case PrintCo. Moreover, Case PrintCo needs to effectively maintain its relationships with its distributors; otherwise, this can cause *market receptivity* when they introduce AS.

AS Scope & Understanding

The category Advanced Services (AS) Scope & Understanding captures the uncertainties related to the knowledge base and individual perspectives on the overarching concept of advanced services. One significant uncertainty within this category is the **lack of understanding about the feasibility of providing guarantees in advanced services:**

> ***"****The focus will, you know be stronger on the guarantee that uptime. But so far, we have been able to, you know, avoid that type of discussion"- Dist1*

> *"We never delivered uptime guarantee it's difficult, instead use preventative maintenance so customers are confident that this won't be a problem."- Dist5*

This uncertainty reveals that distributors are cautious about offering guarantees due to the complexity of ensuring and maintaining uptime as they are not the original equipment manufacturer.

Relational Uncertainty

The relational uncertainty type describes the unpredictability of a partner's action for advanced services. A few uncertainties were identified during the interviews with the distributors, which are presented in Table 26 below.

Table 26: Relational uncertainties apparent in Distributor cases

Uncertainty Category	Uncertainty	Definition	Inferred Implications
Customer Desirability	Customer Mindset & Expectations	Lack of knowledge regarding the customer's mindset and expectations for AS	Misalignment of customer expectations and customer dissatisfaction
Strategic Partnership	Partner Requirements	Lack of information regarding the requirements of partners for AS	Potential conflicts
	Manufacturer Support	Uncertainty regarding the necessary support from equipment providers	Erosion of trust and collaboration

Customer Desirability

The category of Customer Desirability captures uncertainties related to understanding and engaging with target customer segments for advanced services. One significant uncertainty expressed by several participants pertains to the **lack of knowledge regarding the customer's mindset and expectations for advanced services**:

> *"The biggest problem we have is, uh, when we don't have 100% coverage of the client, then it's a potential conflict there; it's always they have very high expectations. And, sometimes, I think that we are giving them too high service, so they become spoiled. So, I am not sure how we can balance expectations". - Dist1*

> *"But I think that we are giving our clients too high service; it's always that they have high expectations, so they become spoiled like our availability through WhatsApp. I think it's very complicated now"- Dist3*

Distributors' concerns about balancing service levels and customer expectations highlight the need for Case PrintCo to understand better how to manage customer needs and preferences.

Strategic Partnership

The Strategic Partnership category describes uncertainties associated with external partners for the provision of advanced services. During the interviews, one of the participants expressed a **lack of information regarding the requirements of partners for advanced services**:

> *"So, this means that if someone has some issues, they call us, and we are responsible anyway for all the issues. You know, we are doing everything as we have the asset, we have the software, etc. So, we can solve this, and we are not dependent, you know, but talking to another partner about the software or hardware. That's always where the problem comes in. The requirements may not align there. This is where we may need to think more about…"- Dist1*

A few participants highlighted another significant **uncertainty regarding the necessary support from equipment providers:**

> *"We have not linked it up to any cloud solutions or things like that, but, it could be something that we could do if Case PrintCo introduces something we could tap into. maybe also you know, doing something where we as distributor could tap into the bigger organisation" - Dist1*

> *"We have customers that are requiring 24/7 services, but with my service team, I'm not able to offer it but if we could have you know, everybody from around the world tapping into this, then I think that a lot of distributors would be, and now I can only talk for myself, of course, but I would be willing, you know, to throw in some people that could assist on this and maybe there could be a hotline somewhere in the Case PrintCo's world" .- Dist4*

The lack of clarity on managing issues involving multiple partners can *increase the risk of service failure* and *potential conflicts*. These statements reflect a significant uncertainty about the level of support that equipment providers such as Case PrintCo can offer. Distributors are aware of the potential benefits of enhanced support and resource sharing, but they are unsure about how to effectively use and integrate these resources within their existing operational framework.

Technical Uncertainty

The technical uncertainty type reveals several uncertainties related to advanced services' technological and data infrastructure. Table 27 presents uncertainties that emerged during the interviews with distributors of Case PrintCo and their descriptions.

Table 27: Technical uncertainties apparent in Distributor cases

Uncertainty Category	Uncertainty	Definition	Inferred Implications
Advanced Technologies and Tools	Automation	Lack of information on the implementation and effectiveness of automated systems for tasks such as capturing faults, handling issues, and managing contracts.	Operational inefficiency, increased costs, and increased resistance to technology adoption
	Cloud Interface	Uncertainty about cloud connectivity for all the equipment	Increased costs and strategic risk
	Technology Upgrades	Lack of understanding of the required technology upgradation to support AS	Operational inefficiency and increased costs
Technical Infrastructure	Data Availability	Lack of information about the availability of the necessary data to support AS	Data silos and fragmentation
	Data Interpretation	Lack of understanding of how to map data to specific needs and provide actionable insights	Increased risk of service failure and customer dissatisfaction
	Cybersecurity	Uncertainty about the adequacy of safety and cybersecurity infrastructure for data sharing	Increased risk of data breaches, compliance issues and erosion of trust and collaboration

Advanced Technologies and Tools

The Advanced Technology and Tools category describes the uncertainties related to the specific tools and technological developments crucial for advanced services. One of the significant uncertainties within this category is the **lack of information on the implementation and effectiveness of automated systems for tasks such as capturing faults, handling issues, and managing contracts,** as indicated in the below statements:

> *"So, it's, you know, how can we use it? How come we set up an alert? We need to get that to work properly. Yeah, cannot do it manually. Every customer side, then it needs to be automated in a way."- Distr1*

> *"We are so used to automatic software changes that happen, and I think also if that could be on the equipment, I think that would be the way it should be really whereas today it's not"- Dist4*

Presently, many assets are not connected to the cloud, which limits data access. Participants expressed **uncertainty about cloud connectivity for all the equipment**:

> *"But we have not been able to, you know, get the cloud rolling because we have been so busy, and also we don't know what the complexities with it"- Distr1*

> *"It would be good to maybe have something like the cloud module that could monitor, and we could do online assistance and things like that"- Dist4*

Another significant uncertainty expressed by several participants pertains to the **lack of understanding of the required technology upgradation to support AS:**

> *"I don't know in terms of technologies. We are not that innovative, and maybe you have some samples you are thinking about or…"- Distr1*

> *"We can maybe get some technical help in terms of tools like the monitoring tool that we spoke about…"- Dist3*

> *"Our customers hate emails; they want to speak to us on the phone. We want to extend back-office systems to the technical helpdesk but need to discuss – it must be simple, and we may need to overcome internal resistance, such as not wanting to use our own phones. [ ] has Cloud dashboard type system, but we did it ourselves but would like to see Case PrintCo's solution."- Dist5*

This category reveals significant uncertainties from the distributors' perspective, directly influencing their *resistance to adopting new technologies*. These can further impact the manufacturer's ability to provide advanced services through distribution channels.

Technical Infrastructure

This category describes the uncertainties linked with the shift of the technical infrastructure and technical readiness to support advanced services. One of the participants expressed the **lack of information about the availability of the necessary data to support AS:**

"There are so many factors that influence uptime because it depends on the production line, the operator, so it's very difficult to capture that"- Dist1

This statement underscores the complexity involved in capturing and leveraging data effectively, which is essential for providing reliable advanced services. Another critical uncertainty pertains to the **lack of understanding of how to map data to specific needs and provide actionable insights,** as indicated in the statement**:**

"But also just get more insight on what breaks when and have been part of, you know, the biggest schemes of things. So, the more products that Case PrintCo has online will give you big data to analyse, it all adds up to bigger challenges at the end"- Dist4

This reflects the difficulty distributors face in interpreting large volumes of data to derive meaningful insights that can improve service delivery and predict potential issues. Additionally, participants expressed a **lack of understanding regarding the alignment of safety and cybersecurity infrastructure for data sharing:**

There's a potential issue with data protection and things like that for the people outside the Case PrintCo organisation having at this, but I'm sure there are ways"- Dist4

The complexities of capturing and interpreting data, as well as concerns over cybersecurity and data protection, can result in significant *delays* and *inefficiencies*. Manufacturers must acknowledge these uncertainties, which is crucial for fostering stronger partnerships with distributors and improving overall service delivery.

Environmental Uncertainty

The environmental uncertainty type describes the unpredictability and complexity of external factors. Participants expressed **uncertainty about the market changes and external business environment fluctuations:**

"We don't know what we're facing tomorrow outside our business, but yeah, that's a concern too, to plan for the in predictable."- Dist2

"So, imagine you signed an agreement two months ago, and the currency starts depreciating. You can't go back and renegotiate. So maybe the lessons learned is now to kind of ties to uh, the exchange rate, which is a bit uncertain"- Dist3

This uncertainty highlights the unpredictable nature of the market shifts and the challenges they pose to distributors in planning and operations. Understanding these market dynamics is critical for Case PrintCo to support distributors effectively. Having examined the distributors' uncertainties, the following section examines Technology suppliers' uncertainties in advanced services.

6.2.3 Technology Supplier Uncertainties

Organisational Uncertainty

The interviews with Case PrintCo's technology suppliers revealed a few uncertainties. Table 28 below summarises these uncertainties into three categories.

Table 28: Organisational uncertainties apparent in Technology Supplier cases

Uncertainty Category	Uncertainty	Definition	Inferred Implications
Internal Dynamics	Culture and Mindset Change	Lack of understanding regarding the cultural and mindset shift towards AS	Less buy-in
	Business System and Processes	Lack of understanding of the internal systems and processes required to facilitate AS	Delays in the development process
Commercial Viability	IT Upgradation Cost	Uncertainty about the cost associated with technological upgrades	Increased cost and delays in development process
AS Scope & Understanding	AS Knowledge & Understanding	Lack of definite knowledge and understanding about the overall concept of AS	Less buy-in and delays in the development process
	AS on other Equipment	Lack of information about manufacturers offering AS on other supplier equipment	-

Internal Dynamics

The Internal Dynamics category describes uncertainties related to human and structural factors within the organisation. Case T1 provides a hardware and software solution to Case PrintCo (section 5.2.2). The company aims to move towards offering a service solution package that includes both hardware and software. However, there has been resistance within the company, transitioning from a hardware-centric to a software and services-oriented mindset. One significant uncertainty identified is the **lack of understanding regarding the cultural and mindset shift towards AS,** as indicated in the statement:

> *"…product managers who have been doing that and having those arguments. UM, it's because it's definitely taking a long time. And there has been a lot of inertia within the industry as well as within our business, you know. As I said, it was your take as traditionally a hardware company, so it's quite a paradigm shift to start thinking purely of software and services sales. Um, I don't think that we're even halfway down the journey, yet even though we've got customers, we don't have particularly standard offerings, yet we don't have everything commercially at least, is quite bespoke to each individual customer"- Tech1*

Another critical uncertainty is the **lack of understanding of the internal systems and processes required to facilitate AS.** Case T1 must undergo a very complicated approval process within Case PrintCo to introduce any new product developments, and they are uncertain if this process will be smoother when Case PrintCo introduces advanced services, as indicated in the below statement:

> *"We had to go through a really involved new product introduction process where Case PrintCo is obeying, and there's a huge amount of documentation and process involved because it's a Case PrintCo's approved part. But I would hope that if we were in more of a service type model where there might be fewer concerns"- Tech1*

Resistance to cultural and mindset changes leads to the implication of less buy-in from stakeholders, and long internal processes cause *delays and inefficiencies* in implementing advanced services.

Commercial Viability

The category Commercial Viability describes uncertainties related to the pricing model and financial benefits that advanced services could bring to their business. During the interviews, participants expressed **uncertainty about the cost associated with technological upgrades:**

> *"Because if they capture more and more data, it would be nice to, you know, how they can reduce the cost somehow for our business as well. So, what would it mean moving forward, how is it going to change in the future in terms of your technology, let's say years from now on in terms of Case PrintCo is moving and improving and offering advanced services to a complete service solution, how can our costs be reduced?"- Tech1*

This uncertainty about the costs of ongoing technological upgrades can affect long-term planning and investment decisions. These upgrades can lead to *increased costs* and *delay the development process*, impacting both Case T1 and Case PrintCo.

AS Scope & Understanding

The Advanced Services (AS) Scope & Understanding category describes the uncertainties that particularly focus on the knowledge and individual perspectives on the overarching concept of advanced services. One significant uncertainty is the **lack of definite knowledge and understanding about the overall concept of AS,** as indicated in the statement**:**

> *“I know that Case PrintCo is working on a lighthouse project of advanced services, but I'm not aligned on the specific content of their advanced services. So, I know that they ensure uptime availability, but not too much in the details”- Tech2*

Another notable uncertainty is the **lack of information about manufacturers offering AS on other supplier equipment.** This uncertainty shows the potential for Case PrintCo to extend its advanced services to equipment produced by other manufacturers, as highlighted by the participant:

> *“…because, of course, Case PrintCo’s customer could say, OK, I have a product of Case PrintCo, but I want to buy the service from another entity, but it could also be an advantage for Case PrintCo to say, okay, I can't deliver the service also on other product. I don't know if Case PrintCo has ever considered delivering services on other manufacturer products”. - Tech2*

These uncertainties can lead to *confusion* and *misalignment* between Case T1 and PrintCo, hindering *effective collaboration* and the successful deployment of advanced services.

Relational Uncertainty

The relational uncertainty type describes the unpredictability of a partner’s action in the context of advanced services. Only one uncertainty is identified under the strategic partnership category.

Strategic Partnership

The interviews with technology suppliers reveal one significant uncertainty under the category of Strategic Partnership. One of the participants expressed a **lack of information regarding the requirements of partners for advanced services:**

> *"I think that one is about partners. So, I know that Case PrintCo is also relying on a partner to deliver their services, so I don't know if they'd also consider their partner to deliver advanced services or if advanced services will be only a direct offering from them to the end customers?"- Part2*

This uncertainty can significantly impact strategic planning and the overall effectiveness of the advanced services delivery. If technology suppliers like Case T1 and their partners lack clarity on their roles and responsibilities, it can lead to misalignment and inefficiencies. Moreover, if partners are unsure whether they are included in the advanced services strategy, they may be less motivated to invest in the necessary infrastructure and capabilities.

Technical Uncertainty

The technical uncertainty type reveals several uncertainties related to the technological and infrastructural aspects crucial for implementing advanced services. Table 29 summarises these uncertainties within this type.

Table 29: Technical uncertainties apparent in Technology Supplier cases

Uncertainty Category	Uncertainty	Definition	Inferred Implications
Advanced Technologies and Tools	Automation	Lack of information on the implementation and effectiveness of automated systems for tasks such as capturing faults, handling issues, and managing contracts.	Operational inefficiency, increased costs, and increased resistance to technology adoption
	Product Reliability & Developments	Lack of information regarding product reliability and future product developments	Operational inefficiency, increased costs and customer dissatisfaction
Technical Infrastructure	Data Requirements	Lack of understanding about the required data to effectively offer AS	Delays in the development process
	Data Interpretation	Lack of understanding of how to map data to specific needs and provide actionable insights	Delays in the developments process, increased risk of service failure and customer dissatisfaction
	Product Connectivity	Uncertainty regarding the reliability of product connectivity for data retrieval	Operational inefficiency, increase strategic risk, and delays in the development process
	Behaviours around the Product	Lack of information about the impact of external factors on the production line due to the operation of other machines and operators	Operational inefficiency
	Cybersecurity	Lack of understanding regarding the alignment of safety and cybersecurity infrastructure for data sharing	Increased risk of data breaches, compliance issues and erosion of trust and collaboration

Advanced Technologies and Tools

The category Advanced Technologies and Tools describes the uncertainties about specific tools and technological developments crucial for advanced services. A notable uncertainty within this category is the **lack of information on the implementation and effectiveness of automated systems for tasks such as capturing faults, handling issues, and managing contracts,** as indicated in the statement**:**

> *"But it is also the responsibility of Case PrintCo to collect the data they need. For example, adding sensors or adding some uhm, new data may be helpful. For example, if they recognise that maybe there is downtime caused by some manual operation, maybe it would be important to detect this manual operation, maybe adding new data, neural data or new sensors in the asset to recognise if something has been done, so this may be something to think about."- Tech2*

Another significant uncertainty where the participants expressed the **lack of information regarding product reliability and future product developments:**

> *"…see how effective your printer is, and if there's a high number of failures, you probably need to check the alignment of something. The speed or you know, there'd be something you would need to tweak to improve the quality metrics."- Tech1*

> *"We have not yet this feature, but I think that in order to support an outcome based contract, it is useful also to have the possibility to manually change something"- Tech2*

The need to deploy automated systems and technologies effectively can impact advanced services development, leading to *delays* and *operational inefficiencies*.

Technical Infrastructure

This category describes the uncertainties linked to the data infrastructure and technical developments required to support advanced services. During the interviews, participants expressed a **lack of understanding about the required data to effectively offer AS**:

> *"And I mean, it may be that Case PrintCo wants to capture more or different metrics from the printer in the future"- Tech1*

> *"So, when we think about an output-based contract or an outcome-based contract, the first thing to do is to measure the outcome. So, it seems easy to speak, but not easy to implement because you cannot rely only on raw data"- Tech2*

This is critical, as technology suppliers capture data for Case PrintCo through their hardware and software. Understanding data requirements is essential to collecting the correct data, which is vital for generating meaningful insights and making informed decisions. Moreover, one of the participants highlighted the **lack of understanding of how to map data to specific needs and provide actionable insight:**

"In other words, how to distinguish the downtime that is really related to the responsibility of Case PrintCo, so that is related to a failure in the machine from a downtime that is simply related to some bad behaviour"- Tech2

Additionally, the **lack of information about the impact of external factors on the production line due to the operation of other machines and operators** was expressed by the participant:

"Yeah, this is tricky to detect exactly. So, for example, we have a customer where the operator pushes the emergency button just to stop the machine. So, the emergency button generates a failure state because it seems that something important and something at an emergency level has happened. But then we discovered that the operator only pushed the emergency button to stop the machine. So, that is not so easy to capture, I suppose."- Tech1

Uncertainty regarding the reliability of product connectivity for data retrieval also emerged as a significant concern:

"So, when you connect Case PrintCo's printing machine, you receive data, of course, but uh, it may happen some disconnection in the middle it for one month Uh, it's not trivial to at the end of the month calculate the uptime of the machine."- Tech1

Furthermore, there is **uncertainty about the adequacy of safety and cybersecurity infrastructure for data sharing**. The concerns around security can prevent customers from fully integrating and utilising connected systems, as indicated in the statement:

"And I think the other thing is related to connectivity is what you say, so maybe some customers are not connecting the equipment because of some security reason?"- Tech2

The technical uncertainties identified by technology suppliers have significant implications for the manufacturer's advanced services. This lack of understanding can lead to misaligned service offerings, disrupted data flow, and compromised service reliability. These uncertainties delay the development and deployment of advanced services for Case PrintCo, affecting the technology supplier relationship and satisfaction.

Environmental Uncertainty

The environmental uncertainty type describes the unpredictability and complexity of external factors. Participants highlighted the **uncertainty in meeting varied regulatory requirements across multiple countries**:

"One of the biggest complicated tasks I foresee is country certifications. At the moment. with like the technology types of Case PrintCo paid us to certify the gateway. For countries that Case PrintCo wished to deploy to, it's quite expensive. All these certifications are expensive. It takes months and months. You have to send samples to labs; in each of these countries, you never get them back to UM; it's a huge scam. I mean, it's a huge amount of revenue for various governments worldwide just to sell stuff in their countries. The best thing about the EU was that all the EU was one umbrella. It's

two umbrellas because we've got our own stupid certificate authority. But anyway. UM, yeah. So, that would be the most off the top of my head. At least I think that would be the most complicated thing to solve would be how do we handle?" - Tech1

Case PrintCo operates in diverse countries, and the complexity is compounded by changes in European laws. Navigating these regulatory requirements is essential for market entry and compliance, but it is a costly and time-consuming process, as highlighted by Case T1. Another notable uncertainty is the **lack of knowledge regarding the market potential and effective strategies to promote and deliver advanced services,** highlighted in the statement**:**

"The market is not completely there, yet most people still like to have a tangible thing for their money. It's been there for a few years; it depends a lot on the use case." - Tech1

These uncertainties are critical as they influence strategic decisions and the ability to operate efficiently in different markets. They could potentially delay market entry and limit Case PrintCo's geographic expansion. Additionally, the lack of market insight and effective strategies can hinder the adoption of advanced services.

6.3 Summary

This chapter provided an in-depth within-case analysis of internal stakeholder cases PrintCo, RoboCo, and BoilerCo, as well as the external stakeholder cases involving customers, distributors, and technology suppliers embedded in Case PrintCo. The analysis employed a thematic coding process, using the research codebook to systematically identify and categorise uncertainties into four main types: organisational, relational, technical, and environmental. By breaking down into these types, the analysis offered insights into specific uncertainties faced by each case.

The coding process allowed for a structured exploration of these uncertainties, with each case revealing unique patterns that provide essential context for cross-case comparisons. This within-case analysis serves as a foundation for the following chapter, where the findings from each case will be contrasted to identify broader themes and insights, enabling a more comprehensive understanding of the uncertainties across different cases.

7. CROSS-CASE ANALYSIS & FINDINGS

This chapter provides a comprehensive cross-case analysis by synthesising the insights generated from the within-case analysis (Chapter 6) across all the cases. The analysis compares the preliminary findings from the within-case analysis across the service network. By examining patterns and relationships across multiple cases, this analysis explores the collaborative dynamics and shared uncertainties encountered by Service Network Actors (SNA) (section 4.4.6). The chapter aims to uncover how uncertainties impact advanced services innovation from a SNA perspective. The chapter addresses the following research questions:

RQ1: What uncertainties arise for internal stakeholders of a manufacturing firm when innovating advanced services?

RQ2: What uncertainties arise for external stakeholders of a manufacturing firm when innovating advanced services?

RQ3: What are the likely implications of these uncertainties for internal and external stakeholders of a manufacturing firm when innovating advanced services?

To address these questions, the chapter is structured into three main sections. Each section systematically examines the four uncertainty types — organisational, relational, technical, and environmental. The first section focuses on the internal stakeholders of the manufacturing cases (PrintCo, RoboCo, BoilerCo), providing a cross-case analysis of these cases to answer *RQ1*. The second section presents an analysis of the external stakeholders, including customers (C), distributors (D), and technology suppliers (T), addressing *RQ2*. The final section explores the implications of these uncertainties for both internal and external stakeholders, providing insights into their broader impact and addressing *RQ3*. Each section concludes with a summary of key findings. These insights lay the foundation for the study's conclusions and contributions.

7.1 RQ1: Internal Stakeholders Uncertainties

7.1.1 Organisational Uncertainties

Organisational uncertainty is defined as "the lack of understanding of firm resources by organisational members, which results in variations in organisational effectiveness and efficiency over time" (Kreye, 2022: 35). This type of uncertainty arises internally and represents a significant barrier for manufacturers, often contributing to failures in servitization efforts (section 2.4.3). The cross-case analysis looks at the patterns by comparing organisational uncertainties across the cases (PrintCo, RoboCo, and BoilerCo), as summarised in Table 30 below. The aim is to identify the organisational uncertainties that emerge for the internal stakeholders of a manufacturing firm when innovating advanced services. To achieve this, the uncertainties identified from the within-case analysis (Chapter 6) are grouped into three categories, *Internal Dynamics*, *Commercial Viability*, and *AS (Advanced Services) Scope & Understanding,* which are examined and compared to draw key insights across the cases.

Table 30: Cross-case analysis of organisational uncertainty for internal stakeholders

	Uncertainty	Cases
Internal Dynamics	Culture and Mindset Change *Lack of understanding regarding the cultural and mindset shift towards AS*	PrintCo, RoboCo, BoilerCo
	Roles and Responsibilities *Lack of knowledge about the specific roles and responsibilities for AS*	PrintCo, RoboCo, BoilerCo
	Skillsets and Expertise *Lack of knowledge about the required skills and expertise for AS*	PrintCo, RoboCo, BoilerCo
	People Training *Lack of understanding about the necessary trainings to deliver AS*	PrintCo, RoboCo, BoilerCo
	Resources & Capabilities *Lack of understanding regarding the allocation and availability of resources and capabilities for AS*	PrintCo, RoboCo, BoilerCo
	Organisational Structure *Lack of understanding about how to effectively organise the firm's processes, people and tools for AS*	PrintCo, RoboCo, BoilerCo
	Business System and Processes *Lack of understanding of the internal systems and processes required to facilitate AS*	PrintCo, RoboCo, BoilerCo
	Sales Team *Lack of certainty regarding the sales team's comprehension and their ability to effectively communicate and sell AS to customers*	PrintCo, RoboCo, BoilerCo
	Dedicated AS Team *Lack of certainty about having a dedicated AS team within the business*	PrintCo, BoilerCo
	Cross-Collaborations *Lack of certainty about the effectiveness and coordination of cross-departmental collaborations within the business*	RoboCo
Commercial Viability	Pricing Model & Strategy *Lack of information regarding the pricing strategies for AS*	PrintCo, RoboCo,
	Service Level Agreement (SLA) conditions *Lack of knowledge regarding the design and conditions of SLA for AS*	PrintCo, BoilerCo
	Financial Benefit *Uncertainty about the revenue generation potential from AS*	PrintCo, RoboCo,
	Funding *Lack of certainty in securing the necessary funding for AS*	PrintCo, RoboCo, BoilerCo
	Legal & Commercial Risk *Lack of knowledge about the legal and commercial aspects of the SLA*	PrintCo, RoboCo, BoilerCo
AS Scope & Understanding	AS Knowledge & Understanding *Lack of definite knowledge and understanding about the overall concept of AS*	PrintCo, RoboCo, BoilerCo
	Value Proposition *Lack of understanding about the specific meaning and boundaries of the value proposition*	PrintCo, RoboCo, BoilerCo
	Service Guarantee *Lack of understanding about the feasibility of providing guarantees in AS*	PrintCo, BoilerCo
	Naming Conventions and Hierarchies *Lack of understanding about the definitions and terminologies used for AS*	PrintCo

Internal Dynamics

Internal Dynamics focuses on the human and structural aspects of the business that contribute to organisational uncertainty. As outlined in Table 30 above, ten uncertainties emerged across the three cases in this category, of which eight are common across the three cases (PrintCo, RoboCo, and BoilerCo). These commonalities suggest a shared set of uncertainties faced by the internal stakeholders of the manufacturing firms, as they are all in the early stages of advanced services development. For instance, the **Sales Team** remains a significant source of uncertainty across all manufacturer cases, where the focus on product sales continues to overshadow the promotion of advanced services. Interestingly, Case RoboCo stands out by developing a unique strategy of identifying 'sales champions'—individuals within the sales team motivated to advocate for advanced services. This approach, however, has yet to take root in Cases PrintCo and BoilerCo, where product-centric sales strategies persist. This difference highlights the varying levels of organisational adaptability and the potential for sales-driven barriers that could obstruct AS adoption if not addressed.

In contrast, two uncertainties exhibited varying prominence across the cases. One uncertainty pertains to the **Dedicated AS Team,** which emerged in PrintCo and BoilerCo but not in RoboCo. However, Case PrintCo demonstrated some progression in addressing this uncertainty. While initially lacking a dedicated team, by the end of the two-year longitudinal study, PrintCo had established a dedicated AS team. In contrast, BoilerCo continues to face difficulties in building this team, highlighting the varied pace of adaptation among manufacturers. Another uncertainty surrounding **Cross-Collaborations** is highlighted only in the case of RoboCo, reflecting the firm's unique uncertainty in collaboration across multiple departments across different service initiatives. These similarities and differences underline how some firm-specific factors, such as organisational culture, resources, and strategic priorities, shape these uncertainties within internal dynamics.

Commercial Viability

Commercial Viability focuses on the uncertainties surrounding the sustained profit-generating ability of advanced services through a competitive pricing model. In this category, a total of five uncertainties were raised by the internal stakeholders, of which two uncertainties were common across all three cases, as summarised in Table 30 above. These uncertainties underscore the critical importance of commercial considerations in shaping decision-making processes for advanced services. One prominent uncertainty common to all cases was securing sufficient **Funding** to support the development of advanced services. While this uncertainty persisted across the cases, PrintCo successfully navigated this issue after two years of continuous effort, eventually acquiring the necessary funding and resources to pilot advanced services. Another widely shared concern was the **Legal and Commercial Risks** associated with advanced services, reflecting apprehensions about their potential impact on business stability.

One of the most significant uncertainties identified is the **Pricing Model and Strategy** for AS, which was prevalent across both internal cases, PrintCo and RoboCo. For manufacturers, the complexity

lay in navigating unfamiliar pricing models, particularly the pay-per-outcome model. Internal stakeholders in these cases highlighted the difficulty of adopting unfamiliar pricing approaches, which created challenges in aligning these models with the business's financial objectives. Relatedly, uncertainty about the **Financial Benefit** of advanced services and their pricing models was raised by stakeholders in these two cases. The inability to predict the overall financial advantage for the business further complicated their strategic decisions. Lastly, **Service Level Agreement (SLA) conditions** were flagged as a concern by PrintCo and BoilerCo.

Overall, commercial viability uncertainties were most prevalent in PrintCo, reflecting the case's active engagement with piloting advanced services compared to BoilerCo and RoboCo. This indicates that companies at the initial stages of advanced services development have increased commercial worries, especially regarding funding, pricing strategies, and legal considerations.

AS Scope & Understanding

AS (Advanced Services) Scope & Understanding focuses on the uncertainties surrounding the knowledge base and individual perspectives on the overarching concept of advanced services. In this category, four key uncertainties were identified, with two being common across all three cases, as illustrated in Table 30 above. One significant shared uncertainty was **AS Knowledge & Understanding,** which is evident in PrintCo, RoboCo, and BoilerCo. While a shared understanding is critical to unlocking the potential of advanced services, the data revealed varied levels of knowledge among internal stakeholders of the firms. Those less involved in the AS initiative demonstrated limited understanding, which created barriers to progress and hindered cohesive efforts toward innovation. Another widely observed uncertainty was related to the **Value Proposition.** This uncertainty arose from the lack of effective customer segmentation, resulting in a lack of clarity around how to tailor and define value propositions for different customer segments. This uncertainty was consistently highlighted across all three cases, emphasising its critical role in shaping AS strategies.

In contrast, **Service Guarantee** uncertainties were specifically emphasised by PrintCo and BoilerCo. Manufacturers expressed reluctance to offer guarantees due to the inherent difficulty of ensuring consistent equipment performance. The unpredictability of various factors influencing uptime was perceived as a significant risk, deterring stakeholders from committing to guarantees that could expose them to potential liabilities. **Naming Conventions and Hierarchies** emerged as a unique uncertainty raised exclusively in PrintCo. This concern reflected challenges in establishing standardised terminology and structures to support AS development.

Overall, the uncertainties surrounding AS Scope & Understanding underscore critical gaps in knowledge, customer-centric strategy, and internal alignment. These insights emphasise the need for structured learning initiatives, clear value definition processes, and robust frameworks to support the successful innovation of advanced services.

7.1.2 Relational Uncertainties

Relational uncertainty refers to the 'inability to predict or explain partners' actions' (Kreye, 2017b: 366) within the service context. This uncertainty is particularly relevant because advanced services require close, dynamic inter-organisational relationships with external stakeholders (section 2.3.3). The relational uncertainties identified from the within-case analysis are categorised into *Customer Desirability* and *Strategic Partnership,* as summarised in Table 31 below. The following sections explain these categories to highlight unique insights and emerging patterns across the cases of PrintCo, RoboCo, and BoilerCo.

Table 31: Cross-case analysis of relational uncertainty for internal stakeholders

	Uncertainties	Cases
Customer Desirability	Customer Mindset & Expectations *Lack of knowledge regarding the customer's mindset and expectations for AS*	RoboCo, BoilerCo
	Customer Engagement *Lack of information on whom to and how to engage within customer organisation for AS*	PrintCo, RoboCo, BoilerCo
	Target Customer Segment *Lack of information on selecting the optimal customer segment for AS*	PrintCo, RoboCo, BoilerCo
	Customer Activities *Lack of information about the customer activities on production lines*	PrintCo, BoilerCo
	Customer Requirements *Lack of clear understanding about the specific requirements of the customer*	PrintCo, BoilerCo
	Staff Turnover on Sites *Lack of information about the rate of staff turnover on customer sites*	PrintCo, BoilerCo
Strategic Partnership	Potential Partnerships *Uncertainty about potential partners for AS and how to sustain these partnerships effectively*	PrintCo, RoboCo
	Partner Requirements *Lack of information regarding the requirements of partners for AS*	PrintCo, RoboCo, BoilerCo
	Supplier Equipment *Uncertainty about the equipment provided by third party suppliers and its integration with product technologies*	PrintCo, RoboCo, BoilerCo
	Distribution Channel as Middleman *Lack of knowledge regarding the distributors' perspective and role in AS*	PrintCo, RoboCo, BoilerCo
	System Integrators & Machine Makers *Uncertainty about the collaborations with system integrators or machine makers for AS*	RoboCo

Customer Desirability

Customer Desirability focuses on the uncertainties related to engaging target customers and effectively demonstrating the value of advanced services. Unlike tangible products, advanced services are inherently more abstract, making it challenging for manufacturers to convey their added value effectively. Table 31 summarises a total of six uncertainties across PrintCo, RoboCo, and BoilerCo. Among these, two uncertainties are common across all three cases, while the remaining four are shared primarily between PrintCo and BoilerCo.

These uncertainties consistently emerge as manufacturers strive to engage customers in advanced services. For instance, uncertainty surrounding **Target Customer Segment** and **Customer Engagement** were consistently highlighted across all cases. Manufacturers expressed concerns about prioritising specific customer segments and identifying effective methods for engagement. This shared pattern underscores a relational complexity that must be addressed, as customer-centricity plays a critical role in co-developing advanced services. Case PrintCo proactively tackled these uncertainties through collaboration with an external partner, which facilitated clearer messaging and better insights into customer perspectives. This approach proved particularly useful, as customers often refrain from sharing relevant information directly with manufacturers. Similarly, RoboCo implemented role-playing exercises within their sales team to identify communication gaps and refine engagement strategies. In contrast, BoilerCo continues to struggle with identifying the right contacts within customer organisations, illustrating the ongoing challenges manufacturers face in this area.

In addition, uncertainty surrounding **Customer Mindset and Expectations** was common to RoboCo and BoilerCo. These cases encountered difficulties in dealing with customers accustomed to traditional product ownership models, creating challenges in anticipating customer responses and expectations toward advanced services. Other uncertainties, such as **Customer Activities** and **Staff Turnover on Customer Sites,** were shared between PrintCo and BoilerCo. This alignment suggests that these two cases are grappling with similar strategic challenges related to customer desirability, albeit at different stages of maturity**.**

Customer Desirability category highlights some shared uncertainties that internal stakeholders of manufacturer cases face in effectively engaging customers and demonstrating the value of advanced services. While PrintCo and RoboCo showcase proactive strategies such as leveraging external partnerships and refining internal communication methods, BoilerCo's continued struggles underscore the critical importance of adopting tailored, customer-centric approaches. These insights emphasise the need to address relational complexities and customer resistance to facilitate the successful innovation of advanced services.

Strategic Partnership

Strategic Partnership focuses on the uncertainties related to collaborations with partners for the effective provision of advanced services. As outlined in Table 31 above, five uncertainties emerged across the three cases in this category, of which three uncertainties are common across all these cases. These shared uncertainties highlight the relational complexities manufacturers face as they navigate partnerships to support advanced services while making long-term strategic decisions.

For instance, uncertainty surrounding **Partner Requirements** was consistently raised across all cases. Manufacturers highlighted a lack of clarity regarding the specific requirements or expectations of their partners for advanced services. Similarly, the uncertainty surrounding **Supplier Equipment** emerged across all cases. Manufacturers expressed concerns about the integration of third-party supplier equipment with their own product technologies, highlighting a critical technical-relational challenge. The **Distribution Channel as Middleman** uncertainty was another commonality,

underscoring the need for manufacturers to better understand the role and perspective of distributors in AS. Since manufacturers often rely on multiple distribution channels and system integrators, managing these intermediaries adds complexity to the process of reaching end customers. Moreover, some of these middlemen operate their own service-led business models, positioning them as potential competitors rather than collaborators. This introduces an additional layer of complexity around how manufacturers can effectively form a bridge and engage with these partners effectively. This lack of clarity creates challenges in aligning strategies and ensuring effective collaboration with distributors, who often act as intermediaries between manufacturers and end customers.

In contrast, case-specific uncertainties further reveal the unique challenges faced by manufacturers. For example, RoboCo expressed uncertainty regarding collaborations with **System Integrators and Machine Makers**, reflecting its reliance on specialised technical partners to deliver AS. This suggests a strategic dependency on external expertise that may not be as pronounced in the other cases. Similarly, uncertainty about **Potential Partnerships** was highlighted by PrintCo and RoboCo, indicating an ongoing search for suitable long-term partners to sustain their AS initiatives.

The insights from this category reveal a clear alignment of uncertainties across the cases, particularly in establishing and sustaining partnerships critical to advanced services delivery. The strategic partnership uncertainties emphasise the need for manufacturers to strengthen collaboration frameworks with partners, focusing on clear communication, role definition, and shared goals. By doing so, manufacturers can create a robust service network for delivering advanced services effectively.

7.1.3 Technical Uncertainties

Technical uncertainty can be defined as a lack of knowledge surrounding significant changes in technologies (maturity and application) (Reim et al., 2020) and data (Durugbo et al., 2010; Hou et al., 2013) in the context of product and service. Given that advanced services often rely on cutting-edge technologies and sophisticated data management processes (section 2.2), uncertainties in this type can significantly disrupt the overall innovation. The technical uncertainties identified from the within-case analysis are grouped into two categories: *Advanced Technologies* & *Tools* and *Technical Infrastructure,* as summarised in Table 32 below. The following sections discuss these categories across the cases to highlight unique insights and emerging patterns.

Table 32: Cross-case analysis of technical uncertainty for internal stakeholders

	Uncertainty	**Cases**
Advanced Technologies & Tools	Automation *Lack of information on the implementation and effectiveness of automated systems for tasks such as capturing faults, handling issues, and managing contracts.*	PrintCo, RoboCo
	Cloud Interface *Uncertainty about cloud connectivity for all the equipment*	PrintCo
	Delivery Tools & Systems *Lack of knowledge about specific tools and systems required to support and deliver AS*	PrintCo, RoboCo
	Technical Requirements	PrintCo

	Lack of knowledge about the technical requirements of technologies, systems and equipment to support AS	
	Technology Upgrades *Lack of understanding of the required technology upgradation to support AS*	PrintCo
	Product Reliability & Developments *Lack of information regarding product reliability and future product developments*	PrintCo, RoboCo, BoilerCo
	Target Product Technology *Uncertainty about selecting the target product technology to offer AS*	PrintCo
Technical Infrastructure	Data Requirements *Lack of understanding about the required data to effectively offer AS*	PrintCo
	Data Availability *Lack of information about the availability of the necessary data to support AS*	PrintCo, RoboCo, BoilerCo
	Data Interpretation *Lack of understanding of how to map data to specific needs and provide actionable insights*	PrintCo, RoboCo, BoilerCo
	Technical Development *Lack of information about ongoing and required technical developments in the data infrastructure*	PrintCo, RoboCo
	Product Connectivity *Uncertainty regarding the reliability of product connectivity for data retrieval*	PrintCo
	Behaviours around the Product *Lack of information about the impact of external factors on the production line due to the operation of other machines and operators*	PrintCo, BoilerCo
	Cybersecurity *Uncertainty about the adequacy of safety and cybersecurity infrastructure for data sharing*	RoboCo, BoilerCo

Advanced Technologies & Tools

Advanced Technologies & Tools describes the uncertainties related to specific tools and technological developments crucial for advanced services. A total of seven uncertainties were identified in this category, of which only one uncertainty is common across all three cases, while two uncertainties are shared across two cases, and the rest are unique to PrintCo, as indicated in Table 32 above. This pattern suggests that while technological concerns are widespread, their specific nature and intensity vary significantly across the cases, with PrintCo facing the majority of these uncertainties in this category.

The only common uncertainty across all three cases, **Product Reliability & Developments**, highlights the shared concern over ensuring that existing products can reliably support advanced services while addressing uncertainties surrounding future product enhancements. This indicates a critical dependency on robust product innovation to align with the service-oriented business model. **Automation** and **Delivery Tools & Systems** were both emphasised by PrintCo and RoboCo, showcasing their focus on operational efficiency and system readiness to facilitate seamless advanced services delivery.

PrintCo, however, faces unique uncertainties that distinguish it from the other cases. These include uncertainties about **Cloud Interface**, **Technical Requirements**, **Technology Upgrades**, and **Target Product Technology**, which collectively underscore its relatively early stage of digital and technological maturity. In contrast, BoilerCo shows limited involvement in this category, with its only significant alignment being the shared concern over **Product Reliability & Development**. This

distinction positions BoilerCo as less focused on technological uncertainties compared to PrintCo and RoboCo, suggesting a lower prioritisation of advanced technologies in its current strategy.
The insights from across the cases reveal that uncertainties are prevalent but unevenly distributed, with PrintCo bearing the majority of them. RoboCo shares a moderate focus on the uncertainties, reflecting a slightly more advanced technological stance than PrintCo. BoilerCo's limited engagement in this category suggests either a more streamlined approach or less emphasis on it. Overall, these patterns highlight the varying stages of technological adaptation among manufacturers, with PrintCo particularly needing to establish a clearer technological pathway to realise its advanced services ambitions.

Technical Infrastructure

Technical Infrastructure describes uncertainties related to the data infrastructure and technical developments required to support advanced services. A total of seven uncertainties were identified in this category, as summarised in Table 32 across the cases. Among these, two uncertainties, **Data Availability** and **Data Interpretation**, are shared across all the cases, while the rest are unique to individual cases. This alignment reflects a broader industry struggle in dealing with vast amounts of data, yet they lack the frameworks to convert this into actionable insights and generate value through data. This shows the variation in technical readiness across the three manufacturers, PrintCo, RoboCo, and BoilerCo.
In terms of case-specific uncertainty, PrintCo expressed concerns regarding **Product Connectivity** and **Data Requirements**. Case PrintCo is notably ahead in its strategy, already considering how these aspects will enable them to guarantee uptime for their services. For RoboCo and BoilerCo, **Cybersecurity** and **Behaviours around the Product** emerged as a major uncertainty. Both cases emphasised the growing risks associated with data sharing, which creates an industry-wide challenge for seamless data exchange with customers.
The cross-case analysis reveals a notable variation in how technical infrastructure uncertainties emerge differently across the cases. While the shared concerns highlight foundational challenges in data management, the unique uncertainties indicate differing levels of technical maturity and focus areas across the cases. The analysis underscores the need for manufacturers to prioritise data accessibility, develop analytical capabilities, and address cybersecurity concerns to innovate their advanced services effectively.

7.1.4 Environmental Uncertainties

Environmental uncertainty is defined as the lack of information surrounding changes or variability in the organisation's external environment (Tung, 1979). Due to limited codes, no specific categories were formed for this uncertainty type from the within-case analysis. As shown in Table 33 below, three key uncertainties emerged, with no specific categories identified during the within-case analysis. The uncertainties were common to both PrintCo and RoboCo, while BoilerCo reported no environmental uncertainties.

Table 33: Cross-case analysis of environmental uncertainty for internal stakeholders

Uncertainty	Cases
Sustainability *Uncertainty about the long-term sustainability and viability of equipment*	PrintCo, RoboCo
Market Potential and Strategy *Lack of knowledge regarding the market potential and effective strategies to promote and deliver advanced services*	PrintCo, RoboCo
Competition *Lack of information about the competitors and their AS offerings*	PrintCo, RoboCo

One interesting observation is about **Sustainability**. The perspectives of the internal stakeholders varied across the cases. Interestingly, PrintCo did not prioritise sustainability to a greater extent. They viewed their equipment as a minor component of the production process, with little pressure from customers to improve energy efficiency. Conversely, RoboCo expressed significant concern about sustainability, particularly regarding energy efficiency and CO2 emissions, driven by regulatory and subsidy requirements. This divergence reflects how external drivers and organisational priorities shape the emphasis on sustainability in advanced services. **Competition**-related uncertainty appeared more confined to PrintCo and RoboCo, who expressed limited knowledge about their competitors' advanced service offerings. This indicates that a comprehensive competitor analysis has not been fully pursued across the cases, adding to the strategic risk manufacturers face.

The shared uncertainty surrounding **Market Potential and Strategy** underscores the difficulty in understanding the market readiness and opportunities for scaling advanced services. PrintCo stakeholders questioned whether their existing customer base could sustain a service-oriented approach, reflecting hesitance in transitioning from product-centric models. Meanwhile, RoboCo struggled to devise effective marketing and promotional strategies for their advanced services. This alignment highlights the broader challenge manufacturers face when navigating uncharted market dynamics to successfully adopt and expand advanced service offerings.

The absence of environmental uncertainties in BoilerCo, in contrast, illustrates a narrower focus, perhaps limited to internal operational priorities rather than external market dynamics at this stage. This difference further emphasises the importance of external analysis for manufacturers aiming to mitigate risks and remain competitive in advanced services. The prevalence of these uncertainties underscores the dynamic and evolving nature of the external environment as manufacturers attempt to adapt to advanced service models.

7.1.5 Findings for RQ1

The cross-case analysis of the four uncertainty types, **Organisational**, **Relational**, **Technical**, and **Environmental,** provides valuable insights into the prevalence of uncertainties faced by internal stakeholders of manufacturing firms when innovating advanced services. Table 34 below summarises these uncertainties grouped into different categories across the four uncertainty types. This leads to the first finding from this study, which answers the first research question*: What*

uncertainties arise for internal stakeholders of a manufacturing firm when innovating advanced services?

Finding 1:

*Internal stakeholders, when innovating advanced services, face a range of uncertainties, of which **Organisational** and **Technical** are the most predominant, while **Relational** are critical but less prominent, and **Environmental** uncertainties are the least.*

Table 34: Internal Stakeholders Uncertainties

	Internal Dynamics	Commercial Viability	AS Scope & Understanding
Organisational	1. Culture & Mindset Change 2. Roles & Responsibilities 3. Skillset & Expertise 4. Resources & Capabilities 5. People Training 6. Organisational Structure 7. Business System & Processes 8. Sales Team 9. Dedicated AS Team	10. Pricing Model & Strategy 11. Service Level Agreement (SLA) Conditions 12. Financial Benefits 13. Funding 14. Product Reliability & Development 15. Legal & Commercial Risk	16. AS Knowledge and Understanding 17. Value Proposition 18. Service Guarantee 19. Naming Conventions and Hierarchies
	Customer Desirability	**Strategic Partnership**	
Relational	1. Customer Mindset & Expectations 2. Customer Engagement 3. Target Customer Segment 4. Customer Activities 5. Customer Requirements 6. Staff Turnover on Sites	7. Potential Partnerships 8. Partner Requirements 9. Supplier Equipment 10. Distribution channel as middleman 11. System Integrators & Machine Makers	
	Advanced Technology & Tools	**Data Infrastructure**	
Technical	1. Automation 2. Cloud Interface 3. Delivery Tools & Systems 4. Technical Requirements 5. Technology Upgrades 6. Product Reliability & Development 7. Target Product Technology	8. Data Requirements 9. Data Availability 10. Data Interpretation 11. Technical Development 12. Product Connectivity 13. Behaviours around the product 14. Cybersecurity	
Environmental	1. Sustainability 2. Marketing Potential & Strategy 3. Competition		

Organisational uncertainties have been widely shared and more significant across the cases. These uncertainties highlight internal dynamics, commercial viability, and the overall understanding of advanced services, collectively underscoring the difficulty manufacturers face in aligning internal operations when innovating advanced services. These uncertainties highlight not only gaps in resources and expertise but also structural and cultural concerns that hinder the transition to service-oriented models.

Technical uncertainties, closely following organisational uncertainties, are primarily concerned with the infrastructure and tools required to support advanced services. The issues related to data and the integration of advanced technologies reflect the operational complexity that manufacturers must address to ensure the successful delivery of advanced services. These uncertainties suggest that the technical framework for advanced services remains under development, necessitating considerable investment and strategic alignment.

Relational uncertainties, while significant, were observed to a lesser extent compared to organisational and technical concerns. Advanced services are fundamentally customer-focused and outcome-driven, necessitating strong relationships with external stakeholders such as customers and strategic partners. However, the relative lack of prominence of relational uncertainties suggests that manufacturers remain somewhat product-centric in their approach. This inward focus indicates a transitional period in which manufacturers are working to align internal structures and capabilities with the demands of advanced services. While this focus on internal readiness is necessary, it reveals a potential gap in comprehensively grasping and meeting customer expectations and the collaborative dynamics required to deliver outcome-focused services effectively.

Environmental uncertainties were the least prevalent among the four types, confined to specific cases. This relative insignificance can be attributed to the fact that manufacturers are still in the early stages of developing advanced services. As these services evolve, environmental considerations may become more prominent and necessitate more strategic focus. Moreover, the variations among manufacturing cases are partly due to differences in the equipment they use. While these uncertainties highlight external factors such as market potential, competition, and sustainability, their limited prominence indicates that manufacturers are more preoccupied with overcoming internal barriers than with addressing broader environmental challenges at this stage of their advanced service innovation journey. The current findings suggest that while environmental uncertainties are present, their impact may evolve as manufacturers continue to advance their service offerings and as market conditions change. Together, these findings reveal that internal stakeholder uncertainties are predominantly organisational and technical in nature, reflecting the strategic and operational hurdles manufacturers face when transitioning to advanced services.

7.2 RQ2: External Stakeholders Uncertainties

7.2.1 Organisational Uncertainties

Organisational uncertainty is defined as “the lack of understanding of firm resources by organisational members, which results in variations in organisational effectiveness and efficiency over time” (Kreye, 2022: 35). This type of uncertainty arises internally and represents a significant barrier (section 2.4.3). The cross-case analysis looks at the patterns by comparing organisational uncertainties across the cases of external stakeholders (Customers: C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, Distributors: D1, D2, D3, D4, and Technology Supplier: T1, T2), as summarised in Table 35 below. The aim is to identify the organisational uncertainties that emerge for the internal stakeholders of a manufacturing firm when innovating advanced services. To achieve this, the uncertainties identified from the within-

case analysis (Chapter 6) are grouped into *Internal Dynamics*, *Commercial Viability*, and *AS Scope & Understanding,* which are examined and compared to draw key insights across the cases of external stakeholders.

Table 35: Cross-case analysis of organisational uncertainty for external stakeholders

	Uncertainty	Cases
Internal Dynamics	Culture and Mindset Change *Lack of understanding regarding the cultural and mindset shift towards AS*	T1
	People Training *Lack of understanding about the necessary trainings to deliver AS*	C5, D3
	Resources & Capabilities *Lack of understanding regarding the allocation and availability of resources and capabilities for AS*	D1
	Business System and Processes *Lack of understanding of the internal systems and processes required to facilitate AS*	T1
	Labour Availability *Uncertainty regarding the availability of on-site labour*	C1, C2
	Technical Team and Expertise *Uncertainty about the availability and expertise of technical personnel to manage technologies and systems*	C5, C9, D1, D4
Commercial Viability	Pricing Model & Strategy *Lack of information regarding the pricing strategies for AS*	C1, C3, C8, D1, D2, D3
	Service Level Agreement (SLA) conditions *Lack of knowledge regarding the design and conditions of SLA for AS*	C1, C2, C3, D1
	Financial Benefit *Uncertainty about the revenue generation potential from AS*	C4, C5, C7, D2
	IT Upgradation Cost *Uncertainty about the cost associated with technological upgrades*	C1, C4, T1
	Performance Benchmark *Lack of knowledge regarding the performance benchmark of equipment on production line*	C2, C3, C4
AS Scope & Understanding	AS Knowledge & Understanding *Lack of definite knowledge and understanding about the overall concept of AS*	C1, C3, C5, T2
	Value Proposition *Lack of understanding about the specific meaning and boundaries of the value proposition*	C1, C3, C5
	Service Guarantee *Lack of understanding about the feasibility of providing guarantees in AS*	C1, C2, C6, D1, D4
	AS on other equipment *Lack of information about manufacturers offering AS on other supplier equipment*	T1

Internal Dynamics

Internal Dynamics focuses on the human and structural aspects of the business that contribute to organisational uncertainty. For external stakeholders, the **Internal Dynamics** category appears less cohesive as compared to internal stakeholders' analysis. This is due to the uncertainties being more spread out among various stakeholder groups, including customers, distributors, and technology suppliers. As outlined in Table 35 above, six uncertainties emerged across the cases, each reflecting unique or overlapping concerns related to workforce readiness, internal systems, and resource allocation.

Unlike internal stakeholders, where common uncertainties often stem from shared organisational structures and processes, external stakeholders demonstrated a more fragmented pattern. For instance, uncertainties like **Labour Availability, People Training** and **Technical Team and Expertise** are prevalent among customers and distributors, suggesting operational dependencies on skilled personnel to enable advanced services. This pattern highlights differing priorities in workforce preparation. Conversely, the uncertainty surrounding **Culture and Mindset Change** and **Business Systems and Processes** is unique to technology suppliers, reflecting their distinct role in adapting to advanced services and highlighting the concerns around aligning internal processes to advanced services delivery. However, in practice, technology suppliers are more adaptive to such service business models.

The uncertainty surrounding **Resources & Capabilities** unique to distributors is indicative of a broader concern tied to their service-led business model. Unlike manufacturers, who typically possess the systems and expertise to initiate advanced services, distributors often find themselves disadvantaged due to their limited capabilities and resources to guarantee outcomes. This complex and interrelated landscape highlights the necessity for tailored strategies to address stakeholder issues while fostering collaboration across the advanced services value network.

Commercial Viability

Commercial Viability focuses on the uncertainties surrounding the sustained profit-generating ability of advanced services through a competitive pricing model. The uncertainties under this category reflect significant concerns for external stakeholders in understanding and navigating the financial and strategic dimensions of advanced services. This category includes five uncertainties, most of which are common across customers and distributor cases, as summarised in Table 35 above.

For distributors, the uncertainty surrounding the **Pricing Model & Strategy** highlights their difficulty in developing pricing mechanisms that meet customer expectations while maintaining market competitiveness. In contrast, customers view the unpredictable nature of pricing models as a barrier, raising concerns about whether to proceed with advanced services. Similarly, uncertainties regarding **Service Level Agreement (SLA) conditions** and **Financial Benefits** are shared by both customers and distributors, reflecting mutual apprehensions about the conditions and profitability of advanced services.

The uncertainty surrounding **IT Upgradation Cost** emerges as a shared uncertainty across customers and technology supplier cases, reflecting the significant financial considerations tied to upgrading technological infrastructure to support advanced services. Unique to customers is the uncertainty about **Performance Benchmark**, which reveals their lack of awareness about the performance of equipment and its implications for production reliability and efficiency. This highlights a broader need for manufacturers to provide transparent, data-driven benchmarks to build confidence in the operational benefits of advanced services. Collectively, these uncertainties highlight the financial and strategic complexities external stakeholders encounter when adopting advanced services.

AS Scope & Understanding

AS (Advanced Services) Scope and Understanding focuses on the uncertainties surrounding the knowledge base and individual perspectives on the overarching concept of advanced services. The cross-case analysis reveals a widespread lack of clarity among external stakeholders regarding the foundational concepts and operational specifics of advanced services. These uncertainties are distributed across the cases. For example, **AS Knowledge & Understanding** is a common uncertainty across customers and technology suppliers, pointing to the need for manufacturers to invest in educating and engaging these stakeholders to foster a shared understanding. Meanwhile, the uncertainty surrounding the **Service Guarantee** indicates that both customers and distributors are hesitant about the feasibility and risks involved in guaranteeing service outcomes. This underscores the necessity for manufacturers to establish strong mechanisms that can ensure reliable service assurances.

The uncertainty surrounding the **Value Proposition** is notably evident, especially among customers, highlighting confusion regarding the distinct benefits and boundaries of advanced services offering. This emphasises the necessity for manufacturers to construct a clear and persuasive value narrative. A unique uncertainty for technology suppliers is **AS on Other Equipment**. This raises their apprehension regarding the potential for advanced services might extend to equipment not produced by the manufacturer. These uncertainties highlight the importance of alignment and education to close the knowledge gaps among these external stakeholders.

7.2.2 Relational Uncertainties

Relational uncertainty refers to the 'inability to predict or explain partners' actions' (Kreye, 2017b: 366) within the service context. The relational uncertainties identified from the within-case analysis are categorised into *Customer Desirability* and *Strategic Partnership,* as summarised in Table 36 below. The following sections explain these categories to highlight unique insights and emerging patterns across the cases of customers, distributors and technology suppliers.

Table 36: Cross-case analysis of relational uncertainty for external stakeholders

	Uncertainties	**Cases**
Customer Desirability	Customer Mindset & Expectations *Lack of knowledge regarding the customer's mindset and expectations for AS*	D1, D2
Strategic Partnership	Potential Partnerships *Uncertainty about potential partners for AS and how to sustain these partnerships effectively*	C1, C6, C9
	Partner Requirements *Lack of information regarding the requirements of partners for AS*	D1, T2
	Manufacturer Support *Uncertainty regarding the necessary support from equipment providers*	D1, D3

Customer Desirability

Customer Desirability focuses on the uncertainties related to engaging target customers and effectively demonstrating the value of advanced services. This category is narrowly represented by

the uncertainty of **Customer Mindset & Expectations**, as seen in two distributor cases. Distributors continue to struggle to grasp their customers' readiness and expectations for advanced services. These uncertainties are heightened by distributors' transition to service-oriented business models, which have raised concerns about their ability to fulfil the high service expectations of their customers.

Strategic Partnership

Strategic Partnership focuses on the uncertainties related to collaborations with partners to effectively provide advanced services. Unlike Customer Desirability, uncertainties in this category are more varied and observed across customers, distributors, and technology suppliers. The uncertainty surrounding **Potential Partnerships**, seen in several customer cases, reflects their difficulty in finding appropriate partners and managing multiple partnerships. Distributors and technology suppliers face additional difficulties due to unclear **Partner Requirements**, which complicates the process of aligning with partner needs and can obstruct effective collaboration.

A unique concern for distributors is the uncertainty surrounding **Manufacturer Support**, which underscores their dependence on manufacturers for specific capabilities to offer guarantees. This dependency highlights the manufacturers' critical role in empowering their external stakeholders and ensuring successful partnerships. These uncertainties highlight the necessity for manufacturers to cultivate collaborative ecosystems and clarify partnership dynamics.

7.2.3 Technical Uncertainties

Technical uncertainty can be defined as a lack of knowledge surrounding significant changes in technologies (maturity and application) (Reim et al., 2020) and data (Durugbo et al., 2010; Hou et al., 2013) in the context of product and service. The technical uncertainties identified from the within-case analysis are grouped into two categories: *Advanced Technologies* & *Tools* and *Technical Infrastructure*, as summarised in Table 37 below. The following sections discuss these categories across the customer, distributor and technology supplier cases to highlight unique insights and emerging patterns.

Table 37: Cross-case analysis of technical uncertainty for external stakeholders

	Uncertainty	**Cases**
Advanced Technologies & Tools	Automation *Lack of information on the implementation and effectiveness of automated systems for tasks such as capturing faults, handling issues, and managing contracts.*	C1, C5, D1, D3, T2
	Cloud Interface *Uncertainty about cloud connectivity for all the equipment*	C4, D1, D3
	Delivery Tools & Systems *Lack of knowledge about specific tools and systems required to support and deliver AS*	C1, C4, C6
	Technology Upgrades *Lack of understanding of the required technology upgradation to support AS*	C1, C2, C3, D1, D2, D4
	Technology Obsolescence Strategy *Lack of understanding regarding technology obsolescence strategies from suppliers*	C4, C5

	Product Reliability & Developments *Lack of information regarding product reliability and future product developments*	T1, T2
Technical Infrastructure	Data Requirements *Lack of understanding about the required data to effectively offer AS*	T1, T2
	Data Availability *Lack of information about the availability of the necessary data to support AS*	D1
	Data Interpretation *Lack of understanding of how to map data to specific needs and provide actionable insights*	C1, C3, D3, T2
	Technical Development *Lack of information about ongoing and required technical developments in the data infrastructure*	D1
	Product Connectivity *Uncertainty regarding the reliability of product connectivity for data retrieval*	D1
	Behaviours around the Product *Lack of information about the impact of external factors on the production line due to the operation of other machines and operators*	T1
	Cybersecurity *Uncertainty about the adequacy of safety and cybersecurity infrastructure for data sharing*	C1, C2, C3, C4, C6, D3, T2

Advanced Technologies & Tools

Advanced Technologies & Tools describes the uncertainties related to specific tools and technological developments crucial for advanced services. A total of six uncertainties were identified in this category, of which a notable commonality is the uncertainty surrounding **Automation**, which spans across a few customers, distributors, and technology supplier cases. This suggests a broad recognition of automation's importance for enhancing service delivery. However, the prominence of this uncertainty across all external stakeholders indicates a shared concern in implementing effective automated systems. The uncertainty around **Cloud Interface** and **Technology Upgrades** is observed across customers and distributors, showing the significance of cloud connectivity for seamless data sharing and the ongoing need for technological evolution to support advanced services. This is important because it points to a discrepancy in the alignment of cloud-based solutions between end-users and intermediaries, underscoring the necessity for manufacturers to close this technological gap to enhance ecosystem-wide connectivity for advanced services.

In contrast, customers uniquely emphasise uncertainties surrounding **Delivery Tools & Systems** and **Technology Obsolescence Strategy**. This suggests that customers are uncertain about the operational tools required to implement and sustain advanced services, as well as the risks posed by outdated technologies. These concerns indicate a need for manufacturers to provide greater support and clearer strategies for technology lifecycle management to instil confidence in their service offerings.

Technical Infrastructure

Technical Infrastructure describes uncertainties related to the data infrastructure and technical developments required to support advanced services. A total of seven uncertainties were identified in this category across the external stakeholder cases, as summarised in Table 37. Among the

uncertainties, **Cybersecurity** and **Data Interpretation** stand out as shared concerns among customers, distributors, and technology suppliers. However, these uncertainties are observed in only a few cases within each stakeholder group. This indicates that although these issues are widely acknowledged, they might not have been universally prioritised.

Conversely, **Data Availability**, **Technical Development**, and **Product Connectivity** are uniquely raised by distributors. They expressed worries about their inability to guarantee service outcomes, which they attribute to restricted access to essential data, insufficient technical capabilities, and unreliable product connectivity. This highlights a critical dependency on manufacturers to provide reliable, connected products and to support distributors with the technical infrastructure required to deliver advanced services effectively.

Furthermore, **Data Requirements** and **Behaviours around the Product** related uncertainty are exclusively noted in technology supplier cases. These uncertainties highlight the suppliers' emphasis on identifying the data necessary for service enablement and understanding how external factors, such as other machines and operators, affect production environments. This reflects their pivotal role in establishing the essential conditions for advanced service delivery. Overall, the patterns in this category show the interrelation of technological and technical abilities across the network while also revealing the specific priorities and challenges encountered by different stakeholder groups.

7.2.4 Environmental Uncertainties

Environmental uncertainty is defined as the lack of information surrounding changes or variability in the organisation's external environment (Tung, 1979). As shown in Table 38 below, four key uncertainties emerged, with no specific categories identified during the within-case analysis.

Table 38: Cross-case analysis of environmental uncertainty for external stakeholders

Uncertainty	Cases
Sustainability *Uncertainty about the long-term sustainability and viability of equipment*	C1, C3, C5, C6
Market Potential and Strategy *Lack of knowledge regarding the market potential and effective strategies to promote and deliver advanced services*	C1, C4, T1
Market Dynamics *Uncertainty about the market changes and external business environment fluctuations*	D1
Cross-Border Regulations *Uncertainty in meeting varied regulatory requirements across multiple countries*	T1

Market Potential and Strategy is a shared uncertainty for both customers and technology suppliers, highlighting a disconnect in their understanding of market opportunities and the necessary strategies to promote advanced services. This disconnect indicates a broader challenge in coordinating value propositions across stakeholders by manufacturers. Another notable pattern is the emphasis on **Sustainability**, observed across multiple customer cases, indicating widespread concerns about the long-term viability and environmental impact of equipment. This highlights that customers increasingly expect clarity and commitment to sustainability, which could influence their adoption of advanced services. However, in contrast, manufacturers and a few other customers do not see

sustainability as a major concern due to the equipment playing a minor role in their production lines. Distributors uniquely face uncertainty related to **Market Dynamics**, highlighting their increased concerns about external market fluctuations and competitive pressures. Meanwhile, technology suppliers alone raised concerns about **Cross-Border Regulations**, signalling that manufacturers should navigate complex regulatory environments, particularly when delivering services globally.

7.2.5 Findings for RQ2

The cross-case analysis of the four uncertainty types, **Organisational**, **Relational**, **Technical**, and **Environmental,** provides valuable insights into the prevalence of uncertainties faced by external stakeholders, including customers, distributors, and technology suppliers. Table 39 below summarises these uncertainties grouped into different categories across the four uncertainty types. This leads to the second finding from this study, which answers the second research question*: What uncertainties arise for external stakeholders of a manufacturing firm when innovating advanced services?*

Finding 2:

*External stakeholders, when innovating advanced services, face a range of uncertainties, of which **Organisational** and **Technical** are the most predominant, while **Relational** and **Environmental** uncertainties are critical but less prominent.*

Table 39: External Stakeholders Uncertainties

Organisational	**Internal Dynamics**	**Commercial Viability**	**AS Scope & Understanding**
	1. Culture & Mindset Change 2. Resources & Capabilities 3. People Training 4. Business System & Processes 5. Labour Availability 6. Technical Team and Expertise	7. Pricing Model & Strategy 8. Service Level Agreement (SLA) Conditions 9. Financial Benefits 10. IT Upgradation Cost 11. Performance Benchmark	12. AS Knowledge and Understanding 13. Value Proposition 14. Service Guarantee 15. AS on other Equipment
Relational	**Customer Desirability**	**Strategic Partnership**	
	1. Customer Mindset & Expectations	2. Potential Partnerships 3. Partner Requirements 4. Manufacturer Support	
Technical	**Advanced Technology & Tools**	**Data Infrastructure**	
	1. Automation 2. Cloud Interface 3. Delivery Tools & Systems 4. Technology Upgrades 5. Product Reliability & Development 6. Technology Obsolescence Strategy	7. Data Requirements 8. Data Availability 9. Data Interpretation 10. Technical Development 11. Product Connectivity 12. Behaviours around the product 13. Cybersecurity	

Environmental	1. Sustainability 2. Marketing Potential & Strategy 3. Market Dynamics 4. Cross-Border Regulations

Similar to internal stakeholders, organisational uncertainties have been widely shared and impactful across external stakeholders, including customers, distributors, and technology suppliers. These uncertainties highlight internal dynamics, commercial viability, and the overall understanding of advanced services, collectively underscoring the significant concerns of external stakeholders and aligning their internal capabilities with the demands of service-oriented models. This reflects a critical dependency on manufacturers to offer structured support and coordination to address gaps in expertise, resource availability, and clear pricing strategies. The findings underscore the necessity for manufacturers to adopt a comprehensive approach across the network, addressing disparities in readiness and capabilities among these external stakeholders to facilitate a smoother transition to advanced services.

While widespread, technical uncertainties expose the varying levels of technological maturity and data infrastructure across stakeholders. For instance, distributors face challenges due to inadequate data infrastructure and limited connectivity, which restrict their capacity to guarantee outcomes, an essential aspect of advanced services. In contrast, technology suppliers focus on data behaviours and cloud solutions, highlighting their role in supporting digital ecosystems. These differences highlight the fragmented nature of advanced services, as various stakeholders emphasise distinct aspects of technical uncertainty. This fragmentation underscores the necessity for manufacturers to serve as integrators, bridging these gaps to ensure a seamless service delivery network.

Relational uncertainties reveal an interesting paradox. While advanced services require deeper partnerships and greater trust throughout the value chain, these uncertainties are notably less pronounced compared to organisational and technical concerns. This indicates that many external stakeholders consider relational issues as secondary to overcoming internal and operational uncertainties. However, the findings reveal an underlying risk: unresolved relational uncertainties, like misaligned expectations or insufficient manufacturer support, may impede the successful scaling of advanced services in the long run. This highlights the significance of establishing effective communication frameworks and fostering collaborative relationships early in the development process. Environmental uncertainties, while less prominent, present critical external pressures that stakeholders must manage. Sustainability and regulatory compliance concerns are particularly noteworthy, as they signal emerging priorities that may influence the future of advanced services. Although these uncertainties are not immediate, they emphasise the changing dynamics of the external environment and the increasing necessity for manufacturers to implement proactive strategies. As these services evolve, environmental considerations may become more prominent and necessitate more strategic focus. Moreover, the variations among manufacturing cases are partly

due to differences in the equipment they use. In some manufacturing contexts, environmental uncertainties may pose a greater challenge. By tackling these wider environmental factors, manufacturers can assist stakeholders in future-proofing their service capabilities, ensuring alignment with global market trends and regulatory requirements.

7.3 RQ3: Implications of Uncertainties

7.3.1 Organisational Uncertainties

Organisational uncertainties present significant implications for both internal and external stakeholders when innovating advanced services. A key observation across the cases is the concern about aligning internal operations with the strategic vision for advanced services, resulting in delays, inefficiencies, and missed opportunities, as illustrated in Table 40 below. These uncertainties create a ripple effect that goes beyond internal processes, influencing relationships with external stakeholders and affecting market outcomes.

Table 40: Implications of organisational uncertainties

	Uncertainty	**Implications**
Internal Dynamics	Culture and Mindset Change	Less buy-in from stakeholders
	Roles and Responsibilities	Delays in strategic decision-making and development process
	Skillsets and Expertise	Operational inefficiency
	People Training	Operational inefficiency, misalignment of customer expectations and increased costs
	Resources & Capabilities	Delays in resource allocation and increased costs
	Organisational Structure	Delays in strategic decision-making
	Business System and Processes	Delays in the development process and operational inefficiency
	Sales Team	Misalignment of customer expectations and delays in the development process
	Dedicated AS Team	Delays in the development process and strategic decision-making
	Cross-Collaborations	Potential conflicts and delays in the development process
	Labour Availability	Increased costs
	Technical Team and Expertise	Increased costs and operational inefficiency
Commercial Viability	Pricing Model & Strategy	Delays in strategic decision making and development process, and market receptiveness
	Service Level Agreement (SLA) conditions	Misalignment of customer expectations and delays in strategic decision making
	Financial Benefit	Delays in strategic decision making and less buy-in from stakeholders
	Funding	Delays in decision making and less buy-in from stakeholders
	Legal & Commercial Risk	Compliance issues and contractual disputes
	IT Upgradation Cost	Increased cost and delays in development process
	Performance Benchmark	Operational inefficiency
AS Scope & Understanding	AS Knowledge & Understanding	Less buy-in from stakeholders and delays in the development process
	Value Proposition	Misalignment of customer expectations
	Service Guarantee	Operational inefficiency and delays in the development process
	Naming Conventions and Hierarchies	Less buy in from stakeholders
	AS on other equipment	-

For internal stakeholders, organisational uncertainties greatly impede progress across various areas. Internal dynamics, including unclear roles, insufficient expertise, and resource constraints, result in delays in strategic decision-making, operational inefficiencies, and increased costs. For example, the lack of a clear organisational structure and dedicated teams for advanced services has extended development timelines in cases like RoboCo and BoilerCo. Moreover, uncertainties surrounding commercial viability, such as pricing models, funding, and service level agreements (SLAs), undermine buy-in from internal teams. Without clarity on the financial benefits or alignment on SLA conditions, key stakeholders remain hesitant to commit to advanced service initiatives fully. This resistance and fragmented business systems and processes exacerbate delays and lead to organisational inefficiencies.

For external stakeholders, organisational uncertainties appear in ways that impede their ability to fully embrace advanced services. A significant issue stems from the training of people and the accessibility of skilled workers at distributor and customer sites. High employee turnover and a lack of expertise frequently result in operational inefficiencies and higher costs, as ongoing training is required to ensure effective equipment usage and service delivery. Unclear pricing structures lead to hesitation among both customers and distributors, diminishing market receptiveness and eroding trust in the perceived value of advanced services.

The necessity for substantial investment in digital infrastructure to support advanced services often results in higher costs and delays in the development process. For technology suppliers, uncertainties surrounding the business systems and processes of manufacturers exacerbate these delays, as inconsistencies in operational workflows complicate collaborative efforts. Lastly, external stakeholders' unclear understanding of advanced services leads to reduced buy-in, making adoption and integration more difficult. This gap in understanding spans value propositions, service guarantees, and technical hierarchies, which are essential for gaining the trust and commitment of external stakeholders to advanced services. Addressing these uncertainties is crucial for fostering stronger partnerships and ensuring smoother innovation of advanced services.

7.3.2 Relational Uncertainties

Relational uncertainties predominantly create more implications for internal stakeholders compared to external stakeholders, as summarised in Table 41 below. Manufacturers must collaborate with customers and strategic partners to align their advanced service offerings with customer needs, thereby effectively creating value. Internally, uncertainties regarding customer desirability and unclear partnership requirements may lead to delays in development, misaligned expectations, and potential conflicts. For external stakeholders, concerns stem from maintaining partnerships and understanding the requirements of the partners, which can complicate collaboration and lead to inefficiencies.

Table 41: Implications of relational uncertainties

	Uncertainty	Inferred Implications
Customer Desirability	Customer Mindset & Expectations	Misalignment of customer expectations and customer dissatisfaction
	Customer Engagement	Erosion of trust and collaboration and delays in development process
	Target Customer Segment	Delays in the development process and strategic decision-making
	Customer Activities	Operational inefficiency and increased risk of service failure
	Customer Requirements	Misalignment of customer expectations and delays in development process
	Staff Turnover on Sites	Operational inefficiency and increased risk of service failure
Strategic Partnership	Potential Partnerships	Erosion of trust and collaboration and increased strategic risk
	Partner Requirements	Potential conflicts and delays in development process
	Supplier Equipment	Operational inefficiency and increased risk of service failure
	Distribution Channel as Middleman	Delays in strategic decision-making
	System Integrators & Machine Makers	Erosion of trust and collaboration and increased strategic risk
	Manufacturer Support	Erosion of trust and collaboration

Internal stakeholders face relational uncertainties mainly due to the complexities of aligning advanced services with customer needs. The lack of clarity around customer mindset and expectations, target segments, and engagement strategies frequently leads to misaligned customer expectations and delays in the development of advanced services. Moreover, unclear partnership requirements may lead to conflicts in later stages, eroding trust and collaboration. Strategic decision-making is further delayed when distributors serve as intermediaries, complicating access to end customers and service delivery strategies. These factors together heighten the risk of service failure and lead to operational inefficiencies.

External stakeholders experience relational uncertainties as concerns associated with partnership requirements and manufacturer support. Customers and technology suppliers, who often engage with multiple partners, face difficulties in managing these relationships, leading to delays in collaboration and development processes. Distributors, in turn, underscore uncertainties regarding the level of support provided by manufacturers, which can undermine trust and collaboration between them. These concerns underscore the need for manufacturers to clearly define partnership roles and responsibilities to mitigate delays and inefficiencies.

7.3.3 Technical Uncertainties

Technical uncertainties significantly impact both internal and external stakeholders, given the critical role technology plays in the development of advanced services. The implications of these technical uncertainties are illustrated in Table 42 below.

Table 42: Implications of technical uncertainties

	Uncertainty	Inferred Implications
Advanced Technologies & Tools	Automation	Operational inefficiency, increased costs, and increased resistance to technology adoption
	Cloud Interface	Delays in development process, increased costs and strategic risk
	Delivery Tools & Systems	Delays in strategic decision-making and increased costs
	Technical Requirements	Operational inefficiency and delays in development process
	Technology obsolescence strategy	Increased costs
	Technology Upgrades	Operational inefficiency, increased costs and delays in development process
	Product Reliability & Developments	Operational inefficiency, increased costs and customer dissatisfaction
	Target Product Technology	Delays in strategic decision-making
Technical Infrastructure	Data Requirements	Delays in the development process
	Data Availability	Data silos and fragmentation and delays in the development process
	Data Interpretation	Delays in the developments process, increased risk of service failure and customer dissatisfaction
	Technical Development	Delays in strategic decision-making and increased costs
	Product Connectivity	Operational inefficiency, increase strategic risk, and delays in the development process
	Behaviours around the Product	Operational inefficiency
	Cybersecurity	Increased risk of data breaches, compliance issues and erosion of trust and collaboration

For internal stakeholders, technical uncertainties lead to operational inefficiencies, higher costs, and delays in development. The need for frequent technology upgrades and ensuring product reliability increases financial strain and complicates decisions internally for manufacturers. Unclear technical requirements and fragmented data infrastructure exacerbate these issues, causing delays in strategic processes. Furthermore, inconsistent data accessibility and interpretation lead to silos, increasing the risk of service failure. The reliance on automation and cloud interfaces brings additional strategic risks, emphasising the necessity for manufacturers to develop robust and flexible technical systems to meet the requirements of advanced services.

External stakeholders, especially customers and distributors, face uncertainties about technology upgrades, automation, and delivery tools, which frequently result in higher costs. Additionally, the reluctance of customers to embrace new technologies hinders the smooth integration of advanced services. Cybersecurity remains a vital issue, given the heightened risk of data breaches and the compliance difficulties posed by strict NDAs and data protection laws. These issues erode trust and collaboration between customers and manufacturers. The absence of connectivity and behavioural data from products hinders service improvements and reduces the perceived value of advanced services for external stakeholders.

7.3.4 Environmental Uncertainties

Environmental uncertainties may pose some significant implications to both internal and external stakeholders. The current data suggest that while environmental uncertainties are present, their impact may evolve as manufacturers advance their service offerings and market conditions change. These uncertainties, arising from sustainability pressures, market dynamics, competition, and regulatory frameworks, demand a high degree of adaptability. The table below summarises the implications of environmental uncertainties.

Table 43: Implications of environmental uncertainties

Uncertainty	Inferred Implications
Sustainability	Increased costs and operational inefficiency
Market Potential and Strategy	Market receptiveness, delays in strategic decision-making, increased risk of service failure
Competition	Increases strategic risk
Market Dynamics	Strategic misalignment and increased risk
Cross-Border Regulations	Legal penalties and increased costs

Environmental uncertainties hold considerable implications for internal stakeholders. The need for sustainability results in higher operational inefficiencies and costs, necessitating internal changes to meet environmental goals. Market dynamics and competitive pressures require strategic agility. Failing to align with these factors may lead to delays in decision-making and increased risks in service development. Furthermore, competition in evolving markets demands the continuous refinement of advanced service offerings to sustain a competitive advantage. For external stakeholders, cross-border regulations introduce legal penalties and increased costs, complicating operations for customers and distributors. Sustainability demands also impose cost pressures on external stakeholders, who must align their practices with manufacturers' objectives. Moreover, unclear market potential and strategy can delay market receptiveness, affecting how customers engage with advanced services.

7.3.5 Findings for RQ3

The cross-case analysis of the four uncertainty types, **Organisational**, **Relational**, **Technical**, and **Environmental,** offers valuable insights into the prevalence of the implications of these uncertainties for internal and external stakeholders of manufacturing firms when innovating advanced services. Table 44 below summarises these implications for both internal and external stakeholders across the four uncertainty types. This leads to the third finding from this study, which answers the third research question*: What are the likely implications of these uncertainties for internal and external stakeholders of a manufacturing firm when innovating advanced services?*

Finding 3:

*The implications of uncertainties for internal and external stakeholders include **delays in strategic and operational processes, misalignment in stakeholder relationships, financial and legal risks, inefficiency in operations** and **market receptiveness**, which can affect advanced services innovation.*

Table 44: Implications of uncertainties for internal and external stakeholders

	Uncertainties			Inferred Implications
Organisational	**Internal Dynamics** - Culture & Mindset Change - Roles & Responsibilities - Skillset & Expertise - Resources & Capabilities - People Training - Organisational Structure - Business System & Processes - Sales Team - Dedicated AS Team - Cross-Collaboration - Labour Availability - Technical Team & Expertise	**Commercial Viability** - Pricing Model & Strategy - Service Level Agreement (SLA) Conditions - Financial Benefits - Funding - Product Reliability & Development - Legal & Commercial Risk - IT Upgradation Cost - Performance Benchmark	**AS Scope & Understanding** - AS Knowledge & Understanding - Value Proposition - Service Guarantee - Naming Conventions and Hierarchies - AS on other Equipment	- Less buy-in from Stakeholders - Delays in the development process - Delays in resource allocation - Delays in strategic decision-making - Misalignment of customer expectations - Customer dissatisfaction - Erosion of trust and collaboration - Operational inefficiency - Increased costs - Increases strategic risk - Increased risk of service failure - Increased resistance to technology adoption - Data silos and fragmentation - Market receptiveness - Strategic misalignment - Legal penalties - Potential conflicts - Compliance issues - Contractual disputes
Relational	**Customer Desirability** - Customer Mindset & Expectations - Customer Engagement - Target Customer Segment - Customer Activities - Customer Requirements - Staff Turnover on Sites	**Strategic Partnership** - Potential Partnerships - Partner Requirements - Supplier Equipment - Distribution channel as middleman - System Integrators & Machine Makers - Manufacturer Support		
Technical	**Advanced Tools & Technologies** - Automation - Cloud Interface - Delivery Tools & Systems - Technical Requirements - Technology Upgrades - Product Reliability & Development - Target Product Technology - Technology Obsolescence Strategy	**Technical Infrastructure** - Data Requirements - Data Availability - Data Interpretation - Technical Development - Product Connectivity - Behaviours around the product - Cybersecurity		
Environmental	- Sustainability - Marketing Potential & Strategy - Competition - Market Dynamics - Cross-Border Regulations			

The findings suggest that **internal stakeholders**, particularly manufacturers, are likely to face critical implications of organisational, relational and technical uncertainties. Internally, delays in resource

allocation, decision-making, and development processes hinder the smooth execution of advanced services innovation. Misalignment in roles, unclear responsibilities, and a lack of collaboration strategies exacerbate these delays. **External stakeholders**, including customers, distributors, and technology suppliers, face implications primarily related to organisational and technical uncertainties. Increased costs from technology upgrades and automation tools, along with cybersecurity concerns, add complexity to their operations. Customers' reluctance to embrace new technologies prolongs the market receptiveness of advanced services. Moreover, cross-border regulations and compliance issues present legal and financial risks, creating further barriers to seamless service innovation. Together, these implications illustrate the interconnectedness of uncertainties and the necessity for manufacturers and external stakeholders to adopt integrated strategies to mitigate these uncertainties effectively.

7.4 Summary

This chapter provided a comprehensive cross-case analysis, presenting the study's findings and addressing the research questions. The three sections addressed the three research questions. Each of these sections compared the data of organisational, relational, technical, and environmental uncertainty types across the cases. Tables within each section illustrated these comparisons and connections across the cases. It demonstrated how uncertainties within the network not only pose challenges but also serve as catalysts for opportunities for manufacturers to design value-driven propositions.

The first section presented a cross-case comparison of the uncertainties across the three manufacturer cases, PrintCo, RoboCo and BoilerCo, to provide insights into internal stakeholders' uncertainties. The second section reported the uncertainties across the external stakeholders, including customers, distributors, and technology suppliers. Finally, the third section summarised the inferred implications of the identified uncertainties for internal and external stakeholders. These sections highlight the emerging patterns across the cases. Furthermore, each section provided a detailed analysis and summarised the key findings by addressing the research questions. The chapter has laid the groundwork for understanding the multifaceted uncertainties in advanced service innovation and answering these research questions by examining internal and external stakeholder uncertainties and their implications for manufacturers. The subsequent chapter will discuss these findings in relation to established literature and developed research framework.

8. DISCUSSION

This research aims to understand how uncertainties impact advanced services innovation from a service network actors' perspective. The previous chapter presented a cross-case analysis of the cases involving manufacturers, customers, distributors, and technology suppliers and the findings by addressing the research questions. This analysis provided an in-depth understanding of the organisational, relational, technical, and environmental uncertainties arising in advanced services, highlighting the complexity involved in these services.

The main purpose of the discussion chapter is to demonstrate how answering the research questions fills the gaps identified in the literature review. The chapter is divided into three parts. First, it discusses the nature and scope of the range of uncertainties identified in this study. Next, it outlines how the perspectives of service network actors (SNA) provide a more comprehensive understanding of uncertainties in advanced services. Finally, it details the implications of the uncertainties for internal and external stakeholders when innovating advanced services. Consequently, this research broadens the current knowledge in advanced services and, more specifically, expands upon value mechanisms, various uncertainty types and broader SNA perspectives, i.e., internal and external stakeholders.

8.1 Range of Uncertainties

Previous research has provided overviews of different uncertainty types (e.g., Erkoyuncu et al., 2013; Kreye, 2018; Poeppelbuss et al., 2022), but it has yet to map out how these uncertainties are distributed across specific service network actors (SNA) in detail. This study demonstrates how different internal (Gap 1) and external stakeholders (Gap 2) across the SNA introduce varying uncertainties, revealing an underexplored dynamic. For instance, the mapping of uncertainties across internal stakeholders, such as service teams, product teams, and management, becomes a crucial factor in how manufacturers plan and innovate advanced services.

The study's findings have some overlap of these uncertainties with existing literature but also unveiled new, specific uncertainties in advanced services across organisational, relational, technical, and environmental domains. Existing literature has highlighted a high level of technical uncertainty in advanced services (Kreye, 2018). Notably, organisational and technical uncertainties were found to be more prevalent across both internal and external stakeholders compared to other types of uncertainty types. In this study, they demonstrated significant implications for advanced services innovation. The similarities and differences between the extant literature and the study's findings are further discussed in this section.

Organisational uncertainties

The existing literature identifies various organisational uncertainties, particularly with the base and intermediate service types, which primarily emerge within manufacturing organisations. This study confirms several of these uncertainties in the advanced services context, some of which are also shared across the broader service network actors (SNA). For instance, defining new processes

(Nudurupati et al., 2016) and systems for managing services (Erkoyuncu et al., 2019) was found to be internal to manufacturers and technology suppliers. Other uncertainties, like determining the pricing of the offering (Ramirez Hernandez and Kreye, 2021), training of engineers (Kreye, 2018) and service teams internally (Erkoyuncu et al., 2019), and fuzziness of value propositions (Erkoyuncu et al., 2019) were shared across both internal and external stakeholders. In contrast, some uncertainties were predominantly internal to manufacturers, such as reorganisation (Kreye, 2022), the lack of a service-oriented culture (Erkoyuncu et al., 2019; Ng et al., 2013; Ramirez Hernandez and Kreye, 2021), uncertain profit margins (Hypko et al., 2010), resistance from the sales team (Björkdahl et al., 2022), availability of critical expertise, and roles and responsibilities (Ramirez Hernandez and Kreye, 2022).

This study confirms some uncertainties from the existing literature but also reveals additional organisational uncertainties that have not been extensively explored in previous research, particularly within the context of advanced services. Some of these uncertainties were widely shared across the service network actors. For instance, conditions within SLAs, the need for internal and external training programs, and the overarching knowledge and understanding of advanced services were common concerns for internal stakeholders, customers, and technology suppliers alike. Specific to internal stakeholders, uncertainties included forming a dedicated team for advanced services within the business and securing the necessary funding for the development of these services.

For external stakeholders, certain uncertainties were more pronounced. For example, customers highlighted issues such as the availability of skilled labour, while both customers and distributors expressed concerns about the availability of a technical team and expertise. Additionally, IT upgrade costs were a significant concern for customers and technology suppliers. These external uncertainties present potential opportunities for manufacturers. For instance, the shortage of labour and technical expertise among customers could be addressed by offering more automated and advanced solutions that reduce the need for personnel on production lines through advanced services.

The identification of these additional uncertainties specific to internal dynamics, commercial viability, and AS Scope & Understanding underscores the greater complexity inherent in advanced services compared to other service types. This complexity leads to a higher degree of uncertainty across the service network. Chapter 7 further details these uncertainties.

Technical uncertainties

The existing literature has discussed the increased level of technical uncertainty in advanced services compared to maintenance services (Kreye, 2018). This increased uncertainty largely stems from the complexity inherent in advanced services, which necessitate the integration of new technologies, extensive data management capabilities, and continuous monitoring of product performance. These factors introduce high unpredictability, complicating the effective development and delivery of advanced services.

Prior research has identified a few technical uncertainties, with a predominant focus on technological aspects, such as unforeseeable technological developments for advanced services (Hypko et al., 2010; Kreye, 2018; Poeppelbuss et al., 2022) and concerns about the long-term reliability of the equipment/technology (Erkoyuncu et al., 2019), which were relevant to both internal and external stakeholders. Uncertainties related to specific technology requirements within manufacturing organisations have also been highlighted (Erkoyuncu et al., 2011). Moreover, the literature identifies cybersecurity as a significant concern (Durugbo and Erkoyuncu, 2016), alongside uncertainties related to the availability and accessibility of data (Bhatti et al., 2024; Durugbo et al., 2010).

This study emphasises that technical uncertainties in advanced services extend beyond mere technological concerns to include significant uncertainties related to data management. The findings indicate that these uncertainties are prevalent across both internal and external stakeholders, underscoring their pervasive nature within the service network. For instance, there is a notable uncertainty surrounding the implementation and effectiveness of automated systems for tasks such as capturing faults, handling issues, and managing contracts. Furthermore, data interpretation emerged as a major concern, with stakeholders struggling to map vast amounts of data to specific needs and to extract actionable insights. Most firms struggle with the underutilisation or inaccurate application of data. Additionally, the uncertainty surrounding the effectiveness of delivery tools and systems was a significant concern, contributing to the complexity of successfully delivering advanced services. Several other uncertainties identified in this study provided deeper insights into the inherent complexity of advanced services. For customers, the uncertainty surrounding manufacturers' strategies for managing technology obsolescence was particularly important. The fast pace of technological advancement and its potential impact on the longevity and value of the services they receive is highly uncertain.

Relational uncertainties

The literature on servitization has discussed relational uncertainties predominantly in the context of partner collaboration, often categorising customer-related uncertainties under environmental uncertainties (Kreye, 2019; Ramirez Hernandez and Kreye, 2021). In the context of advanced services, following the S-D logic, which states that “the customer is always a co-creator of value” Vargo and Lusch (2008: 7), highlights the importance of collaborative engagement between manufacturers and customers. This collaboration leverages the exchange of the manufacturer’s expertise and the customer’s operational insights, which are critical in delivering outcomes with higher use value aligned with the customer’s specific needs (section 2.2.1). Thus, customer-related uncertainties should be reclassified under the relational uncertainty type in the AS context (Kreye, 2018), as customers are no longer passive recipients but proactive participants in the value co-creation process (Agrawal and Rahman, 2015; Marco-Stefan Kleber and Volkova, 2017; Payne et al., 2008; Pinho et al., 2014).

This study corroborates several relational uncertainties previously discussed in the literature, some of which are shared across external stakeholders. For instance, uncertainties related to customer

desirability, such as complexity in aligning customer needs and expectations (Catulli, 2012; Fliess and Lexutt, 2019; Momeni et al., 2024; Ramirez Hernandez and Kreye, 2022; Rexfelt and Hiort af Ornäs, 2009) and customer mindset (Schüritz et al., 2017), were found to be across both manufacturers and distributors. Other uncertainties, including a lack of knowledge about the customer's production process (Helander and Möller, 2007; Hypko et al., 2010) and high staff turnover at customer sites (Björkdahl et al., 2022), were mainly internal to manufacturers. The uncertainty surrounding potential partnerships (Wei et al., 2020) was observed across both manufacturer and customer cases.

Beyond these, the present study reveals additional relational uncertainties that have not been extensively discussed in the context of AS. The findings indicate that the customer-related uncertainties were mainly internal to manufacturers. For instance, manufacturers lack critical information on how to select the optimal customer segment for AS, as well as whom to engage with and how to engage with the customer organisation. Additionally, there is a lack of clear understanding of customers' specific requirements, largely due to the absence of customer-centric approaches. In terms of strategic partnerships, manufacturers face uncertainty regarding the equipment provided by third-party suppliers at customer sites and how this can be integrated with their products in the context of AS. Internal stakeholders further emphasised the distributors acting as a middleman and the role of system integrators and machine makers, which further complicates direct engagement with end customers.

The study also revealed that some uncertainties were shared across external stakeholders, particularly in strategic partnerships. For instance, customers faced uncertainty about potential partnerships, noting the complexity of their ecosystems and suggesting the possible introduction of cybersecurity partners into a shared ecosystem with manufacturers. Technology suppliers reported uncertainty regarding the specific requirements expected of them by manufacturers, while distributors highlighted uncertainties about the level of support they might receive from manufacturers in developing their own service strategies, given their lack of certain capabilities that manufacturers possess.

These additional relational uncertainties, categorised into customer desirability and strategic partnerships, offer an in-depth understanding of the complexities firms face in navigating these relationships with customers, distributors, technology suppliers and other supplier within the advanced services ecosystem.

Environmental Uncertainties

This study builds upon the existing literature on environmental uncertainties in the context of advanced services. Given the early stages of advanced services development, environmental uncertainties were not as prominent as other types. However, the study identifies and elaborates on several key areas where such uncertainties are apparent, corroborating and expanding upon the ones discussed in the extant literature.

For instance, within the environmental uncertainty type, sustainability emerged as one significant aspect, with stakeholders expressing mixed perspectives. Previous studies have underscored the increasing importance of sustainability practices in servitization (Erkoyuncu et al., 2019). However, the findings of this study show that while some customers express uncertainty regarding manufacturers' sustainability strategies, others, including manufacturers themselves, perceive sustainability as a concern that might become more pertinent in the later stages of advanced services development. This divergence suggests that sustainability considerations may not yet be fully integrated into the strategic planning of advanced services.

Among the external stakeholders, distributors highlighted the uncertainty surrounding exchange rate fluctuations (Durugbo and Erkoyuncu, 2016). The long-term nature of service contracts, often negotiated well in advance, introduces financial risks due to the potential depreciation of currency values over time. Uncertainty surrounding cross-border regulations as the changes in data protection in the European Union (Ramirez Hernandez and Kreye, 2022), particularly highlighted by technology suppliers, and the lack of knowledge about competition (Kreye et al., 2014) and their advanced services offering emerged as a significant uncertainty for internal stakeholders.

In addition to the aforementioned environmental uncertainties, market potential and strategy for advanced services was observed as significant uncertainty across both internal and external stakeholders. In advanced services, there could be different value propositions targeting different market segments, which adds a layer of complexity for manufacturers to understand their potential market and develop target strategies to promote advanced services. The findings suggest that while environmental uncertainties are acknowledged, they vary significantly depending on the stakeholder and the specific context of the advanced services.

The distribution of uncertainties across different stakeholders underscores the need for manufacturers to engage proactively with the entire service network. Rather than viewing uncertainties as isolated to their organisation, manufacturers must recognise and manage the broader ecosystem of uncertainties, collectively shaping the outcomes of advanced service initiatives. This study thus extends the understanding of advanced services by providing a more granular perspective on how different stakeholders contribute to the overall uncertainty landscape.

8.2 Service Network Actors' Perspective in Advanced Services

In this section, the discussion pivots from focusing solely on uncertainties to a broader analysis of how engaging a wide range of service network actors is critical in the context of advanced services.

Shifting the focus to a network perspective

The focus on service network actors (SNA) explicitly differentiates this study from extant literature on uncertainties in servitization and advanced services. Previous research in servitization has often been limited to examining uncertainties primarily from manufacturers or dyadic perspectives (Durugbo and Erkoyuncu, 2016; Goh et al., 2015; Ramirez Hernandez and Kreye, 2021; Rexfelt and Hiort af Ornäs, 2009), with advanced services literature also predominantly following this narrow lens (Hypko et al., 2010; Kreye, 2019). This study, however, extends beyond this traditional scope by

incorporating insights from a wider SNA involving internal stakeholders within manufacturing firms, as well as external stakeholders, customers, distributors, and technology suppliers. This multi-actor approach is particularly critical in advanced services, where the inherent complexity demands a more integrated and collaborative perspective (Gebauer et al., 2013; Sklyar et al., 2019b).

Although recent studies have begun to explore triadic and supply chain relationships in advanced services (e.g., Datta, 2020; Karatzas et al., 2016). Some scholars have also discussed the significance of multi-actor service networks and ecosystems (e.g., Reim et al., 2019; Story et al., 2017), highlighting the rapidly evolving role of network actors further complicates the advanced services landscape (Parida and Jovanovic, 2022). This reflects a shift in how value is created, captured, and delivered within a more complex and integrated network (section 2.2). However, a comprehensive network-oriented approach remains underexplored.

This study argues that advanced services, particularly in the early development phase, require an embedded understanding of these network dynamics involving internal and external stakeholders. By expanding the analytical lens to include a broader range of SNA, this research offers a more holistic view of the uncertainties in advanced services. Moreover, this embedded approach reveals the intricate interdependencies among different actors within the service network and underscores the importance of coordinated efforts in navigating the complexities inherent in advanced services.

8.3 Implications of Uncertainties

Existing literature on servitization emphasises the identification of uncertainties and proposing mitigation strategies. However, it has often neglected a critical aspect, which is the practical implications these uncertainties have on the implementation of advanced services by manufacturers (Gap 3). This aspect is critical because the impact of these uncertainties can ripple through various operational and strategic dimensions, influencing everything from decision-making processes to overall service delivery. Moreover, Grote (2009) in their study discusses how the effect of uncertainties varies significantly depending on the actors involved. Therefore, it is crucial to understand the implications as it enables more precise planning and tailoring of mitigation strategies in later stages.

This study's findings have highlighted several of these implications of organisational, relational, technical, and environmental uncertainties for advanced services (section 7.3.5). Some of these implications are crucial and require speedy solutions. The organisational uncertainties identified across the SNA have led to significant implications for internal and external stakeholders when innovating advanced services. These include long delays in the development process, as evidenced in previous studies (Chen et al., 2005; O'Connor and Rice, 2013; Ramirez Hernandez and Kreye, 2021). For example, one of the manufacturing cases experienced a two-year delay in securing the necessary resources and funding. In contrast, the other two cases continued to struggle due to limited buy-in from stakeholders and delays in strategic decision-making. Another critical implication is the misalignment of customer expectations, driven by uncertainties such as the sales teams' ability to effectively communicate the value of advanced services and the lack of clarity surrounding the value

propositions. This misalignment has further delayed customer buy-in. Additionally, these implications are interconnected; for instance, less buy-in from stakeholders can lead to delays in the strategic decision-making and development process, which in turn affects market receptiveness for advanced services.

The technical uncertainties identified across the SNA have significant implications. For instance, the need for automated systems to streamline operations, cloud interface, technological upgradation, and required product and data infrastructure developments lead to increased costs (Erkoyuncu et al., 2019) and delays in the advanced services development process. Additionally, uncertainty surrounding technological advancements has increased customer resistance to technology adoption. In particular, cybersecurity uncertainty poses serious risks. For instance, customers' reluctance to share necessary production data, driven by concerns over data protection and potential breaches, undermines trust and collaboration within the SNA. Consequently, this lack of data sharing can impede the effective delivery of advanced services and potentially lead to compliance issues, where failure to meet regulatory requirements may result in legal penalties.

The cumulative effect of these implications jeopardises the long-term viability of advanced services within the service network, potentially straining relationships with external stakeholders and missed opportunities for advanced services.

9. CONCLUSION

The conclusion chapter reflects upon the study's key outcomes and provides a consolidated summary of the research, highlighting its significance within the broader discourse of academia and practice. The chapter is structured first to summarise the research (section 9.1), followed by a discussion of the theoretical (section 9.2) and practical contributions (section 9.3). Finally, it acknowledges the limitations inherent in the study and concludes by suggesting potential areas for future research (section 9.4). This chapter offers a comprehensive summary of the research, placing it within the current body of literature and highlighting its potential impact on the field.

9.1 Research Summary

In conclusion, this research examined the uncertainties and their likely implications when innovating advanced services from a Service Network Actors' (SNA) perspective. The existing literature on servitization and uncertainty helped formulate a theoretical framework based on Organisational Information Processing Theory (OIPT) that serves as the data collection protocol.

A thorough review of the academic literature on servitization revealed three significant gaps: first, the uncertainties in advanced services (Gap 1); second, the SNA perspective involving both internal and external stakeholders (customers, distributors, and technology suppliers) (Gap 2); and third, the implications of the uncertainties (Gap 3). To address these gaps, the research was structured to explore how *uncertainties impact advanced services innovation from a service network actors' perspective.* The study addressed the following research questions:

> ***RQ1:*** *What uncertainties arise for internal stakeholders of a manufacturing firm when innovating advanced services?*
>
> ***RQ2:*** *What uncertainties arise for external stakeholders of a manufacturing firm when innovating advanced services?*
>
> ***RQ3:*** *What are the likely implications of these uncertainties for internal and external stakeholders of a manufacturing firm when innovating advanced services?*

This study answered these research questions by comprehensively analysing the uncertainties that arise in advanced services, which spanned across organisational, relational, technical and environmental domains identified from the literature. While previous studies have acknowledged the challenges posed by uncertainties, this research bridges the first gap by specifying and categorising these uncertainties in advanced services context. The analysis identified distinct categories within each uncertainty type:

- Organisational Uncertainty related to ***Internal Dynamics***, ***Commercial Viability***, and ***Advanced Services Understanding***.
- Relational Uncertainty related to ***Customer Desirability*** and ***Strategic Partnerships***.
- Technical Uncertainty related to ***Advanced Technologies & Tools*** and ***Technical Infrastructure***.
- Environmental uncertainty reflects the broader external factors.

This research extends the current understanding of advanced services by emphasising how different stakeholder roles create distinct uncertainties, thereby addressing the research questions. The study identifies and categorises the specific uncertainties faced by both internal and external stakeholders, emphasising their critical role in the development and innovation of advanced services.

The first finding provides manufacturers with a detailed understanding of these uncertainties across different teams internally that can affect the successful rollout of advanced services. The second finding provides external stakeholders' perspectives, particularly customers, distributors, and technology suppliers, on uncertainties. Understanding customer uncertainties early helps manufacturers design effective value propositions, while distributors play a crucial role in reaching end-customers as they adopt advanced service business models. Technology suppliers, emerging as strategic partners, emphasise the need for clarity in integrating technological solutions and leveraging data to support service guarantees.

The third finding provides an in-depth understanding of the plausible implications of these uncertainties when innovating advanced services. For manufacturers, these uncertainties complicate the planning and execution of advanced service strategies, potentially leading to misalignment between the service offerings and the expectations of customers, distributors, and technology suppliers. By identifying the critical areas where uncertainties intersect with strategic decision-making, the study offers practical guidance for manufacturers seeking to navigate the complexities of advanced services implementation.

Moreover, this research advances the understanding of network alignment in advanced services by demonstrating the range of uncertainties that must be addressed to achieve the alignment. The findings suggest that a holistic understanding of these uncertainties is essential for fostering collaboration and coherence among network actors.

9.2 Theoretical Contributions

This section outlines the theoretical contributions of this study, showcasing its impact on broader academic disciplines and specific streams of research. The key contribution of this research is providing a clear and in-depth understanding of the uncertainties and their implications that arise within manufacturers, customers, distributors, and technology suppliers when innovating advanced services. The following sections will discuss this contribution across various literature streams.

9.2.1 Uncertainties and their Implications

The study also makes a theoretical contribution to the literature on **uncertainty** and **decision-making** in servitization. By identifying and categorising the uncertainties, this research provides new insights into how these uncertainties influence decision-making processes within manufacturing firms. The findings underscore the necessity for more robust decision-making frameworks to address the intricate and often interconnected uncertainties encountered by service network actors (SNAs). This contribution is relevant for scholars exploring the intersection of uncertainty management and strategic decision-making in advanced services context. In particular, the identification of distinct

uncertainties in advanced services addresses a critical gap in existing research (Durugbo and Erkoyuncu, 2016; Goh et al., 2015; Kreye, 2019; Poeppelbuss et al., 2022; Ramirez Hernandez and Kreye, 2021) and provides insights regarding the implications of these uncertainties (Ahmet Erkoyuncu et al., 2014; Ramirez Hernandez and Kreye, 2021). This study broadens the understanding of uncertainty in advanced services by characterising different uncertainty types (Kreye, 2017a), thereby enriching both theoretical perspectives and practical approaches.

9.2.2 Extends Knowledge on Service Network and Multi-actor Perspective

This research contributes to the broader literature on **supply chain management** (Mentzer et al., 2001; Premkumar et al., 2005), **service ecosystems**, and **network** (Callon and Latour, 1981; Li et al., 2024; Parida and Jovanovic, 2022) by examining the roles and perspectives of multiple service network actors (SNA) within the context of advanced services. Previous studies have emphasised the importance of a multi-actor perspective in advanced services (Parida and Jovanovic, 2022; Reim et al., 2019; Story et al., 2017). Still, most studies continue to focus on dyadic (manufacturer-customer) (Raddats et al., 2017; Ulaga and Reinartz, 2011), triadic (manufacturer-customer-intermediaries) (Bastl et al., 2019; Karatzas et al., 2016) or traditional supply chain relationships (Datta, 2020). This study advances theoretical understanding by exploring the complex multi-actor dynamics inherent in service networks—an area that has been underexplored in the literature.

Specifically, this research uniquely incorporates the embedded perspectives of service network actors (SNA) within the context of advanced services, addressing a notable gap in current studies. In these service networks, stakeholders such as internal teams within manufacturing organisations, customers, distributors, and technology suppliers interact in more complex and interdependent ways. The research identifies how these interactions give rise to specific uncertainties and how these uncertainties, in turn, impact the implementation and overall coherence of advanced services within the service network. In particular, this study addressed the need for future research on understanding uncertainties from a multi-actor collaboration (Kreye, 2017a; Wang et al., 2023b). By integrating the multi-actor perspectives, the study offers a more comprehensive understanding that extends beyond traditional supply chain models, contributing to the literature on managing complex service networks.

9.2.3 Advancing knowledge on Advanced Services

This study makes a significant contribution to the literature on servitization and service innovation (Lusch and Nambisan, 2015; Neely, 2008; Vandermerwe and Rada, 1988), with a particular focus on advanced services research in manufacturing contexts (Baines and Lightfoot, 2013b; Sousa and da Silveira, 2017). The current research on servitization explores the transition from product-centric to service-oriented business models, often predicting the widespread adoption of advanced services. However, in practice, relatively few manufacturers have fully integrated advanced services into their business models. This study reinforces and extends the current knowledge of why manufacturers often proceed cautiously when transitioning to advanced service offerings. It explores the underlying reasons for this slow adoption, offering new insights into the barriers and motivations that influence

manufacturers' decisions to engage with advanced services. These insights contribute to the broader academic discourse by providing a clearer perspective on the complexities of advanced services in practice.

9.2.4 Organisational Information Processing Theory

This research integrates the **Organisational Information Processing Theory (OIPT)** (Galbraith, 1974; Tushman and Nadler, 1978) in the context of advanced services, thereby contributing to the **servitization** literature and the broader discourse on **information systems (IS)** (Levy and Ellis, 2006) within complex organisations. OIPT traditionally explores how organisations manage information flows to cope with uncertainty and achieve optimal performance. By applying OIPT to the context of advanced services, this study identifies the specific uncertainties that generate distinct information processing needs within manufacturing firms.

The application of OIPT in this research provides a foundation for developing a theoretical framework that outlines the various types of uncertainty from the perspective of SNA. This framework is informed by insights from supply chain studies investigating multiple sources of uncertainty (Bensaou and Venkatraman, 1995; Premkumar et al., 2005). By establishing this connection, the research not only advances the understanding of where and how these uncertainties arise but also enables manufacturers to pinpoint areas where enhanced information processing is necessary to manage the complexities of advanced services effectively.

This study also contributes to the growing body of research that utilises OIPT as a theoretical basis for analysis within the servitization literature (Busse et al., 2017; Dalenogare et al., 2022; Kreye, 2017b; Kroh et al., 2018). This contribution not only deepens the theoretical discourse on OIPT but also provides practical implications for organisations aiming to introduce advanced services and effectively navigate uncertainties.

9.2.5 Multiple Embedded Case Study Approach

In addition to these theoretical contributions, this study offers significant methodological insights by adopting a multiple-embedded case study approach (Scholz and Tietje, 2002; Yin, 2018). This methodology is well-established in the broader literature on **qualitative** and **case study research design**. The use of multiple embedded cases has allowed for an in-depth analysis of uncertainties in advanced services in embedded settings, not only from different levels within the focal manufacturing firms but also capturing the complexity and diversity of experiences outside the organisational boundaries.

This approach has proven particularly effective in uncovering the multi-layered challenges and opportunities within service networks. A growing body of studies is adopting an embedded case study approach in servitization (Avlonitis and Hsuan, 2017; Jovanovic et al., 2019; Momeni et al., 2023b). As such, the study contributes significantly to the methodological and servitization literature by demonstrating the value of the multiple-embedded case study design in exploring complex phenomena in real-world settings, offering a robust model for future research in similar contexts.

In summary, this study makes five substantial theoretical contributions across several key literature streams, particularly within servitization, by advancing knowledge of advanced services, operations management, supply chain management, service networks, uncertainty and decision-making, and information systems. The study broadens the understanding of how uncertainties impact advanced services implementation, particularly from a service network actors' perspective. By integrating these concepts, the research bridges the gaps in existing literature and offers new insights into the complexities involved in advanced services. These contributions not only deepen the theoretical discourse across these fields but also set the groundwork for practical applications, which will be discussed in the following section.

9.3 Practical Contributions

This study makes significant contributions to practice, particularly for manufacturing firms seeking to explore and develop advanced services. The research provides guidance for companies on important factors to consider when interacting with service network actors (SNA). It also highlights the involvement of both internal and external stakeholders from the early stages of advanced services development. The following sections describe these practical contributions in detail, focusing on frameworks for uncertainties, enhancing collaboration among SNA, and long-term strategic planning.

9.3.1 Guiding Firms in early Advanced Services Development

A key practical contribution of this research is providing firms with crucial insights into the specific uncertainties encountered during the early stages of advanced services, a phase often characterised by limited knowledge and experience. As the goals and priorities at this initial stage differ significantly from those at later stages of maturity (Baines et al., 2020), this study offers valuable support to manufacturers who may lack experience in advanced services. The study aids in pinpointing the specific areas where there is an increased need for information processing, enabling firms to allocate resources more effectively and develop targeted strategies to mitigate risks. By highlighting these early-stage uncertainties, the research enables managers to make more informed decisions that are essential and proactively manage the complexities for the long-term success of advanced services.

The structured approach to uncertainty identification provides firms with an actionable framework to systematically assess and navigate these uncertainties associated with advanced service innovation. Given the lack of a clearly defined process for firms to transition into advanced services, this study offers a structured categorisation of uncertainties across four broader domains: *organisational*, *relational, technical,* and *environmental,* as shown in the Figure 11 below.

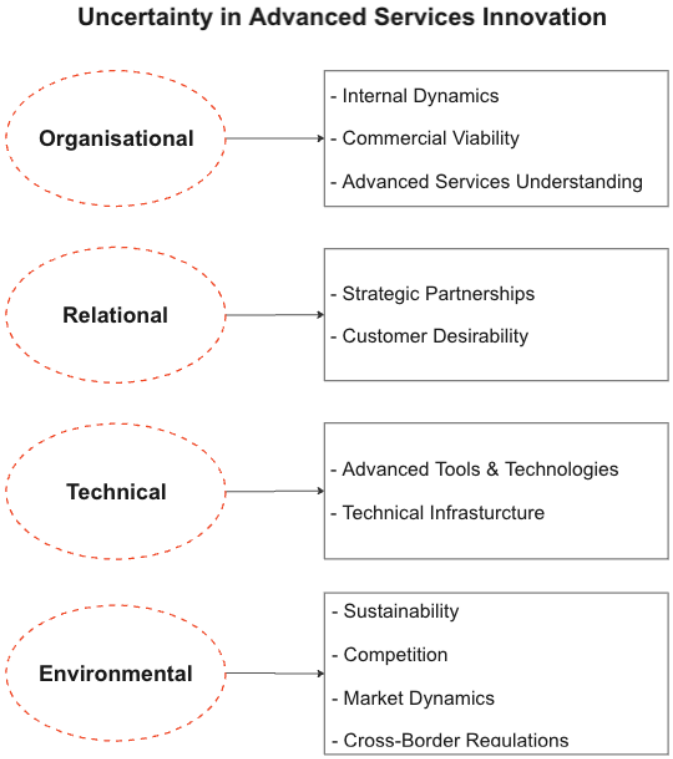

Figure 11: Actionable framework for firms to innovate advanced services

Each of these domains contains specific subcategories that further break down the granular aspects of uncertainty, offering firms a clearer roadmap for managing and mitigating them. This structured approach enables firms to develop targeted strategies, allocate resources efficiently, and establish proactive measures to navigate uncertainties. The categorisation serves as a practical tool that firms can adopt to enhance decision-making and strategic planning in their advanced service journey.

9.3.2 Enhanced collaboration among SNA

The research further encourages industries to enhance collaboration among SNA. It emphasises the importance of early and active engagement with key stakeholders, both within and outside the organisation, for the successful provision of advanced services. The study shows that involving internal stakeholders across various departments can provide a broader and more integrated view of advanced services. It gives manufacturers a thorough understanding of how internal strategies and processes may need adjustment to support advanced services. By addressing the uncertainties identified in the research, manufacturers can better coordinate their internal capabilities, ensuring that their teams are equipped to manage the complexities of advanced services. This alignment facilitates smoother implementation and enhances the organisation's overall readiness to support these offerings.

Moreover, the research suggests establishing strategic partnerships with distributors and technology suppliers to accelerate advanced services development. The insights gathered from these external stakeholders reveal not only the importance of these partnerships but also the specific uncertainties that must be addressed to ensure their success. Manufacturers must recognise that distributors are

increasingly embracing advanced service models, and therefore, fostering strong partnerships with them is vital. By proactively addressing their uncertainties, manufacturers can better align their capabilities with those of their distributors, enhancing service strategies and ensuring that end customers receive more comprehensive support and creating opportunities for mutual growth.

This research also encourages manufacturers to consider technology suppliers as key strategic partners in the long run. They offer the technological expertise and data capabilities necessary for the successful delivery of advanced services. The uncertainties surrounding technology integration, data security, and the rapid pace of technological advancements pose significant challenges for manufacturers. By establishing strategic partnerships with technology suppliers, manufacturers can leverage cutting-edge technology solutions to offer performance guarantees on their equipment, thereby enhancing the overall value delivered to end customers.

9.3.3 Improving Long-term Strategic Planning

Finally, this research provides valuable insights for enhancing the long-term strategic planning of manufacturers engaged in advanced services. The study underscores the significant implications of various uncertainties on advanced services implementation, suggesting that manufacturers must integrate robust strategies and develop capabilities to navigate these uncertainties. By identifying and categorising uncertainties, this research allows manufacturers to prioritise those with the most critical implications and enables them to plan mitigation strategies more effectively. Furthermore, these insights can help firms anticipate potential disruptions in the later stages of advanced services and develop long-term strategic roadmaps to maintain a competitive edge in an increasingly complex service environment.

9.4 Limitations and Future Research

While offering significant insights into the uncertainties in advanced services from a Service Network Actors' (SNA) perspective, this study has certain limitations. This section outlines these limitations and presents potential avenues for future research. First, it provides reflections on theoretical and empirical aspects that offer opportunities for further investigation, followed by a discussion of the limitations of the research sample.

9.4.1 Uncertainty and Implications: Additional Sources and Prioritisation

This study has focused on examining four uncertainty types in advanced services, namely organisational, relational, technical, and environmental. These categories are derived from the sources of uncertainty that emerge within a specific context (Kreye, 2019; Lievens and Moenaert, 2000; Walker et al., 2003). However, they represent only a subset of potential uncertainties. Future research could explore additional forms of uncertainty that may arise as advanced services continue to develop and mature. For instance, uncertainties related to supply and demand dynamics, resource availability, or operational processes could significantly impact service delivery but were beyond the scope of this study.

While this study has identified and discussed the implications of various uncertainties, it did not quantify the severity of these implications. Future research could focus on developing frameworks or methodologies to systematically assess the level of uncertainty and quantify the potential impact on advanced services implementation. By assessing the severity of each uncertainty, companies can better prioritise those that pose the greatest risks. This approach would enable more efficient resource allocation and the development of targeted strategies to navigate the most critical uncertainties, thereby supporting the successful implementation of advanced services.

Additionally, while the study explored uncertainties from both internal and external service network actors, it did not explicitly examine how these uncertainties interact with one another. (Kreye, 2018) explored the interaction between different uncertainty types including environmental, technological, organisational, and relational uncertainties, highlighting a causal chain of effects within service dyads. Building on this, further research could examine similar interaction effects between internal and external uncertainties, assessing how uncertainties in one domain influence or amplify uncertainties in the other. This would provide deeper insights into the cascading effects of uncertainty across service networks and inform more holistic management strategies.

9.4.2 Expanding Theoretical Lens: OIPT and Other Theories

This research uses Organisational Information Processing Theory (OIPT) as the theoretical foundation to create a framework that sets the boundaries for identifying uncertainties from a service network actor (SNA) perspective. The theory introduces three core concepts: information processing needs (IPNs), information processing capabilities (IPCs), and fit (match or alignment). The study specifically focused on the aspect of the framework that involves uncertainties leading to IPNs (section 3.2.1). It emphasises the critical importance of timely access to information for supporting decision-making in organisations. While this study offers a detailed analysis of uncertainties in advanced services, it did not thoroughly investigate IPCs, as this was beyond the scope of the current research. Future studies could overcome this limitation by identifying IPCs and assessing the fit between IPNs and IPCs to evaluate firm performance. Furthermore, the framework developed in this study could be expanded to integrate both IPNs and IPCs. This would offer more comprehensive, actionable insights for organisations looking to optimise their information processing strategies and enhance their performance through advanced services.

While this study primarily used OIPT to explore uncertainties from the SNA perspective, it is important to acknowledge that other theories could also provide valuable insights. For instance, relational theory (RT) posits that successful outcomes in partnerships depend on the development of joint capabilities and collaborative input from all involved partners (Davies et al., 2023; Dyer and Singh, 1998). This could be an effective lens for examining the relational dynamics among the SNA in advanced services implementation. This theory aligns with emerging trends in servitization research, where the success of advanced services is increasingly seen as dependent on strong intra-firm and inter-firm relationships (Reim et al., 2019; Sjödin et al., 2019). Future research could leverage RT to investigate further how relational uncertainties evolve, relationship transformations among network

actors, and governance mechanisms contribute to the effective delivery of advanced services, thereby expanding the theoretical lens beyond OIPT.

9.4.3 Case Study Design: Opportunity for Diverse and Extensive dataset

The exploratory multiple-embedded case study design facilitated diverse data collection across different cases with a range of actors and in an embedded context. However, the significant limitation of this study is its reliance on a relatively small number of cases, including only three manufacturing cases, two of which involved original equipment manufacturers (OEMs). Furthermore, the network actors' data, which includes insights from 10 customer cases, 4 distributor cases, and 2 technology supplier cases, was obtained solely from a single manufacturer case (Case PrintCo). The primary reason for this was the time constraints of the research, coupled with the reluctance of the other two cases to engage their entire network and facilitate access to customers for interviews. While these cases offered valuable insights into the uncertainties, the restricted dataset constrains the generalizability of the findings across the broader industry. To improve the robustness and applicability of future research, it will be beneficial to explore a more diverse and extensive dataset will be beneficial. This could involve expanding the study to include a wider range of manufacturing firms across different sectors. Additionally, incorporating data from multiple manufacturers' networks could provide deeper insights into the variations in how different network actors influence and are influenced by advanced service strategies.

Another limitation of this study is the inconsistent level of participant involvement across the different cases. The data was obtained from a relatively diverse set of participants involving 50 interviews. However, the variation in participant structure and the degree of engagement, particularly with Case PrintCo being a longitudinal study while the other two cases were not, resulted in a mismatch in the level and number of experts available for interviews (Table 8). This lack of consistency affected the depth of insights and comparability across the cases. Future research should standardise participant involvement across cases to ensure more consistent and comparable data, which could lead to more robust findings.

9.5 Extending Future Research Scope

9.5.1 Exploring Temporal Dimensions of Uncertainties in Advanced Services

Moreover, this research primarily identified uncertainties at the early development stages of advanced services, particularly during the exploration and engagement phases (Baines et al., 2020). However, the evolution of these uncertainties as the development of advanced services progresses into the expansion and exploitation stages remains underexplored. Future research could explore the temporal aspects of these uncertainties, investigating how they develop and transform as service offerings mature. Specifically, longitudinal studies could provide valuable insights into the dynamic nature of uncertainties, revealing how initial uncertainties may either dissipate, intensify, or give rise to new forms of uncertainty as advanced services scale and integrate within the service network.

Moreover, studies can map these uncertainties across the four stages, i.e., exploration, engagement, expansion and exploitation.

Such an investigation would further enhance our understanding of the long-term impact of uncertainties on strategic decision-making. It would also provide practical guidance for companies seeking to anticipate and manage uncertainties throughout the entire lifecycle of their advanced services, from initial deployment to full market integration and beyond. By mapping the trajectory of uncertainties over time, scholars can contribute to more robust theoretical models that consider the temporal variability in uncertainty and its impact on manufacturers' advanced services implementation.

9.5.2 Quantitative-based Approaches to Uncertainty

While this study explored uncertainties and their implications through a qualitative research strategy, there remains a need for quantitative approaches to deepen our understanding. Qualitative insights have identified different uncertainties across various actors in advanced services, yet future research could benefit from applying uncertainty quantification to measure and model these uncertainties systematically. Uncertainty quantification refers to the process of measuring uncertainties through computational models, which is an essential step in validating the accuracy (Smith et al., 2023). Future research can employ various approaches, such as Bayesian network modelling, approximation approach, agent-based modelling, and fuzzy-based approach (Bae et al., 2004; Erkoyuncu et al., 2013; Farsi and Erkoyuncu, 2021), to quantify these uncertainties in advanced services. These methods would allow for a more rigorous examination of how uncertainties evolve and influence decision-making processes.

9.5.3 The Role of Digital Platforms in Uncertainty Reduction

This study highlights the importance of collaboration and coordination across the service network for the successful provision of advanced services (section 2.3 and Chapter 7). Effective coordination requires seamless information sharing to enhance decision-making within and across organisations. A platform approach, particularly one enabled by digital technologies, could provide an effective solution for manufacturers to manage this complexity in advanced services. By leveraging digitally enabled platforms, manufacturers can streamline information flows and coordinate their entire service network more efficiently, thus supporting their advanced service strategies.

Moreover, digital platforms can address the challenge of managing complex interdependencies between various actors (Eloranta et al., 2021; Fu et al., 2022). This enables firms to delegate tasks according to each actor's strength and helps develop new capabilities to manage the complexities. From a strategic perspective, platforms promote modularity (product and service modules) and facilitate IT-enabled interactions to maximise the value of digital technologies (Thomas et al., 2014). Moreover, manufacturers can leverage the value of digital technologies and information exchange by adopting a platform approach for advanced services (Cenamor et al., 2017).

Future research could investigate how these platforms enhance decision-making processes, particularly by improving information and real-time data sharing, reducing operational inefficiencies, and managing uncertainties in advanced services. Specifically, define how the information is shared within and across the organisation through platforms. This can help develop a value-sharing model to understand and manage the stakeholder relationships in a digitally connected global advanced services partner model. Additionally, further studies could examine the risks associated with employing digital platforms, such as data security and the dependency on third-party providers and propose strategies for mitigating these risks to maximise the benefits of platform-based coordination.

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11. Appendices

11.1 Appendix 1: Case PrintCo Uncertainties

11.1.1 Organisational Uncertainties

	Uncertainty	Illustrative Quote
Internal Dynamics	Roles and Responsibilities	*"we're confused as a team, I guess internally about who's responsibility is to highlight the data"- Intr1PrintCo* *"there's nobody specifically with just advanced services as their job role, we don't have a services specialist that sort of leads all of those conversations"- Intr2PrintCo* *"What does Case PrintCo expect our technicians and our help desk to do and what value ads are they bringing to the table?"- Intr7PrintCo*
	Skillsets and Expertise	*"we are uncertain around the skills required internally in people…"- Intr1PrintCo* *"then of course I am unsure if our technician or help desk quality meets the standards for this offering."- Intr10PrintCo*
	People Training	*"So, the people training within the channels…how would you train them for advanced services, and we have various channels across the globe"- Intr9PrintCo* *"So, it's about setting expectations on both sides, isn't it training and support and everything else?"- Intr10PrintCo*
	Resources & Capabilities	*"I think it could be the resource which is the other barrier…"- Intr9PrintCo* *"To even consider offering advanced services to when we have the capability to offer it and it there's so many factors here as well, aren't there"- Intr10PrintCo*
	Organisational Structure	*"we don't have I think a very good structure to make sure that everybody can deliver this"- Intr2PrintCo* *"how do we organize ourselves such a way our process, our people, the tools that we have?"- Intr4PrintCo*
	Business System and Processes	*"…more about systems and processes on how can we improve"- Intr2PrintCo* *"What are the processes need to look like to support that value proposition?"- Intr10PrintCo*
	Sales Team	*"there will be resistance within certain teams, so the sales team is the obvious one. We're asking a lot of our salespeople today to learn every product; they have to learn every industry that they're talking to. But with advanced services, it's either a lack of understanding about why it's important for the business, why it would help us, or it significantly complicates their life."- Intr2PrintCo*
	Dedicated AS Team	*"We have lack of support specifically a designated team for AS at this stage…"- Intr2PrintCo*
Commercial Viability	Pricing Model & Strategy	*"I don't think the pricing of such services is clearly set out now…"- Intr2PrintCo* *"Will it be priced according to having such a system…I am not sure?"- Intr4PrintCo*
	Service Level Agreement (SLA) Conditions	*"Would this be written into the service contract, or it could be visits?"- Intr8PrintCo* *"where the risks are going to sit in the SLA? What should be the agreed level of…"- Intr12PrintCo (Field note)* *"What are the conditions around the code accuracy? Would they get discount on the next service if the code is not accurate?"- Field notes (Workshop)*
	Funding	*"there's no pot of funds been given for advanced services…"- Intr2PrintCo*

	Legal & Commercial Risk	*"So, I think it depends on our value proposition that we put together. It's what risk we're willing to take on, I think". - Intr3PrintCo* *"I mean one of the risks I see is probably not with the actual hardware itself. It's all the legal side, the sort of commercial side. The fact that you could start an agreement and then a year in the customer just backs out and says I don't want any more of this, we've got to make sure that Case PrintCo is protected."-Intr16PrintCo*
AS Scope & Understanding	AS Knowledge & Understanding	*"I don't know the outcome that we're trying to achieve other than…"- Intr9PrintCo*
	Value Proposition	*"[ ] of understanding what can we really offer as a service and what's achievable…"- Intr9PrintCo* *"We need to agree just what does uptime means though. And how do we draw the boundaries of it"- Intr4PrintCo*
	Service Guarantee	*"what assurance we can provide to the customer that we're going to you know make sure up time, is it is guaranteed?"- Intr8PrintCo*
	Naming Conventions and Hierarchies	*"we haven't done a significant amount of internal communication yet and so there's generally still a big question mark over what it is and how does it work and why is it important"- Intr2PrintCo* *"We don't know how we should talk about advanced services internally and externally; we have used different terminologies like solutions, outcomes, etc.."- Field notes (Meeting)* *"maybe we need to change the name of advanced services, it's been misunderstood and seems fussy"- Intr17PrintCo Field notes (Meeting)*

11.1.2 Relational Uncertainties

	Uncertainty	**Illustrative Quote**
Customer Desirability	Target Customer Segment	*"And so yes, there's some value in code quality, but it might be for a particular segment and not for all"- Intr8PrintCo* *"You may need to know and choose what you want to present to a customer tailored to that customers expectation or who your audience is"- Intr7PrintCo* *"whether it should be aimed at our A customers or whether actually it's something that would benefit the B, C customer"- Intr9PrintCo* *"Do we really personalize, you know, our services and products and target those industries based on what matters to them? Probably not, if at all."- Intr11PrintCo*
	Customer Engagement	*"It's always a challenge on whom to connect at the customer site..."- Intr2PrintCo (field note)* *"I think we're struggling to get customers to engage on that…"- Intr3PrintCo* *"we might need a more orderly customer interaction process in place, telephone fix takes time"- Intr4PrintCo* *we were initially thinking about a needs-based proposition, in that case, how a customer want to interact with us. So, we talked about self-serve, we talked about consultative, we talked about outcome focused and we talked about partnership"- Intr11PrintCo* *"how do we encourage them to get into partnership with us."- Intr12PrintCo (Field note)*
	Staff Turnover on Sites	*"And the problem is then when those staff rotate, I guess…how would you make sure when it comes to advanced offerings"- Intr9PrintCo*
	Customer Activities	*"we don't know what is going on with the product at that point of time"- Intr7PrintCo* *"So how a customer uses the equipment and usage of consumables...you may want to be able to potentially monitor this from now"- Intr6PrintCo*
	Customer Requirements	*"for me, it's focusing on the customer requirement. You know what those needs are"- Intr8PrintCo*

		"I think that's what we need to maybe look at it from a customer point of view what a customer you know want from his uptime and how do we deliver it"- Intr11PrintCo
Strategic Partnership	Potential Partnerships	*"our goal is to take the advantage of our strategic partnerships… we don't know if we need some additional partners for advanced services"- Intr1PrintCo (Field note)* *"So should we still work with the same suppliers and the same business systems and the same data? Or are there other things that we want to bring in?"- Intr2PrintCo* *"…how can we make the development faster with the help of external partnership?"- Intr15PrintCo (Field note)* *"We we've missed some fundamentals which really hold this up. I think that needs to be done sooner or later with a company to partner"- Intr3PrintCo*
	Partner Requirements	*"how can we best capture the requirements from our current partners"- Intr1PrintCo* *"what we are doing now is we're trying to ask them what their plans are, how do they see the future? What do they know about that might be impacting on our joint ability to serve? but we haven't really made this a structured development process that involves them"- Intr2PrintCo* *"I think it's not just the partner companies, it's there protocols effectively that they have for their equipment which we may need to understand"- Intr3PrintCo*
	Supplier Equipment	*" if you've got supplier equipment integrates well into other people's office supplies equipment and that's a real positive. I think that's often something that's overlooked"- Intr3PrintCo* *"And how are the actors participating in that dialogue and what about their equipment?"- Intr4PrintCo*
	Distribution Channel as Middleman	*"the other half of the world, we go through distribution, which again is another challenge to us in the sense that we're bit further away from the customer"- Intr2PrintCo (Field note)* *"I am not sure if we then deal with a middle person or plan to sell directly to end-user"- Intr9PrintCo* *"Our Distribution channels are already offering advanced services, so it's a challenge in itself"- Intr11PrintCo*

11.1.3 Technical Uncertainties

	Uncertainty	**Illustrative Quote**
Advanced Technologies and Tools	Technology Upgrades	*"Our ERP system cannot cope with outcome-based contracts at the moment…I guess we may need an upgradation"- Intr2PrintCo* *"We need a way of cleaning the defector, practice some advances that need to happen in the technology"- Intr8PrintCo*
	Automation	*"[ ] having to do is very manual for instance pull cloud data off the system and analyse it at the moment…may need to automate it when we innovate"- Intr2PrintCo* *"all the faults and issues may need to be captured at that automated level and currently it is very manual"- Intr7PrintCo* *"[ ] is a technology where they check on a daily basis to switch the machines…I don't know if this should be more at automated level when we offer [ ]…"- Intr9PrintCo*
	Cloud Interface	*"So for instance, and our cloud service doesn't support every model of […], so there's no way we can offer identified service on every model of […]"- Intr2PrintCo* *"a bit unsure if advanced services will only be offered on a printer having a [ ] cloud interface on it that pulls out even more detailed information"- Intr7PrintCo* *"the other things to think about is when we deliver our service it's got to have cloud or not…" - Intr9PrintCo*

	Technical Requirements	*"So how often do we need to monitor before you get into the technical?"- Intr4PrintCo* *"But again, for that that to work we need to have whatever things are necessary for the augmented reality tool to be operable, and whether that's an app or whatever, I don't know"- Intr5PrintCo*
	Delivery Tools & Systems	*"As I mentioned, uh, what are the tools that we need to deliver this…to our customers?" - Intr8PrintCo* *"A lot of this things on having the tools established that will achieve and deliver that uptime guarantee"- Intr5PrintCo* *"you have to have the capacity and the tools to be able to do it remotely, and that might involve augmented reality tools. I don't necessarily think we have all those in place at the moment."- Intr6PrintCo* *"If we get the vision system installed with it then we may be able to offer remote assistance"- Intr7PrintCo*
	Product Reliability & Developments	*"So, how do we build actual product or maybe the internal product for advanced services offering"- Intr1PrintCo* *"We may want to know that our product is reliable, but at the same time, it's how reliable is the customer that's using it."- Intr9PrintCo*
	Target Product Technology	*"whether we want to prioritise based on the opportunities with the customer or we choose particular industry sector or product technology for advanced services offering"- Intr2PrintCo* *"I am trying to avoid mixed environment with complicated product technology, might be something to look at"- Intr13PrintCo*
Technical Infrastructure	Data Requirements	*"how do we articulate what data we need?"- Intr1PrintCo* *"you can extend the question to say which variables do I need to monitor so that I will know when it downtime"- Intr4PrintCo* *"So there's a lot of variables that are there that could cause the downtime which we may need to know to understand that…"- Intr7PrintCo* *"I think to see what the data requirements are – where we can get to from the data"- Intr9PrintCo*
	Data Availability	*"We must have a roadmap understanding what data is missing. So, for the uptime guarantee, we are unsure what data do we have and don't have..."- Intr1PrintCo* *"At the moment there are some things missing in the data…"- Intr5PrintCo* *"you know if we take a step back, what is downtime or why does it happen, do we have that data available somewhere?"- Intr7PrintCo*
	Data Interpretation	*"how do we structure that data in a way that we can handle some moderate mode"- Intr1PrintCo* *"We do capture quite an extensive dataset part. I don't believe it maps well to the customer need"- Intr5PrintCo* *"If by looking at what data there is, it's possible to see the onset of failure approaching. In other words of pattern to a merge, it would be possible to communicate with the customer"- Intr6PrintCo*
	Technical Development	*"there might be some technical developments to capture more data if we choose a particular technology, maybe finding a way to transfer the vision data into the cloud so that we can do a fully automated delivery"- Intr2PrintCo*
	Product Connectivity	*"we don't know how we can have 100% connectivity to the [ ] to pull all the data in real-time we need or would need for AS which is a big challenge…customers don't usually keep the assets in working all the time"- Intr1PrintCo* *"in order to be able to get to a point where we can guarantee something, we have to have % connectivity and I am a bit unsure how this can happen."- Intr7PrintCo*
	Behaviours around the Product	*"There's other behaviours that happen around the [ ] which we need to think about measuring or certainly guessing indication."- Intr2PrintCo* *"the downtime that's occurring at the location without technician interference or without the customer contact and tech support. It's unknown to us, it's invisible, we don't know. And there's a large portion of those points is not captured in any way"- Intr7PrintCo*

11.2 Appendix 2: Customer Uncertainties

11.2.1 Organisational Uncertainties

	Uncertainty	Illustrative Quote
Commercial Viability	Pricing Model & Strategy	*"what the cost is and whether that's this monthly billing neither here or there"- Cust1* *"I don't know it is most favourable light is the best of both worlds it is supposed one's paper bullets like the mushy middle of being half pregnant"- Cust3* *"costs aspect is kind of neutralised that it fits in with the agios expectation is there certain service that you find more attractive case by case example, so I can't give an answer just there you know where be procurement decision or quote in FTP"- Cust8*
	Financial Benefits	*"…able to make a conscious decision seeing the financial versus the benefit"- Cust4* *"just like coding as a solution so there has to be clear cost benefit analysis when we have a formal proposal then only will be able to take this particular case"- Cust7* *"yeah I don't know how the accounts would see that I think that being freaking out if they saw that like this table, it may need some clarity"- Cust5*
	Performance Benchmark	*"I don't know that I can see uptime performance down to the […] level"- Cust2* *"uptime yeah I'm not sure how" - Cust3* *"I don't know the performance benchmark"- Cust4*

11.2.2 Technical Uncertainty

	Uncertainty	Illustrative Quote
Advanced Technologies and Tools	Automation	*"I think that manually interventional overriding or changing of settings and things by operators, it's always an issue. Not sure how can this be improved in systems"- Cust1* *"I mean I can understand quality, but its jersey port is more like if somebody made a typo over, plenty of things are recorded manually so I don't know how this will be recorded"- Cust5*
	Delivery Tools & Systems	*"just depends on how new bits software going into other bits of the system or the bit standing tend to pull down so the only issue comes when yeah things are changing"- Cust1* *"now it is only the user interface how user-friendly the systems are to incorporate this new thing"- Cust4* *"the hardest part is that initial change, that initial system using the initial prototype or alpha you know type in or set up contractually"- Cust6*
	Cloud Interface	*"I'm not sure because in Indian scenarios we are not seeing much of the benefit hosting the data on the cloud" - Cust4*

11.3 Appendix 3: Case RoboCo Uncertainties

11.3.1 Organisational Uncertainties

	Uncertainty	Illustrative Quote
Internal Dynamic	Culture and Mindset Change	*"how human psychology is influencing the acceptance of advanced services rather than all the technical things"- Intr1RoboCo* *"there are also a service-related cultural differences between different countries. So, I know that Japan is a yeah, it's very service-oriented giving service for free,*

		they take it for granted but also Germany is not really a service-oriented country"- Intr4RoboCo
	Roles and Responsibilities	*"these people that are working on the advanced service, are doing a partial job, they are typically involved with their daily job, so they are not 100% dedicated to service. This is also something that we think it should change in the coming years, so having people dedicated to standing services, there is no possibility to have such a dedicated team"- Intr7RoboCo*
	Skillsets and Expertise	*"advanced products that we are developing require more support and skills, not only to our customers but also to our Salesforce. How to sell them"- Intr4B* *"we have different colleagues in this team, let's say skills that they should have, they should be confident speaking with same level people in end user, not only the technical skills are important, but also the soft skills, this is a big challenge"- Intr7RoboCo* *Officially, because we don't have a skill, the solution architect or only skilled people that are dealing with IT and so on mainly because if we are hiring a person that are delivering services, I think that the problem will be solved"- Intr9RoboCo*
	People Training	*"So here the training, experience and coaching with people that are already confident in this kind of ambient. So, you have to speak the same language of the customer and I think there were more difficulties where I noticed the difference"- Intr7RoboCo*
	Resources & Capabilities	*"Once we start to do a proper track of the services activities then we need to allocate resources, we need to control what we monetize, what not and why and so on, I think we are not there yet"- Intr2RoboCo* *"we are still in the lack of resources or what are we looking for until or unless we will have business cases, because this is the chicken and the egg discussion."- Intr9RoboCo*
	Organisational Structure	*"Four different services, business and none of them are actually designed to work together. The training business, operates completely different to the safety business, the safety business operates completely different to the robot, different processes, different terms and conditions, different offer creation, different value propositions, probably our biggest challenge"- Intr3RoboCo* *"it is sometimes very difficult as you have to work with the constraints that you have internally in terms of structure portfolio"- Intr5RoboCo*
	Business System and Processes	*"we need to have at least a kind of generic framework where our services fit in because otherwise the border costs that we need to develop the model, we need to find a platform and we need to find a process"- Intr1RoboCo*
	Sales Team	*"the training I mean salespeople have to be trained to sell services which is different from selling product that's something that is still not completely extended and until this financial year"- Intr5RoboCo* *"This is one of the biggest challenges within Case RoboCo because, Umm, we have done 80 years our Shields in a certain way. And what I'm now describing is not in scope of most salespeople. So, I think we should bring more for younger people that do understand this new way of selling and this is the most fundamental in my opinion in this change."- Intr6RoboCo*
	Cross-Collaborations	*"Cross collaboration only works if the structures and the processes within those are designed to work together and at the moment its a challenge, the moment you start to collaborate, you actually end up with increased admin workload. So, let's say you take an advanced service to market that is not only will we guarantee the outcome of the [ ] will guarantee the safety of the [ ]. So, now I've got two completely separate divisions tied up in an outcome-based Service"- Intr3RoboCo*
Commercial	Financial Benefit	*"how can we use it in our financial infrastructure because we are still very transactional, selling a product on one side and this need to change really into a more long term revenue generation model"- Intr1RoboCo*

		"particularly a challenge around robotics and things as the price of spares genuinely increases. But how do we create a competitive offer for a customer for three years but still cover ourselves but also accept some risk?"- Intr3RoboCo *"We have to find out pure margin from selling services, advanced services and something that on market is really very much appreciated."- Intr9RoboCo*
	Funding	*"So, you have financial limitations and usually when I go into these models, I say I tried to understand first how my company is financially structured. So, what is the paradigm?"- Intr1RoboCo* *"I sit down and talk to the compliance team or to the finance team saying I want £100,000 of you so I can put this service in place. We will have return of investment is 5 years. Their heads explode."- Intr3RoboCo*
	Legal & Commercial Risk	*"How our data is going to be managed and so on, and that is the first challenge because we need to involve the legal department here and it is not and it take uh sometime now, so that is the first issue"- Intr2RoboCo*

11.3.2 Relational Uncertainties

	Uncertainty	Illustrative Quote
Customer Desirability	Target Customer Segment	*"Is it segmentation or is it just a kind of service maturity that we need to focus on? I think in every segment there are companies that are more mature on service side, servitization or ownership then I'm not sure, I don't see a segmentation difference in the total market, I see customers that are ready and I see customers that are not ready for opening such a discussion."- Intr4RoboCo*
	Customer Engagement	*"Who that customer is, that you can talk to and what kind of story to tell? Maybe we should be able to talk about the customers problems and not about our product."- Intr4RoboCo* *"we still have some project that is stopped because I don't think we have the right people on board on customer side."- Intr7RoboCo* *"the way we communicate to customer. We are not in line with a messaging for communication at the moment I guess"- Intr9RoboCo*
	Customer Mindset & Expectations	*"But also, I see that many of our customers when you talk to people in factories, they are not used to services. They are used to investments, so they just want to buy something they want to own something, this mindset change is very difficult"- Intr4RoboCo*
Strategic Partnership	Potential Partnerships	*"So, it's basically a triangle, or maybe it can be even an end customer to multipoint companies because probably you need another supplier, somebody that has a certain software that is doing the same thing, so that you have machine hardware as a service, automation as a service specific software as a service that you provide to that customer"- Intr1RoboCo* *"It's a bit uncertain to establish those new partnership like with consultants, I don't know even consultants to this day, we still have very hesitant relationship with some consultants whilst around the market, everybody else is doing it right"- Intr5RoboCo*
	Partner Requirements	*"Well, one uncertainty that is internal and makes a little bit with external is we are very bad at partnerships with [ ], we don't know how to do that probably because of the culture"- Intr5RoboCo*
	Distribution Channel as Middleman	*"it will be quite tricky to manage the distributors"- Intr1RoboCo* *"it's been more challenging to try to establish those relationships into managing partners, such as distributors, how would that work really"- Intr5RoboCo*
	System Integrators & Machine Makers	*"you can say that depending on the model that some of our system integrators I think not distributors, it's rather more system integrators or machine makers. They have their own advanced service models which becomes far more complex"- Intr1RoboCo* *"it's been a little bit challenging to try to establish those relationships into managing partners, partners being system integrators"- Intr5RoboCo*

11.4 Appendix 4: Case BoilerCo Uncertainties

11.4.1 Organisational Uncertainties

	Uncertainty	Illustrative Quote
Internal Dynamics	Culture and Mindset Change	*"it needs to be owned and I think it needs to be a cultural change and to be part of the service that can be provided which is a challenge"- Intr2BoilerCo* *"So I think the shift culturally would move from a reactive from to where more proactive approach which is ultimately the heart and soul of that servitization model"- Intr4BoilerCo* *"Well, you know, particularly our sales team like what do you mean with segmenting customers?"- Intr5BoilerCo* *"certainly a shift in big shift in mentality really in terms of how we provide it."- Intr7BoilerCo*
	Roles and Responsibilities	*"Somebody needs to know what that data means and at the moment there's very few people in the business that can look at that data, analyze it and say, yes, you've got an error here"- Intr2BoilerCo*
	Skillsets and Expertise	*"it's just finding the right people and sort of deciding which direction we wanted to go."- Intr2BoilerCo* *"Sometimes it might be a competency thing, or sometimes it might be that they've got to be qualified to do it and you know, you could be a multitude of reasons really"- Intr3BoilerCo* *"you'd have a very, very different engineering skill set, and also different managerial skill set."- Intr5BoilerCo* *"So, they don't have the expertise to really manipulate the data"- Intr7BoilerCo*
	People Training	*"That package would we need to have somebody employed on site or would we then train one of the staff that are already on site to do that work for us."- Intr1BoilerCo* *"but I think we may need to make sure that we are supporting it internally through training across different teams"- Intr2BoilerCo*
	Resources & Capabilities	*"I think initially the main challenges that we will face if we were to implement it is staffing possibly because the lot more equipment to maintain"- Intr1BoilerCo* *"if it's gonna grow up because we can't do it with the current resource."- Intr2BoilerCo* *"[ ] we've not experienced that but I think resource will be an issue and the right resource"- Intr5BoilerCo* *"And but like I say, there's sometimes frustrations where I feel that they could benefit from things that we will most likely be able to give them if we have that capability in our business model"- Intr6BoilerCo*
	Organisational Structure	*"when we move into that advanced services space I think we would set up a separate structure for that in the business"- Intr5BoilerCo*
	Business System and Processes	*"There's no SOP for how it is done. How it's managed? How that time is logged when people are connecting remotely?"- Intr2BoilerCo* *"the one of the main sort of uncertainty is I guess is getting purchase orders and so we can set jobs up because of our process is not set"- Intr3BoilerCo* *"You know better interaction internally as opposed to sort of, you know, siloed departments, which is not something you can afford to have if you were to offer this kind of uh, servitization model."- Intr4BoilerCo*
	Dedicated AS Team	*"possibly a new department to be able to manage all of that itself"- Intr1BoilerCo* *"but at this moment I think we're at that sort of division point, decide whether we invest in it and we build that department"- Intr2BoilerCo* *"but we may also look externally and build and a sort of team that has a mixture of internal people and external people"- Intr5BoilerCo*
	Sales Team	*"It isn't certainty and we are getting better, but we are still product orientated, particularly through our sales channels. So, trying to get our sales teams to go*

		into that service space is very difficult, the reward structure is very much around the product"- Intr5BoilerCo *"And the territory of the sales team, they just want to push products. Also renumeration is based on product sales, but don't get any Commission really for service sales. It's all based on shipping and assets Commission. So, the complex thing is changing that mindset"- Intr7BoilerCo*
Commercial Viability	Funding	*"From our perspective and it will be funding as well, I think. Like anything to start this, we're gonna need an initial sort of funding and a pot of money and go right that is"- Intr5BoilerCo*
	Legal & Commercial Risk	*"I don't know whether they see that the liability falls in our hands because we've produced that document"- Intr6BoilerCo*

11.4.2 Relational Uncertainties

	Uncertainty	**Illustrative Quote**
Customer Desirability	Customer Engagement	*"communicate that value proposition in a compelling, clear and transparent way we're not there yet."- Intr5BoilerCo* *"What levels are we talking at in the factory? Are we talking to the CEO's? Are we talking to the guys on the ground?"- Intr6BoilerCo*
	Staff Turnover on Sites	*"So it might not be a high turnover of staff, but you might have a risk high risk there of losing an individual and if you do"- Intr4BoilerCo*
	Customer Requirements	*"I suppose another struggle would be is, if we don't know how much steam the customer requires, we would need to understand completely their steam demand and a lot of lot of customers don't know that"- Intr1BoilerCo* *"Some people don't want the extra cost. Some people obviously will use it because it benefits them. Just depends on the makeup of their operation really"- Intr3BoilerCo*
	Customer Mindset & Expectations	*"it's changing the mindset of certain clients is a massive thing, but I'm not sure it's one of those things that you just have to give it a go and see how we get on."- Intr1BoilerCo* *"So, I think that's helped, but it is a change of our customers. Yeah, it's like I will get into free and now you charge them for it"- Intr7BoilerCo*

11.5 Appendix 5: Interview Questions

11.5.1 Internal Stakeholders (Manufacturer)

	Interview Questions	Probing Questions	Research Outcome
Generative Questions	Could you briefly describe your role within the organisation?		Context and background of participant
	Are you aware of advanced services and can you give a concrete example of an offer you are developing or involved with?	-Can you provide examples of customers with whom you have co-created value propositions? -Have you initiated any recent efforts to improve customer service or product support? -If not, what hinders the development of AS?	Reveals organisational uncertainties
Directive Questions	How do you collaborate with other departments or external partners when implementing new services?	-Are there particular partners you prefer to collaborate with for AS? -How has the outcome of the technology supplier's development been integrated into your systems and processes? -Are there any Distributors you can collaborate with to deliver AS? - Would this collaboration impact the development and delivery of AS?	Reveals relational uncertainties within and outside the business with technology partners, distributors, etc and its impact on AS
	How do you manage the expectations and feedback from your customers regarding new services?	-Can you share an example of feedback that led to a change?	Exploring relational uncertainties and customer interactions for AS
	How do you see the technology changes when introducing AS?	-Do your current technologies support AS innovation? -Do you foresee any changes in how you capture and use data? -Are there any technologies that are affecting the development of AS?	Uncovering technical uncertainties
	Have there been any recent changes in regulations or market conditions that affected your service model?	-Are you aware of any competitors offering AS?	Revealing any environmental uncertainties
Closing Questions	What are your thoughts on the future development of these services within the business?	-What changes do you foresee in the business? -What opportunities do you see?	Reveals organisational uncertainties
	Is there anything else you would like to share or any questions for me?		An opportunity for participants to share additional insights, concerns or ask for clarification

11.5.2 Customers

	Interview Questions	Probing Questions	Research Outcome
Generative Questions	Could you please share your experiences with Case's ( ) products/services?	-Any recent interactions with Case () for support or services? -How satisfied were you with the interaction? - What improvements would you like to suggest?	Context and background of customer perspective on manufacturer products/services and capturing relational uncertainties
	Which areas create delays or inefficiencies in your processes?	-How do Case's () products/services fit in your daily/overall operations? - What information would you need, to be more efficient or flexible in your processes?	Uncovering organisational and technical uncertainties
Directive Questions	How flexible is your organisation in adapting to change in new processes and systems?	-What hinders you in this transformation? -How does this impact your operations?	Reveals organisational uncertainty and its impact
	What specific issues you encounter in the implementation of new or advanced technologies?	- Are there new technologies you are adopting? - How do you think these will affect your use of our products/services?	Reveals technical uncertainty
	How do you think some advanced solutions or services could potentially enhance the efficiency in your operations?	- Can you provide any specific examples or areas in your business or operations where you would like to see outcome or improvements?	Uncovering organisational and technical uncertainties
Closing Questions	Have there been any recent changes in your market or industry that have influenced your needs for our products/services?	-What new needs or requirements have emerged? -How can Case () better support in this context?	Reveals environmental uncertainties and external factors affecting customer needs
	Is there anything else you would like to share or any questions for me?		An opportunity for participants to share additional insights, concerns or ask for clarification

11.5.3 Distributors

	Interview Questions	Probing Questions	Research Outcome
Generative Questions	Could you describe your role in distributing Case's () products/services?		Context and background of the participant's perspective.
	How do you perceive your relationship with Case ()?	-Any specific areas that need improvement? -Do you have sufficient support from Case ()? -How do we compare with other companies you distribute for?	Reveals relational uncertainties and the nature of relationship with manufacturer
Directive Questions	How do you see this shift from traditional product sales to outcome-based business models and customized solutions?	-Do you offer any customised services for your customers on our products? -What does it entail if you don't mind sharing it? - What specific barriers do you foresee in adapting to such a business model with Case () products?	Reveals organisational uncertainties related to shift towards offering
	How do technological advancement or integration impact your offering?	-Are there new technologies you are adopting? -How do these affect your operations?	Reveals technical uncertainty and its influence on AS

	Have there been any recent changes in your market or regulatory environment that affect your distribution?	-How do you keep up with these changes? -How can Case () better support you in this context?	Reveals environmental uncertainty and external factors that affects distribution activities
Closing Questions	How would you coordinate your activities and efforts with manufacturer during this collaboration process?	- What tools do you use to ensure efficient coordination and communication?	Uncover relational uncertainties and opportunities for manufacturer
	Is there anything else you would like to share or any questions for me?		An opportunity for respondents to share additional insights, concerns or ask for clarification

11.5.4 Technology Supplier

	Interview Questions	**Probing Questions**	**Research Outcome**
Generative Questions	Could you describe your role and solution you provide to Case ( )?		Context and background of the participant's perspective.
	How do you perceive your relationship with Case ( )?	-Any specific areas that need improvement? -How do compare with other companies you work with?	Reveals relational uncertainties and the nature of relationship with manufacturer
Directive Questions	How do you see this shift from traditional product sales to outcome-based business models and customized solutions?	- What specific barriers do you foresee in adapting to such a business model? -What opportunities do you see with Case () if they offer outcome-based services?	Reveals organisational uncertainties and technology partner's perspective on AS
	How do you handle technological changes and updates in your solutions?	-How do you communicate these changes to Case ()? What support do you provide during such transitions? -How do these changes impact Case () operations?	Reveals technical uncertainty and the impact of technological changes
	Have there been any recent changes in technology landscape or regulatory environment that affect your solutions?	-How do you keep up with these changes? -What new needs or requirements have emerged? -How can Case () better support you in this context?	Reveals environmental uncertainty and external factors that affects technology soluions
Closing Questions	How would you coordinate your activities and efforts with manufacturer during this collaboration process?	- What tools do you use to ensure efficient coordination and communication?	Uncover relational uncertainties
	Is there anything else you would like to share or any questions for me?		An opportunity for respondents to share additional insights, concerns or ask for clarification

11.6 Appendix 6: Information Sheet

Participant Information Sheet

Uncertainties In Advanced Services: A Service Network Actors' Perspective

Invitation
We would like to invite you to take part in a research study. Before you decide if you would like to participate, take time to read the following information carefully and, if you wish, discuss it with others such as your family, friends or colleagues.

Please ask a member of the research team, whose contact details can be found at the end of this information sheet, if there is anything that is not clear or if you would like more information before you make your decision.

What is the purpose of the study?
The primary purpose of this research is *to identify the uncertainties for the design and delivery of advanced services from a service network actors' perspective*. The research will help to scale up the global delivery of advanced services.

Why have I been chosen?
You are being invited to take part in this study because your insights and expertise will enhance and contribute to the value of the research.

What will happen to me if I take part?
If you decide to take part, you will be invited to participate in an interview focused on specific aspects of advanced services and the digital infrastructure that supports them. The interview will not exceed 90 minutes.

With your permission we will audio or video record the interview and take notes. The recording will be transcribed by a transcriber approved by Aston University. Any information which could be used to identify individuals e.g. names, locations etc will be removed. Audio or video recordings will be destroyed as soon as the transcripts have been checked for accuracy. We will ensure that anything you have told us that will remain anonymous. You are free not to answer any questions that are asked without giving a reason. A follow up maybe requested but will not involve repetitive questioning.

Do I have to take part?
No. It is up to you to decide whether or not you wish to take part. If you do decide to participate, you will be asked to sign and date a consent form.

You would still be free to withdraw from the study at any time without giving a reason and your refusal from participation will not be reported to the company.

Will my taking part in this study be kept confidential?
Yes. A code will be attached to all the data you provide to maintain confidentiality. Your personal data (name and contact details) will only be used if the researchers need to contact you to arrange study visits or collect data by phone. Analysis of your data will be undertaken using coded data.

The data collected will be stored in a secure document store (paper records) or electronically on a secure encrypted laptop, password protected computer server, or the secure cloud storage provided through the university.

What are the possible benefits of taking part?

By participating in the study, you will contribute substantially to the understanding of advanced services and the effective use of information platforms to support them. You will help with the development of management tools to improve and make better use of these information platforms.

What are the possible risks and burdens of taking part?

The risks associated with this study are low. However, the anonymity and confidentiality of your personal data will be guaranteed by data coding methods.

What will happen to the results of the study?

The results of this study may be published in scientific journals and/or presented at conferences. If the results of the study are published, your identity will remain confidential.

A lay summary of the results of the study will be available for participants when the study has been completed and the researchers will ask if you would like to receive a copy.

The anonymised results may be shared with the company providing funding for this study. The anonymised results may be used for research by other research teams as described in Appendix A. The results of this study will also be used to write a PhD thesis.

Expenses and payments

There will be no expenses and payments being made.

Who is funding the research?

The study is being funded by Aston University and the company.

Who is organising this study and acting as data controller for the study?

Aston University is organising this study and acting as data controller for the study. You can find out more about how we use your information in Appendix A. The study is a part of activities at the Advanced Services Group.

Who has reviewed the study?

This study was given a favorable ethical opinion by the ***AARM*** Research Ethics Committee.

What if I have a concern about my participation in the study?

If you have any concerns about your participation in this study, please speak to the research team and they will do their best to answer your questions. Contact details can be found at the end of this information sheet.

If the research team are unable to address your concerns or you wish to make a complaint about how the study is being conducted you should contact the Aston University Research Integrity Office at research_governance@aston.ac.uk or telephone 0121 204 3000.

Research Team

Please contact Dipti Rathi at d.rathi@aston.ac.uk for any more details and questions about the study.

Thank you for taking time to read this information sheet. If you have any questions regarding the study, please don't hesitate to ask one of the research team.

Aston University takes its obligations under data and privacy law seriously and complies with the Data Protection Act 2018 ("DPA") and the General Data Protection Regulation (EU) 2016/679 as retained in UK law by the Data Protection, Privacy and Electronic Communications (Amendments etc) (EU Exit) Regulations 2019 ("the UK GDPR").

Aston University is the sponsor for this study based in the United Kingdom. We will be using information from you in order to undertake this study. Aston University will process your personal data in order to register you as a participant and to manage your participation in the study. It will process your personal data on the grounds that it is necessary for the performance of a task carried out in the public interest (GDPR Article 6(1)(e). Aston University may process special categories of data about you which includes details about your health. Aston University will process this data on the grounds that it is necessary for statistical or research purposes (GDPR Article 9(2)(j)). Aston University will keep identifiable information about you for 6 years after the study has finished.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally identifiable information possible.

You can find out more about how we use your information at https://www.aston.ac.uk/about/statutes-ordinances-regulations/publication-scheme/policies-regulations/data-protection or by contacting our Data Protection Officer at dp_officer@aston.ac.uk.

If you wish to raise a complaint on how we have handled your personal data, you can contact our Data Protection Officer who will investigate the matter. If you are not satisfied with our response or believe we are processing your personal data in a way that is not lawful you can complain to the Information Commissioner's Office (ICO).

11.7 Appendix 7: Consent Form

Consent Form

Uncertainties In Advanced Services: A Service Network Actors' Perspective

Name of Chief Investigator: Dipti Rathi

Please put initial in boxes

1.	I confirm that I have read and understand the Participant interview Information Sheet V2 dated 02/02/2022 for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2.	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and that my refusal to participate will not be reported to the company	
3.	I agree to my personal data and data relating to me collected during the study being processed as described in the Participant Information Sheet	
4.	I agree that a follow-up interview may be requested.	
5.	I agree to my interview being audio or video recorded and to anonymised direct quotes from me being used in publications resulting from the study.	
6.	I agree to take part in this study.	

Name of participant	Date	Signature
Name of Person receiving consent.	Date	Signature