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An exploration of how product-based firms transition to IoT-enabled servitized firms

By

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A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Engineering

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List of Abbreviations

API	Application Programming Interface
APP	Application
B2B	Business-to-Business
B2C	Business-to-Consumer
BI	Business Intelligent
CEO	Chief Executive Officer
CPS	Cyber-Physical System
CRM	Customer Relationship Management
CRT	Customer Road Transport
CSC	Customer Centre Center
CVP	Customer Value Proposition
DaaS	Device-as-a-Service
DC	Dynamic Capabilities
EMEA	Europe, the Middle East and Africa
GDPR	General Data Protection Regulations
HR	Human Resources
ICT	Information and Communication Technology
IoT	Internet of Things
IP	Intellectual Property
JIT	Just-in-Time
KPI	Key Performance Indicator
LNG	Liquefied Natural Gas
MFP	Multi-Functional Printer
MPS	Managed Print Services

MVP	Minimum Viable Product
OEM	Original Equipment Manufacturer
OW	Order Winners
PaaS	Product-as-a-Service
PIL	Participation Information Leaflet
PMO	Project Management Officer
POS	Point-of-Sale
PSS	Product-Service System
RBV	Resource-Based View
RFID	Radio-Frequency Identification
SC	Supply Chain
SDK	Software Development Kit
SDL	Service-Dominant Logic
SLA	Service-Level Agreement
SLR	Systematic Literature Review
SMB	Small-Medium Business
SWOT	Strengths, Weaknesses, Opportunities, Threats
VRIN	Valuable, Rare, Imperfectly imitable, and Non-substitutable

Acknowledgment

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Declaration

This thesis is the original work of the author, submitted to the University of Warwick in support of the application for the degree of Doctor of Philosophy. Also, this thesis has not been submitted in whole or in part as consideration for other degree qualification at this or any other university.

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Published Work

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Abstract

The current trend of Industry 4.0 involves the use of digitalisation and smart technologies in product manufacturing. This has enabled product-based manufacturing firms to make the radical shift in their traditional business model towards the service-oriented business model in order to respond to the disruption of digital technologies. This corresponds to the concept of servitization which refers to the shift from selling pure products to the integration of product-service offerings. It is also expected that by leveraging the Internet of Things (IoT) technology as part of the emerging Industry 4.0 disruptive technologies, product-based firms can fundamentally transform their business model and help to facilitate and enable the novel servitized business models. The existing literature discusses the concept of IoT-enabled servitization under the terms of “digital servitization” and “smart servitization” which can be considered as the transformation of firms’ processes and capabilities to shift from a product-centric business model towards smart product-service software systems in enabling value creation. Although the knowledge of the servitization concept has been advanced in both theory and practice, the existing knowledge of the emerging concept of IoT and servitization is still in its infancy and the literature is fragmented. Therefore, the research on this emerging concept provides an opportunity for further investigation.

The adoption of IoT in implementing servitized business models is associated with the introduction of new service offerings to meet the new market needs in the volatile market, as discussed in the strategic management literature. The importance of renewal and reconfiguration of firms’ resources and capabilities in order to implement a new business model has been emphasised in the theories of dynamic capabilities view and resource-based view (RBV). In this context, the opportunity exists to carry out empirical research that identifies all associated characteristics, resources, capabilities and related factors that lead to the successful implementation of IoT-enabled servitized business models. To explore this research prospect, the purpose of this thesis is to identify firms’ resources and capabilities and the associated processes which are necessary to implement IoT-enabled servitized business models.

In line with the abductive research logic which was underlined by the author’s critical realism, the research design developed to address this research opportunity includes two phases: theoretical and empirical. The former aims to explore the extant literature related to the emerging concept and develop a conceptual framework to serve as a guide for empirical study. The latter is a case-based research method which is adopted to empirically test the conceptual framework and emerge the new findings. Two case studies comprised of six embedded units of analysis are selected to provide an opportunity for the literal replication of the guiding principles that underline the capabilities the product-based firms can adopt in order to transition to an IoT-enabled servitized business model.

The research findings concluded that there are four types of IoT-enabled servitized business model which have different associated characteristics. It was also illustrated that firm resources, operational capabilities and firm's network configurations vary by different IoT-enabled servitized business model strategy, and product-based firms require a particular set of dynamic capabilities (DC) to manage those resources and capabilities. This research highlights the understandings of the transformation process from product-based to IoT-enabled servitized firms. Subsequently, the thesis provides the theoretical and practical contributions by developing a conceptual framework that can be used by academic research in order to further empirically investigate and broaden the knowledge of the emerging concept of IoT and servitization, and by practitioners to evaluate their existing (product-based) firm resources and capabilities, and renew or adjust those resources and capabilities as appropriate in order to implement IoT-enabled servitized business models. Finally, the limitations and future research avenues are highlighted.

Keywords: Servitization, IoT, Business model, Resource-based view, Operational Capabilities, Dynamic capabilities, Business ecosystems

1 Introduction

1.1 Introduction to the Chapter

The focus of this introductory chapter is to lay the foundations for the main body of this thesis by providing the background of the knowledge, which is necessary to conceptualise the study, as well as a route map of this thesis.

The background knowledge required to understand the research settings is covered in Section 1.2, which discusses the disruption of Industry 4.0 in product-based firms, the Internet of Things (IoT) as an enabler of business model change, the concept of servitization, and the emerging concept of IoT as an enabler of servitization.

Section 1.3 presents the thesis route map. This section begins with the gap of knowledge in the existing body of literature. This is followed by the aim of the research, the contribution of the research to the academic domain and practitioners. Finally, Section 1.4 concludes and presents a summary of the chapter.

The structure of this chapter is illustrated in Figure 1.1.

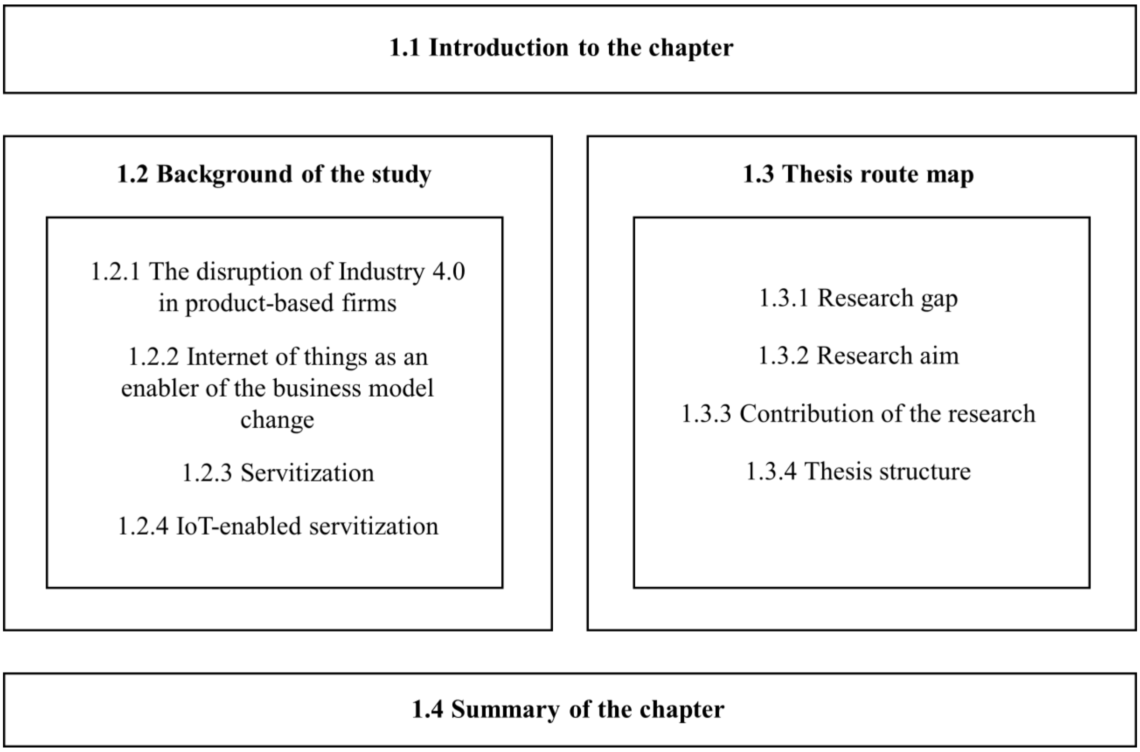


Figure 1.1: Structure of Chapter 1

1.2 Background of the Study

This section presents the background knowledge for this study. It starts with the introduction of the disruption of Industry 4.0 trends in product-based firms (see Section 1.2.1). Section 1.2.2 presents the impact of IoT on the business model change. Section 1.2.3 discusses the concept of servitization. The following subsection highlights the role of IoT as an enabler of servitization.

1.2.1 The Disruption of Industry 4.0 in Product-based Firms

The trend of the fourth industrial revolution of industry, Industry 4.0, has impacted the manufacturing process and strategy since the German federal government in 2011 announced it as one of the key initiatives of its high-tech strategy (Hermann et al., 2016). It highlighted advances in information and communication technologies (ICT) through the use of the Internet. This enables wireless networking with resources, information, objects, and people, resulting in the convergence of physical and digital worlds in the form of a cyber-physical system (CPS) (Kagermann et al., 2013). The fourth industrial revolution was previously anticipated by three industrial revolutions: the first focused on transitioning from hand power to machines through the use of steam and water power at the end of the eighteenth century; the second, which is known as the technological revolution, focused on introducing electrification to be used in mass production lines, starting at the turn of the twentieth century; this was then replaced by the third revolution, which took place in the early 1970s and focused on the development of automation and computers to be used in production processes and is also known as the digital revolution (Drath and Horch, 2014). The summary of the four stages of the industrial revolution is illustrated in Figure 1.2.

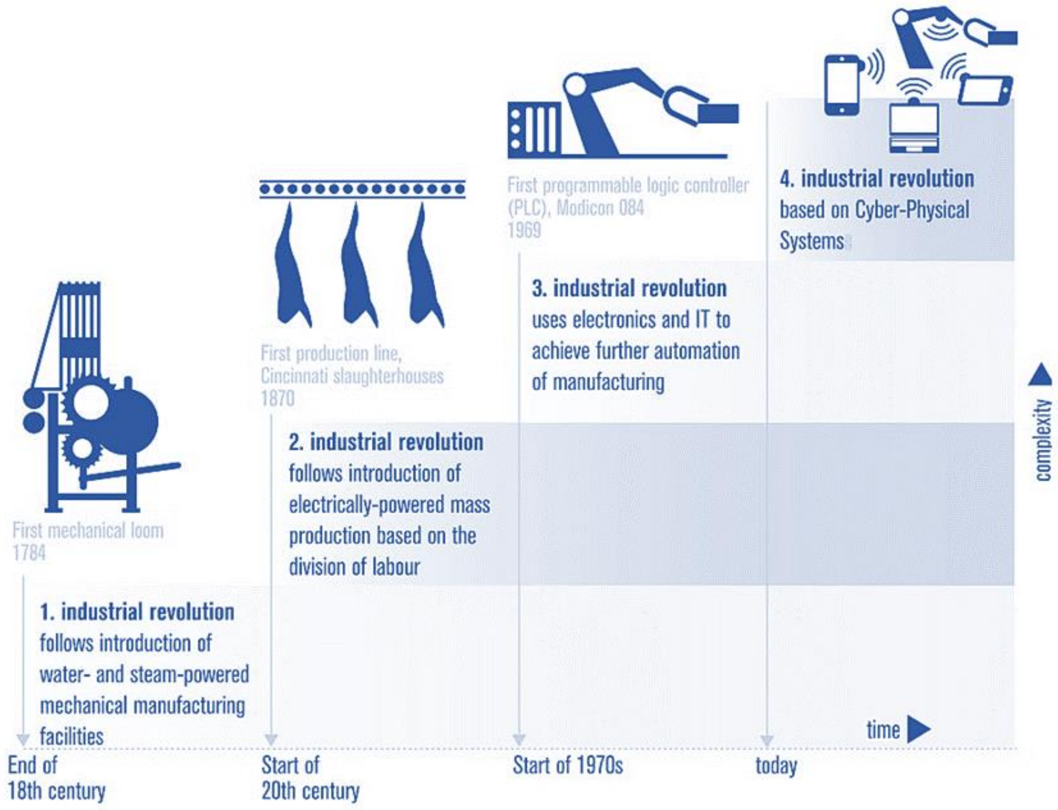


Figure 1.2: Overview of the four stages of the industrial revolution (Adapted from Kagermann et al., 2013)

According to Hermann et al. (2016), there are four major design principles and initiatives of Industry 4.0. First is interconnection, which involved the use of wireless communication technologies and the IoT to connect machines, devices, sensors, and people to enable the interaction, communication, and information sharing between interconnected objects and people (Schroeder, 2016). Second is information transparency. An increase in the interconnection between objects and people generates a vast amount of data from different points of the manufacturing process, which enables a new form of information transparency, allowing people to make decisions based on the information available. Third is decentralised decisions, which are based on the transparency of information obtained in real-time, helping to drive better decision-making and flexible responses as autonomously as possible (Kagermann et al., 2013). Fourth is technical assistance which involved the ability of a CPS to support the operators in making decisions and solving problems at short notice (Ghobakhloo, 2018).

Accordingly, Industry 4.0 has enabled product-centric firms to innovate and digitally transform their existing organisations and manufacturing strategies, i.e. to leverage IoT and CPS to efficiently manage and control the entire value chain of their product life cycles (Ghobakhloo, 2018; Kagermann et al., 2013). In addition, manufacturing is becoming more dynamic and complex as it is possible for firms to engage individual customer- and product-specific features in designing and configuring manufacturing and service processes. This means that product-based firms required the flexibility in manufacturing to produce one-time items with low production volumes (i.e. batch size of 1) (Kagermann et al., 2013; Lasi et al., 2014). The Industry 4.0 trend is based on the technology-push innovation which implies the need for product-based firms to capitalise on the opportunities through upscaling their industrial products which involves the support of radical business model innovation (Frank et al., 2019; Lasi et al., 2014; Schroeder, 2016).

1.2.2 Internet of Things as an Enabler of the Business Model Change

As discussed in Section 1.2.1, one of the core ideas of Industry 4.0 is to leverage the connectivity and IoT in industrial applications (Ibarra et al., 2018). The term Internet of Things (IoT) was originally introduced by Kevin Ashton in 1999 to describe the integration of radio-frequency identification (RFID) and other sensors into physical objects, allowing the interconnection of which to serve various purposes, such as identification, sensing, communication and data collection (Ashton, 2009). Miorandi et al. (2012, p.1497) then further conceptually stated the term IoT as *"the linkages of digital and physical entities, by means of appropriate information and communication technologies, to enable a whole new class of applications and services."* This definition of IoT suggested the broader meaning of the term regarding its applications where IoT is the fundamental technological element that transforms stand-alone things (e.g. tags, sensors and mobile phones) into smart (monitoring and collecting the data) and connected (able to send different types of data) products, allowing firm to reap the benefits of which and turn this into meaningful applications and services (Atzori et al., 2015; Fleisch et al., 2014; Paiola and Gebauer, 2020) and hence, this is the definition of IoT adopted in this thesis. Due to its useful functionalities and applications, IoT has been increasingly leveraged by firms to address new business and market opportunities, as evident in the expectation that the number of connected devices will reach 34 billion in 2020 (Greenough and Camhi, 2016). Furthermore, the adoption of IoT technology allows firms to integrate physical elements with the digital elements, which form hybrid constructs in new value-creation. According to Fleisch et al. (2014), there are five value-creation layers embedded within the hybrid constructs as illustrated in Figure 1.3. The first layer is the physical thing, which refers to the physical elements that supply a direct physical benefit to the end user (e.g. light bulbs supply light). The second layer is the sensors/actuators, which are embedded into the physical things to measure the local data and generate local benefits (e.g. sensors detect the presence of a person while actuators turn the light on when the person is present and off when not). The third layer is connectivity, which refers to the connection of the Internet with the sensors/actuators so they become remotely and globally accessible. The fourth layer is analytics, which allows the sensor data to be collected, stored and classified into generate meaningful information (e.g. on-and-off time in households, motion patterns and the operating hours of each light bulb). The fifth layer refers to the utilisation of previous layers in order to structure the digital service in a suitable form such as mobile application or web services (e.g. the use of the mobile application to control the light bulbs on-demand).

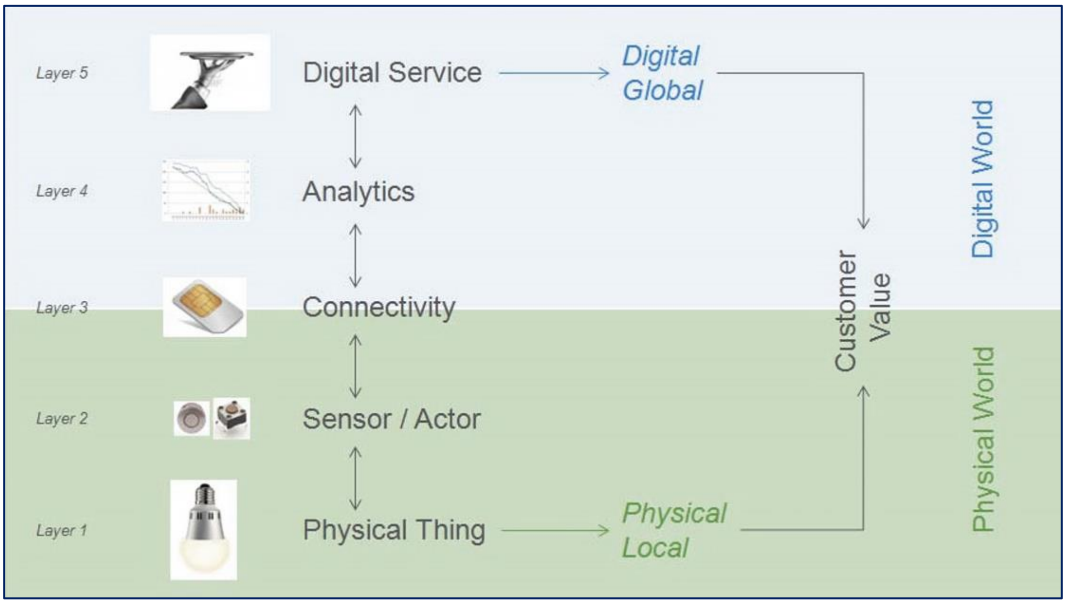


Figure 1.3: Value-creation layers in an internet of things application (Fleisch et al., 2014)

It is suggested that these five layers have to be integrated in order to create new customer value. Consequently, the emergence of physical products and digital services through the IoT applications required the facilitation of new business models with new revenue opportunities as the existing ones may not be applicable to do so (Bucherer and Uckelmann, 2011; Dijkman et al., 2015; Sklyar et al., 2019a).

According to Teece (2010, p.172), the business model is defined as “ the design or architecture of the value creation, delivery, and capture mechanisms it employs.” The essence of a business model is to outline customer needs and how to generate revenues from them by which the business enterprise delivers value to customers through products and services. These three broad elements suggested by Teece (2010) incorporated some specific business model elements which are provided by Osterwalder and Pigneur's (2010) work including the value proposition (value creation); the customer relationship (value delivery) and pricing (value capture). These elements of a business model are the focus of this research.

Teece (2010) also suggested that the rise of IoT popularity leads to business model challenges as the information collected through the connected device and digital services is difficult to monetise as well, as it changes the way that customers interacts with firms. Accordingly, the adoption of IoT has become more relevant to the product-based firms to integrate digital services with their product offerings as the IoT, or digital elements of the connected products, is always a service (Fleisch et al., 2014; Frank et al., 2019; Ibarra et al., 2018). It is also important for them to redesign and align the IoT business model with the core customer needs in order to stay competitive in the market (Coreynen et al., 2017; Rymaszewska et al., 2017).

There are three main over-arching trends of the business model that are influenced by IoT (Fleisch et al., 2014; Ibarra et al., 2018). First is the integration of user and customer to align with customers in the value-creation process to provide flexible value propositions such as the customisation of products or services. Second is service-orientation as the digital services allow firms to establish and maintain customer relationships after product sales. Third is core analytics as IoT measures the precise transaction and accurate usage of the products, the analysis of which could be increasingly valuable for the development of a new business model (Pei Breivold and Rizvanovic, 2018).

Accordingly, IoT has fundamentally disrupted and progressively shifted the mindset of the firms with a product-based business model to derive the understanding of product-as-a-service (PaaS) (Bucherer and Uckelmann, 2011; Fleisch et al., 2014), which focuses on substituting the overall demand of the physical product ownership with access to digital service (Porter and Heppelmann, 2014). This main idea and concept correspond to the concept of servitization.

1.2.3 Servitization

The concept of servitization was first introduced by Vandermerwe and Rada (1988) to explain the transition process of pure product manufacturers to integrated product-service providers by adding service to their core product offerings. Since then, this concept has been studied by many scholars to understand how to use services as competitive strategies for product manufacturers (Baines et al., 2009c; Oliva and Kallenberg, 2003; Slack, 2005; Wise and Baumgartner, 1999). This area of study has also emerged from different disciplines under different terminologies such as product-service system (PSS) and service-dominant logic (SDL). One of the main studies in servitization is that of Baines et al. who define servitization as “the innovation of an organisation’s capabilities and processes to better create mutual value through a shift from selling product to selling PSS” and PSS as “tangible products and intangible services designed and combined so that they jointly are capable of fulfilling specific customer needs” (2009c, p.555).

The classification of servitization proposed by Tukker (2004) has been widely adopted by various authors (cf. Baines et al., 2007; Mont, 2000) who describe three main categories of business models within servitization as illustrated in Figure 1.4.

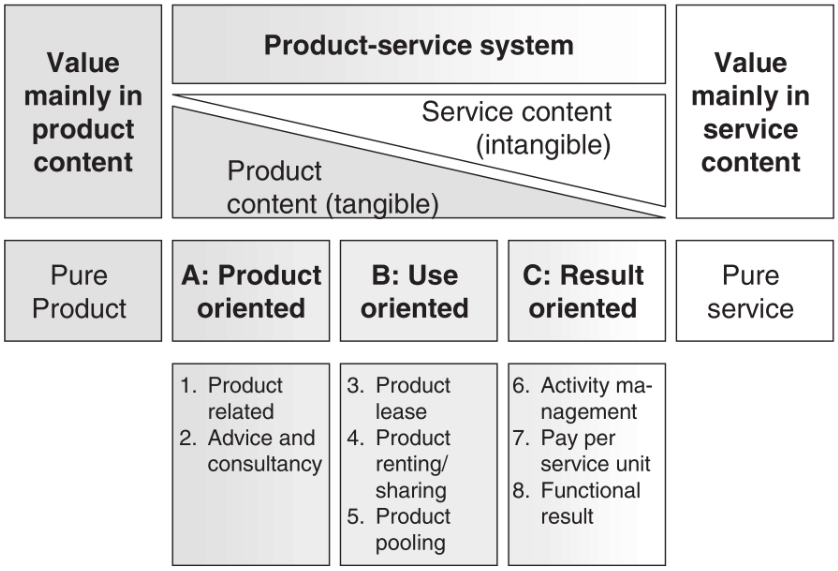


Figure 1.4: The classification of servitization (Tukker, 2004)

The first category is a product-oriented business model which focuses on the sale of products with add-on services such as maintenance contracts and the advice and consultancy related to product sales. The second category is a use-oriented business model which does not focus on selling products but instead, the providers retain ownership and make the products available for different customers to use, such as car leasing and renting. The third category is result-oriented which focuses on delivering the specified results or outcomes of the products based on mutual agreements between provider and customer. An example of this business model is Rolls-Royce’s ‘Power-by-the-hour’ service offering, which guarantees their customers the flight hours of aero engines (Baines et al., 2007; Slack, 2005).

The main driver of servitization is to help product-based firms be less sensitive to the price-based competition and generate new revenue streams (Baines et al., 2007, 2009c). This is because the service can be delivered with higher profit margins and firms can also achieve regular and stable income from providing services after product sales (Brax, 2005; Gebauer and Friedli, 2005; Wise and Baumgartner, 1999). In addition, product-based firms can achieve competitive strategy by using the service elements to differentiate their product offerings from competitors (Baines et al., 2009c; Gebauer and Fleisch, 2007; Oliva and Kallenberg, 2003). Servitization also helps firms to pursue marketing opportunities by leveraging service to sell more products from which the customer relationships are established (Baines et al., 2009b; Gebauer and Fleisch, 2007; Slack, 2005).

On the other hand, the main challenge of servitization involves the design of service offerings and having customers engaged in the service development process (Brax, 2005; Slack, 2005; Zhang and Banerji, 2017). In addition, there are also the challenges associated with the readiness of organisational transformation and culture to adopt the servitization strategy (Gebauer and Fleisch, 2007; Oliva and Kallenberg, 2003; Zhang and Banerji, 2017).

Accordingly, it has been established that in order to provide servitized offering, firms have to modify their existing business models and the value proposition to align with customers' needs. Based on the discussion in Section 1.2.3, it is expected that by adopting IoT, firms can essentially transform their organisational core strategy and business model as well as enable different types of servitized business model which facilitate the provision of servitized offerings (Gerpott and May, 2016; Naik et al., 2020; Rymaszewska et al., 2017; Suppatvech et al., 2019).

1.2.4 IoT-enabled Servitization

The emerging knowledge of IoT and servitization has been increasingly studied regarding the introduction of IoT as an enabler of servitization due to its features and functions that support the integration of product and service. This emerging trend has been captured under different terms including "digital servitization" (Schroeder and Bigdeli, 2018; Sjödin et al., 2020; Vendrell-Herrero et al., 2016;) and "smart servitization or smartization" (cf. Kamp et al., 2017; Kaňovská and Tomášková, 2018). These terms were commonly defined as *"the transformation in process, capabilities and offerings whereby a company and their associated ecosystem shift from a product-centric business model* *toward smart product-service-software systems which enable value creation and capture through monitoring, control, optimisation, and autonomous function"* (cf. Kohtamäki et al., 2019; Sjödin et al., 2020; Sklyar et al., 2019b). Based on this definition, firms should focus on product, service and software dimensions in order to create value from digital servitization. This also changes the conventional view of product-based firms in offering standalone products to leverage the interconnection of the connected product (IoT) and the company's process to deliver the integrated product-service value for its customers (Kohtamäki et al., 2019).

The existing research has discussed both the strategic and operational roles of IoT as an enabler of servitization, which are classified based on the maturity of the IoT involvement and the level of service offered. Gerpott and May (2016) discussed the three main strategic roles IoT used to offer services by incorporating Cusumano et al.'s (2015) work of service taxonomy, including smoothing, adaptation and innovation. Table 1.1 presents the characteristics of the strategic roles of IoT with practical examples.

Table 1.1: Strategic roles of IoT in the context of servitization (Gerpott and May, 2016)

Strategic roles of IoT	Characteristics and examples
Smoothing	• IoT is used to initiate the transaction and potentially reduce the transaction costs • IoT is not the main part of the core product or service offerings • E.g. Car-sharing service and digital payments
Adaptation	• IoT helps to significantly increase the value of the offering but does not alter the core functionality of product or service • IoT helps to enable additional functionalities of product or service • E.g. Parcel tracking in logistics industry and the digital dashboard in the connected car
Innovation	• IoT is the main value driver of product or service offerings • IoT enables product or service functionalities which were not previously available • E.g. Smart home and wearable fitness monitoring

In addition, Porter and Heppelmann (2014) discussed four main operational roles of IoT based on its functionalities and features including monitoring, control, optimisation and autonomy (see Table 1.2) which help to enable servitized offerings. These roles of IoT are important and need to be initially defined by firms in order to deliver to their customers.

Table 1.2: Operational roles of IoT in the context of servitization (Porter and Heppelmann, 2016)

Operational roles of IoT	Characteristics and examples
Monitor	• IoT is used to monitor the product's condition, external environment and operation and usage which may alert or notify when there are changes. • These monitoring data can be used for design, market segmentation and after-sale services. • E.g. The monitoring of health conditions through medical devices
Control	• IoT enables the remote control of the product to respond to the change in its conditions or environments. • These controls allow the personalisation of the user experience • E.g. Philips Hue lightbulbs where the user can adjust the lights from smartphones
Optimisation	• The monitoring data and the ability to remotely control the product allow the optimisation of product operations. • These involve the analysis of in-use or historical data to further improve the product utlisation and efficiency. • E.g. Diebold adopt predictive maintenance to assess a malfunctioning ATM's status in real-time and their ATMs are repaired remotely, if possible
Autonomy	• The combination of monitoring, control, optimisation and autonomy abilities, allows autonomous operations and achieves a certain level of autonomy. • These involve autonomous product improvement and personalisation, and self-diagnosis and service. • E.g. iRobot Roomba, a vacuum cleaner that uses sensors and software to scan and clean floors in rooms with different layouts without the requirement of human intervention.

Therefore, the development of IoT offers firms a unique opportunity to gain insights about how the products are being used by the customers. Consequently, the IoT technology has widely adopted by product-based firms and recognised as a core enabler of the transition from product manufacturing to delivering service and integrated solution, and from selling products to value (Hasselblatt et al., 2018; Rymaszewska et al., 2017). Having recognised IoT as the key enabler of servitization, academic research on this emerging concept has been further discussed through different research focuses and theoretical lenses. The following sections will focus on the current research streams related to the emerging concept of IoT and servitization.

1.2.4.1 Conceptualisation of the IoT-enabled servitized business models

The emerging concept of IoT-enable servitization reshapes the conventional idea of selling stant-alone products by highlighting the connectivity between products (IoT) and companies (i.e. manufacturers and customers) (Frank et al., 2019). There are several business model typologies suggested in the existing literature in order to support the implementation of IoT-enabled servitized business model.

First, the existing research has classified the IoT-enabled servitized business models based on the different associated dimensions including the level of product-service customisation i.e. standardisation to customisation such as 1) equipment supplier 2) availability provider, and 3) performance provider (Kowalkowski et al., 2015) or the types of servitization i.e. product-oriented to outcome-oriented such as 1) product business model, 2) service-agreement business model, 3) process-oriented business model, and 4) performance-oriented business model (Huikkola and Kohtamäki, 2018); 1) add-on services, 2) maintenance and product support services, 3) R&D-oriented services, and 4) functional and operatioal services (Parida et al., 2014).

Second, the current research has also conceptualised the IoT-enabled servitized business models based on the revenue models and the payment structure. For example, firms may monetise their IoT-enabled servitized offerings by using freemium, pay-per-use, subscription, and performance-based contracts (cf. Ardolino et al., 2018; Fleisch et al., 2014; Gebauer et al., 2017).

Finally, there are several studies that conceptualise the IoT-enabled servitized business models based on the strategic adoption of IoT technology such as monitoring to autonomous (Porter and Heppelmann, 2014) and closed to open network (Herterich et al., 2015a; Leminen et al., 2012).

1.2.4.2 Resources and capabilities to support IoT-enabled servitization

The current research on this emerging concept further investigates the realisation of key specific IoT opportunities and capabilities in order to create value through servitization (Ardolino et al., 2016; Herterich et al., 2015a, 2015b; Rymaszewska et al., 2017). Herterich et al. (2015a) identified seven IoT affordances such as remote diagnosis, information and data-driven services, and predict and trigger service activities. Ardolino et al. (2016) further discussed 11 IoT capabilities (e.g. product and user identification, geo-localisation, and condition and usage monitoring) which have different levels of impact, depending on their strategic roles as a servitized manufacturer. Schroeder and Bigdeli (2018) have suggested 11 IoT artefacts (e.g. repair efficiency, maintenance optimisation and consumables/worn parts replenishment) that contribute to the different service value propositions (e.g. repair service, product maintenance service, and consumables/worn part replacement). In addition, by extending the idea of Herterich et al.'s (2015a) work on IoT affordances, Naik et al. (2020) identified three levels of IoT affordances (first-order, second-order and third-order affordances) which could enable different outcomes (i.e. basic, internal and external), based on the manufacturer's strategy and actions. These illustrate that IoT opportunities have been substantially leveraged by product-based firms to deliver integrated product-service offerings.

Although, the strategic capabilities and functionalities of IoT are crucial for firms to implement servitized offering, the strategic organisational resources and capabilities in transitioning to IoT-enabled servitization are also required in order to achieve competitive advantage (Huikkola and Kohtamäki, 2017; Kohtamäki et al., 2019; Lenka et al., 2017). It has been argued that the adoption of IoT has required firms to renew their resources, internal processes and capabilities in order to capture value from their product-service offering. This aligns with the RBV and DC view theories in the strategic management research which consider the exploitation of the strategic resources and particular capabilities seize new business opportunities such as IoT-enabled servitization and hence, generate competitive advantage.

Accordingly, there are a number of studies of this emerging concept focuses on the strategic resources and capabilities required to implement IoT-enabled servitization (Huikkola and Kohtamäki, 2017; Kohtamäki et al., 2019; Lenka et al., 2017). Ulaga and Reinartz (2011) have identified four unique resources (e.g. installed based product usage and product development and manufacturing assets) and five distinctive capabilities (e.g. service-related data processing and interpretation capability and design-to-service capability) while Schroeder and Kotlarsky (2015) identified five digital resources (i.e. distribution sensors and transmission devices, analytic software and product-service data) and capabilities (i.e. interpretive and relational) which help to create value through IoT-enabled servitization. Extending from Ulaga and Reinartz's (2011) study, Coreynen et al. (2017) highlighted the particular resources and capabilities required for three servitization pathways (i.e. industrial, commercial and value) which are enabled by IoT. Lenka et al. (2017) focused on the specific types of digitalisation capabilities (i.e. intelligent, connect and analytics) which could help firms to leverage IoT in co-creating value with customers. Hasselblatt et al. (2018) found five strategic IoT capabilities (e.g. IoT value selling, IoT value delivery and digital business model development) that manufacturers can leverage to implement servitized business models. These studies suggested that IoT seems to significantly transform the resources and capabilities for product-baed firms and hence, further research is required in order to define the capabilities and how the resources are deployed to support the implementation of IoT-enabled servitized business model.

1.2.4.3 The view of service network in the context of IoT-enabled servitization

It has been suggested that the development of IoT-enabled servitization has impacted the current view of buyer-supplier relationships (supply chain) and traditional value chains (cf. Boehmer et al., 2020; Chakkol et al., 2018; Kohtamäki et al., 2019; Porter and Heppelmann, 2014). The value chain is defined by Porter (1998, p.36) as "the collection of activities that are performed to design, produce, market, deliver, and support its product" This can be illustrated in Figure 1.5 where a value chain of an auto manufacturing firm may include the supplier of raw materials, the manufacturer of parts and assemblies and involve selling cars to the final customers. Product-based firms tend to view the relationship with their suppliers and customers within a concept of the value chain while the service-related components mainly involve the marketing and service support activities which exist within the value chain (Davies, 2004; Valdez-De-Leon, 2019).

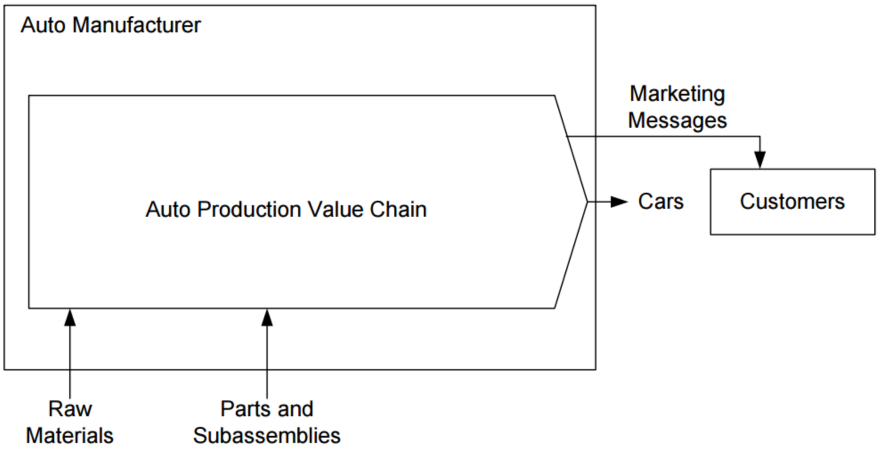


Figure 1.5: The example of the value chain of an auto manufacturing firm (Harmon, 2017)

However, the existing studies of the emerging concept of IoT and servitization suggested that the adoption of IoT tends to move the supplier or manufacturer towards the downstream integration while establishing a closer relationship with their customer through monitoring and controlling the products at the point-of-use as well as leveraging the customer's usage information (Boehmer et al., 2020; Gerpott and May, 2016). Since the IoT and connected devices allow firms to directly engage with the end customers and understand exactly what the customer wants, the product manufacturer may turn into the service provider or connect with the other available service providers in order to fulfill customer requests when required. This can be seen as different from the term "value chains" coined by Porter (1998) but instead, Harmon (2017) defined this concept as the "ecosystem". The transition from a value chain to an ecosystem is illustrated in Figure 1.6.

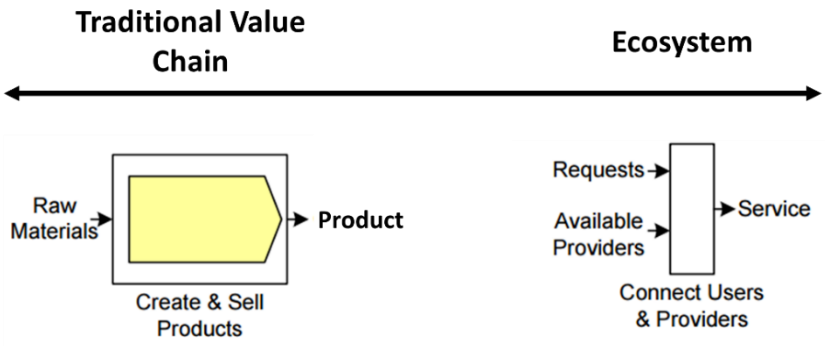


Figure 1.6: The transition from a value chain to an ecosystem (Adapted from Harmon, 2017)

Furthermore, the existing literature suggests that by leveraging IoT, firms can effectively integrate their associated partners to improve the collaborations, facilitating new services and opportunities between different actors within the ecosystem (Andersson and Mattsson, 2015; Rabetino and Kohtamäki, 2018; Schroeder and Bigdeli, 2018; Sklyar et al., 2019b). This broadens the scope of IoT-enabled servitization beyond the firm-centric to explore the collaboration of interfirm and intrafirm actors. Accordingly, it is important for product-based firms to define the configurations of their service network and their position in which when implementing IoT-enabled servitized business models.

1.3 Thesis Route Map

This section discusses the four main elements of the thesis. The first element focuses on the research gap (see Section 1.3.1). The second and third elements present the aim and contribution of the research (see Sections 1.3.2 and 1.3.3). The fourth element demonstrates an overview of the thesis structure (see Section 1.3.4).

1.3.1 Research Gap

Whilst the concept of servitization is well developed in terms of theoretical and practical knowledge, the existing knowledge of the intersection of IoT and the servitized business model is still in its infancy. Accordingly, the existing literature on this emerging concept has demonstrated itself as a promising area of research in the field of operations management. As discussed in Section 1.2.4, there are three main research gaps available in the existing research streams which are addressed in this thesis.

First, based on the discussion in section 1.2.4.1, there is a gap regarding the characterisation of IoT-enabled servitized business model configurations. Although the authors in this extant literature suggest that the IoT enables product-based firms to pursue different pathways of servitization which could lead to new value propositions and innovative business models (e.g. Coreynen et al., 2017; Kohtamäki et al., 2019), the literature regarding the typology of the IoT-enabled servitization is still fragmented and in its infancy. Authors tend to adopt the typology of the traditional servitization literature (e.g. Baines et al., 2009a; Kowalkowski et al., 2015; Tukker, 2004) or the different roles of IoT (e.g. Gerpott and May, 2016; Porter and Heppelmann, 2014) but a commonly accepted typology of an IoT-enabled servitized business model does not yet exist. Therefore, there is a gap in the existing literature to consolidate the literature related to the emerging concept of IoT and servitization and empirically investigate the different types of IoT-enabled servitized business model that exist in the literature and how these can be characterised.

The second research gap is derived from the extant literature (as discussed in section 1.2.4.2) which focuses on reconfiguring the firm resources and capabilities required to move towards IoT-enabled servitized business models (e.g. Coreynen et al., 2017; Hasselblatt et al., 2018; Huikkola and Kohtamäki, 2017; Sklyar et al., 2019b). However, the existing studies mainly focus on the strategic resources and capabilities required to leverage IoT from the perspective of the solution providers and the advance services (c.f. Hasselblatt et al., 2018; Huikkola and Kohtamäki, 2017) but lack evidence on how these resources' configuration and capabilities align with the different types of IoT-enabled servitized business model as these could differ in terms of generating competitive advantage. As addressed in the study of Kohtamäki et al. (2019) there is still a gap in the knowledge regarding the strategic resource configurations, the capabilities and the roles of dynamic capabilities (DC) to implement the different types of IoT-enabled servitized business model, which needs to be addressed as these could differ in terms of generating competitive advantage. Accordingly, this thesis is underpinned by the strategic management theory including the theories of RBV and DC view.

Third, based on the discussion in section 1.2.4.3, there is a gap in the current understanding of how the firm's position within the traditional value chain and the view of the firm's network configuration is changed in providing IoT-enabled servitized offerings to customers. To date, the IoT-enabled servitized business models tend to be conceptualised within the view of ecosystems where the complementarities and interdependencies between actors are presented (cf. Kohtamäki et al., 2019; Rabetino and Kohtamäki, 2018). However, the literature still lacks empirical analysis of the industrial practices regarding the view of a firm's network configurations in delivering different types of IoT-enabled servitized business model. Accordingly, there is a need to empirically investigate the current view of a firm's network configurations adopted to facilitate the IoT-enabled servitized business model.

1.3.2 Research Aim and Questions

As discussed in Section 1.3.1, the current landscape of the emerging concept of IoT and servitization focuses on the servitized business model enabled by IoT, the configuration of the service network and the strategic resources. There are gaps in the knowledge regarding the lack of common typology of IoT-enabled business models and their associated characteristics consolidated from the literature, the understandings of the network configurations and the strategic resources and capabilities required by firms to transition from their traditional (product-based) to different types of IoT-enabled servitized business model.

Therefore, in order to address these gaps, the aim of this thesis is:

'To explore how firms reconfigure their resources and capabilities to transition from product-based to different types of IoT-enabled servitized business model.'

The following research questions are supplementary in order to achieve the research aim.

RQ1: What are the different types of IoT-enabled servitized business models and what are their characteristics?

RQ2: What are the resources required for product-based firms to implement IoT-enabled business models?

RQ3: What are the operational capabilities required for product-based firms to implement IoT-enabled servitized business models?

RQ4: What is the view of network configurations required to support IoT-enabled servitized business models?

RQ5: What are the dynamic capabilities required by firms to upgrade from their product-based to IoT-enabled business models?

In order to answer five research questions, two phases of research design is adopted and the conceptual framework was developed from reviewing the literature.

This research started with the identification of the current types of IoT-enabled servitized business model and associated characteristics which are implemented by the product-based firms. Then, the firm resource configurations, the operational capabilities and the network configurations required to implement and support a particular type of IoT-enabled servitized business model needed to be investigated. Lastly, there is a need to understand the role of dynamic capabilities in which three main processes are included: sensing opportunities, seizing those opportunities and transforming capabilities (Teece, 2017), that contribute to the firm's transition from their existing (product-based) to different types of IoT-enabled servitized business model and these will be underlined.

In this context, the literature proposes the opportunity to conduct empirical research that identifies all relevant underlying mechanisms, including the business model characteristics, resources, firm's network configurations and capabilities which lead product-based firms to offer different types of IoT-enabled servitized business model.

1.3.3 Contribution of the Research

This thesis aims to make a valuable contribution to both theory and practice. First, it contributes to the theoretical advancement of servitization research. Given the immaturity of the field of digital servitization, this research develops a comprehensive review of different IoT-enabled servitized business model archetypes and their associated characteristics existing in the literature. In addition, the research further extends the contribution to theory by introducing the resource-based view (RBV) and dynamic capabilities (DC) to address the current research gaps of digital servitization. This application of the RBV and DC theories to the digital servitization expands the research focus into the strategic analysis of the particular firm resource configurations, operational capabilities and highlights the particular types of dynamic capabilities required to transition from the product-based business model to IoT-enabled servitized business model. These also serve as the theoretical and analytical bases to meet the research aims.

Subsequently, this research further investigates the strategic repositioning of the product-based firms in order to implement different types of IoT-enabled servitized business models which correspond to the reconfiguration and renewal of a firm's resources and capabilities. This contributes to the understanding of the firm's network configurations and the firm boundaries through exploring the coordination or interplay between the IoT-enabled servitized firms and their associated internal and external partners in creating value to the end customers.

Finally, this thesis makes a contribution to practice as it enables the firm with a traditional product-based business model to upgrade its business model to implement an IoT-enabled servitized business model. The typology of IoT-enabled servitized business models provides the essential knowledge of the different business model characteristics such as the value proposition, the customer relationship and the pricing model for implementing IoT-enabled servitized business models. In addition, the product-based firms can evaluate and reconfigure their resources and capabilities to leverage IoT in implementing a servitized business model and staying competitive in the market.

1.3.4 Thesis Structure

This thesis is divided into six chapters. Each chapter contains multiple sections that begin with the chapter introduction and concludes with a chapter summary. The structure of this thesis is presented in Figure 1.7.

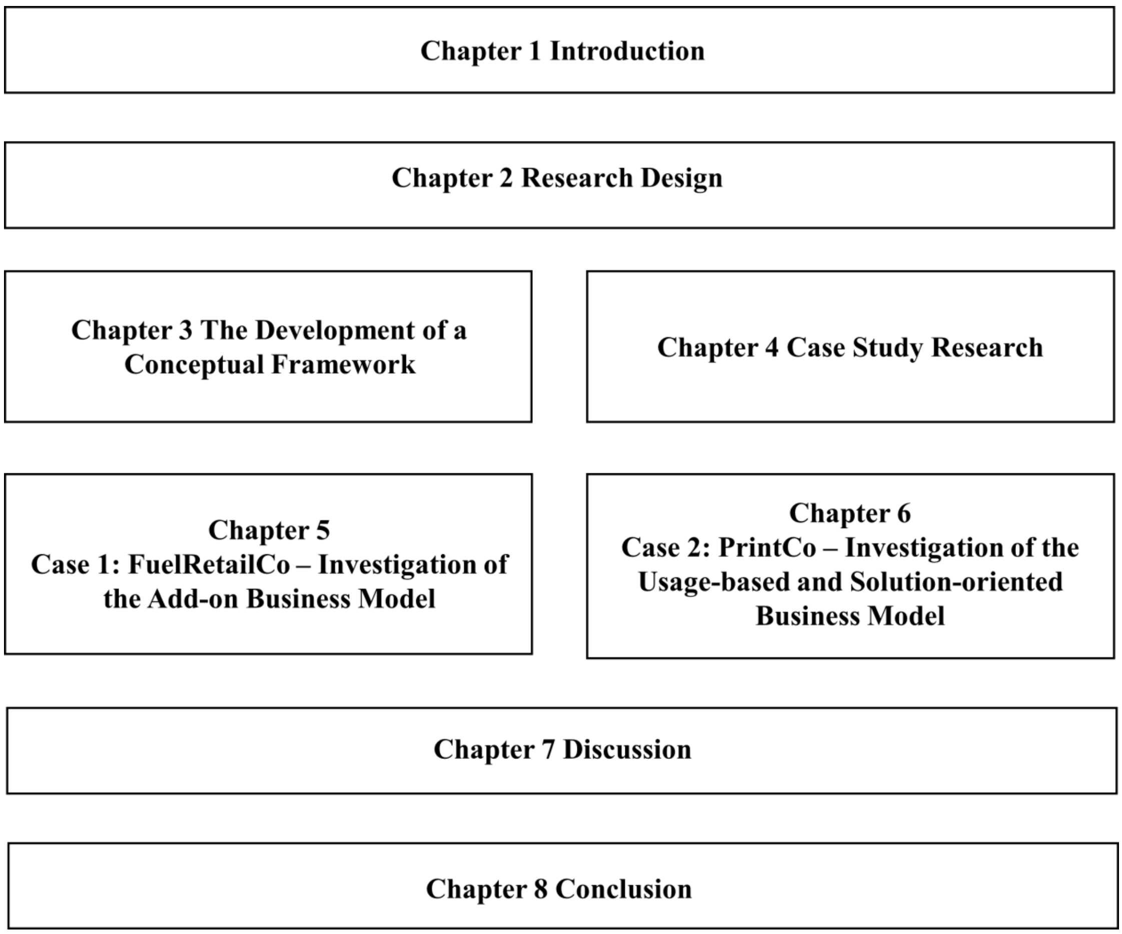


Figure 1.7: Structure of the thesis

Following this introductory chapter, Chapter 2 discusses the research design of this thesis. It introduces the importance of ontology, epistemology and methodology and how these considerations are associated with the author's personal beliefs, and the rationales for the selected methodology for the research are explained. This is followed by the justification for and details of the author's choice of the two-phase abductive research design.

Chapter 3 discusses the first phase of the abductive research design which is the development of a conceptual framework by systematically combining the underpinning theories, a systematic literature review (SLR) and the extended literature. The discussion of underpinning theories introduces the theoretical model for the study. Following this, an SLR is conducted which results in a conceptual framework based on its findings. The extended literature is then included to extend the conceptual framework and operationalise the research constructs. The chapter concludes with the development of the updated conceptual framework for this study.

Chapter 4 discusses the second phase of the abductive research design which is the case study research. The details of the case study design and the process for conducting case study research are discussed. Finally, the rigour of the case study research and the associated ethical considerations are addressed.

Chapter 5 presents the case study results of four units of analysis within the FuelRetailCo case study based on the templates developed using the template analysis procedure. The case study findings start with an overview of the case and the product-service offerings provided by FuelRetailCo. This is followed by the characteristics of the business model, firm resources, the operational capabilities, the network configurations and the dynamic capabilities.

Chapter 6 presents the case study results of two units of analysis within the PrintCo case study based on the templates developed using template analysis procedure. It then follows the same structure as in Chapter 5. It starts with an overview of the case and the product-service offerings provided by PrintCo. This is followed by the characteristics of the business model, firm resources, the operational capabilities, the network configurations and the dynamic capabilities.

Chapter 7 discusses the findings of this research with the reference to the existing literature. This chapter serves as a synthesis of literature and the emerging findings which reflect the conceptual framework. This provides the foundations for theoretical and practical contributions.

Chapter 8 summarises the key findings of this research and explains how these associate with and answer the research questions set for the study. The contributions to theoretical knowledge and practice are then outlined. This chapter also discusses the limitations of this research as well as proposing the avenues for future research.

1.4 Summary of the Chapter

This introductory chapter serves two main purposes: (1) to present the background of the study and (2) to provide an overview of the thesis structure.

In order to serve the first objective, this chapter started by discussing the trend of Industry 4.0 adopted by product-based firms, IoT as an enabler of a business model change, the concept of servitization and the emerging concept of IoT and servitization.

Regarding the second objective, this chapter provided the research agenda for this thesis. In addition, three main contributions of this thesis were discussed. Finally, the thesis structure was demonstrated.

Chapter 2 now provides the research design of the thesis.

2 Research Design

2.1 Introduction to the Chapter

The purpose of this research is to outline the research design adopted in this research in order to address the research gaps presented in Chapter 1.

Section 2.2 discusses the research philosophies and the researcher aims to explain the meaning and importance of ontology, epistemology and methodology in conducting research. More importantly, how these considerations associated with the author's personal beliefs and the rationale for the selected methodology for the research are explained in Section 2.3.

The structure of Chapter 2 is shown in Figure 2.1.

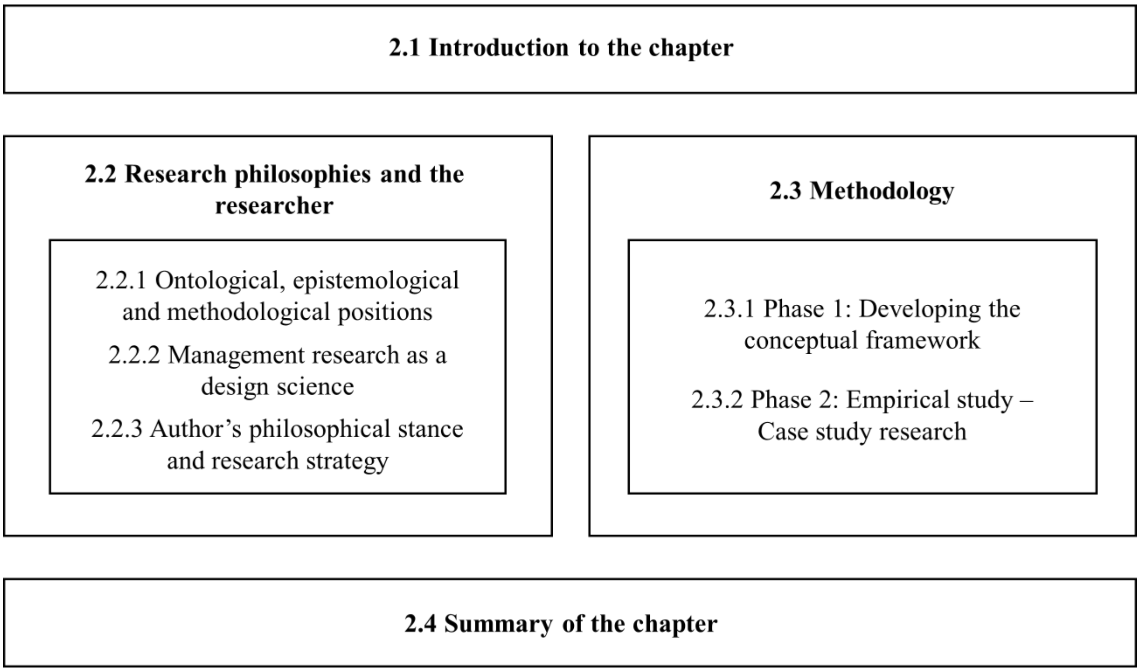


Figure 2.1: Structure of Chapter 2

2.2 Research Philosophies and the Researcher

Terre Blanche and Durrheim (1999) suggested that the research process has three major dimensions: ontology, epistemology and methodology. These different dimensions and how these relate to social research will be discussed in Section 2.2.1.

2.2.1 Ontological, epistemological and methodological positions

2.2.1.1 Ontological positions

Ontology is the starting point for conducting all social research. Ontology can be defined as "*the assumptions which are made about the nature of social reality* (Easterby-Smith et al., 2002, p. 31)". These assumptions are concerned with what kinds of social phenomena exist, the condition of their existence, and how they are related (Blaikie, 2010). Chia (2002) suggests that the ontology related to contemporary Western thought is underpinned by two opposed views: Heraclitean and Parmenidean. The former is one 'of becoming' and develops from a view that the world is in a continual state of flux and is changeable. This supports the logic of understanding. On the other hand, the latter is one 'of being' and is based on a view that the nature of reality is permanent and unchangeable. It considers reality to be formed from discrete entities with identifiable properties and characteristics that are underlined by universal patterns or laws. The supporting logic is causality. Parmenidean ontology has been dominantly adopted in Western education and hence this supports the author's view of reality. The difference between two contrasting ontological positions are summarised in Table 2.1.

Table 2.1: Comparison of two different ontological positions (Chia, 2002)

Ontology – Assumptions about the nature of reality		
	Heraclitean	**Parmenidean**
Ontology	'of becoming'	'of being'
View of reality	Fluxing, changeable and emergent world	Permanent and unchangeable nature of reality
Basic unit of reality	'event cluster'	'atom'
Logic	Understanding	Causality

2.2.1.2 Epistemological positions

Epistemology is concerned with how we understand the nature of social reality (Blaikie, 2010). Parmenidean ontology is underpinned by two contrasting views of how social research should be conducted: positivism and constructionism, as suggested by Easterby-Smith et al. (2018).

The main characteristics of positivism are that the social world exists externally from the human perceptions and therefore, the phenomena can be measured through objective methods rather than through human beliefs or experiences. Positivists aim to operationalise the measurable constructs from the observable facts and then identify the causal explanation about them. Then, the findings are generalised through statistical analysis.

On the other hand, constructionists argue that reality is not objective and cannot be understood independently of the observers. As discussed by Berger and Luckman (1966), social reality can be discovered by the ways that people make sense of the world – particularly through sharing experiences with others. Constructionists position researchers as part of what is being observed and make an interpretation of the meaningful social action. This aims to increase the general understanding of the social regularities in a typical context (Blaikie, 2010).

The middle ground between positivism and constructionism is realism. Realism rejects the positivist view but adopts the constructionist view. The realist view considers the reality which is claimed to exist or has not yet been observed. Fundamentally, the view of realism focuses on investigating both the observable and unobservable characteristics of the real world (Bhaskar, 1978). The difference between the three different epistemological positions is summarised in Table 2.2.

Table 2.2: Three different epistemological positions (Adapted from Easterby-Smith et al., 2018)

Epistemology – Assumptions about the most appropriate way to acquire knowledge		
Positivism	**Realism**	**Constructionism**
The social world exists externally. Therefore, its properties should be measured through objective methods.	Reality consists of different layers including both observable and unobservable characteristics.	Reality is determined by people rather than by objective and external factors. Therefore, it can be formed through the way people make sense of their experience.

2.2.1.3 Methodological positions

The methodology needs to be considered after the researcher's epistemological position has been identified. It involves the selection of a procedure and logic used for generating knowledge. The distinct research logics include inductive, deductive, retroductive and abductive; the first two are based on the linear process which supports the positivists' logic while the last two are based on the cyclical process which supports the realists' logic (Ackroyd, 2009).

The inductive research approach aims to produce generalisations by searching for associations between variables. This begins with data collections or specific observations and measures to detect patterns and regularities. This leads to emerging propositions and results in formulating some general conclusions or theories to explain further observations. The deductive research approach starts with scanning the existing theory (e.g. from a literature review), from which the hypotheses and propositions are deduced. An appropriate data collection is then conducted to test whether it supports or rejects these hypotheses and propositions. The theory is then modified in the light of the findings.

The abductive research approach aims to construct the theory, which is derived from determining and combining the meaning and context of the everyday activities of social actors, in order to understand the research problems. Accordingly, the starting point in this approach is to discover these meanings and activities and derive from them the concepts of the meanings of the social world which can form the basis of an understanding of the research problem. This is then followed by developing the theory and testing iteratively.

The retroductive approach complements the abductive research logic, aiming to discover the distinct processes and real underlying mechanisms or structures that help to explain the observed regularities (Blaikie, 2010). It begins with the construction of a hypothetical model of mechanisms that are assumed to produce the empirical phenomena (Bhaskar, 1978). This is followed by finding the real mechanisms that are responsible for producing the observed regularity from the empirical observation. Blaikie (2010) suggests that the retroduction involves the process of working back from data to a possible explanation using the creative imagination and analogy.

The difference between these two methodological positions is illustrated in Table 2.3.

Table 2.3: Four different methodological positions (Blaikie, 2010)

Methodology – Methods and approaches used to gather data				
	Positivist logics		Realist logics	
	Inductive	**Deductive**	**Abductive**	**Retroductive**
Aim	To establish universal generalisations to be used as pattern explanations	To test theories, to eliminate false ones and corroborate the survivors	To describe and understand social life in terms of social actors' motives and understanding	To discover underlying mechanisms to explain observed regularities
Start	Accumulate observations or data Produce generalisations	Identify a regularity to be explained Construct a theory and deduce hypotheses	Discover everyday lay concepts, meaning and motives Produce a technical account from lay accounts	Document and model a regularity Construct a hypothetical model of mechanisms
Finish	Use these 'law' as patterns to explain further observations	Test the hypotheses by matching them with data	Develop a theory and test it iteratively	Find the real mechanism by observation and/or experiment

2.2.2 Author's philosophical stance and research strategy

As argued by Easterby-Smith et al. (2002), all researchers are affected by their underlying philosophical assumptions which serve as a belief regarding how the data should be gathered, analysed and used. Therefore, in order to understand the rationale behind the choice of the author's methodology, the author's epistemological position and research strategy need to be explained and aligned with the methodology. The following sections will explain the author's epistemological position as a critical realist and the adoption of the abductive research approach.

2.2.2.1 Critical realist epistemology

Based on the discussion in Section 2.2.1.2, positivism and constructionism can be considered as lying at two different ends of the epistemology position. Both of them have their own strengths and weaknesses with regard to the way of conducting social research. Therefore, critical realism is introduced as a compromise epistemological position lying between positivism and constructionism (Easterby-Smith et al., 2018). Reed (2009) suggests that the main distinctive characteristic of the critical realist, which distinguishes them from the positivist, is that the former believe that the existing reality cannot be reduced to a series of discrete events as suggested by the latter. In contrast, the knowledge of social reality consists of stratified and differentiated levels or domains of reality that possess their own characteristics and are interconnected (Sayer, 2000). According to Bhaskar (1978), this stratified ontology consists of three independent layers of domains of social reality: 'the empirical', 'the actual' and 'the real'. The empirical consists of experiences and perceptions that can be observed. The actual consists of events which may or may not be observed. The final layer is 'real' which consists of the causal powers and mechanisms that generate the events but cannot be observed directly. These three layers of reality can be illustrated as ellipsis shaped, as shown in Figure 2.2.

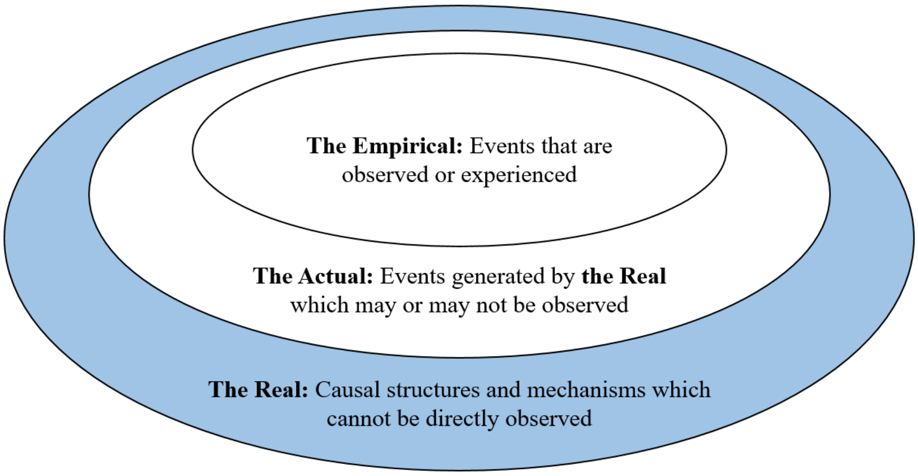


Figure 2.2: Three layers of reality (Adapted from Bhaskar, 1978)

By applying critical realism epistemology to this research, the author aims to explain the underlying mechanisms (resources and capabilities for implementing an IoT-enabled servitized business model) that generate the observable events or certain outcomes (types of IoT-enabled servitized business models). This investigation aims to answer the following over-arching research question of this research:

"How do firms reconfigure their resources and capabilities to transition from product-based to different types of IoT-enabled servitized business model?"

2.2.2.2 Methodology selection: The abductive research approach

Building upon the approach based on methodological positions, the abductive research approach is used for theory building which primarily aims to develop the understandings of new concepts as well as theoretical models (Kovács and Spens, 2005). In line with critical realism epistemology, abductive research explores a new phenomenon, identifies patterns and explains the generative mechanisms to generate a new theory which can be tested subsequently.

A three-stage abductive research approach is adopted in this thesis to provide the ability to suggest new insights, as illustrated in Figure 2.3. Stage 1 focused on exploring the applicability of the 'theory' related to resource and dynamic capability to the emerging concept of IoT and servitized business model. Stage 2 was an iterative process called 'theory matching' which involves the systematic matching of IoT-enabled servitized business models and the resources and capabilities required in implementing those models. The abductive cycle is finished in stage 3, when the saturation of empirical data is reached, and the 'theory suggestions' were made in the form of a conceptual framework.

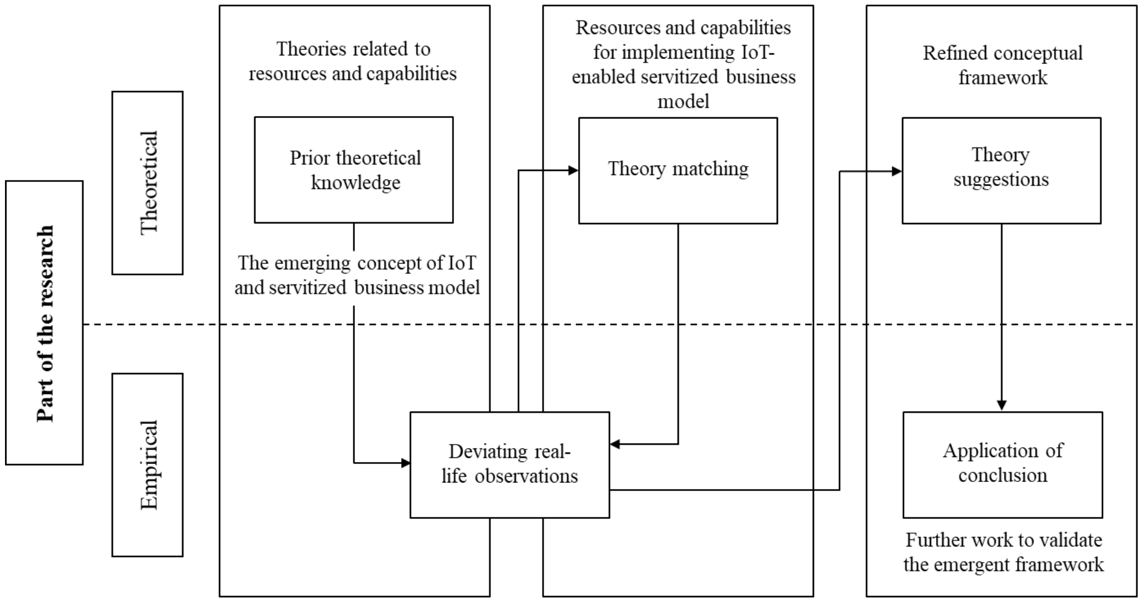


Figure 2.3: Three stages of abductive research design

The aim of stage 1 is to understand the context of the IoT-enabled business model and the applicability of the theories of resources and capabilities prior to the empirical data collection. Stage 2 is the theory matching stage which is emergent and iterative. It involved systematically combining theory and empirical data (Dubois and Gadde, 2002). Finally, through theory matching, this leads to the theory suggestions where the refined conceptual framework is developed to provide the insights of the resources and capabilities required in implementing IoT-enabled servitized business models.

2.3 Methodology

This section focuses on the research methodology and the sources of data collection selected for conducting empirical data, in order to refine the theoretical framework. As a critical realist, the author adopts the abductive research cycle (see Figure 2.3) which suggests two phases of research design: theoretical and empirical. Accordingly, the author's choice of research methodology for this study was divided into two phases. The first phase of the abductive research design is to conduct the first stage of the theoretical phase involving the development of a conceptual framework. This phase aims to explore and understand the existing knowledge about the roles of IoT in enabling servitized business models. It aims to establish the theoretical framework which emphasises the observable events (IoT-enabled servitized business model) and their potential underlying mechanisms (resources and capabilities required to implement IoT-enabled servitized business models). The methodology used is a combination of conducting SLR and a traditional literature review, and applying the underpinning theories.

The second phase of the research design is an empirical phase which involves the empirical data collection. This leads to stage 2 in the abductive research cycle in which the existence of the underlying mechanisms (from the pre-developed conceptual framework in phase 1) is identified and continuously iterated through matching the emerging empirical data. The case study research is selected to conduct the empirical study as an appropriate method that fits this phase of the abductive research design. The rationales and the details of the author's choice of research methodology are discussed in Sections 2.3.1 and 2.3.2.

2.3.1 Phase 1: Developing the conceptual framework

2.3.1.1 Systematic Combination of Theory, SLR and Extended literature

The starting point for the abductive research design involved the development of research questions and the conceptual framework. In the context of this thesis, the research questions led to the theory development of IoT-enabled servitized business models. In theory building research, the prior view of general constructs or variables and their related relationships should be given (Voss et al., 2002). It is suggested that this can be formulated as a conceptual framework that underlies the focus of this research (Miles and Huberman, 1994). A conceptual framework presents a visual presentation explaining the key constructs and their associated relationships which aim to be studied. Building a conceptual framework drives a researcher to think about those constructs and variables logically and collectively to be included in the context of this research.

The development of the conceptual framework in this research was done in a multi-step way which involves the systematic matching of 'prior knowledge' of the theory on firm's resources, operational capabilities and dynamic capabilities required to implement IoT-enabled servitized business models, the SLR findings and extended traditional literature review (see Figure 2.4).

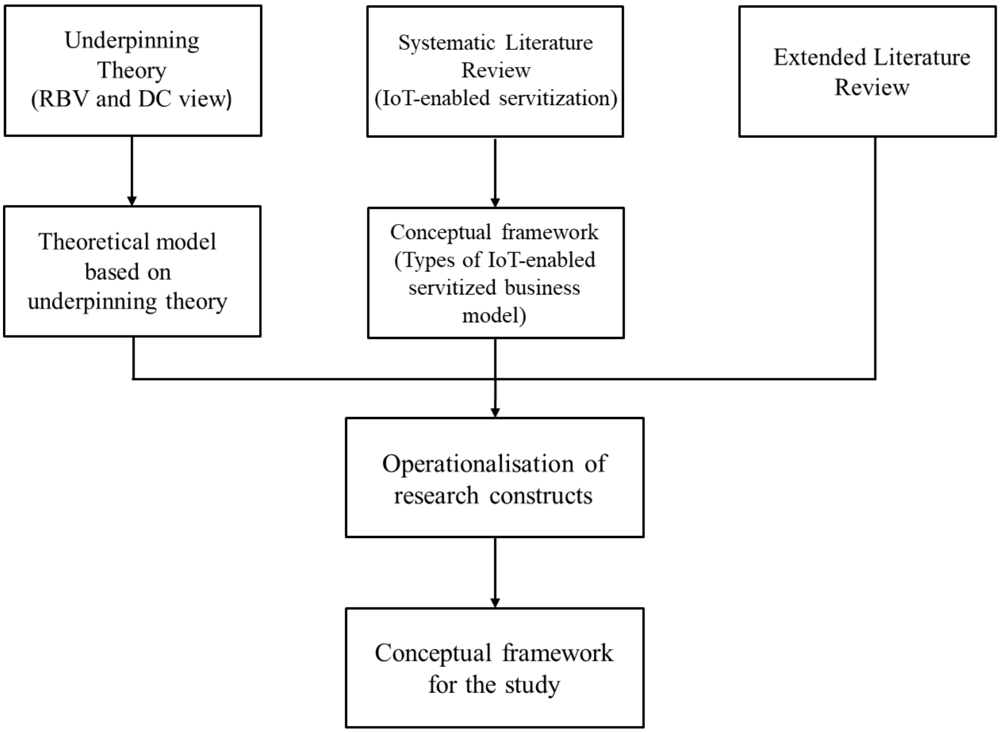


Figure 2.4: Systematic combining of underpinning theory, extended literature and SLR

A conceptual framework of the SLR findings was produced to explore the existing knowledge of IoT-enabled servitized business models, and the theoretical model of the underpinning theories, along with the extended literature, helped to operationalise the research constructs including resources, operational capabilities, and network configurations required by firms to implement particular types of IoT-enabled servitized business model. Consequently, both the conceptual framework of SLR and the theoretical model based on underpinning theories and extended literature were systematically combined to produce an extended conceptual framework. The next section discusses the methodology of conducting an SLR and the underpinning theory related to a firm's resources and capabilities, and its theoretical framework, SLR findings, the extended literature and how these were merged, to develop the ultimate conceptual framework are discussed in Chapter 3.

2.3.1.2 Systematic Literature Review (SLR) Methodology

Part of the development of a conceptual framework includes the SLR which was conducted in order to systematically review the existing literature on an emerging concept of IoT and servitization, and develop the conceptual framework for empirical research. This was conducted before administrating the case study. An SLR was considered to offer the most rigorous and high-quality method for identifying and evaluating the literature, for addressing specific questions (Mulrow, 1994). It is a five-step approach proposed by Denyer and Tranfield (2009) as illustrated in Figure 2.5. The details of the process are discussed in the following sections.

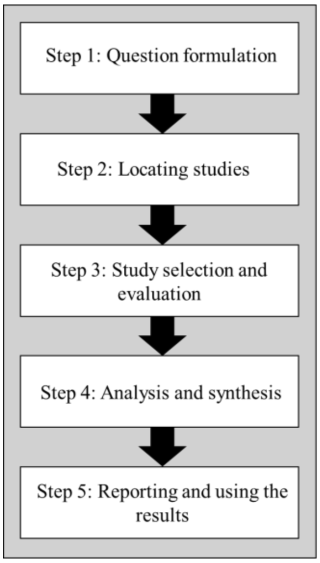


Figure 2.5: Five-steps of systematic literature review process (Adapted from Denyer and Tranfield, 2009)

2.3.1.2.1 Question formulation

In the planning phase, the review protocol, including the review question and search strategy, was developed and discussed with an expert panel for review. The review questions and sub-questions were then formulated from setting the scope, identifying emerging research fields and through the discussion with panel members. The review question is given as:

How do IoT technologies enable different types of servitized business models?

This review question suggested the three following supplementary questions to focus the enquiry further:

a) *What are the different types of IoT used and which business models do they support?*

b) *What are the benefits of the different IoT-enabled servitized business models?*

c) *What are the factors which inhibit firms from adopting IoT-enabled servitized business models?*

The search keywords were then developed from the guidance of these questions.

2.3.1.2.2 Locating studies

In order to locate the relevant studies for answering the review and sub-review questions, two classes of keywords relating to the concept of servitization and IoT were selected to search for the articles on five databases (see Table 2.4). The databases are Emerald, ABI/INFORM Global, ScienceDirect, Scopus, Web of Science. They were selected because they cover the key topics addressed in this study and are commonly used in the area of recent servitization research (cf. Grubic, 2014).

Table 2.4: Specification of search terms used in the systematic review

Servitization		Internet of Things
Serviti* OR Servici* OR "Service-dominant logic" OR "Product-Service System" OR "Product Service System" OR "Product-Service" OR "Integrated solutions" OR Service-orien* OR Service-cent* OR "Service-based business model" OR "Value Co-creation"	AND	"Internet of Thing*" OR IoT* OR "Cyber-Physical" OR "Connected Device"

2.3.1.2.3 Study selection and evaluation

For the initial search, only English language articles were included and 7,680 papers from the five databases were identified. After removing the duplication, screening the papers against the inclusion and exclusion criteria (as illustrated in Table 2.5). 7,391 papers were rejected at these processes. This is primarily because those papers focused on developing platforms and architecture for IoT applications rather than describing IoT-enabled servitized business models or the roles of IoT used in providing an integrated produce-service offering.

Table 2.5: Criteria for including and excluding papers

Criteria	Rationale
Inclusion	
Publications since 1999	The term "Internet of things" was first coined by Kevin Ashton in 1999
Publications included academic journals, conferences papers, reports and chapters of edited books	To ensure that all relevant published work was included
Peer and non-peer reviewed publications (e.g. conferences proceedings, chapters of edited books, and business reports)	The research in this area is in its infancy. Hence, there is a trade-off between publication quality and the available publications on this research topic. It has been decided to relax common quality guidelines to allow for more publications to be included, as is common with other reviews of nascent bodies of literature (Masi, Day, and Godsell, 2017)
All business contexts (e.g. business-to-business (B2B), business-to-consumer (B2C))	To make a comparison between roles of IoT in different business contexts and widen the scope beyond B2B
Papers in the field of information systems, engineering, manufacturing technology and marketing	To ensure that all possible fields relating to the research were covered
Exclusion	
Non-English language papers	Due to limited language capability of the authors
Papers focused on IoT platform or architecture development	The main objective of this research is to identify and explore IoT-enabled business models rather than develop an IoT platform or architecture

The remaining 320 papers were then read in full and each paper was evaluated against quality assessment criteria to distinguish between less and more robust studies, assess contributions, and scrutinise theory, research methodology, and data analysis (Wong et al., 2012). Only the publications which contribute to answering the review and its sub-questions and aligning with quality criteria were selected to be taken forward. Only 58 papers were identified as relevant to this research, after this final screening. An additional 16 papers from cross-referencing were added because they were revealed as relevant to the research but were not found in the initial literature search. Accordingly, a total number of 74 papers were selected for further analysis and synthesis. The systematic selection process is illustrated in Figure 2.6.

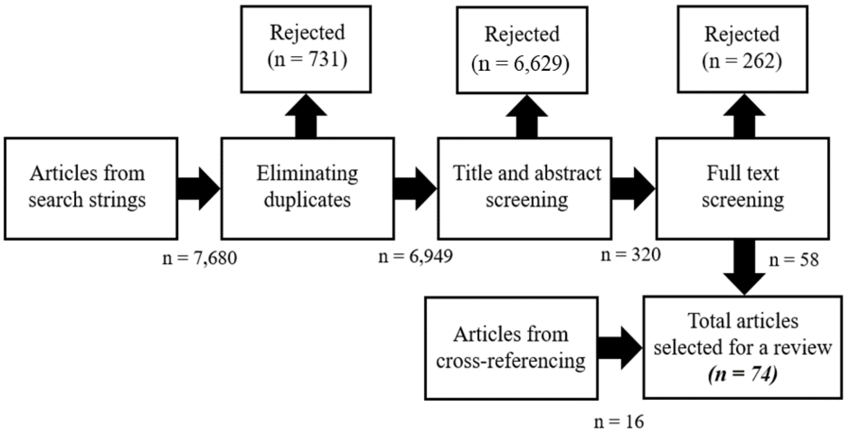


Figure 2.6: Summary diagram of the systematic selection process

2.3.1.2.4 Analysis and synthesis

The content of the selected publications was analysed descriptively and thematically. In the descriptive analysis, a deductive approach was adopted, which focuses on the classification of papers according to the year of publication, type of publication, the geographical location of where the fieldwork was conducted, methodology, and industry.

The thematic analysis identifies and categorises different types of IoT-enabled servitized business models, as well as other factors that may be relevant. An inductive approach was chosen to synthesise constructs of interest related to the review questions to form the basis of a data extraction sheet (Denyer and Tranfield, 2009). These constructs were then grouped according to themes and presented to the expert panel for discussion. The revised data extraction sheet, including the constructs clustered by themes (i.e. different roles of IoT used, benefits, and inhibiting factors corresponding to each type of IoT-enabled servitized business model), was then applied to all 74 papers. The tables and cross-tabulations, which form the basis for the descriptive and thematic results, were discussed with the expert panel in a similar way. These results were later fed into the conceptual framework as one of the main findings of the SLR. The findings from the thematic analysis and the business model archetypes were subsequently reviewed with the author's research group to ensure an unambiguous presentation.

2.3.1.2.5 Reporting and using the results

This stage aims to report the results of descriptive and thematic analysis, and how these results are associated were discussed (see Chapter 3). The results contributed to the development of the framework of IoT-enabled servitized business model archetypes and its associated findings, which have been published in the *Industrial Marketing*

Management (IMM) journal in 2019 for both academic and practical audiences to access. This ultimately guided empirical research for this doctoral thesis.

2.3.2 Phase 2: Empirical Study – Case Study Research

The second phase of abductive research design is to conduct an empirical study. Case study methodology was selected as it supports the author's epistemological belief as a critical realist, which incorporates the abductive research approach in gathering data (cf. Dubois and Gadde, 2002; Kovács and Spens, 2005). Case studies provide the unique means of theory development and by utilising in-depth insights of empirical phenomena and their contexts (Yin, 2009). Figure 2.7 suggested that the framework developed in Phase 1 consisted of articulated preconceptions based on existing theories and literature which directs the search for empirical data (Dubois and Gadde, 2002). The case study research allows the researcher to identify unanticipated but related issues that can be explored from the cases. This leads to a further need to redirect the existing theoretical framework through expansion or refinement of the theoretical model (Voss et al. 2002). Accordingly, the case study research can be considered as an appropriate research method for the empirical phase of the author's research design.

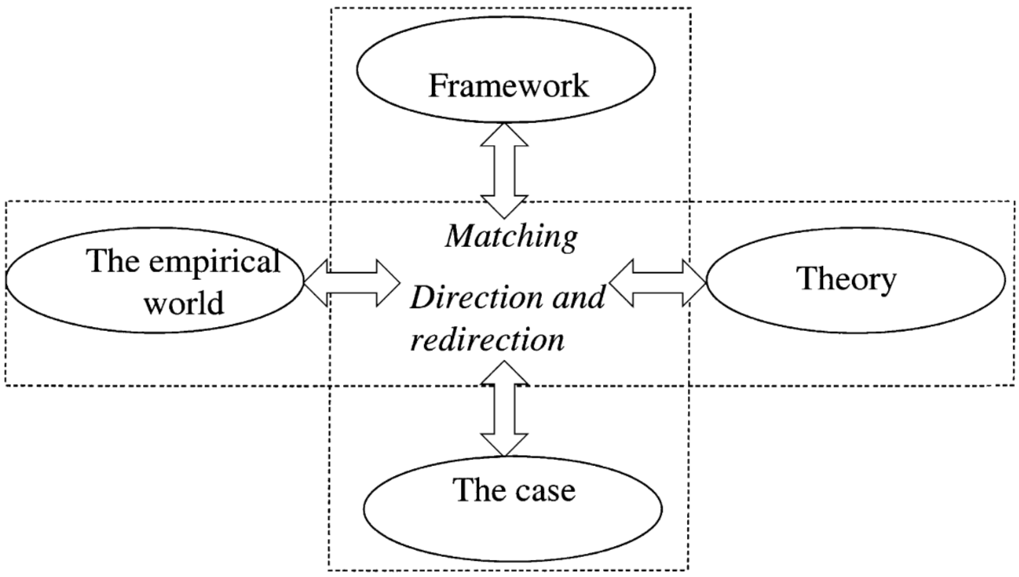


Figure 2.7: Systematic combining process of the case study and framework (Dubois and Gadde, 2002)

Case study research was defined as:

"An empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." (Yin, 2009, p.18)

The objective of this thesis is to empirically study the contemporary phenomenon of the IoT-enabled servitized business model, which is difficult to differentiate from its organisational context. The context in which the IoT-enabled servitized firms operate is genuinely complex spanning beyond the organisational boundaries. Hence, the boundaries between the phenomenon and the context are not clearly evident, adding further support to a case study methodology. Furthermore, as the emerging of IoT and servitization is still nascent, the current studies of IoT-enabled servitization adopted the case study method to enable the understanding of the rich experiences of organisations exploring rapid technological changes (cf. Hasselblatt et al., 2018; Schroeder et al., 2020) which is the focus of the thesis.

In addition, a fit of the case study research methodology is ascertained by the nature of research questions (see Section 3.6). According to Yin (2009), the research questions vary based on the type of case study: descriptive, explanatory and exploratory. Generally, the 'what' questions can either be exploratory (in which any of the research methods could be used) or descriptive (in which surveys or archival records are favoured). On the other hand, explanatory supports 'how' and 'why' questions which favour the use of case studies, experiments or history (Yin, 2009). As the author's main research question is an exploratory 'how' question, the case study research is considered to be an appropriate method to explore this research question.

Therefore, the case study method fits well with the empirical phase of the author's abductive research approach which involves empirically exploring the conceptual framework. This method allows the author to conduct an iterative process of theory matching, or stage 2 of the three-stage abductive cycle, where the empirical data are continuously emerging and the conceptual framework is iteratively refined during the data collection and analysis. Accordingly, the detail of the process for conducting case research is presented in Chapter 4 after the conceptual framework is developed as presented in Chapter 3.

2.4 Summary of the Chapter

This chapter presented the author's philosophical position as a critical realist.. Based on these arguments, the three-stage abductive research approach is adopted, suggesting two phases of research design: the development of a conceptual framework and empirical study.

The first phase is the theoretical phase which focuses on exploring and understanding the existing knowledge about the roles of IoT in enabling servitized business models, aiming to develop the conceptual framework as a guide for empirical study. The detail of the development of a conceptual framework is discussed in Chapter 3.

The second phase is the empirical phase which involves empirically testing the conceptual framework. The case study method is selected to collect the empirical data and continuously iterate the framework through theory matching. The refined conceptual framework was ultimately established as the new theory suggestions. The details of the process for conducting case study research presented in Yin (2009) are discussed in Chapter 4.

3 The Development of a Conceptual Framework

3.1 Introduction to the chapter

This chapter focuses on the development of a conceptual framework for this study. Section 3.2 introduces the theories of the firm's resources and capabilities as a competitive strategy which suggests RBV and DC view as suitable theoretical lenses for the study. This section is then followed by elaborating and presenting the theoretical model based on the discussion of the underpinning theory.

Section 3.4 presents the conceptual framework based on the SLR findings. This section discusses the different archetypes of IoT-enabled servitized business model and their associated business model characteristics as the main focus for the study.

Section 3.5 introduces how the conceptual framework is structured based on an underpinning theory, SLR and the extended literature. The research constructs including firm resources, operational capabilities, network configurations and the dynamic capabilities relating to the IoT-enabled servitized business model are operationalised to provide the detailed preconceptions for the conceptual framework.

Section 3.6 presents the conceptual framework for this study which was developed based on the underpinning theory, SLR findings and the extended literature. Finally, Section 3.8 provides the summary of the chapter.

The structure of Chapter 3 is shown in Figure 3.1.

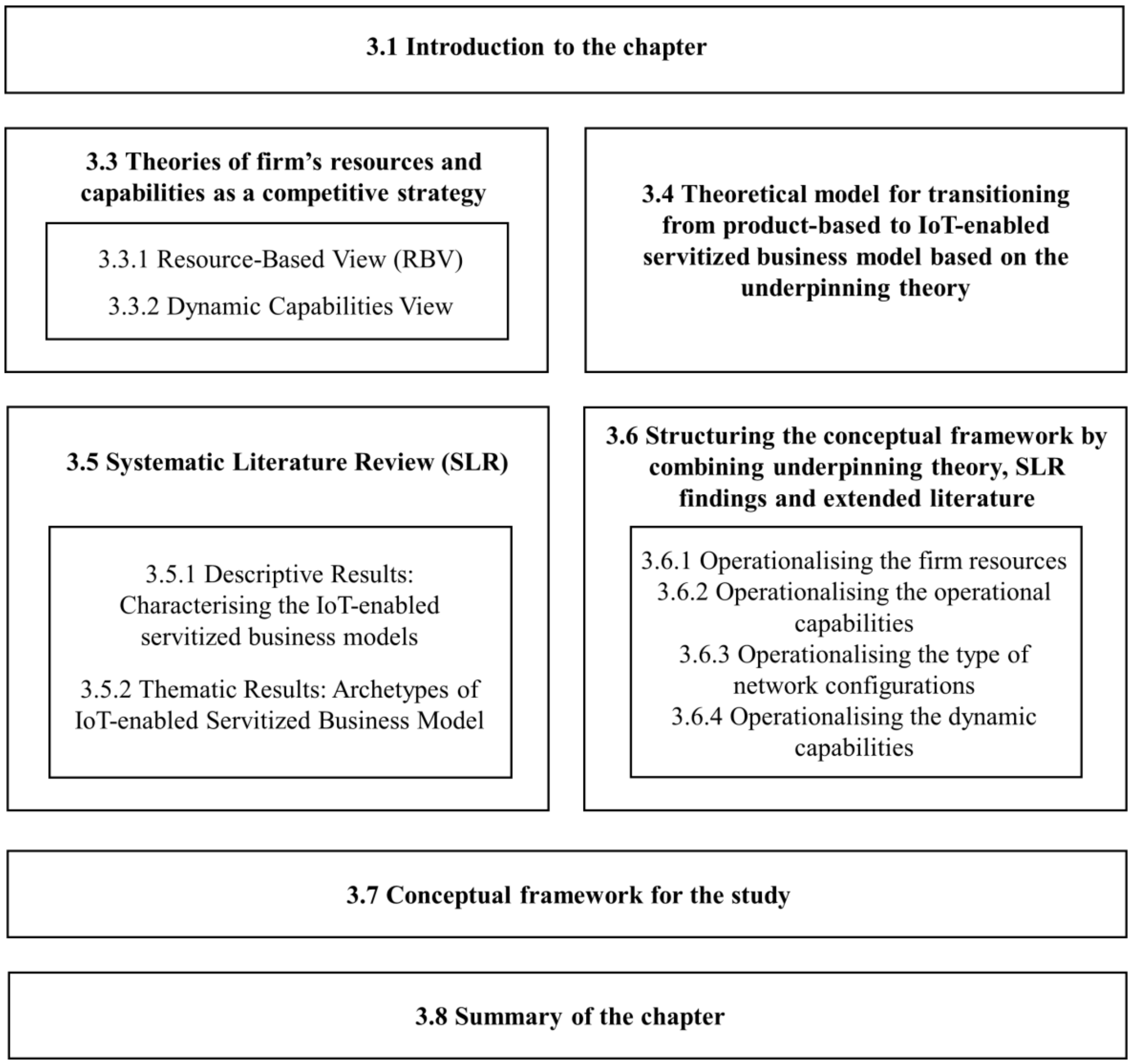


Figure 3.1: Structure of Chapter 3

3.2 Theories of the firm's resources and capabilities as a competitive strategy

In order to understand how product-based firms can make a transition from their existing business model to IoT-enabled servitized business models, requires the development of their internal resources and capabilities. Therefore, the RBV and DC view are considered as suitable theoretical lenses within the strategic management literature that supports the focus of this research. See Sections 3.2.1 and 3.2.2.

3.2.1 Resource-Based View (RBV)

RBV is a theory that helps firms to understand their competitive position in the market through analysing their internal resources or from an inside-out perspective. The concept of RBV, which is one the current crucial paradigms in strategic management research, originates from Penrose's (1959) "The Theory of the Growth of the Firm". Her work focuses on the causes of the growth of the firm, which are contributed by the endowment of certain resources managed by the firm. She suggested that there are two types of resources – physical and human. These resources are seen as a bundle of potential services. This implies that in order for firms to grow, they need to focus on particular resources which are capable of rendering their own productive purposes (i.e. profits). Her work is also supported by Wernerfelt (1984), who proposed that firms' resources can be both tangible and intangible assets, and, by analysing their resource position, firms will be able to understand how to strategically achieve their performance.

Barney (1991) extended Penrose's (1959) work by looking at strategic resources which are the sources of firm's sustained competitive advantage. He identified these resources through the lens of RBV, based on the assumptions that they are heterogeneously distributed across the competing firms and imperfectly mobile. These were categorised as physical capital, human capital and organisational capital resources, as illustrated in Table 3.1. These resources can be combined or reconfigured in order to formulate firms' unique resource portfolios. However, not all aspects of these resources are strategically relevant to the firms and hence some certain conditions should be applied and considered when identifying the strategic resources (Wernerfelt, 1984).

Table 3.1: A classification of firm resources (Barney, 1991)

Type of resource	Description
Physical	The physical technology used in a firm, a firm's plant and equipment, its geographic location and its access to raw material
Human capital	The training, experience, judgement, intelligent, relationships and insights of individuals managers and workers in a firm
Organisational capital	A firm's formal reporting structure, its formal and informal planning, controlling and coordinating systems as well as informal relations among groups within a firm and between a firm and those in its environment.

According to Barney (1991), in order to achieve a sustainable competitive advantage, firm resources must be heterogeneous and immobile with four distinct attributes. First, these resources must be valuable (V) which refers to the resources that enable firms to exploit the opportunities and neutralize the threats in the firm's environments. Second, these valuable resources must be rare (R), which means they are not possessed by large numbers of firms. Third, these resources must be imperfectly imitable (I) which means that competitors who do not own these resources cannot obtain them. Fourth, these resources must be non-substitutable (N) with other strategically relevant resources. Based on his two assumptions and the discussion on VRIN resources, the framework is established as shown in Figure 3.2.

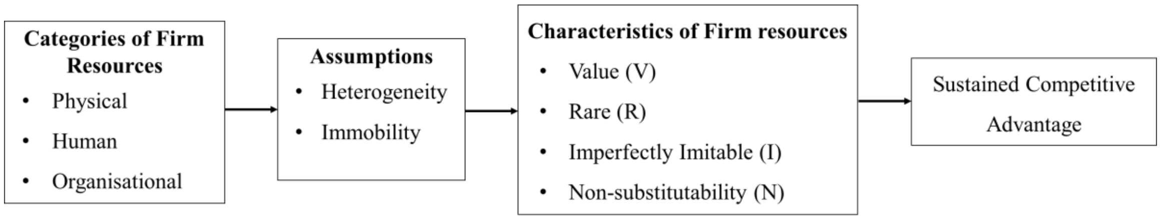


Figure 3.2: The relationship between firms' resources and sustained competitive advantage (Barney, 1991)

Barney's (1991) framework suggested that firms will achieve a sustained competitive advantage if they own resources which have VRIN attributes and those resources are heterogeneously distributed across firms and persist over time. The VRIN framework was then later evolved to VRIO framework which was published in Barney's (1995) work. The "O" characteristic refers to the organisation which explains how a firm is organised in order to exploit and capture VRI resources. However, it was argued this characteristic can be understood as the capabilities in the DC view literature (Cardeal and António, 2012) (see Section 3.2.2). Therefore, the original VRIN characteristics were adopted in this thesis to describe a bundle of unique resources in a firm.

This thesis is in line with this view regarding the need for firms to identify and obtain the resources which may possess the VRIN characteristics in order to achieve a competitive advantage when leveraging IoT in implementing a new business model. However, it is argued that these resources can only help firms to achieve competitive advantage at one point at a time but they may not show the strategic characteristics in different environments. Accordingly, the concept of dynamic capabilities was introduced as an extension of the RBV approach to analyse a firm's ability to continuously renew and reconfigure its resources in order to achieve new forms of competitive advantage (or also known as the "O" characteristics in the Barney's (1995) VRIO framework in the unpredictable and changing business environments (Eisenhardt and Martin, 2000; Teece et al., 1997). This will be discussed in Section 3.2.2.

3.2.2 Dynamic Capabilities View

3.2.2.1 Dynamic Capabilities (DC)

The concept of dynamic capabilities was first defined by Teece et al. (1997) by considering two key aspects: first is the term 'dynamic' which refers to the capacity to renew competencies to achieve the congruence of change in business environments and second is the term 'capability' which highlights the key role of strategic management in adapting, integrating and reconfiguring resources and competences to match the changing environments. Accordingly, Teece et al. (1997, p.516) defined dynamic capabilities as a "*firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments.*"

The definition of dynamic capabilities as given by different authors is summarised in Table 3.2. These definitions commonly refer to the particular organisation's ability or organisational process in manipulating the resources in order to address changes over time.

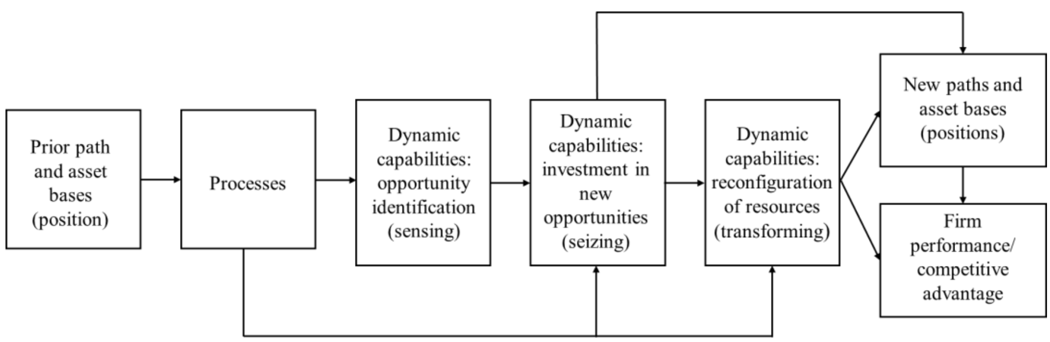
Table 3.2: The definitions of dynamic capabilities

Authors	Definition of dynamic capabilities
Teece et al. (1997)	"Firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments"
Eisenhardt and Martin (2000)	"The firm's processes that use resources, specifically the processes, to integrate, reconfigure, gain and release resources to match and even create market change. Dynamic capabilities thus are the organisational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die"
Zollo and Winter (2002)	"a learned and stable pattern of collective activity through which the organisation systematically generates and modifies its operating routines in pursuit of improved effectiveness"
Winter (2003)	"…those that operate to extend, modify or create ordinary capabilities."
Zahra et al. (2006)	"The abilities to reconfigure a firm's resources and routines in the manner envisioned and deemed appropriate by its principal decision maker(s)"
Teece (2007)	"Dynamic capabilities can be disaggregated into the capacity (a) to sense and shape opportunities and threats, (b) to seize opportunities, and (c) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets"
Wang and Ahmed (2007)	"a firm's behavioural orientation constantly to integrate, reconfigure, renew and recreate its resources and capabilities and, most importantly, upgrade and reconstruct its core capabilities in response to the changing environment to attain and sustain competitive advantage"
Helfat and Peteraf (2009)	"the capacity of an organisation to purposefully create, extend, or modify its resource base"
Pavlou and Sawy (2011)	A means for addressing turbulent environments by helping managers extend, modify, and reconfigure existing operational capabilities into new ones that better match the environment

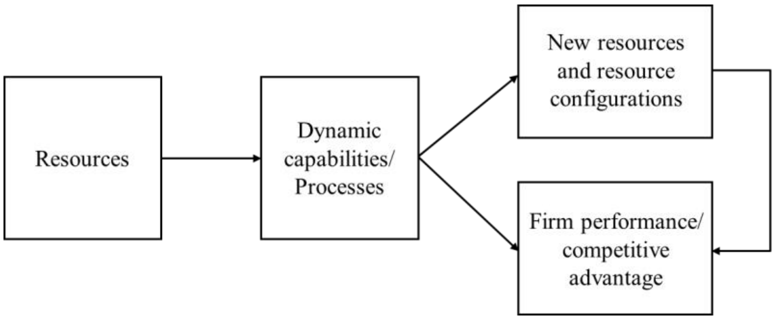
In addition to the given definition of dynamic capabilities, Teece et al. (1997) argued that firms have their own prior path (influenced by their history or previous investment) which leads to their current position. Hence, dynamic capabilities depend on the firm processes that can alter the current position which affects their performance and competitive advantage as well as leading to new paths and positions. Teece (2007) then further develops his previous work by discussing the microfoundations of dynamic capabilities which focus on three particular types of dynamic capabilities. These include sensing, seizing and transforming capabilities. *Sensing capabilities* refers to the ability to spot new markets and recognise new opportunities, based on the knowledge and learning capacities of the firms. After a new opportunity is sensed, this must be addressed through new investment in the development of new products, services or processes. Firms then need to adjust or mobilise their existing resources in order to respond to such opportunities (known as *seizing capabilities*). Subsequently, firms will be required to continuously renew their resources and periodically transform aspects of the organisation (known as *transforming capabilities*), which results in firms achieving competitive advantage or new positions.

On the other hand, Eisenhardt and Martin's (2000) work defined dynamic capabilities as the processes embedded within firms that consist of particular strategic and organisational processes such as alliancing and product development, by which the resource base is manipulated, resulting in generating new value creation strategies. Their work also discussed that even dynamic capabilities may be idiosyncratic to a firm and path-dependent in its emergence (as discussed in Teece et al.'s (1997) work); they demonstrate 'best practice' or commonalities for certain capabilities across firms. They also suggest that dynamic capabilities have a direct impact on firm performance and competitive advantage and also an indirect impact through resource configurations.

The chain of logic of dynamic capabilities based on these authors is demonstrated in Figure 3.3 (a) and (b).



(a)



(b)

Figure 3.3: The chain of logic of dynamic capabilities, basing on (a) Teece's (1997; 2007) and (b) Eisenhardt and Martin's articles (Adapted from Helfat and Peteraf, 2009)

Wang and Ahmed (2007) also looked at the perspective of both the RBV and DC view. They believe to some extent, the concept of DC is complementary to the original position of RBV. Accordingly, they argue that dynamic capabilities are not only processes but they are embedded in the process. The capabilities in their definition refer to the firm's ability to deploy resources and is commonly through a combination of both an explicit process and those tacit elements embedded in the process (e.g. learning mechanism, leadership and governance).

They also distinguished firm resources, capabilities and dynamic capabilities' hierarchical order. They tend to share the same view as other authors (e.g. Eisenhardt and Martin, 2000; Teece, 1997; 2007), regarding the resources, capabilities and dynamic capabilities. The hierarchy view of firms' resources and capabilities is summarised as shown in Table 3.3.

Table 3.3: Different levels of organisational capabilities (Wang and Ahmed, 2007)

Level	Elements	Description
Zero-order	Resources	Considered as the foundation of a firm and the basis for firm's capabilities
First-order	Capabilities	The ability to deploy resources to attain a desired goal
Second-order	Core capabilities	A bundle of a firm's resources and capabilities that is strategically important to its competitive advantage at a certain point in time
Third-order	Dynamic capabilities	A firm's constant pursuit of the renewal, reconfiguration and recreating of resources, capabilities and core capabilities to address environmental change

3.2.2.2 Hierarchy of dynamic capabilities

Many scholars also suggest that there are different levels of dynamic capabilities. Therefore, a hierarchy view of dynamic capabilities has emerged from dynamic theory.

Collis (1994) first proposed that there are distinctive levels of firms' capabilities and suggested that there are four types. The first refers to an ability that helps a firm to perform basic functional activities, known as firm resources. The second category of capabilities concerns the dynamic improvement to the firm's basic activities. The third category is closely related to the second category, but specifically, focuses on recognising the intrinsic value of other resources or developing a firm's novel strategies before competitors. Accordingly, both the second and third category of capabilities are the dynamic capabilities that help firms to extend their resource base. The fourth category is referred to as meta-capabilities and related to learning-to-learn capabilities. These are the capabilities that help to develop the capability that innovates faster or better and include the ability to respond to a significant change or to a shift between capabilities more efficiently or faster than competitors and can go *ad infinitum* (the continuous or infinite improvement of the capabilities).

Danneels (2002) proposed two main types of capability: first-order and second-order capabilities. First-order capabilities involve the development of a resource base to produce certain products or address a particular group of customers while second-order capabilities refer to the competence required to acquire first-order capabilities. Daneels's (2002) first-order capabilities mainly focus on the competences which help firms to serve a certain market and directly earn a living. His second-order capabilities refer to the dynamic capabilities which help a firm to renew itself through enabling the creation of new resources or renewing their first-order capabilities. However, the issue regarding how the dynamic capabilities themselves might be renewed or changed was not considered in his work.

Winter (2003) also progressed his idea of the hierarchy of capability from Collis's (1994) and Danneels's (2002) work. He started with operational capabilities which he described as zero-level capabilities (also referred to as a resource base). These allow firms to earn a living or stay in the market in the short-term. He then described first-order capabilities as the ability to change or modify the zero-order capability. Finally, he identified higher-order capabilities as the result of organisational learning which allowed a firm to create or modify its dynamic capabilities.

Zahra et al. (2006) also presented their view of the hierarchy of capability. They referred to Winter's (2003) zero-level capabilities as substantive capabilities or ordinary capabilities which are the set of resources and activities that help firms to solve problems or achieve the desired outcome. They differentiate substantive capabilities from dynamic capabilities, which are referred to as the higher-order ability to change or renew their existing substantive capabilities.

By extending these concepts of the hierarchy view of dynamic capabilities from previous scholars, Ambrosini et al. (2009) proposed three levels of dynamic capabilities. These were built upon Eisenhardt and Martin's (2000) argument that dynamic capabilities can also be presented in a stable environment which is simple and iterative. Accordingly, Ambrosini et al. (2009) introduced three types of dynamic capabilities based on the dynamism of the firm's environment as perceived by the managers of a firm, as shown in Figure 3.4.

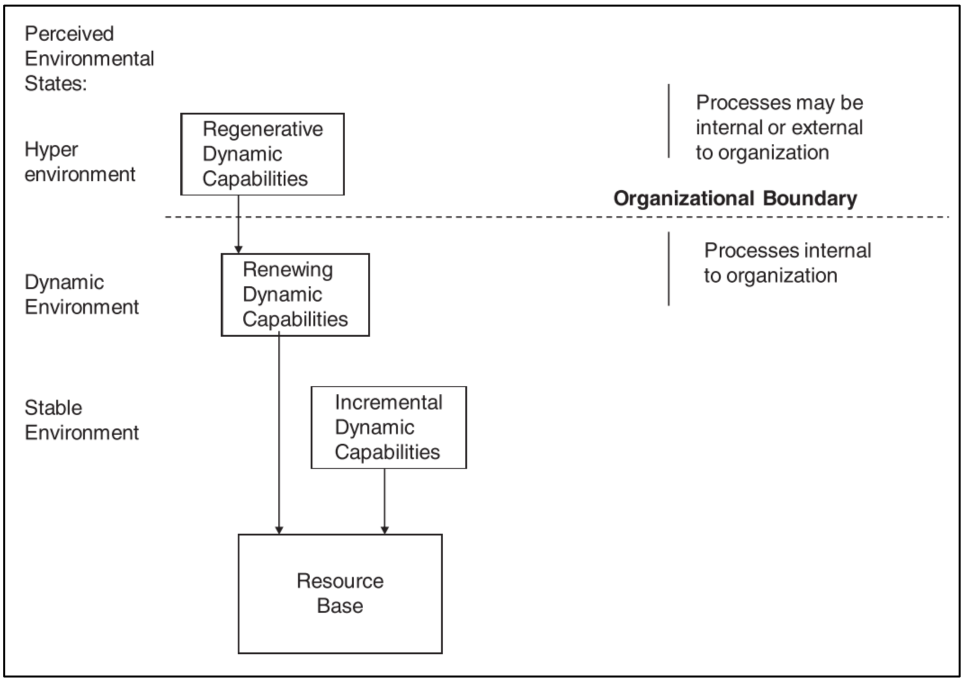


Figure 3.4: Three levels of dynamic capabilities (Ambrosini et al., 2009)

First is *incremental dynamic capabilities* which refer to the adjustment of a firm's current resource base when a stable environment is perceived. However, the rate of change will be relatively slow and the resource base would only be incrementally adjusted and adapted but not transformed. Therefore, it is suggested that even in a stable environment, it is important to have a process of continuous improvement in order to maintain the value of the current resource base.

Second is *renewing dynamic capabilities* which are commonly defined in dynamic capabilities literature. It refers to the ability to refresh and renew the resource base in the dynamic environment. This is because when the firm's environment shifts, the VRIN resource that used to help firms to achieve a competitive advantage can become disadvantages if there are no attempts to refresh or modify the existing resource base. Hence, these dynamic capabilities do not only undergo incremental change or small adjustments in the resource base but also the modification or extension in such a way that new resources are introduced or created, or resources are combined in new ways. This is to continuously achieve a competitive advantage.

Third is *regenerative dynamic capabilities* which refer to the capabilities that allow a firm to develop a new set of capabilities to act upon the current set of dynamic capabilities when they are not sufficient to adapt in the turbulent environment. These dynamic capabilities are applied based on managerial perception and the understanding of the substantial dynamism in a firm's current environment. Hence, firms need to change the way they renew or modify the current resource base.

Table 3.4 illustrates the three types of dynamic capabilities discussed by Ambrosini et al. (2009) in comparison with different views of the hierarchy of dynamic capabilities, indicated by various authors.

Table 3.4: The comparison typologies of the hierarchy of dynamic capabilities adopted by different scholars (adapted from Ambrosini et al., 2009)

Hierarchy of Capabilities	**Level/ Environmental state**	**Collis (1994)**	**Danneels (2002)**	**Winter (2003)**	**Zahra et al. (2006)**	**Ambrosini et al. (2009)**
Operational capabilities (Resource base)	1 Baseline	First category of capabilities	First-order capabilities	Zero-order capability/ Operating routine	Substantive capabilities	Resource base
Lower level dynamic capabilities	2 Stable environment	Second category of capabilities	Second-order capabilities	First-order capabilities	Dynamic capabilities	Incremental dynamic capabilities
	3 Dynamic environment	Third category of capabilities				Renewing dynamic capabilities
Higher level dynamic capabilities	4 Hyper dynamic environment	Meta-capabilities		Higher-order capabilities		Regenerative dynamic capabilities

To sum up, the hierarchical view of dynamic capabilities was principally adopted from RBV and the dynamic theory while considering the four main different states of the perceived business environments. At a baseline level, firms are required to have the ability to operate normal routines, in order to ‘earn a living’ which is also known as operational capabilities. For example, firms may need to acquire a certain resource base to develop particular products and generate revenues from the addressed market. In a stable environment (indicated by the slow rate of change), firms may be required to do small adjustments to their existing resource base while in a dynamic environment, firms may be required to act more than with small adjustments, by renewing or refreshing their resource base in response to such a business environment. These abilities of a firm are commonly referred to dynamic capabilities in the literature (Ambrosini et al., 2009; Winter, 2003; Zahra et al., 2006). In a rapidly changing business environment (also known as a hyper dynamic environment) firms may acquire higher-order capabilities which help them to modify or renew their current dynamic capabilities in order to move towards new ones that are more suitable to the new environment.

3.3 Theoretical model for transitioning from product-based to IoT-enabled servitized business model based on the underpinning theory

Based on the previous discussion on dynamic capabilities, the dynamic capability view aligns with the the devepment of new products and services, resulting from the new bundle of firm resources. Dynamic capabilities reconfigure their existing resource base to allow firm to develop new products and services within the evolving market environments.

By defining the dynamic capabilities as the firm’s ability to renew and reconfigure their resources and operational capabilities, it implies that the dynamic capabilities helps firms to upgrade their existing products and services to the next level. The hierarchical view of dynamic capabilities emphasises the need for incremental dynamic capabilities in a stable environment or renewing dynamic capabilities in a dynamic environment. Therefore, in the stable environment, the firm’s resource base and operational capabilities stills need to be incrementally improved. On the other hands, in the dynamic environment, renewing dynamic capabilities support firms to renew their resource base and operational capabilities to upgrade product and service offerings. For the purpose of this thesis, by linking the concepts of the RBV, dynamic theory and the hierarchy view of dynamic capabilities, the theoretical framework based on underpinning theory can be illustrated, as shown in Table 3.5.

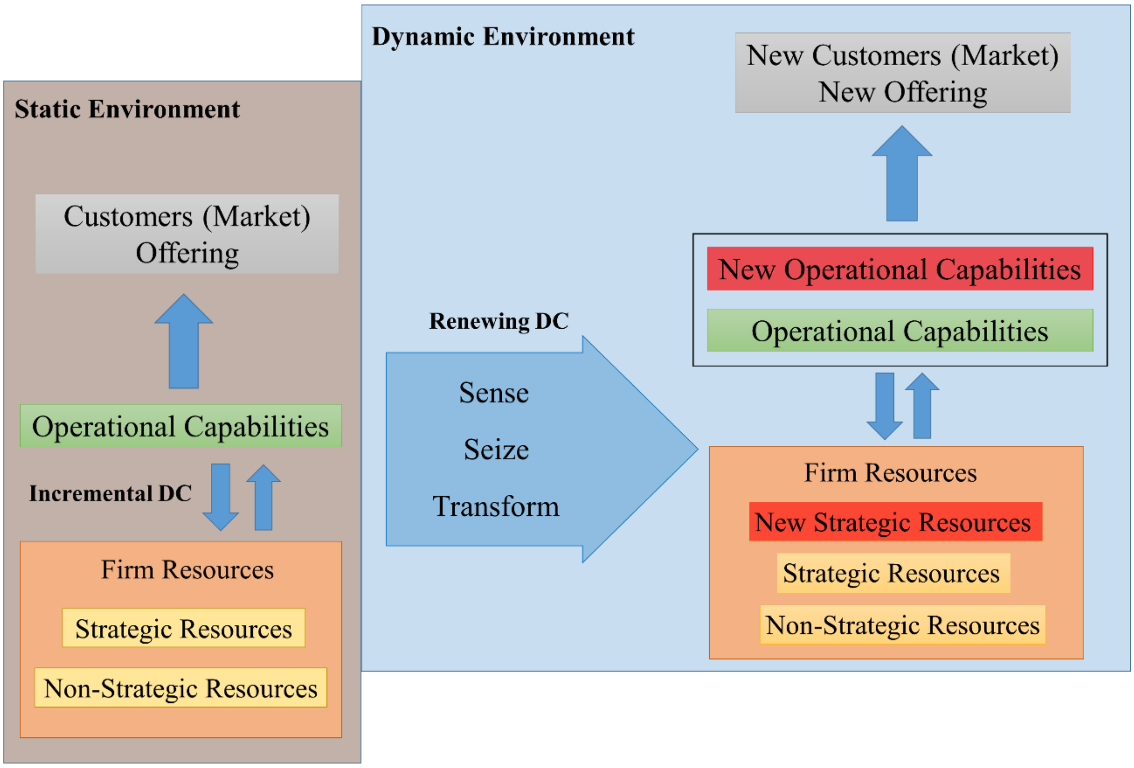


Figure 3.5: Theoretical model based on underpinning theory

At the beginning, firms will upgrade the products and services within the same market by using their incremental dynamic capabilities. This means incremental dynamic capabilities help firm to do a small improvement on their existing resource base and operational capabilities, resulting in the enhancement of the operational capabilities which improves the existing offering to continuously satisfy current market needs.

When the business environment is dynamic, and the market needs are evolved to the new market needs, then current offering will usually be upgraded to the new offering. Accordingly, a new set of operational capabilities will be required to respond to such needs in the evolving market. In order to develop new operational capabilities, to upgrade the current offering, firm has to transform its resource base to create new strategic resources that will develop new operational capabilities, by using renewing dynamic capabilities.

These renewing dynamic capabilities have been supported by Teece's (2007) microfoundations of dynamic capabilities where the firm needs to follow three dimensions of dynamic capabilities, i.e. the ability to sense new opportunities, the ability to invest new resources to address the new opportunity (seizing capability) and the ability to mobilise and reconfigure those resources (transforming capabilities), in order to respond to the seized opportunities, resulting in an upgrade to a new firm's position, as discussed in Section 3.2.2. In addition, it has been highlighted that the dynamic capabilities are path-dependent, which involves protecting their existing resource base while the capabilities are being reconfigured. Hence, the current firm resources and operational capabilities that are advanteous to offer the current offerings still exist after the upgradation process to offer new offerings. By considering the context of the research in this thesis, traditionally, the product-based firms mainly focus on new product development and selling products to customers. In a stable environment, the product-based firms may incrementally adjust their existing resources in order to improve the product offerings or extend the functions of the products to meet the demand within the same markets. However, in the dynamic environment, when the customer needs to evolve and the technology disrupts this (in this thesis, an emerging IoT technology is focused on), the customer tends to demand the integration of service and product or customised solutions rather than purely owning products. This process of transition is known as servitization. Product-based firms need to be able to respond to such an evolving market demand by transitioning to IoT-enabled servitized firms. Accordingly, dynamic capabilities as well as the firm resources and operational capabilities serve as the enablers for product-based firms to transition to an IoT-enabled servitized business model.

In order to further conceptualise the emerging concept of IoT and servitized business models, an SLR is conducted.

3.4 Systematic Literature Review (SLR) findings

As discussed in Section 2.3.1.2, the process of conducting an SLR comprises five steps: question formulation, locating studies, study selection and evaluation, analysis and synthesis, and reporting using the results. Since a journal article based on SLR processes and its findings has been published (see Appendix G), this section will briefly explain the descriptive findings and thematic findings related to this research.

3.4.1 Descriptive Results: Characterising the IoT-enabled servitization literature

The resultant 74 publications covered the time range from 1999 to 2018, as the term 'the Internet of Things' was first coined in 1999, and these were descriptively analysed. As illustrated in Figure 3.6, only six studies on the emerging concept of IoT and servitized business models are published between 1999 and 2013 and this gradually increased to 68 papers from 2014 onward, contributing to 90% of the total number of papers. The peak was reached in 2016 and with a minor decline in the following years. However, it can be expected that as more practical cases from industry are reported, the number of publications will continue to increase in the coming years. This is also reflected in the reduction in conceptual studies and a large increase in the number of case studies in 2018.

In these conceptual studies, which contribute to 38% of the total, the authors have mainly focused on discussing the concept of IoT based on the existing literature and reported practical case examples to support their argument. This has changed in favour of case studies in 2018, making up 38% of the total over the whole period. This illustrates that tentative theory development based on empirical studies has increasingly become more common in terms of research methods used. However, quantitative studies are still lacking, which could be because existing knowledge about this emerging concept is still at its exploratory stage. The number of papers using quantitative methods is expected to increase in upcoming years once the knowledge and theory have been maturely established from empirical studies, in order to aid theory validation and generalisation.

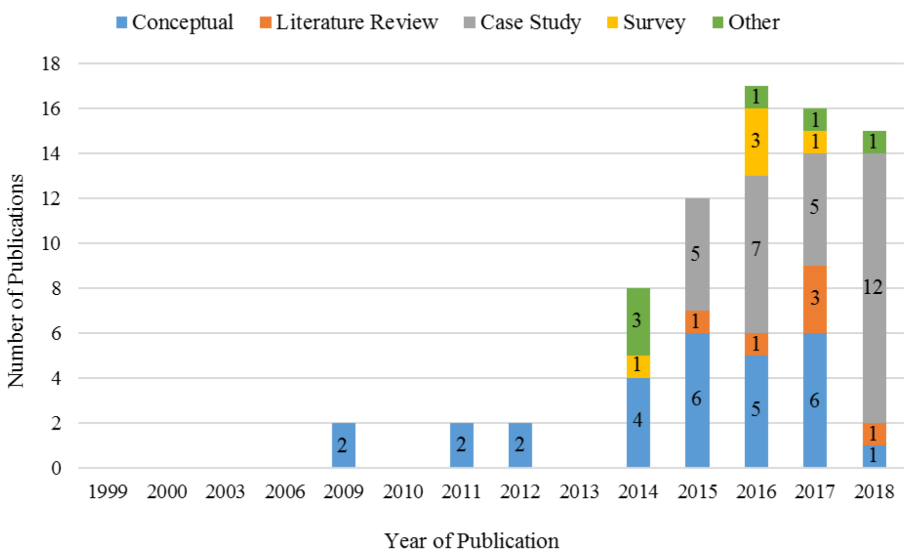


Figure 3.6: Analysis of papers according to publications across the years and research methodology (Suppatvech et al., 2019)

With respect to geographical location, the scholars over five continents, i.e. Europe, the Americas, Asia and Australia illustrated an interest in IoT-enabled servitized business models. The contributions predominantly came from European countries, which account for 74% of the total number of papers, demonstrating a strong interest in the topic in Europe. The US accounts for the fourth largest contribution of papers at 8%. The rationale behind this could be because IoT has been mostly recognised by firms in developed countries in terms of its substantial benefits in extending their service business to increase profitability and business growth in responding to Industry 4.0. Consequently, this has encouraged local scholars to initiate research on this topic. The contribution of other countries, including Australia, Canada and China, only accounts for 8% of the total number of papers.

It is also essential to explore which industry sectors have contributed to the body of knowledge on IoT-enabled servitized business models. The findings indicate that the study of leveraging IoT in the concept of servitization is predominantly discussed in the context of manufacturing/machinery (34%) and consumer goods (28%). This shows that the application of IoT in enabling servitized business models is within the context of both B2B and B2C.

3.4.2 Thematic Results: Archetypes of IoT-enabled Servitized Business Model

Through an analysis of 74 publications thematically, four main archetypes of IoT-enabled servitized business model are classified, i.e. add-on, sharing, usage-based and solution-oriented business models. The operational and strategic roles of IoT, inhibiting factors and benefits were also identified, with their respective business models. The summary of relationships between the IoT-enabled servitized business models, as synthesised from the literature, is illustrated in Figure 3.7.

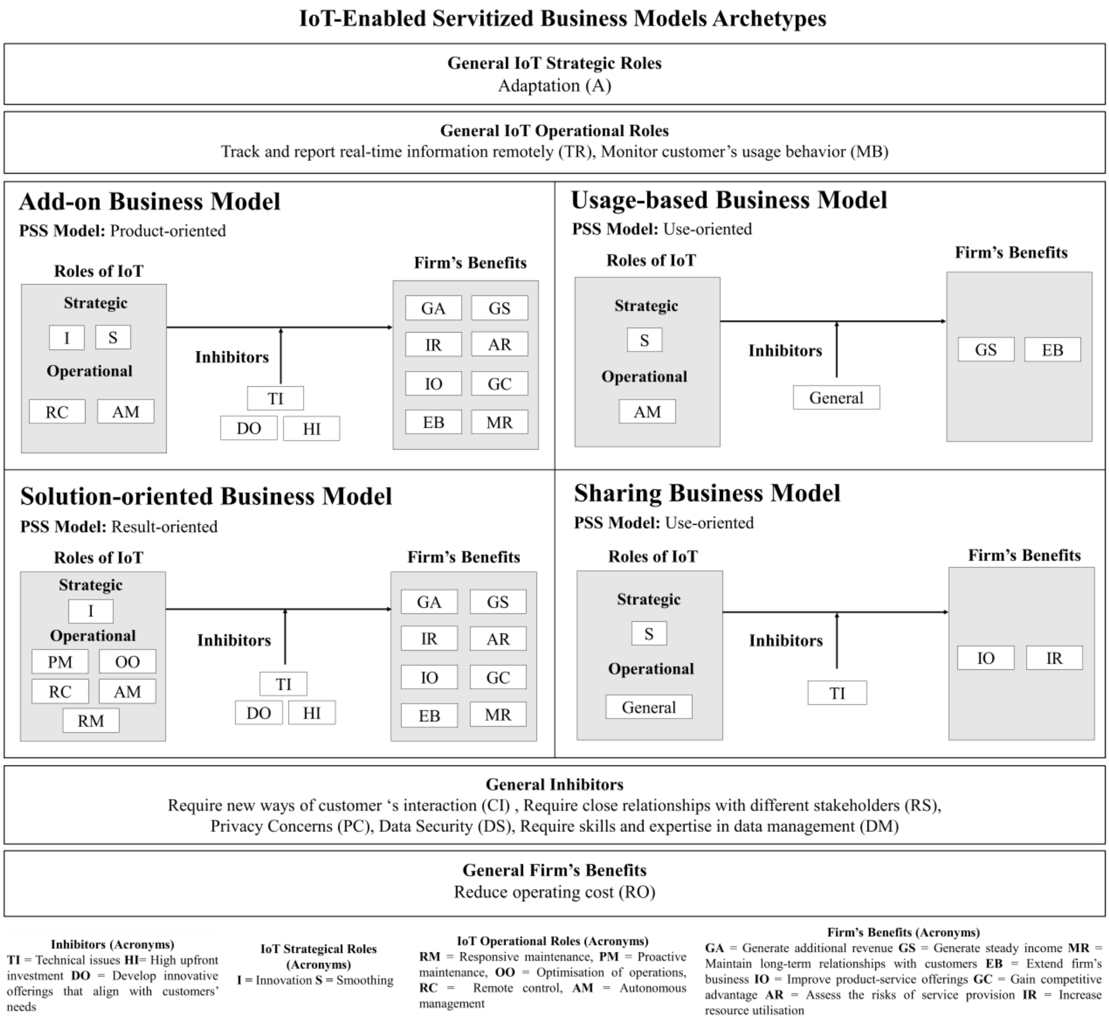


Figure 3.7: Archetypes of IoT-enabled servitized business model (Suppatvech et al., 2019)

In the light of this thesis, the main characteristics of different archetypes of IoT-enabled servitized business model as a result of conducting the SLR were focused on. These main characteristics include the type of business model with regard to Tukker's (2004) classification, the value proposition (refers to what customers value, as discussed in Baines et al.'s (2009a) work), the customer relationship (refers to the type of relationship a firm has with its customers or the way of interaction with customers (Schön, 2012)), pricing (how firms apply an appropriate pricing logic to the offerings (Schön, 2012)) and order winning criteria (refers to the characteristics of the offering that help firms to win customers' purchases, as highlighted by Hill (2000)). The details of these will be further discussed, regarding each archetype of IoT-enabled servitized business model in the following sections.

3.4.2.1 Add-on business model

Add-on business model refers to the business model that leverages IoT in enabling additional functions or adding personalised services to the existing physical products or service. This can be considered as corresponding to product-oriented business models in the traditional servitization categorisation, where firms offer services that are added to a physical product to support its function (Tukker, 2004). The findings of the SLR show that with the adoption of IoT, product-based firms will be able to offer additional services, within the context of both B2C and B2B.

The example of a B2B case study is Geis Group, a logistic service provider to the automotive industry (Leminen et al., 2012). The company leverages IoT to help facilitate existing product-related or service provision to increase efficiency and/or decrease overall complexity in delivering services. Specifically, Geis Group utilises IoT to smooth the process of their customers' orders by allowing the customers to track their products remotely.

Summarising, add-on business models are defined by the provider offering digital services in addition to the utility of existing physical goods or services, which are enabled by IoT. This business model aligns with the product-oriented service provider indicated in Kohtamäki's et al. (2019) study which is conceptualised as one of the digital servitization business models. In this definition, this business model reflects the use of digital technologies (e.g. the remote diagnostics, IoT technology) depending on the firm's technology strategy to provide add-on services (i.e. smart features or functionalities). This helps product-based firms to escape from the commoditisation trap through improving the sale of products by offering new digital services. Accordingly, this can be described as a product-oriented servitized business model, according to Tukker (2004). The main value proposition is to own the product with the digital service. The relationship between the provider and customer is transactional as customers need to purchase the main physical good to access the additional service. In some cases, customers pay a premium to access the IoT-enabled service. The OW criteria are features of the product and the delivery of products with the digital service experience. A summarised table of the main characteristics of the add-on business model is illustrated in Table 3.5.

Table 3.5: The main characteristics of the add-on business model

Main characteristics of the business model	Add-on business model
Type of Business model	Servitized business model: Product-oriented
Value proposition	Ownership of the products with digital service as an add-on
Customer relationship	Transactional
Pricing	Customer pays the normal product price or a premium price to obtain service as a complementarity
Order winning criteria	Feature of products
	Delivers products with a digital service experience

3.4.2.2 Sharing business model

Sharing business model refers to the business model that allows the customers to pay for using or accessing a product for a limited amount of time. Subsequently, this product can continue to be used by different users when it is available. This corresponds to a type of use-oriented business model according to Tukker's (2004) servitization classification. From the provider's perspective, this increases asset utilisation, but they need to take responsibility for ensuring sufficient products are available for the customers to access. Since the ownership of the physical products, providing utility to the customer, remains with the provider and users change, this business model is conceptually close to renting. However, Alfian et al. (2014) and Firnkorn and Müller (2012) argue that a sharing business model generates more frequent changes of ownership and shorter use periods than their traditional renting counterparts. For example, when comparing traditional car renting and car-sharing concepts, this is achieved by allowing the vehicles to be cycled among customers without being returned to the provider or the original point after each use, precluding the need for booking requirements, and by enabling more accurate use and payment by utilising mobile applications and technology to track product use. According to the current literature, a sharing business model, featuring IoT technology is currently only reported in the B2C context, although this business model has the potential to be transferred to the B2B context.

A case example of a sharing business model is Car2Go, an innovative car-sharing scheme that, in comparison to traditional car renting, features shorter and previously unspecified use times. Instead of collecting it from the store, the customer will be able to access the car at the nearest available public parking point (Leminen et al., 2012; Rong et al., 2015). Car2Go embeds IoT technology in their vehicles to allow customers to locate the nearest available car, unlock and drive it from that point via mobile app. Customers can then return the car to the nearest car park after use, allowing different customers to continue using the available car.

To sum up, the sharing business model involves integrating services to the physical product, and therefore it represents the use-oriented servitized business model according to Tukker's (2004) classification as customers pay to access the product. The main value proposition is to deliver the accessibility of the product. In terms of the customer relationship with the firm, it is still transactional but the same customers tend to return to the service more frequently. As the IoT helps to monitor the product usage more accurately, so the common pricing logic is pay-per-use. As the provider focuses on providing the accessibility of the product, the OW criteria will be the ease of access and the capacity to deliver service, ensuring the customer's demand are met. The summarised table of the main characteristics of a sharing business model is illustrated in Table 3.6

Table 3.6: The main characteristics of the sharing business model

Main Characteristics of the business model	Sharing Business Model
Type of Business model	Servitized business model: Use-oriented
Value proposition	Deliver the accessibility of product
Customer relationship	Transactional
Pricing	Pay-per-use
Order winning criteria	Ease of product accessibility
	Capacity to deliver service

3.4.2.3 Usage-based business model

Usage-based business model refers to the use of IoT to measure the amount of product usage and allow customers to pay for, or subscribe to, the plan, based on their actual usage and needs. The provider has the responsibility to deliver expected utility in use. This can be considered as a use-oriented model in a traditional servitized business model as the provider guarantees unlimited access to the service for the customer until the end of the subscription (Tukker, 2004). Within this, business can be applied in the context of both B2C and B2B.

The case study of the B2C context is the instant ink offered by Hewlett-Packard (HP), the printer manufacturer, which is discussed by Gerpott and May (2016). Instant ink is the ink automatic replenishment service, where HP monitors the ink level remotely through their IoT-embedded printers. HP is then signalled from their connected printers when the ink runs low and automatically ships the ink to their customers, which also allows the return and recycling of used ink cartridges afterwards. The customers can subscribe to the plan based on the number of pages printed regardless of the amount of ink they use.

In the B2B context, Bucherer and Uckelmann (2011) report a case study of an information service provider, who offers information services on verification and detection of counterfeit spare parts in the machinery and equipment industry. After purchasing this service through a monthly subscription, customers may remotely access a database containing aggregated information from a variety of sources. This database allows the customer to verify the authenticity of a product via serial numbers. Accordingly, the customer is charged for unlimited access to the product or service, restricted to the time span of a subscription. Customers will need to pay a fee for being able to access the product or service.

To conclude, the usage-based business model involves guaranteeing customers access to IoT-enabled services, which represents the use-oriented servitized business model according to Tukker's (2004) classification. The main value proposition is to deliver availability and the outcome of the product during the period of subscription. The customer relationship with the provider is a mix of transactional and relationship-based as the IoT enables the provider to closely monitor their customer's product usage while the customer can cancel the services any time after the end of the subscription. The common pricing logic of this business model is a subscription based on actual product usage. The OW criterion is the availability of products or services. The summarised table of the main characteristics of the usage-based business model is illustrated in Table 3.7.

Table 3.7: The main characteristics of the usage-based business model

Main Characteristics of the business model	Usage-based business model
Type of Business model	Servitized business model: Use-oriented
Value proposition	Deliver availability
	Deliver the outcomes of products
Customer relationship	Transactional and relationship-based
Pricing	Subscription-based on a pay-per-use basis
Order winning criteria	Availability of products or services

3.4.2.4 Solution-oriented business model

The solution-oriented business model refers to business models that utilise IoT in enabling the provision of solutions to customers. With the aid of IoT technology, providers are able to offer integrated solutions which are tailored to match individual customer needs. In B2B practice, these integrated solutions are related to supporting customers' core operations and increases in efficiency, and expanding business capabilities (Kralewski, 2016; Noventum, 2016). Accordingly, this business model corresponds to the result-oriented servitized business model, where firms make agreements with their customers in order to deliver a specified outcome or result (Tukker, 2004). Currently, the existing literature indicates that solution-oriented business models in the context of IoT are only available in the B2B context.

An example of a solution-oriented business model is discussed in a study by Rymaszewska et al. (2017). They look at a provider of sheet metal machinery in Finland that originally focused on designing and selling complex machines prior to transitioning to product-service offerings with the adoption of IoT technology. By leveraging IoT, the provider remotely monitors the actual daily performance of connected machines at customers' sites and understands the pattern of their operations. This allows firms to offer long-term contracts through the provision of remote support and optimisation of their customers' production schedules. This means that the provider is responsible for the installation and scheduled maintenance, and helping customers optimise their production and increase asset utilisation, resulting in the reduction of operating costs. Thus, instead of purchasing ownership of the machine, customers pay for the integrated solution to a business function through long-term contracts.

Summarising, the solution-oriented business model involves the service providers utilising IoT in monitoring the current usage of the product and analysing the pattern of operations. This helps the providers to offers solutions and/or advice to the customer's core business operations. Accordingly, this is considered as corresponding to Tukker's (2004) result-oriented classification. The main value proposition for this business model is to deliver specified product performance and solutions tailored to individual customer needs. The provider tends to establish a long-term relationship with its customers through a long-term contract. The OW criterion is the performance of the products and customised solutions. A summarised table of the main characteristics of the solution-oriented business model is illustrated in Table 3.8.

Table 3.8: The main characteristics of the solution-oriented business model

Main Characteristics of the business model	Solution-oriented Business Model
Type of Business model	Servitized business model: Result-oriented
Value proposition	Deliver specified performance of the products
	Deliver solutions for individual needs
Customer relationship	Long-term relationship
Pricing	Customers pay for the performance of the product based on mutual agreements
Order winning criteria	Performance of products
	Customised solutions

A summary of types of the IoT-enabled business model and corresponding business context, PSS and pricing mechanism is illustrated in Table 3.9.

Table 3.9: Types of IoT-enabled business model and corresponding business context, PSS and pricing mechanism (Suppatvech et al., 2019)

IoT-enabled Servitized business model	Business Context	PSS	Pricing Mechanism	References
Add-on	B2C/B2B	Product-oriented	Transactional	Bohli et al. (2009), Haller et al. (2009), Mejtoft (2011), Leminen et al. (2012), Fleisch et al. (2014), Harvard Business Review Analytic Services (2014), Turber and Smiela (2014), Andersson and Mattsson (2015), Atzori et al. (2015), Dijkman et al. (2015), Keskin and Kennedy (2015), Lee and Lee (2015), Mikusz (2015), Rong et al. (2015), Wünderlich et al. (2015), Balaji and Roy (2016), Dominici et al. (2016), Gerpott and May (2016), Hagberg et al. (2016), Hartmann and Halecker (2016), Kralewski (2016), Parry et al. (2016), Sassanelli et al. (2016), Scholze et al. (2016), Shih et al. (2016), Takenaka et al. (2016), Vendrell-Herrero et al. (2016), Zheng et al. (2016), Green et al. (2017), Klein et al. (2017), Mikusz et al. (2017), Ng and Wakenshaw (2017), Risteska Stojkoska and Trivodaliev (2017), Saarikko et al. (2017), Woodside and Sood (2017), Ibarra et al. (2018), Ikävalko et al. (2018), Leminen et al. (2018), Mittag et al. (2018), Pei Breivold and Rizvanovic (2018), Zheng et al. (2018)
Sharing	B2C	Use-oriented	Pay-per-use	Bucherer and Uckelmann (2011), Harvard Business Review Analytic Service (2014), Schenkl et al. (2014), Rong et al. (2015), Wünderlich et al. (2015), Ardolino et al. (2016), Carpanen et al. (2016), Dominici et al. (2016), Gerpott and May (2016), Nishino et al. (2017), Ardolino et al. (2018)
Usage-based	B2C/B2B	Use-oriented	Pay-per-use/ subscription	Bucherer and Uckelmann (2011), Fleisch et al. (2014), Gerpott and May (2016), Kralewski (2016), Zancul et al. (2016), Gebauer et al. (2017), Ardolino et al. (2018), Bressanelli et al. (2018), Heinis et al. (2018), Mittag et al. (2018)
Solution-oriented	B2B	Result-oriented	Performance-based contract	Bucherer and Uckelmann (2011), Fleisch et al. (2014), Lee et al. (2014), Paluch (2014), Herterich et al. (2015a), Herterich et al. (2015b), Porter and Heppelmann (2015), Tuunanen et al. (2015), Wünderlich et al. (2015), Ardolino et al. (2016), Kralewski (2016), Scholze et al. (2016), Takenaka et al. (2016), Zancul et al. (2016), Zheng et al. (2016), Gierej (2017), Helo et al. (2017), Kiel et al. (2017), March and Scudder (2017), Rymaszewska et al. (2017), Wiesner et al. (2017), Ardolino et al. (2018), Cedeño et al. (2018), Hasselblatt et al. (2018), Kaňovská and Tomášková (2018), Metallo et al. (2018), Mittag et al. (2018), Rachinger et al. (2018), Sayar and Er (2018)

3.5 Structuring the conceptual framework by combining underpinning theory, SLR findings and extended literature

This section discusses the combination of underpinning theories, SLR results and extended literature in order to structure the conceptual framework for the study. In order to understand how the firm's resources and capabilities, as discussed in the RBV and DC view, can be aligned with different types of IoT-enabled servitized business models found in SLR, the business alignment framework discussed by Godsell et al. (2010) is considered Figure 3.8. This framework suggested that in order to achieve the strategic alignment in the competitive and dynamic environment, firms must focus on creating customer value and make a strategic response to the market (product strategy). Accordingly, the detailed design of the organisation strategy including infrastructure and operating model as well as supply chain strategy should be focused.

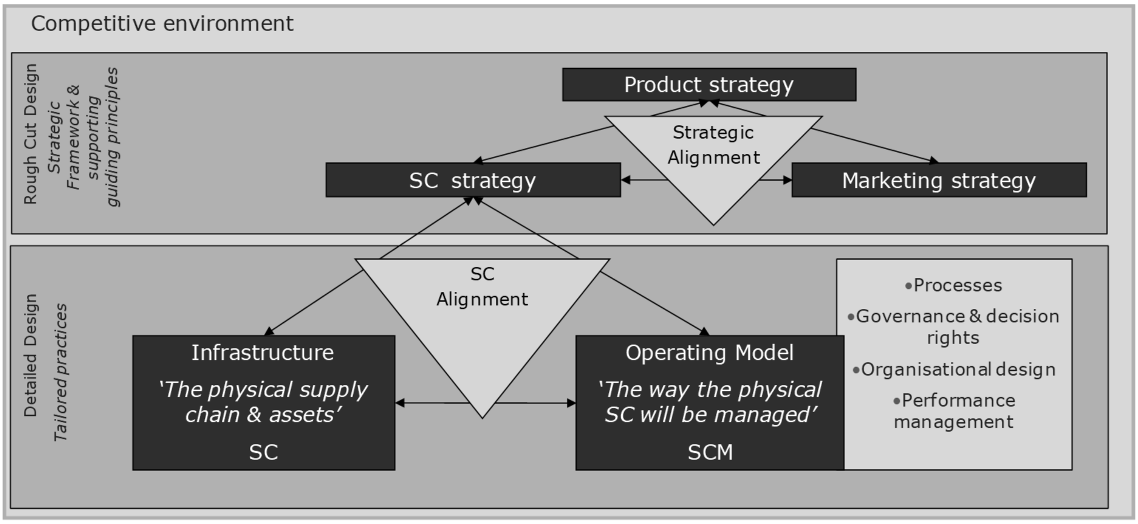


Figure 3.8: Business alignment (Godsell et al., 2010)

Godsell et al. (2010) described the SC infrastructure as the physical assets required by firms in order to deliver certain products or services. These assets correspond to the firm's resources, which were discussed in RBV theory. In addition, these assets need to be managed by an operating model which is also in line with the operational capabilities or the lower-level capabilities as described in the DC view theory. In addition, the view of SC strategy, describing the firms' interdependencies and the firm's position within the value chain or network has to support the firm's assets and operating model.

By considering the context of this thesis, the strategic alignment of the corresponding research the constructs can be mapped into Godsell's et al. (2010) framework as illustrated in Figure 3.9. The framework suggested that the underlying organisational capabilities including firm resources (infrastructure) and operational capabilities (operating model) as well as the network configurations (SC strategy) need to be aligned with IoT-enabled servitized business models (product strategy). In addition, the particular capabilities that help product-based firm to transition to IoT-enabled servitized business model are needed to be considered as one of the research constructs. These capabilities can be referred to as the dynamic capabilities with three dimensions (sense, seize and transform) in the DC view theory, according to Teece (2010).

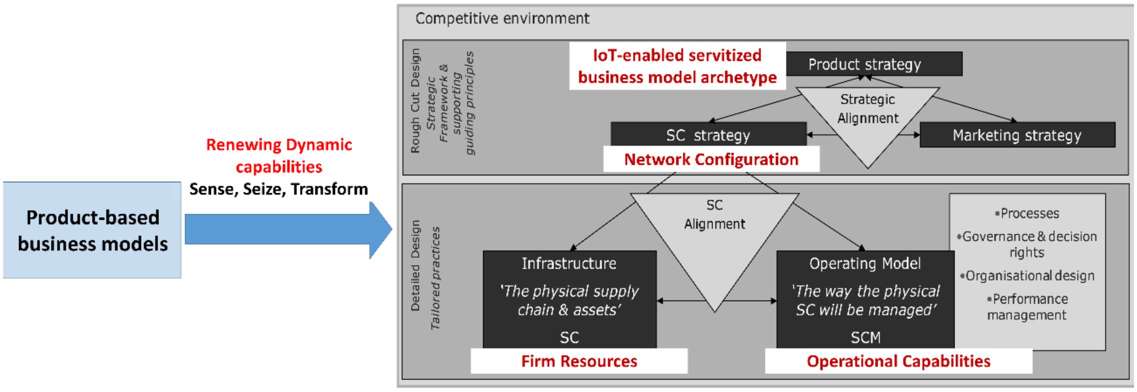


Figure 3.9: The strategic alignment of the research constructs in the context of this thesis

Accordingly, based on the illustration of Figure 3.9 it showed that in order to structure the conceptual framework, regarding how product-based firms transition to an IoT-enabled servitized business model, the operationalisations of the firm's resources, operational capabilities, network configurations how these are aligned with each type of IoT-enabled servitized business model, found in the SLR, need to be considered. In addition, the dynamic capabilities have to be operationalised based on the extended literature related to IoT-enabled servitization to form the conceptual framework. The following sections will focus on how the firm's resources, operational capabilities, the view of network configurations and dynamic capabilities are operationalised with the support of extended literature related to each archetype in order to provide the detailed "preconceptions" and guiding principles for the framework. As a result, the conceptual framework is ultimately be established to serve as guide for empirical study in this research.

3.5.1 Operationalising the firm resources

As this thesis is underpinned by the RBV theory, the firms resources related to the context of IoT-enabled servitized business model have to be focused in order to operationalise the firm resources. Slack and Lewis (2015) identified the firm's operational resources, including different types of assets, information, people and technology, that are considered as appropriate to help firms fulfil their objectives. Baines et al. (2009a) suggested that these firms' main resources include the facilities, human resources, and process and technology, which is also supported by the work of Hill (2000) and Slack and Lewis (2015). In addition, the ownership of these resources will be investigated in terms of what is produced or done by firms and what is produced or done by their external partners. Accordingly, this thesis operationalises firm resources into two main categories: assets and their location, and the ownership of assets. These will be specifically detailed corresponding to each type of IoT-enabled servitized business model.

3.5.1.1 Assets and its location

In terms of the assets, the focus of this research aims to understand both tangible (i.e. facilities and process and technology) and intangible assets (i.e. people and skills) required in enabling different types of IoT-enabled business model. Therefore, corresponding to the studies of Baines et al. (2009a) and Porter and Heppelmann's (2014) work, the firm resources will focus on the facilities, IoT network (i.e. process and technology) and people and skills.

In the add-on business model, the OW criteria are a feature of products, firm's strategy in terms of facilities, and their location, which tends to follow the traditional product manufacturer where multiple points of the distribution centres and/or retail stores are required to deliver the product, allowing customers to receive additional service. They tend to have an IoT open network as this helps to facilitate the service provision of the company. In terms of the people and skills, the staff at the frontline or customer services need to be trained to have a fundamental understanding of the digital service being delivered.In the sharing business model, as their OW criteria are the accessibility of the product and service, the facilities tend to focus on providing sufficient product availability by having multiple distribution centres and/or retail stores close to the market. These allow it to be more convenient for the customer to access and return the products. The IoT network tends to be open, allowing integrated partners to help in providing the service. Similar to the add-on business model, the staff at the frontline or customer services are required to have an understanding of the process of providing services when the customers have problems with access.

In the usage-based business model, firms tend to bypass the distribution channels as IoT allows firm to monitor product usage remotely and directly provide the service to the customer. Instead, firms may have field facilities close to the market to continuously supply the product throughout the subscription and support customers when there are technical issues. Furthermore, an IoT network tends to be a closed network, meaning only the firms are allowed access to the connected product. The staff tend to have high skills and technical knowledge of product and digital services in order to correctly measure the product usage and support customers in installing the IoT-enabled service.

In the solution-oriented business model, as the OW criteria are to deliver the product performance and customised solutions for customers, firms tend to bypass the distribution channels as the IoT is utilised to closely monitor the product and tailor the service to satisfy individual needs. Accordingly, in order to deliver this type of business model, firms require multiple field facilities. IoT is a closed network as the customer data are important and utilized by firms to improve their service. Consequently, the staff need to have high skills and sophisticated knowledge of their product in order to leverage the product data and customised service for individual customers.

3.5.1.2 Ownership

In terms of ownership, this refers to make or buy decisions. This leads to a firm's decision involving what operations or assets that firm develops in-house using internal capabilities and what is bought from external partners or providers (cf. Baines et al., 2009a; Bustinza et al., 2019; Kohtamäki et al., 2019). This will be further discussed, according to different types of IoT-enabled servitized business model.

In the add-on business model, firms tend to focus on manufacturing their products. Hence, product manufacture tends to be vertically integrated in order to ensure the quality and efficiency of product manufacture, and firms tend to outsource or collaborate with partners (e.g. IoT service providers) to deliver service.

In the sharing business model, the firm tends to be vertically integrated in their product manufacture to control cost and quality but outsource or collaborate with integrated partners to aid firms in delivering service. These partners may include the IoT platform service providers and the partners for product maintenance and repair or the provider of public space to return the product after use (Bucherer and Uckelmann, 2011).

In the usage-based business model, the firm tends to be vertically integrated in both their product manufacture and service provision. This is because firms can control and monitor their product usage directly at the customer's place and own the customer data, which firms can leverage for further service improvement. However, firms may outsource with non-core business activities, e.g. logistics service providers, to supply the product.

In the solution-oriented business model, the firm tends to be vertically integrated in both their product manufacture and service provision. This is important for firms to own both their product and service as such control allows firms to maximise the quality and minimise costs of the product (which is retained by firms) and deliver a service including repair, maintenance and consultation. In addition, the product data used by the company will be owned by the company, allowing firms to understand customers and tailor to satisfy individual needs. However, firms may again outsource the non-core business activities, e.g. logistics service providers, to supply the product.

The operationalisation of firm resources regarding the different types of IoT-enabled servitized business model is illustrated in Table 3.10.

Table 3.10: The operationalisation of firm resources

Firm resources		Type of IoT-enabled servitized business model			
		Add-on	**Sharing**	**Usage-based**	**Solution-oriented**
Assets and their location	**Facilities**	• Multiple distribution channels close to market	• Multiple distribution channels close to market • Product located in close proximity to customers	• Bypassing intermediaries • Multiple field facilities close to market for supplying product	• Bypassing intermediaries • Multiple field facilities and close to market for product maintenance and repair and supply
	IoT network	Open network	Open network	Closed network	Closed network
	People and skills	Low skilled workers with fundamental IoT-enabled service knowledge on product and service on front line/customer service	Low skilled workers with fundamental IoT-enabled service knowledge on product and service on front line/customer service	Highly skilled workers with technical knowledge on product and service	Highly skilled workers with technical knowledge on product and service
Ownership	**In-house**	Vertically integrated in product manufacture to control quality and minimise the cost of product	Vertically integrated in product manufacture to control quality and minimise the cost of product	Vertically integrated in product manufacture and delivering service provision to control quality, and minimise the cost of both product and service	Vertically integrated in product manufacture and delivering service provision to control quality, and minimise the cost of both product and service
	Outsource/ partnerships	• Integrated partners to deliver service	• Integrated partners to deliver service • Product maintenance and repair	• Non-core products or service operations	• Non-core products or service operations

3.5.2 Operationalising the operational capabilities

Operational capabilities are referred to as the lower-level capabilities in the DC view theory. According to Godsell et al. (2010), the operating model is defined as the firm's ability to act on their resources and these were operationalised as process, governance and decision rights, organisational design and performance management. These capabilities are referred to operational capabilities in this thesis and will be discussed in detail in terms of how they support each type of IoT-enabled servitized business model, based on the extended literature related to this research context.

3.5.2.1 Process

Process refers to business processes, which are part of organisational routines that firms adopt in order to implement their business model. The product-based firms tend to adopt lean or agile practices as their business process (Qi et al., 2011). Lean practices focus on eliminating internal waste and continuously improving productivity in the production processes in order to provide products or services that satisfy customers' requirements in a low-cost manner (Shah and Ward, 2007; Womack and Jones, 2013). Agile practices focus on flexibility and differentiation of operations in order to provide customer-driven products or services and quickly respond to the market changes (Sharifi and Zhang, 2001; Yusuf et al., 1999).

In the add-on business model, firms tend to follow lean practices as they focus on streamlining the manufacturing and service delivery process in order to deliver products and service at low cost, aiming to achieve cost advantage (Kohtamäki et al., 2019). Both products and integrated digital services tend to be standardised. Firms tend to use digital service as an add-on to improve their existing product offering and differentiate themselves from their competitors.

In the sharing business model, firms also tend to follow lean practices in providing sufficient products close to the market. This means they try to make it as efficient as possible by aiming to achieve a cost advantage in obtaining the product; however, in the service part, the firm is required to be more agile in their customer service to support customers remotely. Accordingly, firms tend to adopt a mixture of lean and agile practices in their process.

In the usage-based business model, firms tend to be more efficient in manufacturing products, aiming to obtain competitive advantage costs. A firm has the responsibility to remotely monitor the product in real-time in order to continuously supply the product throughout the period of subscription, so firms tend to be more accurate in predicting the inventory and streamlining the manufacturing process, by following lean practices. However, firms tend to be more agile in technical and customer support to ensure continuous service.

In the solution-oriented business model, IoT is used by firms to help control and optimise their products at customers' sites as well as support and provide solutions to individual customers' operations. Accordingly, the variety of demand is high and firms need to have flexibility in providing a customised service. Consequently, in order to implement this business model, firms tend to follow agile practices as their operating routines.

3.5.2.2 Governance and decision rights

In order to act appropriately regarding their resources, firms need to understand what type of governance of the organisation the role of decision makers use within the organisation. The governance and decision rights can be categorised into two types: hierarchy and heterarchy (Espinosa et al., 2007; Leminen et al, 2018). The former refers to the closed mode of operation where the decision-making right has been assigned or centralised to the high members in the structure – also known as top-down management – while the latter refers to the openness of operations, where the decision rights are distributed or decentralised among participants within the organisation – also known as bottom-up management.

In the add-on business model, firms have their main focus on the product with an add-on digital service, and hence, the top management tends to have control over making the products and the additional service provided. Accordingly, the type of governance and decision rights is hierarchical, meaning the decision rights are centralised to the top management.

In the sharing business model, firms tend to utilise IoT in extending their service from traditional renting, hence the main governance and decision rights tend to follow the hierarchy, where the top management has to control any decision on the product. However, in the service provision part, the customer services or front line staff tend to have the right to support the customer in real-time. Accordingly, the type of governance and decision rights tends to be a mix of hierarchy and heterarchy.

In the usage-based business model, governance and decision rights also tend to be a mix of hierarchy and heterarchy. This is because the decision rights tend to be centralised to the top management for producing the products, while the customer support team tends to be centralised to make proactive decisions to ensure the availability of products.

In the solution-oriented business model, firms need to be flexible in terms of their operation in order to provide customised solutions to satisfy individual customers' needs. Accordingly, the type of governance and decision rights that support this type of business model tends to be heterarchy. This means that the power and decision rights will be decentralised to the customer support team who have direct responsibilities for monitoring customers' operations and directly support and give advice to customers.

3.5.2.3 Organisational Design

Organisational design mainly reflects the identity and culture of an organisation, and supports firms to implement a particular business model (Kohtamäki et al., 2019). This is considered to be a firm's core value and part of its operational capability in order to manage resources. This needs to be aligned with a particular type of IoT-enabled servitized business model. Firms who integrate their services with their product offering may perform as a value facilitator or a value co-creator (Grönroos and Voima, 2013). The firm's role as a value facilitator will generate the potential value in the form of product-service offerings which the customer turns into value-in-use. On the other hand, the firm's role as a value co-creator will interfere with the customer's value creation process through direct engagement with customers (Grönroos and Ravald, 2011). This allows firms to have co-creation opportunities in creating value (Payne et al., 2008).

In the add-on business model, firms tend to identify themselves as a product provider and focus on delivering product, while IoT is leveraged to facilitate the potential added value through service for the customers. The provider and customers generally have no direct interaction during the value-creation process. Hence, the organisational design tends to be considered as value-facilitation.

In the sharing business model, in order for the provider to facilitate the sharing service, the provider requires the customer's engagement. The customers are required to share some real-time personal information (i.e. the current location, the amount of product usage), allowing the provider to accurately offer accessibility to the product or service (Kohtamäki et al., 2019). Accordingly, the organisational design for this type of business model tends to be value co-creation.

In the usage-based business model, the main value proposition is to deliver the availability and outcome of the products. Therefore, the provider has an interaction and co-creating value with customers with the aid of IoT where the real-time product usage and information at the customer's site is monitored remotely. Consequently, the provider is able to ensure the availability of products and accurately measure product usage through the period of subscription. Hence, the organisational design tends to be value co-creation.

In the solution-oriented business model, the organisational design tends to be value co-creation. This is because in order for firms to deliver the specified performance or the customised solutions to support individual customers' operations, both customers and provider have to share some resources and information. Through the enablement of IoT, the provider is able to monitor and analyse the performance of the product, while the customer shares insights of their operating environment, allowing the firm to optimise the performance of products and tailor solutions for individual operations. Accordingly, the organisational design tends to be considered as a high level of value co-creation.

3.5.2.4 Performance Management

Performance management refers to the measurement of firms' performance in delivering value to customers. Firms need to set the performance measure of their product or services, as part of their operational capabilities. Hill (2000) and Slack and Lewis (2015) suggested five generic options of performance objectives: quality, speed, dependability, flexibility and cost, as described in Table 3.11. These performance measures have to be aligned with order winning criteria of the corresponding business model and this will be discussed in this section.

Table 3.11: Performance measure (Hill, 2000; Slack and Lewis, 2015)

Measure	Description
Quality	The specification of product or service which includes hard and soft dimensions. Hard dimension refers to the physical aspects of the product or service while soft dimension is associated with the personal interaction with the customers in delivering a product or service.
Speed	The elapsed time, which indicates the time between the start of the operations process and its end. This could relate to the time when the product or service is requested until received by customers.
Dependability	Also referred to as the delivery reliability, i.e. the ability to keep to the delivery time of product or service that is promised to the customers.
Flexibility	The firm's ability to adapt to different states by doing different things. The flexibility measure can be associated with the modification of products or service, relating to the variety of products or service given at a time period, the volume and the delivery.
Cost	The firm's ability to lower the cost of producing their product or services, resulting in lowering the price for their customers.

Since the add-on business model mainly focuses on a product with additional service, the performance objectives of the product are the main concerns. The quality, speed and cost measures focus on the product quality – ensuring the specifications of the product are met, as well as the speed of product delivery and the cost of delivering the product. Besides, cost and speed will be mainly focused on the service aspects, including the cost of delivering the service. However, the dependability and flexibility measures are not the main focus for this type of business model, as the digital service is seen as the add-on service to improve the overall product-service offerings.

As the sharing business model focuses on the accessibility of the products, the performance measures start to focus on the service aspect in regards the customer's experience in accessing the products. Accordingly, the quality measure tends to focus on the service quality while the speed measure focuses on the time it takes for the customer to access the product. The dependability and flexibility measures focus on the availability of the product and the range of products and services for customers to access. The cost measure is not the main performance objective of this type of business model.

The usage-based business model focuses on delivering the outcome of the product based on the actual needs; this includes more responsibility from the provider's side. Accordingly, the performance measure tends to focus on both product and service aspects. In the quality measure and speed, these tend to focus on service quality and responsiveness. Dependability and flexibility measures focus on product availability during the period of service subscription and the diversification of products or services that can support different customers' needs. The cost measure is also not the main performance objective of this type of business model.

In the solution-oriented business model, the provider focuses on providing support to a customer's core operation based on their specific needs and, therefore, the performance measure tends to mainly focus on the service aspect. The quality measure will focus on the quality of service (which is measured through customer satisfaction). The speed and dependability measures will focus on the service response time and reliability. The flexibility measure focuses on the firm's performance in supporting individual customers. The cost measure again is not the main performance objective of this type of business model.

A summary of the operational capabilities according to the different type of IoT-enabled servitized business model is illustrated in Table 3.12.

Table 3.12: The operationalisation of operational capabilities

Operational Capabilities		Type of IoT-enabled servitized business model			
		Add-on	**Sharing**	**Usage-based**	**Solution-oriented**
Process		Lean	Lean-agile	Lean-agile	Agile
Governance and decision rights		Hierarchy	Hierarchy-Heterarchy	Hierarchy-Heterarchy	Heterarchy
Organisational design		Value facilitation	Value co-creation	Value co-creation	Value co-creation
Performance measurement	**Quality**	The specifications of product/service are met	Service quality	Service quality	Service quality
	Speed	Product delivery speed	Time to access to product	Service response time	Service response time
	Dependability		Product availability/ accessibility	Product availability	Service reliability
	Flexibility		Product/service range	Product/service range	Service performance of individual customers
	Cost	Cost of delivering product			

3.5.3 Operationalising the type of network configurations

Base on the framework illustrated in Figure 3.9, the view of network configuration is required to strategically support the IoT-enabled servitized business model strategy. This refers to how the different stakeholders interact or interdependencies within the firm's network in order to deliver products or services. This can be operationalised as coordination, which focuses on the mechanism of how the actors within the focal firm's network are coordinated in order to deliver products and services. The conventional value chain concept, as discussed as by Porter (1985), refers to the coordination of the discrete activities performed by a firm and those by its suppliers, distributors and buyers in order to produce particular products or services to the firm. The actors involved in the upstream and downstream, such as suppliers, distributors and customers, are interconnected as linear sequential links. Accordingly, the value chain concept is centred on the focal firm. The value chain concept is illustrated in Figure 3.10.

Figure 3.10: Value chain activities (Adapted from Porter, 1985)

On the other hand, the business ecosystem concept has a higher complexity which focuses on a set of all actors contributing to the focal product or service offered to end customers (Andersson and Mattsson, 2015; Kapoor, 2018; Valdez-De-Leon, 2019). These actors could come from different sectors, such as hardware manufacturers, and software developers, and present non-linear interconnected links through the lens of complementarities and interdependencies (Adner and Kapoor, 2010; 2016). Accordingly, the concept of business ecosystems is centred on the focal offer, user value proposition as illustrated in Figure 3.11.

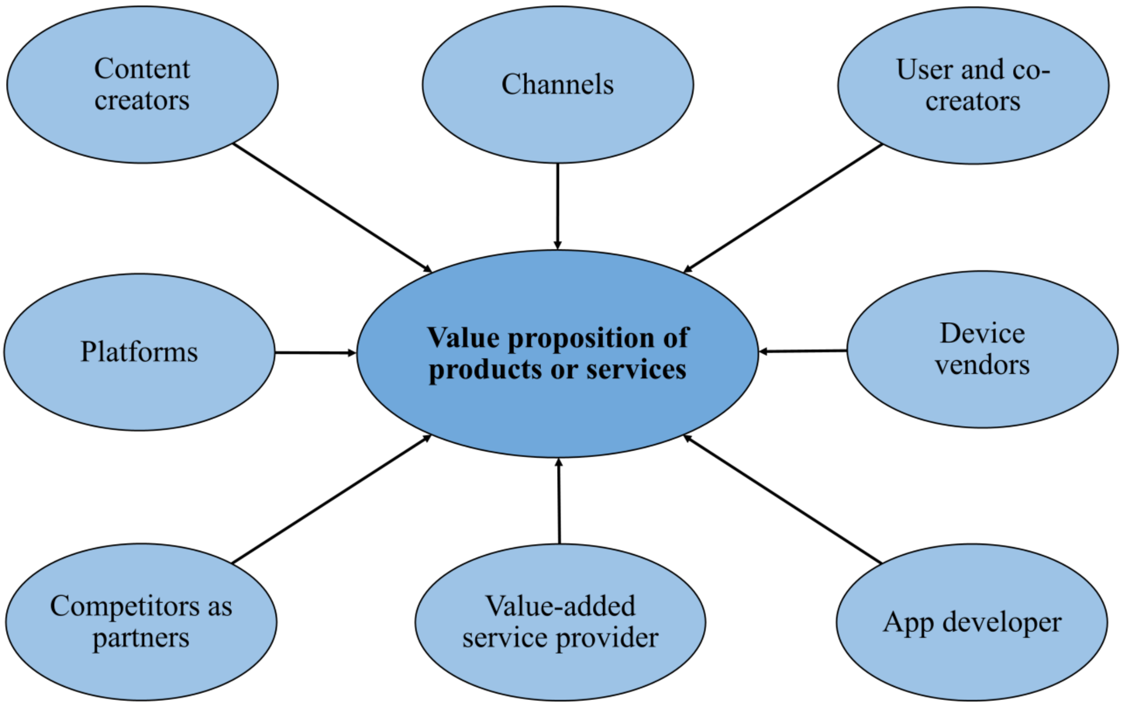


Figure 3.11: The concept of business ecosystems (Adapted from Valdez-De-Leon, 2019)

The different views of a firm's network configurations will be discussed according to the different archetypes of an IoT-enabled servitized business model.

In the add-on business model, the network configurations tend to focus on the product value chain and how the product is delivered from the upstream to the downstream chain. The flow of products tends to be in a linear sequence while the IoT-enabled service will be integrated as an add-on in the form of features or functions of the product or to improve the customer experience during purchasing products. Accordingly, the type of coordination between actors tends to be within the SC to follow the traditional value chain concept.

In the sharing business model, the type of coordination tends to be a mix of a value chain and a business ecosystem. This is because in the supply side or the upstream chain, firms tend to focus on delivering the product from suppliers to be available for the demand, while on the demand side or in the downstream chain, firms tend to collaborate with the different set of external actors within the ecosystem to enable the sharing service (Kohtamäki et al., 2019).

In the usage-based business model, firms focus on delivering both the availability and outcome of products. This means that on the supply side the products flow within the concept of traditional value chain concepts, while on the demand side all the different actors within the service ecosystem will remotely monitor the product to accurately measure the usage and ensure product availability throughout the entire period of subscription.

In the solution-oriented business model, firms focus on delivering solutions and performance of the products to customers. Hence, all the stakeholders or actors involved will be interconnected in order to deliver the customised solutions which are the focal offerings to the downstream individual customers (Boehmer et al., 2020; Chakkol et al., 2018). All the actors involved in the service network tend to remotely control and monitor the performance of products in real-time and act promptly to support the customer's operation. Accordingly, the coordination of all actors is viewed as a business ecosystem.

The summary of the network configurations according to the different type of IoT-enabled servitized business model is illustrated in Table 3.13.

Table 3.13: The operationalisation of the firm's network configurations

Firm's network configuration	**Type of IoT-enabled servitized business model**			
	Add-on	**Sharing**	**Usage-based**	**Solution-oriented**
Type of coordination	Value chain	Value chain - Business Ecosystem	Value chain – Business Ecosystem	Business Ecosystem

3.5.4 Operationalising the dynamic capabilities

In order to transition from the traditional product-based to IoT-enabled servitized business model, the dynamic (higher-order) capabilities are required. Dynamic capabilities refer to the particular set of capabilities that involve the development and orchestration of a firm's resources to address the change in the market place and these need to be aligned and coherent with the design and operation of a business model (Teece, 2017). These are operationalised as the sensing, seizing and transforming capabilities, suggested by Teece (2007) in the DC view theory.

The existing literature related to IoT-enabled servitization and digital servitization suggested some key dynamic capabilities that are required to implement IoT-enabled servitized business models and these can be categorised within sensing, seizing and transforming dynamic capabilities. The associated key dynamic capabilities and their descriptions are illustrated in Table 3.14.

Table 3.14: The key dynamic capabilities related to the transition from product-based business model to IoT-enabled business model

Dynamic Capabilities		Description	References
Sense	Market sensing capability	The firm's ability to identify the new market opportunities and recognise emerging market requirements.	Day (1994); Helfat and Winter (2011); Teece (2012; 2017)
	Technology sensing capability	The firm's ability to explore and recognise the IoT as a technological possibility to support market needs.	Teece (2012; 2017)
Seize	Digital service development capability	The firm's ability to develop new service offerings that create value for customers. This ability consists of a combination of back-office development work and interactions with customers that provide an IoT-enabled business model with a unique value proposition in accordance with market opportunities.	den Hertog et al. (2010); Hasselblatt et al. (2018); Kindström and Kowalkowski (2009); Sjödin et al. (2016); Suppatvech et al. (2019); Wallin et al. (2015)
	Mass service customisation capability	The firm's ability to integrate the knowledge of specific customers' needs and effectively tailor products and services to fit with those needs across a large variety of customers.	Matthyssens and Vandenbempt (2010); Sjödin et al. (2016)
	Digitalisation capability	The firm's ability to use smart and connected physical products and data analytics to facilitate the development and delivery of service offerings.	Coreynen et al. (2017); Lenka et al. (2017); Parida et al. (2019); Sjödin et al. (2016); Ulaga and Reinartz (2011)
	Network management capability	The firm's ability to effectively manage and share knowledge with network partners in the service delivery network.	Chakkol et al. (2018); Gebauer et al. (2017); Huikkola and Kohtamäki (2017); Sjödin et al. (2016); Suppatvech et al. (2019); Wallin et al. (2015)
Transform	Services methodologies and processes for developing efficiency gains capability	The firm's ability to develop economies of scale (high volumes, low variable costs and intensive use of fixed assets) or skill (developing process innovations and/or identifying, deploying and replicating scarce capabilities).	Auguste et al. (2006); Coreynen et al. (2017); Paiola et al. (2013)
	Service culture capability	The firm's ability to develop a business model with a service culture and mindset.	Neely (2008); Ostrom et al. (2010); Story et al. (2017)
	Risk management and mitigation capability	The firm's ability to manage risk for service provision, involving risk and reward sharing contracts, execution of risk assessment and mitigation capability.	Baines and Lightfoot (2013); Cova and Salle (2008); Ulaga and Reinartz (2011)

Sensing capabilities refer to the ability to spot, interpret, and pursue opportunities in the environment. In order for product-based firms to initiate the transition towards an IoT-enabled, servitized business model, firms need to have the capabilities for identifying the market opportunities and exploring IoT as a technological possibility to support market needs. Therefore, the firm's capabilities associated with these categories include *market sensing capability* and *technology sensing capability*.

Seizing capabilities refers to the firm's ability to mobilise its resources in order to address an opportunity and capture its value. In the context of the IoT-enabled servitized business model, this means that the firm's capabilities associated with this category involve the development of the right services in responding to the IoT technology, an increase in the efficiency of customisation and management of their service network in order to address new market opportunities and new digital services. The dynamic capabilities in this category include *digital service development capability*, *mass service customisation capability*, *digitalisation capability*, and *network management capability*.

Transforming capabilities refers to the firm's ability to continuously reconfigure its resource base by altering its resources and operating capabilities as needed. These involve identifying an efficient way to deliver the service with the IoT-enabled business model, assessing the associated risks and developing the right mindset to embed in the IoT-enabled business culture. Accordingly, the capabilities associated with *services methodologies and processes for developing efficiency gains*, *service culture* and *risk management and mitigation capabilities* are included in this type of dynamic capability.

3.6 Conceptual Framework for the Study

As a result of systematically combining the underpinning theory, the findings of SLR, and the extended literature, the conceptual framework for this study was ultimately established as illustrated in Figure 3.12.

The framework presents the four types of IoT-enabled servitized business model including the add-on, sharing, usage-based and solution-oriented business models, which are the results from conducting the SLR (see Figure 3.7). In order for product-based firms to upgrade from their existing business model to each type of IoT-enabled servitized business model, they are required to renew their current resources and operational capabilities, while the dynamic capabilities are required as illustrated in the theoretical model based on the underpinning theory (see Figure 3.5). In addition, the firm's network configurations need to be considered along with the resources and capabilities to support the business model. The existing literature related to the study was extended and combined to help in operationalising and conceptualising the details of the research constructs which are developed and presented in the conceptual framework for the study. Finally, RQ1, RQ2, RQ3, RQ4 and RQ5 illustrated in the conceptual framework shown in Figure 3.12 present five research sub-questions developed to support the over-arching research question of this thesis.

			Add-on	Sharing	Usage-based	Solution-oriented
RQ 1	**Characteristics of business model**					
	Type of business model		Product-oriented	Use-oriented	Use-oriented	Result-oriented
	Value proposition		Ownership of products with digital service as an add-on	Deliver accessibility of products	Availability and outcome of products	Performance of the product and solutions for individual needs
	Customer relationship		Transactional	Transactional	Transactional and relationship-based	Long-term relationship
	Pricing		Normal product price or premium price to get service as a complementarity	Pay-per-use	Subscription based on pay-per-use basis	Performance-based contracts
	Order winning criteria		Feature of products, deliver products with digital service experience	Ease of product accessibility, capacity to deliver service	Availability of products and services	Performance of products, customised solutions
RQ 2	**Firm's resources**					
	Asset and its location	Facilities	Multiple distribution channels close to market	Multiple distribution channels and products close to market	Multiple field facilities close to market for supplying product	Multiple field facilities close to market for product maintenance and repair and supply
		IoT network	Open network	Open network	Closed network	Closed network
		People and skills	Low skilled workers with fundamental knowledge of IoT-enabled service	Low skilled workers with fundamental knowledge of IoT-enabled service	High skilled workers with technical knowledge on product and IoT-enabled service	High skilled workers with technical knowledge on product and IoT-enabled service
	Ownership	In-house	Vertical integration in product manufacture	Vertical integration in product manufacture	Vertical integration in product manufacture and delivering service provision	Vertical integration in product manufacture and delivering service provision
		Outsource/ partnership	Integrated partners to deliver service	Integrated partners to deliver service, product maintenance and repair	Non-core products or service operations	Non-core products or service operations
RQ 3	**Operational capabilities**					
	Process		Lean	Lean – Agile	Lean – Agile	Agile
	Governance and decision rights		Hierarchy	Hierarchy – Heterarchy	Hierarchy – Heterarchy	Heterarchy
	Organisational design		Value facilitation	Value co-creation	Value co-creation	Value co-creation
	Performance management		Quality/Speed/Cost of products	Quality/Speed/Dependability/Flexibility of products and service	Quality/Speed/Dependability/Flexibility of products and service	Quality/Speed/Dependability/Flexibility of service
RQ 4	**Network configurations**					
	Type of coordination		Value Chain	Mixed value chain – Business ecosystem	Mixed value chain – Business ecosystem	Business ecosystem

RQ 5 — Dynamic capabilities

Sensing
- Market sensing
- Technology sensing

Seizing
- Digital service development
- Mass service customisation
- Digitalisation
- Network management

Transforming
- Services methodologies and processes for developing efficiency gains
- Service culture
- Risk management and mitigation

Figure 3.12: Conceptual framework for the study

The over-arching research question of the study corresponds to the research aim which is:

'How do firms reconfigure their resources and capabilities to transition from product-based to different types of IoT-enabled servitized business model?'

Based on the conceptual framework, five research sub-questions are derived as follows:

RQ1: What are the different types of IoT-enabled servitized business models and what are their characteristics?

RQ2: What are the resources required for product-based firms to implement IoT-enabled business models?

RQ3: What are the operational capabilities required for product-based firms to implement IoT-enabled servitized business models?

RQ4: What is the view of network configurations required to support IoT-enabled servitized business models?

RQ5: What are the dynamic capabilities required by firms to upgrade from their product-based to IoT-enabled business models?

These research questions were answered and the conceptual framework was empirically explored and tested through conducting the case study research. The process for conducting case study research will be discussed in Chapter 4.

3.7 Summary of the chapter

This chapter discusses the development of the conceptual framework for this thesis by systematically combining the theoretical model, conceptual framework and the extended literature. It started with the theories of firms' resources and capabilities including RBV, and highlighted the need for a DC view for staying competitive in a dynamic environment.

Furthermore, based on the discussion of the underpinning theory, the theoretical model was developed. It is suggested that in a stable environment the product-based firm may leverage incremental dynamic capabilities to make a small adjustment to their resources and operational capabilities to improve their current offering. However, in order for product-based firms to leverage IoT in transitioning to a servitized firm, their existing resources and operational capabilities need to be reconfigured and renewed. These require the renewing dynamic capabilities, which are considered to be the higher-level capabilities, to help firms successfully transform their existing business model to meet the new market needs in the dynamic environment. Accordingly, three microfoundations of renewing dynamic capabilities, i.e. sensing, seizing and transforming, were focused on.

Following the theoretical model, the findings from conducting the SLR and a conceptual framework presenting the four archetypes of IoT-enabled servitized business model: add-on, sharing, usage-based and solution-oriented, was developed. In addition, the characteristics of each type of IoT-enabled servitized business model were discussed.

In addition to the theoretical model and the conceptual framework from the SLR, the extended literature relating to the research construct (i.e. firm resources, operational capabilities, network configurations and dynamic capabilities) and the IoT-enabled servitized business model were combined to operationalise and conceptualise the details of the final framework for the study.

Based on the inputs from the underpinning theoretical model, the conceptual framework from SLR and the extended literature, the chapter summarises by providing an emerging framework for this thesis.

4 Case Study Research

4.1 Introduction to the chapter

This chapter discusses the second phase of abductive research design which is case study research. The chapter begins with a discussion of case study design in Section 4.2. Section 4.3 describes the process for conducting case study research, adopting a five-step approach. This section particularly outlines the research parameters, instrument development, method of collecting data, method of analysing data and case study reporting.

Section 4.4 highlights the rigour of the case study research by using four tests that are commonly conducted in all social science methods – construct validity, internal validity, external validity and reliability. This is followed by considerations related to research ethics in Section 4.5. Section 4.6 provides a summary of the chapter

The structure of Chapter 4 is shown in

Figure **4.1**.

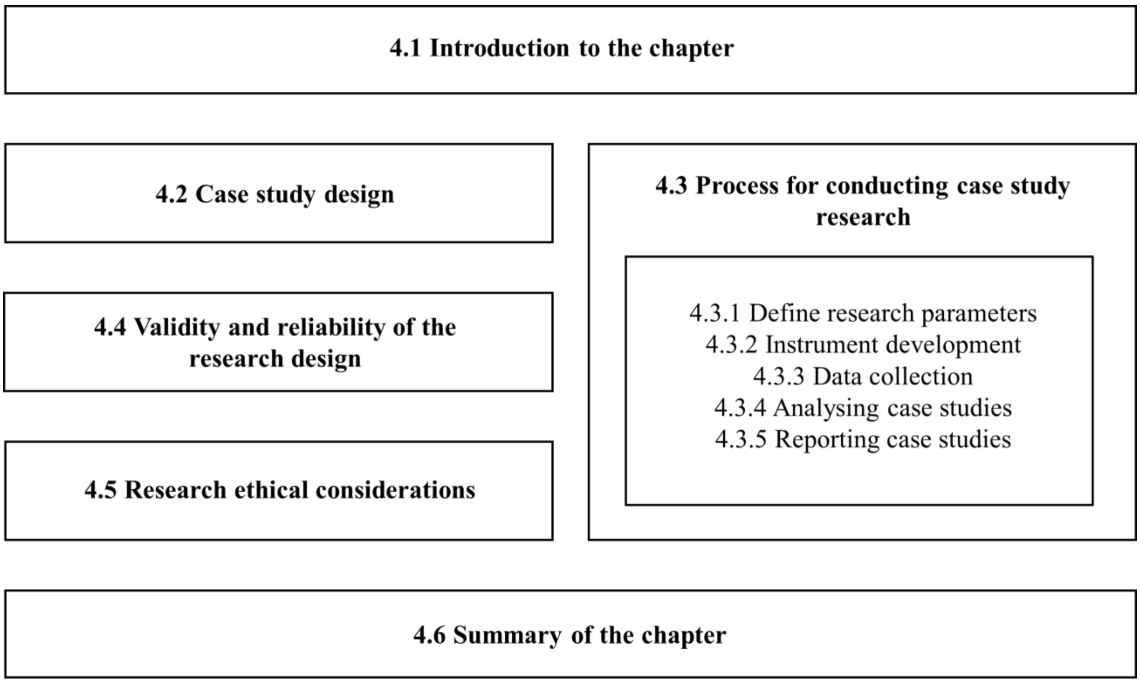


Figure 4.1: Structure of Chapter 4

4.2 Case study design

Case study research is conducted as part of the second phase of research which involves conducting an empirical study. There are several different types of case design within the case study research. For this thesis, an embedded multiple-case design is favoured. According to Beverland and Lindgreen (2010), multiple case studies allow the researcher to explore theory and investigate the boundaries of theory and relationships associated with the phenomenon of interest and the context, as well as adding the breadth and depth of the collected data (Yin, 2009). One of the key advantages of multiple case studies research is that the evidence and findings from multiple case studies are considered more compelling and hence the overall study can be regarded as robust (Herriott and Firestone, 1983).

In addition, multiple case studies can consist of multiple holistic cases or contain embedded sub-units, depending on the type of phenomenon being studied (Yin, 2009). As the author of this thesis aims to explore the situation uniqueness of a phenomenon (different types of IoT-enabled business models), which can be embedded in a case (IoT-enabled servitized firms), embedded multiple case studies were selected as an appropriate case study design. Nevertheless, Stake (2013) suggested that both single case studies and multiple case studies should be focused on particularisation rather than generalisation. Accordingly, two case studies, which had their embedded units of analysis, representing three types of IoT-enabled servitized business model, were conducted and investigated.

In terms of the number of cases to include in the research design, the decision was made to have two cases for practical reasons. The rationale in terms of time, the access to the case and the financial considerations can be considered as sufficiently meeting the research objectives. Accordingly, with the logic of the multiple case study design outlined, a more detailed process for conducting the case study research used in this thesis will be discussed in the following sections.

4.3 Process for Conducting Case Study Research

This section aims to explain the process carried out for case study research. The 5-stage process described by Yin (2009) as shown in Figure 4.2 was adopted in order to ensure the rigour and robustness of the case study research design.

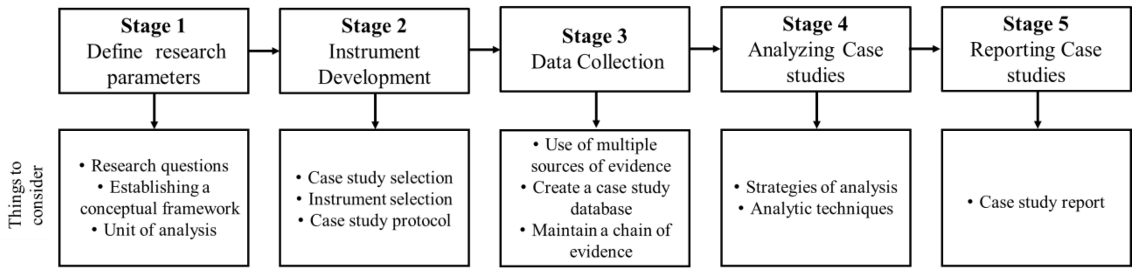


Figure 4.2: Stages of conducting case study research (Yin, 2009)

Although the five stages shown in Figure 4.3 provide the fine detail of how case study research should be conducted, the author argues that the underlying logic is not fully in line with the abductive research approach as it lacks the detail of how the iteration process is made during the case study research process. Therefore, the author incorporates the abductive research approach with the process of conducting case study research, suggesting the shifts from linear to a more flexible representation of the case study research design process, as shown in Figure 4.3.

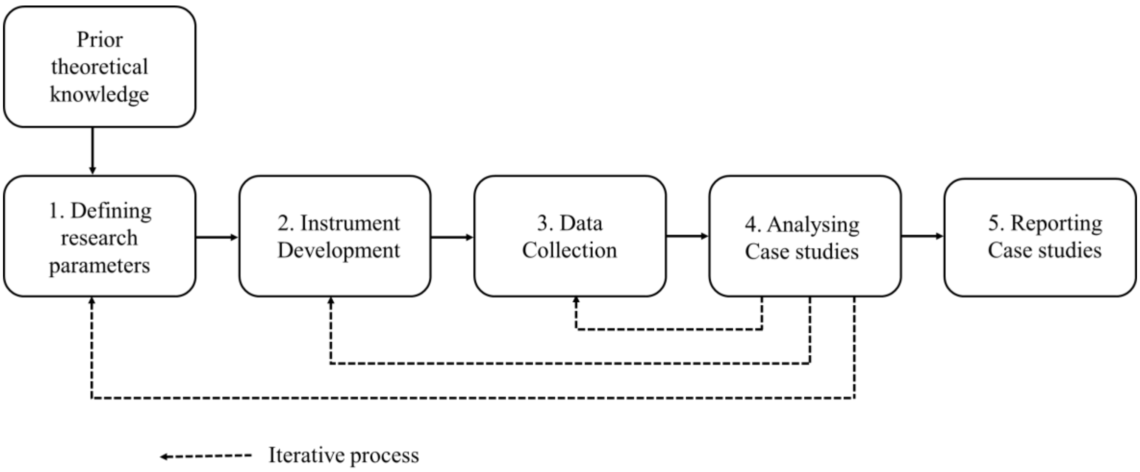


Figure 4.3: The research process used for the case study

As it is grounded in an abductive logic, the research process used for the case study starts from the pre-existing theoretical knowledge in order to define the research parameters. These stages of the case study research correspond to the first phase of the author's abductive research design or the theoretical phase. This is then followed by the instrument development, data collection and data analysis which correspond to the second (or empirical) phase of the author's abductive research design. An iteration process was made continuously, by going back and forth between these stages (this is presented by the arrows in Figure 4.3 being directed from the case study analysis stage back to the initial stages). This stimulated the matching between theory and reality. For example, the researcher may revisit the data collection instrument after conducting interviews in order to make changes, such as the revision of interview questions for the next interview according to the emerging empirical data. This refers to the theory matching process in Stage 2 of the abductive research approach (Dubois and Gadde, 2002; Kovács and Spens, 2005). The final stage involved reporting the case study findings to the targeted audiences. The details of each of these five stages will be further explained in the following sections.

4.3.1 Define Research Parameters

According to Yin (2009), the first stage of the research design is to define the research parameters. There are three main components involved at this stage: research questions, establishing a conceptual framework, and unit of analysis. This stage was initially conducted as part of the first (or theoretical) phase of the author's two-phase research design before administering the case study research.

4.3.1.1 Research Questions

The purpose of this thesis is to identify the resources and capabilities required in enabling IoT-enabled business model. Accordingly, the over-arching research question of the study is set as:

How do firms reconfigure their resources and capabilities to transition from product-based to different types of IoT-enabled servitized business model?

The output of the first phase of the author's abductive research design (see Chapter 3) suggests five research sub-questions in order to understand the three layers of reality, which are underpinned by the critical realist, as follows:

RQ1: What are the different types of IoT-enabled servitized business models and what are their characteristics?

RQ2: What are the resources required for product-based firms to implement IoT-enabled business models?

RQ3: What are the operational capabilities required for product-based firms to implement IoT-enabled servitized business models?

RQ4: What is the view of network configurations required to support IoT-enabled servitized business models?

RQ5: What are the dynamic capabilities required by firms to upgrade from their product-based to IoT-enabled business models?

In order to address the over-arching research question, the first 'what' research question describes the empirical domain, known as the empirical observable events. Hence, RQ1 describes the types of IoT-enabled servitized business model which have currently been implemented and identifies their associated characteristics. This is followed by the three 'what' research questions that describe the 'actual' domain in order to understand the events that make observables events. Therefore, RQ2 describes the resources which are required by product-based firms to implement an IoT-enabled servitized business model; RQ3 describes the operational capabilities which firms have currently developed in order to implement an IoT-enabled servitized business model; and RQ4 describes the view of network configurations which are adopted by product-based firms in order to deliver an IoT-enabled servitized business model. Following this, the final exploratory 'what' question describes the 'real' domain which is underneath the series of observable events. Accordingly, RQ5 describes the dynamic capabilities, which refer to the particular capabilities that transition product-based to IoT-enabled servitized business models.

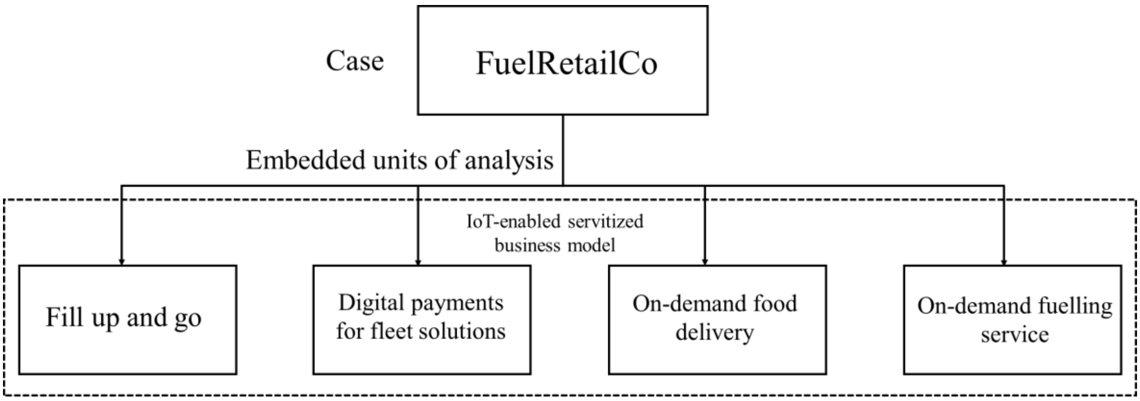
4.3.1.2 Establishing a Conceptual Framework

The second component of defining the research parameter is the establishment of a conceptual framework. The aim of a conceptual framework is to clearly explain the links between research questions and the scope for and purpose of conducting a case study. In line with the first phase of the author's abductive research design, it involved the systematic matching of the 'prior knowledge' of the resources, operational capabilities, firm's network configurations and dynamic capabilities for implementing IoT-enabled servitized business models. This refers to Phase 1, or the theoretical phase of the author's abductive research design (see Section 2.3.1). Accordingly, the conceptual model developed (see Figure 3.12) during the first phase of the author's abductive research design, will serve as the overall framework guide for the empirical study. The underlying assumptions and rationales of the framework were discussed in Chapter 3.

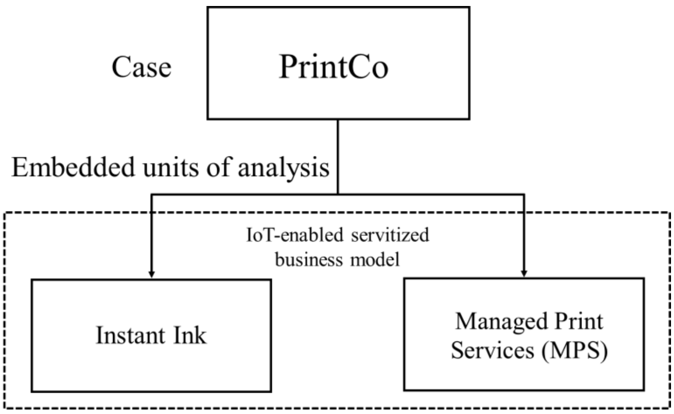
4.3.1.3 Unit of Analysis

Unit of Analysis is related to how the 'case' is defined. Yin (2009, p.30) suggested that "*…your tentative definition of analysis (which is the same as the definition of the "case") is related to the way you have defined your initial research questions*". Accordingly, a suitable unit of analysis will be selected when the researcher's primary research question has been accurately specified. He also suggested the role of existing literature which can be used as a guide for defining the case and the unit of analysis.

Within the context of this research, the cases are two individual firms who deliver IoT-enabled servitized offerings. Accordingly, this study will focus on the individual firm level and the unit of analysis will be the IoT-enabled servitized offerings offered by firms. The two cases and their embedded units of analysis for this study are illustrated in Figure 4.4 (a) and (b).



(a)



(b)

Figure 4.4: Two cases (a) FuelRetailCo and (b) PrintCo and their embedded units of analysis for the study

4.3.2 Instrument Development

Yin (2009) suggests three main elements are involved in the process of instrument development as a preparation for data collection: case study selection, instrument selection and the case study protocol.

4.3.2.1 Case Study Selection

The case selection for this research was carried out through a sampling procedure from which the empirical settings, events and social processes are selected (Pattron, 1990). Unlike quantitative research where a random sampling strategy is used and aims for large sample size, the sampling strategy used for qualitative research tends to be purposive and focuses on a case's unique context (Miles and Huberman, 1994). As this research is an exploratory qualitative research, a purposive sampling strategy was adopted. By taking a purposive sampling technique as a method for case study selection, the author aims to strategically choose the cases/participants, the samples of which are relevant to the research questions (Bryman, 2012).

Siggelkow (2007) suggested that it is appropriate to target and select particular organisations because this allows the researcher to gain insights that other organisations are not able to provide, such as the organisation being a pioneer in particular field or industry. Nevertheless, extra consideration should be taken to draw conclusions from studying 'special' organisations and how these provide particular insights which permit the researcher to draw inferences about 'normal' organisations (Siggelkow, 2007). In contrast to random sampling, where the research participants may include diverse backgrounds, ages and cultures, purposive sampling aims to focus on participants with certain knowledge and experience who are more appropriate to aid with the research (Etikan et al., 2016). However, in addition to certain characteristics required from the participants, the resulting case sample or participants should be considered as a 'convenience sampling', where they meet particular criteria including ease of access, availability at a certain time and a willingness participate (Bernard, 2002).

Accordingly, this research seeks to explore analytic generalisation which is different from another types of results generalisation (i.e. statistical generalisation) in empirical studies. Yin (2009) described analytic generalisation as a way of generalising the results from a particular case to a broader theory, which is different from generalising to a population. He mentioned that this mode of generalisation aims to compare the case study results against the previously developed theory. Alternatively, analytical generalisation may be based on either (a) corroborating, modifying, rejecting or otherwise advancing theoretical concepts that were referenced in a theoretical framework or (b) new concepts that came up after completing the case study (Yin, 2009, p.38).

Miles and Huberman (1994) also explain the importance of identifying specific parameters in conducting case studies. These help to inform different levels of sampling selected and are considered as appropriate in this research context. By considering the author's research objective and questions, the context, industry, case company, business models/offering, individuals and secondary data sources were identified as the primary levels of sampling, which need to be deliberated. These criteria were applied in order to define the specific parameters used for case selection. The level of sampling, the criteria and their rationale are explained in Table 4.1.

Table 4.1: The level of sampling, the criteria and their rationale

Level of Sampling	Criteria	Rationale
Context	The context within the case study has to be conducted in developed countries.	The rationale of this research is established from the proposition that the emerging concept of servitization was originally adopted by Western manufacturers to compete with the low-cost manufacturing countries, and then further leveraging IoT to establish a source of competitive advantage (Baines et al., 2009b; Neely, 2008; Noventum, 2016; Porter and Heppelmann, 2014).
Industry	The industry has to be a consumer industry, leveraging IoT to transition from their product-based to a servitized business model.	The context of the study focuses on the consumer industry as the majority of the academic research on IoT and servitized business model is mainly focused on high-value manufacturing (cf. Noventum, 2016; Porter and Heppelmann, 2014; Rymaszewska et al., 2017). Accordingly, this research seeks to further explore the application of IoT in enabling a servitized business model for consumer products.
Case Company	The case companies selected have to leverage IoT in enabling servitized business models.	This research aims to investigate how firms transition to IoT-enabled servitized models
Offerings/ Business models	- The product and service components must be sold as bundled packages to the customer. - The business model of the product-service offerings must be enabled or leveraged by IoT.	The servitized offering is defined as the integration of product-service offerings and selling to the customer as bundled packages (Baines et al., 2009a). These offerings have to be developed corresponding to the IoT-enabled business models (Suppatvech et al., 2019).
Individual	The participants have to be involved and taken part in developing an IoT-enabled servitized business model.	This is because the participants can provide insightful information regarding how particular IoT-enabled servitized business models were developed (cf. Dijkman et al., 2015).
Secondary Data Sources	The documents were selected based on their relevance to the research questions.	All documents obtained within the scope of this research, including online content, will be screened with further verification from the interviewees (Yin, 2009).

Based on the criteria discussed in Table 4.1, a number of companies were contacted in order to secure access for this research. The contact details for the company were obtained through WMG Supply Chain Research Group and the companies which fulfilled the criteria were contacted individually. Two cases that leveraged IoT in implementing servitized business model and agreed to participate in the research are selected as representative cases for this research. For the purpose of this thesis, the first case is referred to as FuelRetailCo who is one of the largest oil and gas companies in Europe and currently pilot four IoT-enabled servitized business model within their retail stations, in order to respond to the trend of digital disruption. The second case is referred to as PrintCo who is one of the global leading printer manufacturers and currently offers two IoT-enabled as their core business models.

4.3.2.2 Instrument Selection

According to Yin (2009), there are six sources of evidence which are commonly used in conducting case studies: documentation, archival records, interviews, direct observations, participant observations and physical artefacts. These are the primary sources of evidence for this thesis. Table 4.2 as adopted from Yin (2009, p.102) details the strengths and weaknesses of six different sources of evidence or instruments. He also suggests that there is no single source of evidence better than the others and hence, they should be used as complementary to each other.

Table 4.2: Strengths and weaknesses of six sources of evidence (Yin, 2009)

Source of evidence	Strengths	Weaknesses
Documentation	- Stable: It can be reviewed repeatedly - Unobtrusive: not created as a result of the case study - Exact: Contains exact name, references, and details of an event - Broad coverage: a long span of time, many events, and many settings	- Retrievability: can be low due to difficulty to find - Biased selectivity, if the collection is incomplete - Reporting bias: reflects the (unknown) bias of the author - Access: may be deliberately blocked
Archival Records	- [Same as those for documentation] - Precise and usually quantitative	- [Same as above for documentation] - Accessibility due to privacy issues
Interviews	- Targeted: focuses directly on the case study topic - Insightful: provides perceived causal inferences and explanations	- Bias due to poorly constructed questions - Response bias - Inaccuracies due to poor recall - Reflexivity: interviewee gives what interviewer wants to hear
Direct observations	- Reality: covers events in real-time - Contextual: can cover the case's context.	- Time-consuming - Selectivity: difficult to broad coverage - Reflexivity: action may proceed differently because it is being observed - Cost: hours needed by human observers
Participant-observations	- [Same as those for direct observation] - Insightful into interpersonal behaviour and motives	- [Same as above for direct observations] - Bias due to investigator's manipulation of events
Physical Artefacts	- Insightful into cultural features - Insightful into technical operations	- Selectivity - Availability

To serve the purpose of this study, three sources of evidence (documentation, archival records and semi-structured interviews) are used. A semi-structured interview is selected and used as a primary source of data collection where possible. Interviews have the main benefit of allowing the interviewer to gain insights of the research context from the participants' perspectives and also help to explain the research questions. However, the drawback of using interviews is that they can cause bias due to the interview questions being poorly constructed, interviewee response bias, and inaccuracies due to poor interviewee recall and reflexivity (Yin, 2009). Therefore, in order to mitigate these risks, a semi-structured interview protocol was established.

A semi-structured interview allows the researcher not only to ensure that the topics and main issues of research questions have been addressed and covered during the interview but also the flexibility to ask additional questions to follow up on the interviewee's answer (Easterby-Smith et al., 2018). Archival records and documentation were also combined with the semi-structured interviews as secondary sources of evidence to aid data triangulation and minimise any bias through poor interviewee recall or reflexivity.

4.3.2.3 Case Study Protocol

A case study protocol is developed in order to increase the reliability of case study research and guide the researcher in carrying out data collection, essentially in multiple-case study research. It will also keep the researcher focused on the topic being researched. According to Yin (2009), a case study protocol should have four elements:

1. An overview of the case study
2. Data collection procedures
3. Interview protocol
4. Reporting protocol

The first section of the case study protocol is to incorporate an overview of the case study. Yin (2009) suggested that background information about the case study should be covered in this section. Accordingly, case study research questions (as discussed in Section 2.4.1.1), the relevant background readings (literature review chapter) and the conceptual framework of the case study are clearly demonstrated in the first part of the case study protocol.

The second section is data collection procedures, which determine the key phases of the case study, indicating the set of activities during the data collection. Four main phases are conducted for case study research in the study. Phase 1 is preparation for the data collection; this phase includes gaining access to the key organisations or interviewees and ensure sufficient resources are available when doing fieldwork. Phases 2 and 3 involve conducting interviews and collecting sources of secondary data resources of focal firms. Phase 2 is referred to as a scoping study which is conducted in order to understand the company background, missions and the different business models operating within the focal firms. The information about the company's business environments will also be collected in this phase to gain insight about its competitive position. Phase 3 is the main study, which is conducted in order to explore the company specific resources, network configurations and capabilities required by firms to enable different types of servitized business model and also the upgrade (dynamic) capabilities required to transition from their traditional business model to an IoT-enabled business model. Phase 4 is a verification phase which involves the key informants of the focal firms to confirm the findings and conclusions of the study. The details of the four phases of the study are illustrated in Table 4.3.

Table 4.3: Phases of the study

Phase	Main Objectives	Roles of people to be contacted or interviewed Documents to be reviewed
1 **Preparation**	• To gain access to and obtain a commitment from focal firms • Identify any specific questions related to each focal firm • Finalise the approach, resources and timings for the scoping study and main study	• The point of contact of focal firms, also known as the gatekeeper • Secondary data resources including company official website and company business reports
2 **Scoping Study**	• To understand the company background and the competitive environment of the focal firms • The overview of IoT-enabled servitized offerings, provided by focal firms • Identify the key informants for the main study	• Senior management (e.g. head of digital transformation)
3 **Main Study**	• To understand the characteristics of different archetypes of IoT-enabled servitized business model, adopted by focal firms • To understand the operational capabilities required to adopt a particular type of IoT-enabled servitized business model • To understand the network configuration adopted to support a particular type of IoT-enabled servitized business model • To understand the capabilities required to transition from their product-based business model to an IoT-enabled servitized business model	• Key informants identified during the scoping study (e.g. product owners, digital transformation managers, IT manager) • Secondary data resources, including company report, practice-oriented journals, consulting reports
4 **Verification**	• Verify the analysis and findings of the study with the focal firm	• The key informants within the focal firms, who were previously interviewed in the scoping study or main study

The third element of the protocol is the interview protocol questions, which are considered as the most important components of the case study protocol. This protocol was used when conducting the actual interviews, and it contains the basis on which the questions were asked. It consists of a series of main headings which act as a topic guide, followed by more detailed questions. There are four main sections involved in the interview protocol: interview checklist, introduction, interview questions and end of the interview. The overview of the interview protocol is illustrated in Table 4.4.

Table 4.4: Overview of the interview protocol

Section	Description	Additional Details
1 **Interview checklist**	This includes the checklist of all items required for conducting the interview.	These items include laptop, recorder, printed copy of interview protocol, blank sheets of paper and pen.
2 **Introduction**	This section involves introducing the research participants to the interviewer's research background and objectives, informing the participants about the duration of the interview and asking for consent to record the interview.	In case the interviewee is more comfortable without being recorded, the interviewer needs to be prepared to ensure that the key information related to the research question is noted during the interview and repeated to the interviewee if unclear. The interviewer also needs to ensure that the contact sheet is established as soon as possible after the interview.
3 **Interview questions**	The first part of the interview questions is related to the context of the research. These questions are associated with personal history, organisational background and business environments, in order to understand the real-life context of the study.	• Personal History: Role and history • Operating company's mission, vision and company values • Size and business scope • Industry structure • SWOT Analysis
	The second part of the interview questions is related the to the characteristics of IoT-enabled servitized business models (i.e. RQ1), the strategic resources (i.e. RQ2), the operational capabilities (i.e. RQ3) and the network configurations (i.e. RQ4) required to implement IoT-enabled servitized business models.	• Main characteristics of business models: value proposition, customer relationship, pricing, order winning criteria • Strategic resources: core assets, locations and ownership • Operational capabilities: business process, governance, organisational design and performance management • Network configurations
	The third part of the interview questions aims to understand the dynamic capabilities (i.e. RQ5) required to transition to IoT-enabled servitized business models.	• Dynamic capabilities - Sensing - Seizing - Transforming
4 **End of interview**	This section involves concluding and finalising the interview. It also includes asking the interviewee for the contact details of the key people mentioned during the interview as prospective participants for future interviews.	Thank the interviewees for agreeing to participate in the research and also ask whether they would like to be informed about the case study results.

The fourth section is the reporting protocol which includes the plan to bring the case study results and findings to closure. The main audiences for the case study report in this thesis are the case companies, academic community and practitioners. This will be detailed in Section 4.3.5 reporting case studies (the fifth stage of the case study research process).

4.3.3 Data Collection

Yin (2009) identifies three main principles which help to maximise the benefits of using different sources of evidence and strengthen the data collection phase: use multiple sources of evidence, create a case study and maintain a chain of evidence. The application of these principles to the studies in this thesis will be discussed in the following sections.

4.3.3.1 Use of Multiple Sources of Evidence

Data collection is part of conducting fieldwork. As discussed previously, the primary research instrument used for the case study research was semi-structured interviews and these were developed in line with an interview protocol. First, private space was identified in which to conduct the interview. Since the major form of interviews was the online call, the area for conducting the interviews also had to be covered with an Internet connection. The second step is to request the interviewees for the interview to be recorded, approximately 95% were recorded. The author also took additional notes during the interviews.

Miles and Huberman (1994) suggest that notes taken during the interview be turned into a contact summary sheet for capturing the main points. A contact summary sheet, which includes the summary of the answers for main questions and main themes or issues raised during the interview, was then developed within 24 hours after each interview. The format of the contact summary sheet, suggested by Miles and Huberman (1994) is presented in Figure 4.5. Additionally, all interviews were transcribed to enable the accuracy of the contact notes. They were checked against the actual interview dialogue in case of an unsure detail or when further detail was required.

Fieldwork - Contact Summary Sheet

Interviewee		**Contact sheet no.**	
Job title		**Date**	
Contact details		**Location**	

1.0 Interview Background

2.0 Main Issues or Themes Arising

3.0 Summary of Information Gathered

4.0 Other Salient, Interesting, Illuminating or Important Aspects

5.0 New/Outstanding Questions for Next Visit

6.0 Secondary Data

Figure 4.5: Template of the contact summary sheet

Secondary data in the form of documentation (e.g. company business reports, used case reports) and archival records (e.g. organisational chart, data flow diagrams) were sought for data triangulation, where possible.

However, as this research topic is considered as an emerging one, the author also realised the possible bias of obtaining the main information from the selected interviewees of particular cases and the issues of having them engaged with the author's research. Due to the intensive competition with other firms within the same industry, particularly those indicated within the mature industry, they tend to preserve, protect and not disclose the real information of their business to the public and academic researchers and hence, secondary resources become more relevant and had greater potential to obtain information about the firm (Reddy and Agrawal, 2012). Accordingly, in the case of PrintCo, the author first became engaged with the senior manager of the firm, who is considered to be the expert on the research topic, for the interview. Secondary data resources (including company business reports, research papers, and relevant documentation) which were recommended directly from the interviewee were collected as main sources of evidence. The additional relevant secondary resources, which are publicly available, including company press releases, consulting reports and practice-oriented research journals (e.g., Harvard Business Review and Quocirca) were also collected as main sources and found appropriate and useful in answering the author's research questions (Beverland and Lindgreen, 2010; Boehmer et al., 2020). This is also in line with other studies who draw on the expert interviews and use secondary data to supplement the interview data and expand the breadth and depth of data available for analysis (cf. Coreynen et al., 2017; Herterich et al., 2016; Naik et al., 2020)

To ensure the quality and validity of the collected secondary data, the expert interviewee was re-contacted to corroborate the collected information and other additional details. This process helps to ensure the quality of collected secondary data and also aids data triangulation (Yin, 2009).

4.3.3.2 Create a Case Study Database

In order to organise and document the primary and secondary data sources, a case study database was established. All contact notes and secondary data sources were kept in an electronic format. A summary of case study documents was formed in a word format and stored in the project folder. In order to reference the specific case study, each interviewee was allocated a pseudonymised code against the case number. For example, the interviewees from FuelRetailCo will begin with number 1 those from PrintCo will begin with number 2, followed by the number of interview order. Contact notes and audio-recorded interviews were also numbered in line with the interviewees in order to be able to trace back to them when needed. Secondary resources (including documentation and archival records) were also numbered, likewise. An example of the part of the case study database for FuelRetailCo is illustrated in Table 4.5. A full detailed summary of the FuelretailCo's case study database is attached in Appendix B.1 and a full detailed summary of PrintCo's case stady is attached in Appendix B.2.

Table 4.5: Summary of the case study database: FuelRetailCo

Interviewee	Role of interviewee	Date and Location	Duration (hr and min)	Reference	Documentary evidence
IN1-01	Global digital payments manager and chief product owner	15/05/2019 Skype meeting	1.08	R1-01, F1-01, T1-01, C1-01	Company's official website (DC1-01)
IN1-02	Digital transformation lead	24/05/2019 Skype meeting	0.45	R1-02, F1-02, T1-02, C1-02	Company's official website (DC1-02)
IN1-03	Global B2B digital payment product owner	30/05/2019 Skype meeting	1.14	R1-03, F1-03, T1-03, C1-03	Company's presentations and process map (DC1-03)
IN1-04	Digital transformation manager	10/06/2019 Skype meeting	0.55	R1-04, F1-04, T1-04, C1-03	Company's official website (DC1-04)_
IN1-05	Global innovation manager	03/07/2019 Skype meeting	0.53	R1-05, F1-05, T1-05, C1-04	Company's brochure (DC1-05)
IN1-06	Business PMO	10/07/2019 Skype meeting	1.00	R1-06, F1-06, T1-06, C1-06	
IN1-07	Head of digital channels	12/07/2019 Skype meeting	0.49	R1-07, F1-07, T1-07, C1-07	
IN1-08	IT manager	01/08/2019 Skype meeting	0.57	R1-08, F1-08, T1-08, C1-08	
IN1-09	Digital transformation manager	01/10/2019 Skype meeting	0.49	R1-09, F1-09, T1-09, C1-09	Company's official website (DC1-09a), News article (DC1-09b)
IN1-10	CEO of a digital service	04/10/2019 Skype meeting	0.45	R1-10, F1-10, T1-10, C1-10	Company's official website (DC1-10a), company's video presentations (DC1-10b)
IN1-11	Global CR commercial manager	29/11/2019 Skype meeting	0.30	R1-11, F1-11, C-11	
R - Recorded audio file, F –Field notes, T- Transcript, C – Contact Sheets, DC - Documentation					

4.3.3.3 Maintain a Chain of Evidence

A chain of evidence illustrates the reliability of the information in a case study. The main purpose of this is to allow the audience to derive any evidence from initial research questions to final case study findings. The chain of evidence for this study is the documents (i.e. contact notes, transcripts from the audio recordings and secondary data) stored within the case study database which evidently support the findings in the case study report. The case contact notes are considered to be the major part to illustrate a chain of evidence, an example of a contact note of one of the interviewees is given in Appendix D.1. The inputs to this are the primary data in the form of field notes, transcripts and secondary data in the form of archival and documentary evidence.

The analysis of the contact notes, transcripts and secondary data was then formed as the input to the final case study reports. These showed a chain of evidence for individual cases. These will be discussed in more detail in Sections 4.3.4, analysing case studies and 4.3.5, reporting case studies.

4.3.4 Analysing Case Studies

The approach to analysing case studies for this thesis corresponds to the reporting protocol. Essentially, the research may start from developing a general strategy as a guide through data analysis, after which the analytic techniques can be considered (Yin, 2009).

The strategy selected by the author is to use theory to analyse case studies which is one of the general strategies proposed by Yin (2009). He suggested that the theoretical framework developed at the initial stage of case study research reflects a set of research questions and the related review of existing literature and hence, this would have yielded analytic priorities. The author's conceptual framework started with four archetypes of IoT-enabled servitized business models as a result of conducting an SLR while the underpinning theories and the extensive literature were combined to explain what resources, operational capabilities, network configurations and dynamic capabilities (see Chapter 3) are required to implement IoT-enabled servitized business models. Accordingly, this framework will be used to organise the data analysis of the corresponding embedded unit of analysis for the two case studies.

Regarding the consideration of analytic techniques, Miles and Huberman (1994) suggested content analysis as one of the applicable methods for case study analysis. The main principle of this process is a matrix format that captures the themes and codes on the premise of the theoretical data. These codes can be developed basing on three positions from which the research has been started: the first is to have predefined codes/a priori codes based on the theoretical position of the research; the second is to develop codes after some initial data have been explored; the third is to take a halfway position with some initial codes (possibly from the interview questions) and refine them after exploration of the data.

In line with the first position, template analysis will be used in analysing data collected from the two case studies. Template analysis involves the development of a coding template, and summarising the themes identified by the researcher through the initial framework. The coding template helps to organise those themes in a meaningful and useful manner. Yin (2009) refers to the use of template analysis based on predefined codes such as pattern matching, which is considered to be one of the most favourable techniques for case study analysis. This involved comparing the empirically-based pattern (which is based on the case study findings) with a predicted one (which is based on the predefined codes given by the theory).

This approach supports the critical realist epistemology, as the predefined codes are developed to understand both the observable phenomena (empirical domain) and the unobservable underlying mechanisms (real domain). Besides, in line with the abductive research methodology, using the exploration of empirical data, the author can test the existence of the unobservable mechanisms matching the conceptual framework. In each case, the main study data were analysed against the template developed for individual cases. The template of analysis used for individual cases is included in Appendix C.

4.3.5 Reporting Case Studies

The final aspect of case study research is dissemination which involves reporting the results and findings to the targeted audience (Yin, 2009).

The initial conceptual framework derived from the SLR was disseminated to the wider academic community in operations management research through a presentation at the EurOMA International Conference in 2018. The ultimate conceptual framework for the case study research was then accepted to be published in the Industrial Marketing Management Journal in 2019. The results of the case studies were submitted to the POMS international conference in 2020. The details of existing publications are detailed in Table 4.6. The author also reported the case study findings from secondary data sources to the case companies to validate the case study results.

Table 4.6: Publications of the research findings

Academic publications	
Journal	**Description**
Suppatvech, C., Godsell, J. and Day, S. (2019). "The roles of internet of things technology in enabling servitized business models: A systematic literature review"	Accepted for publication in Industrial Marketing Management Journal (IMM)
Conferences	**Description**
Suppatvech, C., Godsell, J. (2019) "An exploration of how product-based firms transition to IoT-enabled servitized firms: Dynamic capabilities perspective"	Accepted for POMS 2020 annual conference
Suppatvech, C., Godsell, J. and Ignatius, J. (2019). "The roles of internet of things in enabling servitized business models: A systematic literature review"	Accepted and presented at the EurOMA 2018 international conference in Budapest, Hungary

4.4 Validity and Reliability of the Research Design

A detailed overview of the 5-stage case study research process has been provided in Section 4.3. In order to ensure the rigour of the research design, four basic tests which have been commonly used in the field of social research were assessed. These tests are summarised in numerous textbooks (see Yin, 2009, p.40):

- ***Construct validity:*** Identifying correct operational constructs for the concepts which are being studied.
- ***Internal validity:*** Developing a causal relationship, by which certain conditions are believed to lead to other conditions, as distinguished from spurious relationships.
- ***External validity:*** Establishing the domain to which the findings of the study can be generalised.
- ***Reliability**:* Illustrating that the processes of the study (e.g. data collection procedures) can be repeated, with the same results.

These four tests correspond to different phases in the case study research, as illustrated in Table 4.7. This model was used in this thesis as a checklist to ensure that appropriate tactics have been applied to maintain the quality of the case study research.

Table 4.7: Case study tactics for four design tests

Tests	Case Study Tactic	Employed for this PhD study	A phase of case study research in which the tactic occurs
Construct Validity	• Use multiple sources of evidence • Establish a chain of evidence • Have key informants review a draft case study report	Yes Yes Yes	Data collection
Internal Validity	• Do pattern-matching • Do explanatory building	Yes Yes	Data analysis
External Validity	• Use literal replication logic	Yes	Research design
Reliability	• Use a case study protocol • Develop a case study database • Maintain a chain of evidence (Appendix D)	Yes Yes Yes	Data collection

4.5 Research Ethical Considerations

Ethical considerations have been thoroughly addressed in this research. Prior to commencing the data collection, ethical approval was applied for to conduct this study. The application consisted of the research protocol, the participant information leaflet (PIL) and the consent form (see Appendix E for PIL).

The research protocol was developed following the university guidance and regulations. It highlighted the background of the research, research design and ethical considerations during data collection, data analysis and the publication of the findings, such as confidentiality of an individual participant and organisational identity.

The PIL and consent form played an important role before starting the data collection. These were sent out to the individual research participants before conducting the interviews to ensure that they were aware of how the data were to be used in this research. The details included the purpose of this research, the data security, how the identities of participants and their organisations have been kept confidential in the research outputs, the participant's right of withdrawal and data dissemination. The consent form had to be signed by research participants before giving the interviews.

The application submitted for ethical approval by the Biomedical & Scientific Research Ethics Committee (BSREC) of the University of Warwick, and ethical approval was granted to this research. The reference number is REGO-2019-2356 dated 26th of February 2019 (see Appendix F).

4.6 Summary of the Chapter

This chapter presented the second phase of the author's abductive research design which is the use of the case study method to conduct the empirical study. An embedded multiple case study research was chosen as the case study design and the process for conducting case study research presented in Yin (2009) was discussed.

Subsequently, the research parameters involved in the study were discussed and the unit of analysis was selected. The two cases are the individual firms and their embedded units of analysis are the different types of IoT-enabled servitized business models. The major instrument for collecting data was the semi-structured interview protocol and secondary data were also combined to aid data triangulation. A case study database was established in order to store all the recorded interviews and contact summary sheets. Template analysis was selected as the method for data analysis, which was developed based on the predefined codes and using pattern matching logic. In order to ensure the rigour of the research design, four tests, i.e. construct validity, internal validity, external validity and reliability have been conducted.

5 Case 1: FuelRetailCo – Investigation of the Add-on Business Model

5.1 Introduction to the Chapter

This chapter investigates four embedded units of analysis within FuelRetailCo. It focuses on the characteristics of business model firm resources, operational capabilities, network configurations and the dynamic capabilities required to implement the add-on business model.

There are three parts to this chapter following the introduction. The overview of the FuelRetailCo and their product-offerings is presented in Section 5.2. Section 5.3 presents the results of the case study; this section discusses the results based on the template (template analysis) developed against the conceptual framework for the case study. Section 5.4 presents the summary of the chapter.

The structure of Chapter 5 is shown in Figure 5.1.

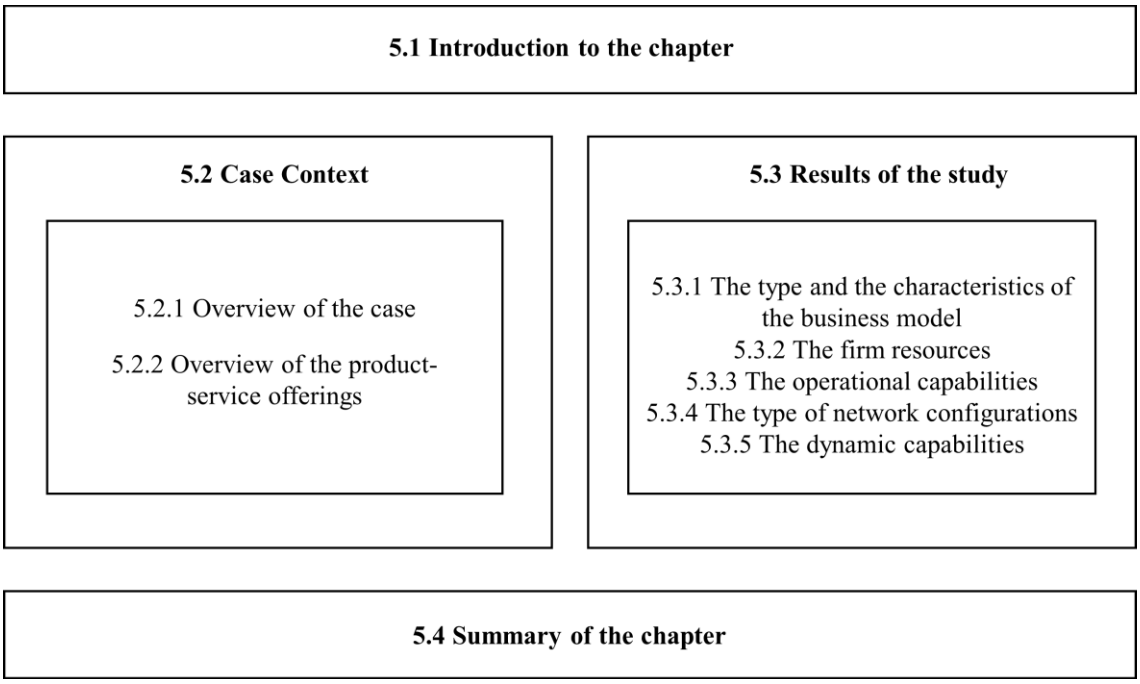


Figure 5.1: Structure of Chapter 5

5.2 Case context

5.2.1 Overview of the case

The case company, referred to FuelRetailCo operates in the oil and gas industry and is one of the world's largest independent energy companies. FuelRetailCo is currently headquartered in Europe and has operations in over 70 countries or markets worldwide. There are approximately 44,000 petrol station sites globally, and more than 1000 petrol station sites in the UK, served by FuelRetailCo.

FuelRetailCo is organised mainly into four business areas: upstream, integrated gas (including new energies), downstream, and project and technology. The *Upstream business* is responsible for conventional oil and gas businesses globally including the exploration and extraction of crude oil, natural gas and natural gas liquids. The *Integrated gas and new energies* manage the manufacturing and distribution of LNG and gas-to-liquid products which include new energy and low carbon energies. The *Downstream business* manages different oil products and chemical activities, including distribution, trading and marketing activities. Their oil products are sold around the world for domestic, industrial and transport use and their petrochemicals are used by industrial customers. The *Project and technology* organisation is responsible for the delivery of projects and drives research and innovation to develop new technology solutions. It also provides technical services and technology capability for the other three areas. The full details of FuelRetailCo's business activities are illustrated in Figure 5.2.

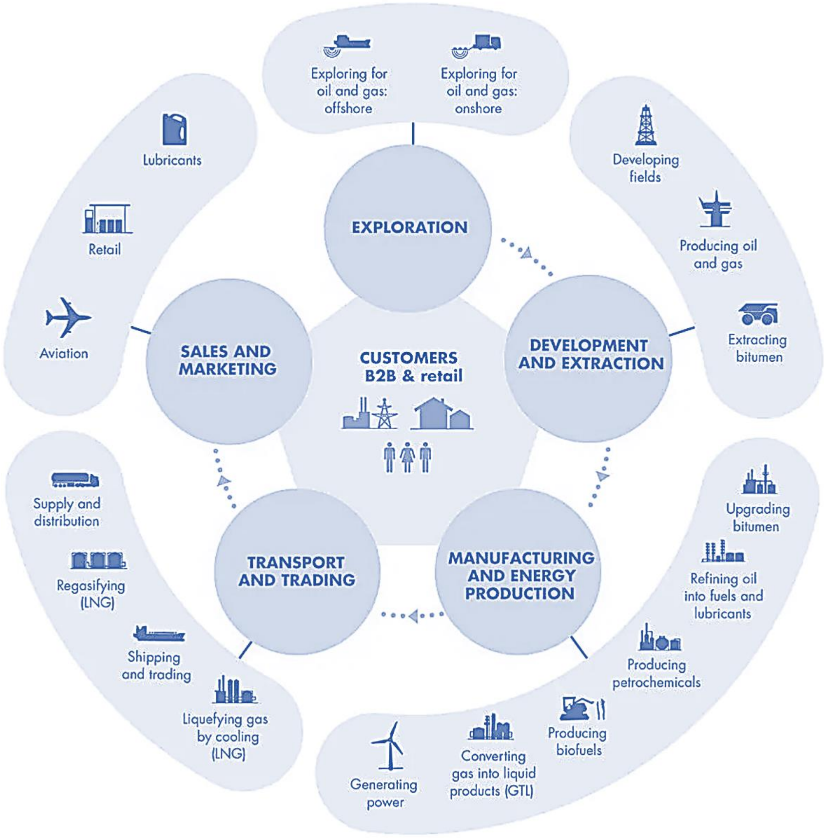


Figure 5.2: FuelRetailCo's full details of business activities

The retail business is sitting in FuelRetailCo's downstream business which includes FuelRetailCo's sales and marketing activities. This business part of FuelRetailCo was selected to be the main focus of the specific case in this research because the company provides the products and service offerings (including fuel and grocery products in the retail shops) and interacts directly with the business customers and end consumers. Their retail business involves developing new business models, in response to digitalisation in order to improve customer experiences.

In order to understand the business context of the case, two key elements were investigated and explored. First, the company mission was thoroughly explored to understand how FuelRetailCo positions the strategy of their retail business. Secondly, an overview of the firm's environment in which FuelRetailCo operates in the retail business based on a SWOT analysis was examined.

5.2.1.1 Company mission

The overall company mission of FuelRetailCo is to be the global energy provider for the consumer. In the retail business, there are specifically five core missions:

- To treat every customer as a guest when they come to the service stations.
- To commit to a reduction of waste and find a way to serve customers in a more efficient way, which also somewhat benefits local communities, within the service station.
- To reduce carbon intensity from the operations and look at ways to make the operation carbon neutral around the service stations.
- To increase fuel merchants of low emission energy such as biofuels and alternative fuels.
- To increase the margins not only from fuel but also from non-fuel retail business such as the goods sold on service sites.

Overall, FuelRetailCo's retail business is currently considered as growing. As the Chief Product Owner (IN1-01) stated *"Our business is growing and it grows because of a number of reasons and obviously because we are focusing on, not just because of the cost elements but also expansion. So we are expanding in a number of markets that we operate in, that bring us new customers, that bring us new volume, and also new revenue."*

This statement illustrates that their current strategy is not only to reduce costs in their operation in order to stay competitive in the market but also they aim to explore new ways to expand the market and develop a new business model to generate additional revenue.

5.2.1.2 Overview of the firm's environment

FuelRetailCo's main competitors historically were other oil and fuel majors and local oil providers in different countries. However, since FuelRetailCo started to look at the energy transition and recognise the rise of digitalisation across all areas of the economy, their competitors now come from different forms. Overall, FuelRetailCo currently has direct competition with not only oil and fuel majors but also anybody that offers energy to consumers. In the digital space, where FuelRetailCo offers digital payment services for its customers, the competitors could also come from different energy provider that have Application Programming Interface (API) opened to alliance customers to transaction on the forecourt. In addition to the competitors in oil and fuel majors, FuelRetailCo is also in competition with other retail companies.

In order to understand FuelRetailCo's business environments, it is important to look at FuelRetailCo from both internal (strengths and weaknesses) and external (opportunities and threats) perspectives through a SWOT analysis. This was conducted by three interviewees as part of a scoping study.

Strengths: FuelRetailCo's main strength is the brand and the infrastructure of retail service stations. FuelRetailCo is a trusted retail brand and instantly recognised by customers as the biggest retail network globally which allows a lot of purchasing power. This also means that they attract large customers and strategic partners to collaborate with the company. Another main strength is FuelRetailCo's organisational structure in which they can manage different holding companies within the business under one ambition and one vision.

Weaknesses: Since the size of FuelRetailCo's organisation is large, even within the retail business, decisions take a long time to happen when compared to local start-ups. This also results from the red tape as there are various procedures to follow within the organisation and these need to be scrutinised before any transformation can take place. Furthermore, the legacy of the existing IT infrastructure and the system on service sites makes it difficult for FuelRetailCo to successfully deliver digital products or services as it takes a long time and is expensive. Different countries also have different point-of-sale systems and to build digital products would require integration with the site system, which is complex and takes time to put network coverages into all site stations.

Opportunities: The energy transition is a big opportunity for FuelRetailCo. There is also an opportunity to establish a direct relationship with customers through digital channels. This also allows FuelRetailCo to create digital products or services, fitting the way that individual customers want to interact with the company. Accordingly, there is an opportunity for FuelRetailCo to offer customers a choice of transaction on the platform that is the most convenient for them. Currently, they cannot only pay for fuel at the retail store or through the mobile application but also on their car platform.

Threats: Threats are from new start-ups that are developing new ways and new business models within energy. For example, the company that delivers fuel directly to the customer and bypasses service stations. Sometimes, because of the scale, it means FuelRetailCo is not as fast as the local start-ups. Furthermore, there is a threat from the amount of speed in not only the energy transition (i.e. the use of electrification instead of hydrocarbon) but also the digital transition. Therefore, FuelRetailCo needs to keep up with the pace of change in the market. Because, if customers own electric vehicles, they will be no longer need to go to the petrol station unless they are planning a long journey. One of the key challenges is also from the legislation and laws regarding customers' data privacy, as digital offerings tend to require access to customers' personal information such as vehicle registration number.

Overall, FuelRetailCo's main strengths are their brand reputation and their large network of service stations. Their main weaknesses are their large size of organisation and a legacy of IT infrastructures which result in the amount of time taken to implement digital products or services. The main opportunity for FuelRetailCo is to establish direct relationships with customers through digital products and service offerings. Finally, the main threats come from new small companies (i.e. start-ups), which deliver similar service offerings, and the company's response to digital disruption.

5.2.2 Overview of the product-service offerings

In FuelRetailCo's retail business, two main types of products are offered at their service stations, including fuel and grocery products (e.g. food, snacks and beverages). The traditional way for a customer to purchase fuel is to come to the service stations and then leave their car to pay for the fuel at the retail shop. The conventional way of purchasing grocery products from FuelRetailCo is to come to the closest service station and enter the retail shop to buy grocery products such as food and beverages. However, with the aid of IoT or what the FuelRetailCo call 'digitalisation', FuelRetailCo is able to offer customers their digital service offerings, improving customers' experiences in purchasing fuel or grocery products. This thesis will focus on four digital services offered by FuelRetailCo, including fill up and go, digital payments for fleet solutions, on-demand food delivery, and on-demand fuelling service.

5.2.2.1 Fill up and Go

Fill up and Go offers a business-to-consumer (B2C) facility to make a cashless payment for their fuel through the mobile application on their smartphones or connected car dashboard, allowing them to pay for fuel directly from their vehicle. The process includes the customers to drive up to the service station and geo-locate to identify the site they are at and then put in the pump number. The customer's account is then pre-authorised to ensure that they have got sufficient funds for the fuel that they will take. Once the pre-authorisation is completed, the pump is automatically unlocked for the customer to use. Customers can then get out of the car and refill their vehicles. When they put the nozzle back into the pump, this will send a completion message back to the system. The customers will finally receive a confirmed message, giving them the confidence to drive away. Fill up and Go is one of the first proper customer-facing digital transformation services offered by FuelRetailCo.

In terms of the strategic role of IoT used to enable Fill up and Go, FuelRetailCo leverages the smoothing role of IoT as suggested by Gerpott and May (2016). This means IoT helps to initiate the transaction and facilitate the service provision by smoothing the process of fuel payments. Regarding the operational roles of IoT discussed in Suppatvech et al. (2019), the roles of IoT in Fill up and Go are remote control (to unlock the fuel nozzle) and to track and report the information (e.g. pump number and amount of the fuel consumed) remotely.

5.2.2.2 Digital payments for fleet solutions

Digital payments for fleet solutions refer to the digital payments which are similar to Fill up and Go but this offering is specifically for FuelRetailCo's business-to-business (B2B) customers. There are three customer segments within the B2B space. First is fleet customers, which include the companies where their employees have got fuel cards from their employers. This fuel card can be configured in the mobile application, allowing them to pay from their mobile phone.

Second is Commercial Road Transport or CRT. This type of customer usually has their own telematics device (i.e. truck infotainment). FuelRetailCo offers API which allows the company's truck drivers to pay for fuel directly through truck infotainment when they are working for business purposes and/or abroad, rather than using their private mobile phone.

Third is indirect customers, which are car leasing or car rental companies. These companies have their own mobile application as a channel for communication with their own customers. FuelRetailCo offers API integration which allows those customers to purchase fuel from the car rental's mobile application but at FuelRetailCo's service sites. The customers do not pay for fuel to FuelRetailCo as fuel is covered in the car rental agreement but these transactions will be recorded in real-time and sent to car rental companies at the end of the invoicing cycle.

Similar to Fill up and Go, Gerpott and May's (2016) strategic role of IoT used to enable digital payments for fleet solutions is smoothing, where IoT helps to smooth the process of fuel payments. Regarding the operational roles of IoT discussed by Suppatvech et al. (2019), the roles are similar to Fill up and Go which is remote control (to unlock the fuel nozzle remotely) and to track and report the information (e.g. pump number and amount of the fuel consumed) remotely.

5.2.2.3 On-Demand food delivery

On-demand food delivery is the online food delivery where customers can purchase convenient retail products from FuelRetailCo's sites online and have them delivered to their place. The customers can send their orders to the nearest FuelRetail's site through local third-party delivery's online platform. The orders will appear on the device on a particular FuelRetailCo's site and will be packed by site staff. The delivery will then be made to the customers by the local third party delivery providers which are vary from market to market.

Gerpott and May's (2016) strategic role of IoT used to enable the on-demand food delivery service is smoothing, where IoT helps to facilitate and smooth the process of ordering and purchasing food and groceries. Regarding the operational roles of IoT discussed by Suppatvech et al. (2019), the roles of IoT are to track and report the information remotely (e.g. the location of the nearest available site, the location of the drivers and the exact delivery time).

5.2.2.4 On-demand fuelling service

On-demand fuelling service refers to the mobile fuelling service which is offered to both B2C and B2B customers, meaning that FuelRetailCo will directly deliver fuel to customers' vehicles without them coming to service stations. For B2C customers, they can schedule fuel delivery online or through the mobile application. They have to enter the date, time and location they want it to be delivered, the type and amount of fuel, and their vehicle plate number. FuelRetailCo will then come to the customers' vehicle and fill it up with fuel. Once it is completed, this real-time information and transaction will be sent directly to the customer. Similarly, B2B customers such as car rental or car-sharing companies and last-mile delivery companies will experience the same process in terms of the service, but they can request a flexible invoicing cycle (e.g. monthly or fortnightly).

Gerpott and May's (2016) strategic role of IoT used to enable the on-demand fuelling service is smoothing, where IoT helps to facilitate and smooth the process of purchasing fuel. Regarding the operational roles of IoT discussed by Suppatvech et al. (2019), the roles of IoT are to track and report the information remotely (e.g. the current location of fuel vehicles, the transactions and invoice information).

A summary of the four main FuelRetailCo's IoT-enabled product-service offerings is illustrated in Table 5.1.

Table 5.1: IoT-enabled product and service offerings provided by FuelRetailCo

Service offering	Description	Customer(s)	Role of IoT	
			Strategic	Operational
Fill up and Go	The service that allows customers to purchase fuel and fill up from their vehicles through FuelRetailCo's mobile application or connected car dashboard.	B2C	Smoothing	• Remote control • Track and report real-time information remotely
Digital payments for fleet solutions	Enhances the similar digital payment solution (Fill up and Go) for B2B customers. Fleet drivers can pay directly through their truck infotainments. Partners with car rental companies to include fuel costs in their rental contracts with consumers.	B2B (3 main segments: fleet customers, commercial road transport (CRT) and car rental companies)	Smoothing	• Remote control • Track and report real-time information remotely
On-demand food delivery	Partners with third-party delivery service providers and uses their online platform and their drivers to deliver grocery products from FuelRetailCo's convenience store to customers	B2C	Smoothing	• Track and report real-time information remotely
On-demand fuelling service	Mobile fuelling services in which FuelRetailCo directly delivers fuel to consumers and businesses. This allows consumers and businesses to conveniently schedule orders for fuelling and other additional services for their vehicles.	B2C and B2B (e.g. car rental/car-sharing companies and last-mile delivery companies	Smoothing	• Track and report real-time information remotely

5.3 Results of the Study

5.3.1 The Type and the Characteristics of the Business Model

This section will focus on the four IoT-enabled servitized business model implemented by FuelRetailCo and their associated characteristics.

5.3.1.1 Fill up and Go

Fill up and Go involves improving customers' service experience when they come to purchase fuel at the service stations and utilises digital elements to enable the digital payments to facilitate the service provision for their customers. Therefore, Fill up and Go is considered to be a servitized business model. In addition, fill up and go was implemented as the add-on service to improve the process of purchasing fuel and this illustrates an add-on business model within the IoT-enabled servitized business model archetypes found in the literature.

Regarding the value proposition, the head of digital transformation (IN1-02) highlighted that:

"They (customers) want to interact with us (FuelRetailCo) seamlessly between digital channels and physical channels and we want to treat customers like a guest. No matter how they choose to interact with us, whether that's physically coming into our locations or whether that's interacting with us digitally."

The value proposition for customers is to have more options in order to purchase fuel. Fill up and Go allows them to pay on site or in their vehicle without queuing up at the retail shop if they do not want to buy grocery products. Accordingly, the main value proposition focuses on providing a range of options for the customer to purchase fuel.

In terms of pricing, the customers pay the same amount as if they go into the service stations. However, the chief product owner (IN1-01) stated that:

"To the customer, it is whatever the pole sign said the price of the fuel is, that what they pay. From our perspective, it costs us more to transact through digital than it does in the store. And that's because it's an over-the-air transaction and obviously in store you got a customer card presented transaction. You also get varying prices depending on the different method of payment that you have."

She also mentioned that the customers who use the digital payment have a double propensity to purchase premium fuel, helping FuelRetailCo to offset those costs. However, in terms of FuelRetailCo's relationship with customers, this is transactional but tends to retain the same groups of customers through satisfying customers with a digital service.

By using Fill up and Go, customers will safely pay for fuel as they do not necessarily leave the car, and walk around in the forecourt to go and pay at the retail shop. Hence, this is more convenient to customers. They will also spend less time at the service station which improves the availability of the pump for other customers to fill up. Therefore, the OW criteria for Fill up and Go is to purchase fuel with a good digital service experience.

5.3.1.2 Digital payments for fleet solutions

Similarly to Fill up and Go, digital payments for fleet solutions aim to provide B2B customers who have large numbers of vehicles and drivers, better fuel management. This business model is a servitized business model, as the digital payment is integrated into the purchase of fuel as the add-on digital service. Accordingly, this business model can be refers to the add-on business model found in the digital servitization literature. There is an additional value proposition offered to B2B customers.

The product owner of the B2B digital payments (IN1-03) mentioned that:

"These days, the option of payment are not strictly on mobile, you can use smart watches or whatsoever for payment. In B2B space, there are certain partners that offer telematics solutions. You can imagine that in the truck, you got like a board computer, with the telematics solution which is a device, all the solutions that capture all the telemetry data from the vehicle, such as evaluating your driver behavior and something like for better efficiency and so on. So, you can run this type of payment even from this type of devices. Because since we are exposing the service from an API and is actually third party and these partners can just develop their own user's experience."

He also added that:

"We believe it's more convenient for the drivers as these drivers that are simply on a fuel mission, fuel only mission, so they want to fill up and disappear from the site as soon as possible."

Accordingly, the value proposition of this service is to offer various options for customers to purchase fuel. This helps the B2B customers to obtain the fuel quickly and safely, allowing them to have a better focus on their core business operations.

In terms of pricing, FuelRetailCo can monetise this service in two ways as the product owner of B2B digital payments (IN1-03) mentioned that:

"One is that we simply monetise this as a service so let's say a monthly fee or certain fee per virtual card and so on or even we could think of some fee per transaction which no one likes by the way. The other thing is that we still… if you get more customers and then it means more fuel that we sell and we would have a certain margin on the fuel so we could monetise this simply by a bigger volume being sold."

Therefore, FuelRetailCo tends to have long-term relationships with their B2B customers where they pay for fuel cost plus the monthly subscription for a service fee. However, this service is still in a pilot stage and FuelRetailCo is still working on negotiations with customers to allow FuelRetailCo to recover the investment costs within the solutions.

Accordingly, the OW criteria are similar to Fill up and Go where FuelRetailCo developed this service, aiming to improve the overall experience of the B2B customer in purchasing the product (fuel). As the product owner of the B2B digital payments (IN1-03) stated:

"It's really important that this whole user experience can be done while you are sitting in a car. The transaction process is being designed in such a way that you just start this transaction while sitting in a car."

5.3.1.3 On-demand food delivery

The on-demand food delivery business model aims to deliver the products which are sold at the retail site including food, snacks, and beverages to customers at their home or workplace by using third party delivery providers. This service is integrated into the traditional business model which involves customers coming to the retail site to purchase grocery products. Therefore, this is considered to be a servitized business model, where IoT is used to enable this service and is an add-on to the traditional way of purchasing the products. This refers to the add-on business model within the IoT-enabled servitized business model archetypes found in the literature.

The value proposition of on-demand food delivery is to deliver products to customers without them coming to stores through online ordering, as the product owner of on-demand food delivery (IN1-09) mentioned:

"So, we thought if people are willing to pay a premium for having something fast, having something very convenient how can we get our - instead of them having to come to our service stations, we can probably deliver something to them. So, that you change the customer journey."

Regarding the pricing, FuelRetaillCo puts a premium price on the products and the customer also has to pay the delivery fee. The reason for that is, as she mentioned:

"He (customer) would pay slightly more for the product itself plus a delivery fee to kind of offset the costs for the delivery."

In line with the value proposition, the OW criteria of the on-demand food delivery business model are to deliver with convenience and speed for customers to obtain the product. This is because this offering aims to deliver the grocery products to the customer's home or workplace at a time convenient to them

5.3.1.4 On-demand fuelling service

The on-demand fuelling service providesa flexible infrastructure to deliver and fill up with fuel and other additional services such as tyre pressure checks and cleaning services to both B2C and B2B customers. The customer can schedule this service, using the mobile app. IoT enables FuelRetailCo to smooth their service operation and allow customers to track the progress of service delivery as well as invoice processing in real-time. This means FuelRetailCo provides the digital service as an add-on since the core offering still focuses on fuel. Hence, this current business model can be considered as the add-on business model based on the digital servitization literature.

The main value proposition for this service focuses on delivering fuel to the customers through the digital service offered as well as other related services to the customers without them coming to the service stations. This also aligns with their mission which is to serve their customers in a more efficient and greener way as the CEO of on-demand fuelling service (IN1-10) mentioned:

"…the proposition there is we are part of the energy transition by providing more cleaner fuel to the customer and also reducing kilometres and distance (from the vehicles) on the road because we are bringing the product to the customer."

Regarding the pricing, FuelRetaillCo does not charge the premium price on fuel but customers need to pay a service fee.

"…we are charging not a premium on fuel, we are charging the same price as you get from a service station. However, what we are asking for is a service fee." (The CEO of on-demand fuelling service, IN1-10)

However, for B2B customers, who own large numbers of a vehicle and may need their vehicle filled up regularly, FuelRetailCo tends to establish a long-term relationship with them. B2B customers have flexibility in terms of payment and invoicing. They can request to pay weekly or monthly.

The OW criteria of the on-demand fuelling business model are to deliver convenience and save customer time for obtaining the products and other related services through digital add-on services. As stated on the company's official website:

"Our service allows consumers and businesses to conveniently schedule orders for fueling and services for their vehicle(s). We are here to eliminate your effort and return to you the world's most precious resource: TIME. No more spending time at the fueling station every week or even the car wash! Whether you're at your daily job or owning your own fleet business."

A summary of the main characteristics of FuelRetailCo's add-on business models is illustrated in Table 5.2.

Table 5.2: Main characteristics of four business models: FuelRetailCo

Type of Business model and its characteristics	Theory	Actual Fill up and Go	Actual Digital payments for fleet solutions	Actual On-demand food delivery	Actual On-demand fuelling service
Type of Servitized Business model	Servitized business model: Product-oriented	Servitized business model: Product-oriented	Servitized business model: Product-oriented	Servitized business model: Product-oriented	Servitized business model: Product-oriented
Value proposition	Ownership of the product with digital service as an add-on	Ownership of the product with digital service (a range of purchasing options) as an add-on	Ownership of the product with digital service (a range of purchasing options) as an add-on	Ownership of the (grocery) product with digital service (online delivery service) as an add-on	Ownership of the (fuel) product with digital service (online delivery service) as an add-on
Customer relationship	Transactional	Transactional	Tends to develop long-term relationships with customers	Transactional	Transactional for B2C and tends to develop long-term relationship for B2B
Pricing	Customer pays for normal product price or at a premium price to obtain service as a complementarity	Customer pays for normal product (fuel) price (but costs more internally)	Customers can pay a monthly subscription fee or a fee per transaction, depending on negotiation	Customers pay a premium price on (grocery) products plus delivery fee	Customers pay for the product (fuel) plus service fee (for both B2B and B2C) and flexible invoicing for B2B
Order winning criteria	Feature of products, deliver products with a digital service experience	Deliver products (fuel) with a good overall service experience	Deliver products (fuel) with a good overall service experience	Deliver convenience and speed of obtaining the (grocery) products to customers	Deliver convenience and speed of obtaining the products (fuel) to customers

5.3.2 The Firm Resources

This section will focus on the alignment between firm resources and the different FuelRetailCo's IoT-enabled business models. It will focus on assets and their location, and the ownership of particular resources required for implementing the business models.

5.3.2.1 Fill up and Go

In terms of the assets and their location, the main facilities of FuelRetailCo are their large retail or service stations network. This is the biggest asset and persuades customers to come and purchase fuel from their service stations. They are distributed widely and closely to the end consumers. In terms of the IoT network, this tends to be hybrid as FuelRetailCo can control the access which is limited to their specific partners (i.e. payment service providers) to contribute to the service. In addition, in order to implement this service, the front-line site staff need to understand how the digital service works fundamentally to be able to support the end consumers when they are using the service at the site stations. As the chief product owner (IN1-01) stated:

"…the site team needs to be fully trained in what the customer is doing and in terms of what streams safe behaviours and unsafe behaviours."

In terms of ownership, FuelRetailCo is vertically integrated and owns their fuel supply chain in all areas of the oil and gas industry, including exploration, production, transport, distribution and marketing. They leverage their expertise to ensure the product quality which provides the barrier to entry and also economies of scale which allows cost advantages. However, in order to be able to offer this service, the downstream business needs to integrate partners such as different payment service providers, software providers and the POS vendors which are also different from market to market. As the chief product owner (IN1-01) IN1-01 mentioned:

"Our mobile payments platform sticks on a (name of company) which is an e-commerce channel. We have payment service providers. We have a direct API to a

company called (name of company) which is our service provider. We also maintain a direct SDK to PayPal. The mobile payment platform will talk to our site system of which, for example, in the UK you've got (name of company) and in Germany is (name of company) and in other markets it might be to (name of company), so you've got a number of different POS vendors as well."

5.3.2.2 Digital payments for fleet solutions

Similarly to Fill up and Go, the main facilities of FuelRetailCo is their large retail or service stations network which is strategically distributed close to customers. This persuades the customers to come and purchase fuel from their service station and can be considered as their strategic resources. The IoT network tends to be a hybrid network as FuelRetailCo only allows their particular business partners or B2B customers to access the service or provide the service to the end-users through the API platform.

"…we have got some platform-to-platform integration between the third party back-end system and our API platform is the borderline between our IT landscape and public Internet. So we take these kinds of APIs and make them available for the third parties on the API platform." (The product owner of the B2B digital payments, IN1-03)

In terms of people and skills, in order to implement this service, the site staff need to understand how the digital service works fundamentally to be able to respond to end users in case they have problems while using the service. As the product owner of the B2B digital payments (IN1-03) mentioned:

"You know instead of - if you run into problems, instead of calling a customer service centre or somewhere you just try to ask someone on the site because it's far easier. And that's why it is absolutely vital to have this type of knowledge, at least some basic knowledge how it works, also on the site."

In terms of ownership, this is similar to Fill up and Go as FuelRetailCo is vertically integrated and owns their fuel supply chain which is their core expertise in order to control the quality of the product. In addition, in order to deliver this service, FuelRetailCo has to integrate the service with different partners or vendors, including payment service providers and software providers.

5.3.2.3 On-demand food delivery

The main strategic facilities in order to implement this business model are their large convenience retail store network which is distributed close to the market and considered to be strategic resources. This allows FuelRetailCo to be able to deliver their fresh food or grocery products to customers from the nearest site. This offering also requires access to third-party platform service providers, which are only open to their shops or restaurants partners. Accordingly, the IoT network is hybrid. In terms of people and skills, the low skilled site staff are required to understand how the digital service and system work and also quickly respond when there are orders from customers.

Regarding ownership, FuelRetailCo is vertically integrated on their fresh food products in order to ensure the good quality of their products in every market. FuelRetailCo's GM Global Convenience Retail stated in the news article (DC1-09b) that:

"We find that in every market we need a different offer to be locally relevant. However, that's underpinned by our core values of (fresh food), which are tasty, quality and fresh. That comes out in every market."

They also have different alliances and suppliers to supply grocery products. It was mentioned in the company brochure (DC1-09b) that:

"Partnerships are key here too. Alliances with the likes of Starbucks, Costa, Red Bull, Unilever and Coca-Cola can help us extend our product offer and make our forecourts a convenient, holistic 'service station' for customers."

In terms of delivery service, FuelRetailCo partner with different third party delivery service providers who can offer both platform and delivery service. This was mentioned by the product owner of on-demand food delivery (IN1-09):

"So, we don't want to set up our own logistic, we don't want to employ our own driver so we were looking for partners that do not only offer a platform but also

platform plus delivery. And that was really something where we wanted to, like, kind of start with. So, we ended up working with (service delivery platform)."

5.3.2.4 On-demand Fuelling service

The main facilities for this business model are their mobile fuelling vehicles, as this offering bypasses the service stations and delivers fuel directly to their customers. Accordingly, FuelRetailCo is required to have sufficient staff and mobile vehicles close to end consumers' locations and also ensure that they are available when there is a demand from the customer. The IoT network for this service is hybrid where FuelRetailCo has controlled the access of partners (e.g. the car washing, car maintenance and tyre pressure checks) in delivering the service to the customers.

In terms of people and skills, the staff tend to be highly skilled as they need to employ service champions who can drive the mobile fuelling vehicles and know how to operate the service (fill up the tank) for customers in a safe manner as well as the digital transactions. As the CEO of on-demand fuelling service, (IN1-10) stated:

"In terms of HR or people, we are owning the service champion – these are employees of FuelRetailCo's subsidiary. These service champions are driving the vehicle, they know exactly how it goes."

In terms of FuelRetailCo's ownership of the business model, FuelRetailCo's upstream business is vertically integrated, meaning they own their fuel production. However, in the downstream business, in order to offer an on-demand fuelling service, FuelRetailCo also operate their service operations by themselves. This means the vehicles FuelRetailCo outsource to their partners to build their mobile fuelling vehicles and maintenance.

"We have partners who have built our vehicles right, the partner in the Netherlands is doing that for us, also the maintenance for a retail site - but overall in terms of customer delivery or vehicle drivers service champions, we are of course doing that by ourselves." (The CEO of on-demand fuelling service, IN1-10)

The summary of the firm resources required to implement the FuelRetailCo’s add-on business models is illustrated in Table 5.3.

Table 5.3: Firm Resources: FuelRetailCo's four add-on business models

The firm resources		Theory	Actual Fill up and Go	Actual Digital payments for fleet solutions	Actual On-demand food delivery	Actual On-demand fuelling service
Assets and their locations	**Facilities**	Multiple distribution channels close to market	The large network of service stations distributed close to market	The large network of service stations distributed close to market	The large network of service stations distributed close to market	• Bypass service stations by delivering service directly to customers. • Sufficient mobile fuelling vehicles close to the market
	IoT network	Open network	Hybrid network	Hybrid network	Hybrid network	Hybrid network
	People and skills	Low skilled workers with fundamental IoT-enabled product or service knowledge on front line/customer service	Low skilled workers with fundamental IoT-enabled product or service knowledge on front line/customer service	Low skilled workers with fundamental IoT-enabled product or service knowledge on front line/customer service	Low skilled staff on site with fundamental knowledge about the digital service to remotely and quickly respond to customer orders	Highly skilled workers are required (service champions are selected to deliver fuelling service to customers)
Ownership	**In-house**	Vertically integrated in product manufacture to control quality and minimise the cost of product	Vertically integrated to control quality and minimise cost (of fuel production)	Vertically integrated to control quality and minimise cost (of fuel productions)	Vertically integrated to maximise quality products (e.g. fresh food) but also partner with alliances and suppliers to extend product offers	Vertically integrated in all operational activities including product (fuel) manufacturing and service delivery (fuelling vehicles).
	Outsource/ partnerships	Integrated partners to deliver service	Integrated partners to deliver service (i.e. payment service providers and POS vendors)	Integrated partners to deliver service (i.e. payment service providers and POS vendors)	Integrated partners to deliver service (i.e. local third party platform delivery providers)	Partner with the vehicle manufacturers and integrated partners to deliver additional service (i.e. cleaning, maintenance, and tyre pressure checks)

5.3.3 The Operational Capabilities

This section will focus on the alignment between operational capabilities and the different FuelRetailCo IoT-enabled business models. This will focus particularly on the operational capabilities required for implementing different types of FuelRetailCo's business model, including business process, governance and decision rights, organisational design and performance measurement.

5.3.3.1 Fill up and Go

In terms of business processes, the upstream business, which involves fuel production and delivery to the service stations, focuses on lean practices and tries to make the business more efficient, while in the downstream business it focuses on delivering the service to the end user. Accordingly, FuelRetailCo will follow the agile practice focus to keep up with customer demands as the chief product owner (IN1-01) mentioned:

"…when it comes to digitalisation, it involves working on an agile methodology which is all about being quick and working in sprint and getting out a minimum viable product. We would like to be able to move quickly and keep up with the customer demand ultimately."

Regarding the governance and decision rights, as FuelRetailCo is a global business, the governance is a hierarchy from the whole organisation perspective. However, in terms of delivering service, the product owner (a person who is responsible for the product backlog) of this service has autonomy in making decisions in delivering service within the small, cross-functional team. The digital transformation manager (IN1-04) mentioned:

"If you look at the whole organisation, I think it's the top-down but I think, there are some certain people and elements where either myself and also product owner and the scrum team, pretty much have all autonomy on a decision. We do have some governance through a decision review board, that is a certain big decision, and the decision review board will then make a decision from our recommendations. So, I think it's a bit of both from my perspective."

In terms of organisational design, to implement this business model, FuelRetailCo sees themselves as a value facilitator as they try to leverage IoT in offering additional service that potentially improve the current offering. However, there is no direct engagement with the customers in designing or creating value for this business model.

Regarding performance management, FuelRetailCo measures the performance of Fill up and Go from the digital service rather than the products through customers' experience. The KPIs used include the number of transactions from using digital services and their value. The time dimension focuses on the time to complete the service (i.e. from the customer arriving at the pump until leaving the pump) and the quality dimension is measured through customer satisfaction and service experience by looking at customer feedback from the app review.

5.3.3.2 Digital payments for fleet solutions

Similarly to Fill up and Go, the upstream business, which involves fuel manufacture and production, focuses on lean practices in order to deliver value to the customers as efficiently as possible. However, regarding the process of designing and delivering services, FuelRetailCo tends to adopt agile practices in order to quickly develop new digital services on a small scale over a short period in order to keep up with the customer demand.

In terms of the governance and decision rights, the governance supporting the implementation of digital payments for fleet solutions is the same as Fill up and Go, which is hybrid or a mix of hierarchy and heterarchy. FuelRetailCo has a top-down directive from the global perspective to advise or gives consultancy to the local business in which the product owner has autonomy and responsibility in implementing this business model. Global innovation manager (IN1-05) said:

"…it's hybrid 100% because we're such a big company. It's hard to say which one or the other because what happens in retail is very different from what happens in global commercial which is very different from what happens in gas and power. …I would say we're local. We have a little bit of global supervision but we manage everything locally, every local business has to stand up and work for themselves."

Although the service offered in this business model is similar to Fill up and Go, the organisational design is relatively different in B2B customers. FuelRetailCo has relatively good relationships with their B2B customers and co-creates in the value creation process (i.e. during the implementation of this business model). Besides, some B2B customer segments such as car rental companies, are FuelRetailCo's customers but not the end users (i.e. the customers of the car rental companies). Accordingly, both FuelRetailCo and B2B customers are required to work together in order to have mutual understandings and benefits from providing a digital service which is also referred to as value co-creation.

Regarding the performance measurement of this business model, the main focus is on the quality of the service, which is measured through the performance of the digital service offered (i.e. uptime and reliability). In addition, the amount of user retention is also measured as well as the number of active users. The cost of delivering the service tends to be the secondary objective as stated by the head of digital channels (IN1-07):

"…(*The KPIs include) performance of the app, uptime, reliability, active users and looking at retention of users. So if we're actually able, getting customers in through the door, but later then, you know, leading straightaway that's not great for a market to be able to get value from that customer. We might also have cost KPIs we do again for the app. So, right now one of our objectives is to bring the running costs down of the app. So, our targets have to be very much about thinking about how we best support markets, you know profitability targets.*"

5.3.3.3 On-demand food delivery

Similarly to Fill up and Go and digital payments for fleet solutions, in the upstream chain, FuelRetailCo has adopted lean practices in delivering value (grocery products and convenience products) to the retail stores from the suppliers. However, in terms of the process of delivering service, FuelRetailCo focuses on the agile practices which leverage the small team to quickly implement services to respond to the demand in the potential market. As the digital transformation lead (IN1-02) explained:

"And working in an agile way with a product owner isn't much more around understanding what features are most important to the customer or the business, but focusing the team on delivering those pieces of functionality quickly. And so that there's always a product for users to give feedback on or even being in the market and continue developing those products."

Regarding the governance and decision rights, governance is the same as Fill up and Go and digital payment for fleet solutions which is hybrid, a mix of hierarchy and heterarchy, supporting FuelRetailCo to implement this new business model. Hence, the governance is hybrid where the organisation is centralised from the global perspective but the local business, particularly the product owner is empowered in implementing a similar business model across the markets. The head of digital channels (IN1-07) mentioned:

"I think broadly there's a good support for people to be able to drive their areas. But, we always get some top-down directives. I think every business does. But I also think there is support for, if we think about things like agile is empowering, product owners to be able to properly own their products and make their own decisions."

In terms of organisational design, in implementing this business model, FuelRetailCo does not involve customers in designing and delivering the digital service. FuelRetailCo focuses on identifying the potential markets and demand from this service provision. Accordingly, this type of organisational design is value facilitation.

Regarding performance measurement, the KPIs of this business model are currently focused on the sales revenues which are measured through the amount of product sold and the total worth of sales by online delivery or through digital channels at certain stores.

5.3.3.4 On-demand Fuelling service

In terms of the process of delivering the on-demand fuelling service, this is a mix of lean and agile practices. This is because FuelRetailCo follows the lean practices in the upstream chain to minimise cost and pursue efficiency as well as eliminating waste in fuel production and delivering fuel to the distribution channels or service stations. However, in the downstream business that focuses on delivering this service for the customers, agile practices are adopted to quickly respond and address the variety of the demand (i.e. the types of fuel, types of vehicles, the time scheduled and the location of customers).

Regarding the governance and decision rights, the on-demand fuelling service is operated by FuelRetailCo's subsidiary, where the CEO of the service has their own employees and decision rights in implementing the business model and product-service offering under FuelRetailCo brand. Accordingly, the governance of this business model is a mix of hierarchy and heterarchy where the CEO of the service has been empowered to make any decisions associated with the business model under the control of the parent company or FuelRetailCo. This helps to achieve agility in the business model operations.

"…this is an internal start-up and it can act outside of the FuelRetailCo framework and that is helping us to keep this agility here on this. So we have our board meeting and we have of course embedded it into the (FuelRetailCo) organisation in a sense but we can make our decisions by ourselves and that is good. Because you create a culture in your organisation, the culture is about start-up and disrupting yourself that is important here ." (The CEO of on-demand fuelling service, IN1-10)

In terms of organisational design, in order to implement this business model, FuelRetailCo required involvement and engagement from the customers, especially the B2B customers during the value-creation process. In addition, the customers have to share an insight into their operations, the types of vehicles, the amount and types of fuel needed and their expectations from the service. As the CEO of on-demand fuelling service (IN1-10) mentioned:

"….the customers, they just like want to get from A to B in the… in a car which is not running out of energy. And with this proposition we have of course customers like (example of car-sharing companies) where they are very open to speaking with us."

Regarding the performance measurement, this business model tends to focus on the time and quality dimension of service delivery. The KPIs include the total service time, customer satisfaction and service reliability. These data are stored in the cloud and collected in real-time from the customer feedback loop.

"We know of course how long by minute a service champion stays at the location. So that gets all recorded that we've had that all in our cloud and we can take that information immediately from the cloud and put it into an overview. So, we have in our dashboards - we call it 'navigator'. We have volume, we have margin, we have customers but we have also customers' satisfaction and service reliability, that means our target is 100% and at the moment we are 99.6% which means we are serving customers in the time that we are supposed to. So these are the qualitative KPIs that we have established." (The CEO of on-demand fuelling service, IN1-10)

The summary of the operational capabilities required by the FuelRetailCo's add-on business models is illustrated in Table 5.4.

Table 5.4: Operational Capabilities: FuelRetailCo's add-on business models

The operational capabilities	Theory	Actual Fill up and Go	Actual Digital payments for fleet solutions	Actual On-demand food delivery	Actual On-demand fuelling service
Process	Lean	Lean in the upstream business (Fuel and grocery products supply)			
		Agile in the downstream business (in delivering service by leveraging IoT to the end customers)			
Governance and decision rights	Hierarchy	Hierarchy - Heterarchy	Hierarchy - Heterarchy	Hierarchy - Heterarchy	Hierarchy - Heterarchy
		The product owner has autonomy in making decisions	The product owner has autonomy in making decisions	The product owner has autonomy in making decisions	The business model is funded by FuelRetailCo as a start-up and the CEO is established to make the decisions
Organisational Design	Value facilitation	Value facilitation	Value co-creation	Value facilitation	Value co-creation
Performance Management	Cost of delivering products	• Number of service usage • The value of the transaction	• Number of service usage • Cost of delivering services	• Amount of products sold by online delivery • The total worth of sales through digital channels	
	Quality of products and service	• Customer satisfaction • Service experience	• Performance of the digital service (app) • Retention of the user		• Customer satisfaction • Service reliability
	Speed of product delivery	• Time to complete the service	• Time to complete the service		• Time to complete the service

5.3.4 The Type of Network Configurations

This section focuses on the type ofnetwork configurations required to support FuelRetailCo's IoT-enabled servitized business models.

5.3.4.1 Fill up and Go

In terms of the coordination between the partners involved in delivering services, FuelRetailCo still maintains their value chain in the upstream business which involves fuel sourcing and production. However, in the downstream business in which the FuelRetailCo lies, they tend to focus on setting up an ecosystem to help deliver service. In the case of Fill up and Go, the main actors within the business ecosystem mainly include digital payment platforms, payment service providers, and POS vendors, which vary from market to market as discussed in Section 4.3.2.1. Accordingly, the type of network configuration tends to be a mix between a value chain and business ecosystem.

5.3.4.2 Digital payments for fleet solutions

Regarding coordination, this business model requires collaboration between different partners in the ecosystem in enabling this digital service. It involves customers sharing specific data with FuelRetailCo, collaboration with the car manufacturer and the provision of a digital payment platform from a third-party service provider. Hence, they work together as an ecosystem rather than a traditional value chain.

The product owner of the B2B digital payments (IN1-03) mentioned:

"…with B2B it gets a bit more complicated because if you want to, for instance, minimise the fraud then we need a bit more data because there are also some B2B specifics."

Accordingly, the type of nework configuration is a mix of the value chain and the business ecosystem as the FuelRetailCo's upstream business which involved the fuel production still focuses on the traditional value chain concept but in the downstream business, FuelRetailCo has set up partners within a service ecosystem to deliver the digital service.

5.3.4.3 On-demand food delivery

Regarding the type of coordination, this business model requires collaboration between different partners working together in the ecosystem to enable on-demand food delivery where customers order the products online from FuelRetailCo's platform and a service delivery provider or FuelRetailCo's co-location partners, and use FuelRetailCo as their pick-up locations. These are different from market to market, as the digital transformation manager (IN1-09) stated:

"In Singapore where we partnered up with (partner A) and (partner B) and customers can get ice cream or beer delivered to their requested place and it's also been picked up from a retail site but the end customer doesn't necessarily know that it comes from a FuelRetailCo's site. It's more us being a pickup location and yeah but that's the vibe markets and so, slightly different, as well as different partners in every market and different stage of maturity."

Accordingly, the network configuration for this business model is a mix between a value chain and the business ecosystem as in FuelRetailCo's upstream chain which involves supplying grocery products to the retail stores; this tends to follow the traditional value chain while in the downstream business FuelRetailCo set up the relevant partners or actors within the ecosystem of this service.

5.3.4.4 On-demand fuelling service

Regarding the coordination for the on-demand fuelling service, this business model involved different partners and actors involved within the ecosystem in delivering service. These partners include the service partners who provide additional services related to customers' vehicles such as vehicle washers, vehicle maintenance and tyre inflation service. In addition, FuelRetailCo aims to expand their business model by integrating their infrastructure with the OEM or car manufacturers and deliver the service to their end users. As mentioned by the CEO of on-demand fuelling service (IN1-10):

“,,,if we were getting into OEM or the engine manufacturers to cooperate with them to get close to their infrastructure and also being part of their vehicle. So, those cars and if you start the engine and if you would say okay would you like to fill up you just click on this, and then we get this, or there's also this integrated data management with OEMs which could be a tremendous opportunity.”

Accordingly, the network configuration of this type of business model is a mix between a value chain and the business ecosystem as the upstream chain focuses on the activities that are in manufacturing and delivering the product to the distribution channels (i.e. retail stations) which follow the traditional value chain, while in the downstream business, FuelRetailCo and their partners within the ecosystem are interconnected to deliver the on-demand fuelling service to the end users.

The summary table of the network configurations according to FuelRetailCo’s four add-on business model is illustrated in Table 5.5.

Table 5.5: Network configurations: FuelRetailCo’s add-on business models

Network configurations	Theory	Actual Fill up and Go	Actual Digital payments for fleet solutions	Actual On-demand food delivery	Actual On-demand fuelling service
Type of coordination	Value Chain	Value chain – Business ecosystems (Value chain in upstream business and setting an ecosystem in downstream business to deliver digital service)			

5.3.5 The Dynamic Capabilities

This section aims to explore the specific capabilities required in order to successfully transform FuelRetailCo’s IoT-enabled business models. Different capabilities were categorised according to the three dimensions of dynamic capabilities: sensing, seizing and transforming capabilities.

5.3.5.1 Fill up and Go

5.3.5.1.1 Sensing capabilities

Regarding the sensing capabilities, in order to implement Fill up and Go, FuelRetailCo started by identifying the market opportunities through addressing the customer's pain points, which in this case was to save the customer's time in queueing and paying at the retail stores. FuelRetailCo then further explored the IoT technology as one of the technological possibilities to solve those pain points via the integration of a pump connected to the mobile app. In addition, FuelRetailCo has to have initial ideas on how these can be fitted in the current business.

"With the onset of smartphone adoption, it was obvious we needed to move into a more digital mindset for payment. And subsequently, this is where 'fill up and go' was derived from the real core of customer need and business challenges around cost and IT infrastructure so we decided to do an over-the-air payment service." (Chief Product Owner, IN1-01)

"I think it's a combination of understanding what technologies are out there, what start-ups are out there and what the technology can do combined with an understanding of what the pain points are. So trying to understand maybe a triangle of what can technology do? What are some real pain points that need solving? And where does it fit with the way our business works?" (Digital Transformation Lead, IN1-02)

"…you need to start with a proposition and you need to start with a customer… at the heart needs to be customer-centric, design process, a mixture of business and IT. I think the big thing is that it's changed from an IT delivery perspective." (IT manager, IN1-08)

Accordingly, FuelRetailCo has adopted market sensing capabilities through identifying customer pain points, capabilities related to an exploration of technology possibilities as well as an identification of the potential areas of the current business operations that fit with the market requirements and can be supported by IoT technology.

5.3.5.1.2 Seizing capabilities

Digital service development capability

FuelRetailCo has addressed the sensed opportunities through the development of new service offerings (i.e. Fill up and Go) as well as the support of new business models. Accordingly, it has looked at new ways to generate revenues and value from providing a service to its customers within the same market or new markets as the traditional business model may not be relevant any more.

"I think this is just finding new ways of revenue and new ways of new business models that we can enter. I would say a new market but it's the same market but just let's say blue ocean. So we're just looking at different areas of the ocean to gain value from." (Digital Transformation Manager, IN1-04)

"…from a digital perspective, it's very much about how we use our estate to be able to use digital, the capabilities facilitated by digital, to make money from our sites. When our traditional business models aren't relevant as much any more." (Head of Digital Channels, IN1-07)

In addition, the strategy used by FuelRetailCo is to develop and implement their service offerings quickly on a small scale before committing to full investment. This aims to learn about the market demand and obtain feedback from customer insight as well as understand the challenges in terms of service operations, technical issues and how to develop an appropriate financial model for Fill up and Go.

"We approach this (digital) transformation in innovation in order to test and learn quickly on a small scale so that we can get feedback, especially feedback in terms of customer insights, but also any operational issues, and any big blockers and challenges and kind of how the financial model would work for us." (Chief Product Owner, IN1-01)

Mass customisation capability

These capabilities are mainly related to leveraging the customer data (i.e. type and amount of fuel purchased at particular site stations) from which to understand the individual customer's usage pattern in order to provide a customised offering for particular customers. FuelRetailCo's IT manager explained that these capabilities have been adopted in CRM or marketing perspectives by providing offers or promotions to suit individual interests.

“So, from a digitalisation perspective, you get into personalisation and segmentation. So, when a company is collecting data on its customers to understand their customers better and from a CRM point of view – the thinking there is about what is the right message for this customer or what is the right offer for this customer.” (IT Manager, IN1-08)

Digitalisation capability

FuelRetailCo has adopted digitalisation capabilities and this involved the integration of the IT infrastructure with the partners within the service ecosystem (i.e. payment service providers and software providers) to ensure the compatibility and interoperability of the systems and be able to provide the service to the customers.

“A lot of integration with the site system, the way that we have digital payments is we still master the transaction on the POS and one of the biggest capabilities is being able to have the site system integrated. Because obviously, the app is one thing, for us something created within the site system was integrated with the payment service provider.” (Chief product owner, IN1-01)

In addition, FuelRetailCo needs to develop its data management and analytics capabilities in-house and also be able to leverage and utilise the data captured from customers to improve the current product-service offering or further add to the value propositions for the customers.

“We now have a daily credit data analytics team that serves the whole downstream retail group. And yeah that capability is actually there now. We pretty much have a solid team of data engineer, data scientist and data analyst that work a lot on our data.....these people just need to be more aware that data is available and use it when the decision needs to be made” (Digital Transformation Manager, IN1-04)

The IT manager (IN1-08) also supported this point and added:

“…API means an industry is just a standard way to exchange data really in a secure manner. We also get to a point where the data exchange is easier so we get to a

data-sharing economy. So, you know the ability to share data with your partners and your customers. And that adds a lot of value to your business."

Another point related to digitalisation is that it is also important to consider the connectivity capability from both the firm and customer sides as the digital transactions have to be processed in real-time. Although FuelRetailCo has managed to get the connectivity or signal coverage to the majority of their service sites, their customers might not be able to get the phone signal and access to the Internet, meaning they cannot use the service.

"As we move into digital always-on connected systems. There is no room for batch processing; there has to be a real-time and always on – you need much more reliable telecoms. You need to be looking out for… or what… not only your own telecoms but also if you are looking at IoT or mobile and then what is the signal coverage in the area and particularly a distributed network like a retail fuels operation, then we have a network that's distributed over vast areas of different countries and you can't always guarantee a phone signal. So, how do you think about your customers' connectivity as well as think about that thing in real-time?" (IT manager, IN1-08)

Network management capability

Network management capabilities are also adopted by FuelRetailCo which involved the management and collaboration with the partners in the service ecosystem. Specifically, this is done by locating the partners to work at their site and also sending their staff to their office to work closely with each other. This allows FuelRetailCo to assess and strategically choose their partners to be part of their service delivery network.

"It's more collaborative working (with partners)*. When we choose vendors, that's part of the culture that we're looking for… is when they're assessed how we think they could work with us. And I think there's also a natural connection between the themes and that really helps. Having co-located themes, bringing members of the vendors to work in our offices with us and vice versa when you're developing is really practical."* (Chief Product Owner, IN1-01)

Capability related to staff training on digital knowledge

In order to implement Fill up and Go, the capabilities related to staff training are relevant to both back-office and front-office staff. The back-office staff have to be trained on the digital knowledge and agile methodologies through workshops, courses and on-the-job training. This helps the back-office staff, who are behind the scenes of delivering new product-service offerings, to have practical knowledge of the digital knowledge and in designing an IoT-enabled business model. The training also relates to the agile methodologies that help the back-office staff understand how to work in a small, cross-functional team, in aiming to deliver the new product-service offerings in a short time.

"It would always be a mixture of things so I think there'll be training that will be needed in terms of both product training as well as generalistic training around digital and agile methodologies and so forth. But workshops are great short-term. On-the-job training is really critical. Courses are great for that short injection of knowledge, go away for 2-3 days learning a theory. But then it's only when that theory's put into practice in the job role itself… that's, I think, what people really get from it" (Chief product owner, IN1-01)

In addition, the existing back-office staff, particularly IT staff who help to design the technology support for the digital business model, should also have hybrid skills, meaning they need to understand both sides of IT and business, as explained by the IT manager (IN1-08):

"…for me it is really is about hybrid skills. That's the fundamental shift. If you want to digitalise your business, you need to understand your business. You can't digitalise a business that you don't understand. I think there's a focus on speed and value which is required."

Furthermore, the front-office staff who have direct contact with the customers (i.e. customer services and the site staff) have to be trained on how to support the customers online and in real-time. For example, the service station staff have some fundamental knowledge of how the service works and can support customers on-site. However, in terms of the technical issues, the customer service staff have to be able to access the information real-time and remotely support the customers.

"Other big area for training is around our supportability team. So this is supportability in terms of our IT system but also supportability for our customers. So, the first one with our IT system is our support desk being able to monitor the services. And that the call centres also need to have a lot of information and access to the mobile payment platform. When a customer phones they can identify themselves. They can go in see the transactions and even verify to that customer why it failed." (Chief product owner, IN1-01)

5.3.5.1.3 Transforming capabilities

Service methodologies and process for developing gains capability

These capabilities are related to the continuous improvement of the service offered. One of the areas that FuelRetailCo covers is to encourage the product owners to use the service themselves and continuously look at customer feedback to see the technical problems and the problems experienced by the end users. The product owners need to prioritise the areas of product-service improvement by focusing on the customers' values in order to deliver an improvement in a short period of time.

"…when it comes down to the reporting and the tagging that we have at the moment and this has really grown as a product owner. So, they're really looking after their product and looking at the report. Then, the moment they can see an area that isn't working for them, justifying that they need to make a change, need to iterate... they would then add back to the backlog, they would then scope what that means in terms of user stories, they'd articulate value to it." (Chief Product Owner, IN1-01)

FuelRetailCo also continuously improves Fill up and Go by reducing the complexity of the process flows in delivering this system; this is done through the support of the partners within the service ecosystem. The initial design of delivering IoT-enabled offerings could be complicated due to the legacy of the IT infrastructure. However, by partnering with the payment service provider or software providers, the process map of Fill up and Go is less complex, meaning there are fewer points of failure and hence, better customer experience.

"…we've changed architecturally some of the payment flows. So historically within FuelRetailCo, we had our own twittering capture service for payments. And initially, we routed all the digital payments through there as well. With (provider name) as the payment service provider, we don't need that any more. So we've eliminated further complexity by routing straight through to a payments service provider. ...So it's a lot simpler, it's a lot less complex, there's less point of failure. And then ultimately, it's a better customer experience and we will continue to iterate in that way as the opportunities are presented to us" (Chief Product Owner, IN1-01)

She also mentioned:

"...your vendors will also help you to know if they've got a new product or a new platform or new cloud capabilities that could be a better product or a more stabilization, or whatever it may be. Then, it may be a case of back-end changes that the customer… they don't see anything but actually you've eroded a second or how long it takes for the receipt to be delivered." (Chief Product Owner, IN1-01)

Service culture capability

These capabilities refer to the shift from product-centric to a service mindset. However, as well as having a service culture mindset, FuelRetailCo has focused on embedding a digital mindset and agile mindset within the organisation. These mindsets involved the capabilities to quickly respond to the disruption of digitalisation and the change of customer demand.

"….the mindset that we would like to adopt to be able to move quickly and keep up with the customer demand ultimately and I think as such FuelRetailCo needs to work out how we can manage our risks and manage all of the various procedures that we have in place because they are there for a reason, that allows the framework that enables us to move quicker as we want to sort out digitalising the business." (Chief Product Owner, IN1-01)

Additionally, it is also important to have the capabilities for predicting and looking for future demand and, by leveraging digitalisation, the IT manager suggested that this will help FuelRetailCo to move towards the focus on services rather than the products.

"…So, we see a massive update only in the UK of electric vehicles recently. …. So, from a fuelling perspective, if you're filling up with petrol and then it's you who can fill up, pay and be gone in five minutes. With an electric vehicle, even on a fast charge it probably takes 15-20 minutes. So, what can you offer the customer in that time with digital - you can also look at things like subscription services and I think a lot of things start to move towards a service that you buy rather than a product." (IT manager, IN1-08)

Risk management and mitigation capability

These capabilities involved the management of risks associated with the implementation of an IoT-enabled servitized business model in which FuelRetailCo highlighted the privacy of customer data. Accordingly, the process or procedures of using customer data for other purposes or sharing the customer data with a third-party has to be considered.

"…and obviously GDPR and protecting customers' data, there's a very strong (FuelRetailCo's) process that's about information risk management and data privacy to make sure that those processes are robust." (Digital Transformation Lead, IN1-02)

In addition, as Fill up and Go moves from physical payments with the card presented to over-the-air payments, the security concerns have to be taken into consideration when designing the system for the service in order to protect the customers' sensitive data (i.e. bank card details) from fraudsters.

"The other scenario is there might have been a customer trying to fraudulently use the system and of course in any digital payment or payment system this is a big consideration in terms of design and the security." (Chief Product Owner, IN1-01)

Scalable capability

As the deployment or investment in the new technology could be high, as Fill up and Go started from a small scale, once the concept has been tested and successfully proved in the market, FuelRetailCo has then to develop the capabilities in scaling this business model up across the markets.

"…. I think the second level is then what's the unit margin or the unit benefit on that. So can we see a path to value if we scale this up." (Digital Transformation Lead, IN1-02)

5.3.5.2 Digital payments for fleet solutions

5.3.5.2.1 Sensing capabilities

FuelRetailCo has sensed the opportunities from Fill up and Go, which are the digital payments offered to B2C customers, and tried to apply and develop similar sets of capabilities to offer a similar value proposition to B2B customers.

"…it's my responsibility to make this also happen in B2B customers. So you might actually know that FuelRetailCo is actually the biggest fuel card issuer globally. And we are now enhancing this mobile payment solution also for B2B fuel cards. So, if now you are a fleet driver or a truck driver, until you get your fuel card, now you will be able to pay by your mobile phone as well." (Product owner of B2B digital payments, IN1-03)

FuelRetailCo also sees the technological possibilities through the trends of connected cars and connected fleet vehicles in which there is an infotainment or dashboard that is connected to the Internet and offers various functions and features for the drivers. Accordingly, for B2B segments, FuelRetailCo has designed and exposed their digital payments service through API integration with third-party partners (e.g. car manufacturers) or B2B customers as a complementary service offered to their end users.

"Connected cars was going to become a trend, the cars have access to the Internet and all this data and we want to have a relationship with the consumer. It's whoever

gets more and more digitally savvy. Then we're using design thinking - you would look at where the opportunities are for a consumer to have a deeper more immersive relationship with FuelRetailCo." (Global innovation manager, IN1-05)

"These CRT customers typically they have got their own telematics solutions. These would be using APIs because truck drivers are not so keen to be using the app on their private mobile phone to be filling up for business purposes. In these cases effectively we see the opportunity to offer this payment service by our APIs to these truck companies." (Product owner of B2B digital payments, IN1-03)

"These car rental companies typically have got their own mobile app because they use this mobile app as a channel for communication where they offer their service to their customers. And now with this API integration, it allows them to introduce payment for fuel in their app but at the FuelRetailCo site." (Product owner of B2B digital payments, IN1-03)

Accordingly, FuelRetailCo has adopted the market sensing capabilities through expanding the existing service from B2C segments to the B2B segments. In addition, FuelRetailCo has capabilities in identifying the potential technologies which can be used to address the market opportunities.

5.3.5.2.2 Seizing capabilities

Digital service development capability

After the opportunities have been sensed, it is important to design the right business models and service offerings in order to address those market and technological opportunities. However, this has to be balanced between the design of the digital service and the complexity of the internal IT process from the back-end perspective required to implement the business model

"But once you start to move to a mobile (and online) one, you'd then need to be able to orchestrate transactions centrally and it's learning to find that balance from a design point of view .... It's a lot more a business process than it is IT and it's a

business process change which is, I think… the bigger piece of the digitisation is your business model in a different way." (IT manager, IN1-08)

Similarly to Fill up and Go, this business model was developed on a small scale in order to test the market demand in the potential markets and explore an appropriate pricing model for the business model. This also allows FuelRetailCo to assess the feasibility of the integration with third-party platform partners and prove the concept before committing a large investment to the resources need for full implementation of the business model

"…we are probably the first in the market, especially this API integration function. There's ongoing discussion on how we actually position the pricing for this service because we are just testing this with our customers …to see actually what is a fair and acceptable price for the customers. They allow us to recover the costs that we invested in the solutions." (Product owner of B2B digital payments, IN1-03)

Mass customisation capability

These capabilities are related to integrating the knowledge of specific customer needs and tailoring the product-service offering to fit the large variety of customer demand. Specifically, in B2B customer segments, FuelRetailCo has digitally integrated the customised offering with their digital payment service. For example, based on the information given by the fleet managers, FuelRetailCo will automatically unauthorise the transactions when an attempt has been made to use the incorrect type of fuel to fill up the fleet vehicles.

"…if you are a fleet manager, you want to limit your drivers to be able to use only regular diesel or regular under a ninety-five, you do not want them to fill up with premium diesel. …So, they can configure the fuel card so they can pay only for regular diesel and not premium diesel. So, during this authorisation, process, we actually send a bit more data and actually detail to the site to unlock only a regular diesel nozzle so, for instance, if the driver picks up the nozzle of premium diesel, the dispenser doesn't start." (Product owner of B2B digital payments, IN1-03)

In addition, the customers can allow FuelRetailCo to track and monitor their drivers' behaviour and the individual vehicles specifically contribute to fuel consumption by analysing the distance travelled which is collected from the telematics data of the vehicle dashboard against the fuel consumption for each trip (through the record of FuelRetailCo's sales data in real-time). This provides the opportunity for FuelRetailCo to offer customised data of individual drivers or end customers as an additional service to improve the efficiency of their fleet. As mentioned in the brochure (DC1-05):

"…(the app) will record and analyse trips, allowing motorists to track and monitor how their driving behaviour contributes to fuel consumption."

Digitalisation capability

These capabilities are related to developing and adjusting the existing IT system and infrastructure to address the business model's requirements. As FuelRetailCo's IT manager (IN1-08) mentioned:

"*…we need to look at a more microservices-based architecture, and services talk to each other via API. And then it becomes a lot more of an agile route to be able to upgrade, modify, add new features because you're looking at smaller services."*

Furthermore, FuelRetailCo has to develop the capabilities in data management and analysis to extract the useful information data generated from the service. In addition, it needs to leverage the data to improve the current offerings or generate a new value proposition and revenue from the insights obtained from customers' data. Consequently, as these data can be considered as strong firm's assets, it is important to consider who is allowed to access the data.

"You have plenty of data, the challenge is how you extract some meaningful information….So, the challenge is really how to use the data in order to create a better customer's value proposition or better customer experience. How do we have the data, how we monetise this, what kind of other services we can offer to our customers based on the data that we have got. ….the data is key and we need to be very careful when we share the data with third parties because it's becoming quite a strong asset by all means." (Product owner of B2B digital payments, IN1-03)

In addition, in order to enable this digital payments service, it is important to ensure the Internet connectivity coverage to all FuelRetailCo's service sites, allowing customers to access the pump number through the mobile app or car infotainment as the product owner of B2B digital payments (IN1-03) mentioned:

"...everything needs to be fully online because this whole thing works in really… only in online mode and you can imagine that our sites are sometimes very remote locations and we may simply lose Internet connectivity or connectivity to a site and then the digital payment doesn't work."

Network management capability

In order to implement this business model, FuelRetatilCo has to work closely and frequently with their third-party partners (i.e. connected car manufacturers) or B2B customers (i.e. car-sharing companies) especially during the beginning of the implementation. This is because the partners have to understand how the digital payment offered through FuelRetailCo's API integration works on their app or infotainment, and how this digital service can be accessed by the end users. Additionally, FuelRetailCo has to go through business deals (i.e. price negotiations and mutual incentives) with their B2B customers and partners to allow the company to integrate and use their systems to offer the digital service to end consumers.

"But if I just give you the example of (car sharing company), the first partner that is using the service, we have been let's say in touch with them on a weekly basis sometimes even three times per week because we are providing all the consultancy and bit of hand-holding on how this whole solution works and how they should design it on their site and so on." (Product owner of B2B digital payments, IN1-03)

In addition, FuelRetailCo has to be able to strategically choose their partners including the platform providers, the software vendors and the car manufacturers to be part of their service ecosystem. The key factors that FuelRetailCo considered are that the platform providers should have the ability to serve significant numbers of FuelRetailCo's users, while the car manufacturers that FuelRetailCo choose to partner with should have already established business relationships with FuelRetailCo, as well as the established digital platform with which FuelRetailCo can integrate.

"There's a number of partners that are out there that want to work with us. They are platform providers in connected cars but there's not that many that actually have agreements with consumers to be connected to. So a lot of them are start-ups that say they've got the technology but what they don't have is they don't have customers, so we get inundated with companies." (Global innovation manager, IN1-05)

"You'll always be working with partners and you need to have strong partners and vendor management skills." (IT Manager, IN1-08)

Capability related to staff training on digital knowledge

Similarly to the implementation of Fill up and Go, FuelRetailCo has to train the front-office staff at the service station to have the fundamental knowledge on how it works in order to be able to support the customers when using the service on site.

"So, whenever we launch a service like this we do organise or we produce a training material for the site staff, for site managers and for cashiers. And then it is the responsibility of the site manager to make sure that our cashiers know how this works and that customers can pay in this way. ...And it's actually an ongoing effort to make sure that people who used to be (only) selling fuel cards and our services now need to be able also to sell this type of almost an IT service, to explain to these big partners how the API works and what kind of service this actually offers, what kind of benefits. So, it is a big change, a big transformation." (Product owner of B2B digital payments, IN1-03)

In addition, the Global innovation manager (IN1-05) also believed that, apart from training the front-office and back-office staff in helping to understand how the digital service works and support the service delivery, FuelRetailCo should change the human resources strategy by recruiting more staff who have hybrid skills (in both areas of business and technology).

"So, I think we would need to have a very different human resources strategy and at the moment we're probably a follow-up but not a leader in the spaces of technology resources. ...I think that if you understand the technology and you understand the business problems, you can articulate where the problem is and how you can solve it with technology. I had practical knowledge in technology and understanding of consumers that our company was trying to connect with and I found that actually we needed to get more technology people into the business to be able to pull the business forward on digital transformation." (Global innovation manager, IN1-05)

"…there is no separate IT department, there is only a business professional with an IT lens who looks at things through IT eyes but ultimately they are business professionals and that's the big cultural change that needs to come from the IT team perspective." (IT Manager, IN1-08)

5.3.5.2.3 Transforming capabilities

Service methodologies and process for developing gains capability

It is important for FuelRetailCo staff to continuously re-skill and update their technical skills and other technological possibilities in order to support the service provision more efficiently.

"A technology that is moving very quickly ...that time compresses with each technology jump and so the lifespan of a particular technical skill becomes shorter and so what IT professionals need to get used to is constantly re-skilling, constantly educating themselves. And what's going on and what's changing and going into it you now need a continuous learning mentality in a way that you perhaps didn't need in the past." (IT manager, IN1-08)

Service culture capability

In terms of the capabilities related to service culture, the product owner of B2B digital payments also agreed with the product owner of Fill up and Go that FuelRetailCo, as well as embedding service culture, should develop an agile mindset within the organisational culture as the company has to be able to respond to further technological disruption as it keeps changing.

"I can understand it is a bit of challenge because there are a lot of new things coming in that direction. And for them, it means effectively every quarter there is something new they need to learn, some new offering, you know, and so on. So, of course, it's a bit of a challenge to keep up a little bit with all the changes." (Product owner of B2B digital payments, IN1-03)

In addition, to have an agile mindset, FuelRetailCo has to shift the mindset from being company-centric (from being a large organisation) to being more customer-centric. In order to successfully transform from their traditional to IoT-enabled servitized business model, FuelRetailCo has to focus on recognising and meeting the customers' expectations through the digital service offering.

"…being a large organisation has been quite restricted to the class of business that you're in and what the business targets are. And so by switching that mindset into the customer-centricity - if the customers like it, the revenue will come - we still want to make sure we're making wise investments but we also recognise the expectations and the choice that the customers have, meaning that there is much more opportunity for us to be disruptive." (Business PMO, IN1-06)

Risk management and mitigation capability

The main risks to implementation of this business model are associated with the privacy of customer data and the GDPR have to be taken into consideration and customers asked for their consent in order to utilise those data to either improve the offering or create a new value proposition. As the product owner of B2B digital payments (IN1-03) mentioned:

"…but you know how it is with GDPR these days - so actually we always need to ask for the consent from the end-users to say if they are willing to share, let's say the device details, you know, with us so we can then analyse them for our internal marketing purposes and we state we will not share them with any third-party."

The global innovation manager (IN1-05) also commented on this issue:

"I think there are some things around customer data and data privacy which ae also becoming essential because you want to make sure that you are trusted and you're authentic and that you're handling someone's data properly. So, understanding the technology around data privacy is an important thing because it is a growing, you know, for growing industry… the requirements get bigger then."

In addition, he suggested that another inherent risk associated with digital payment is the fraud in online transactions, and hence, it is important to have a process in place that ensures the safety and security of service provision.

"We have got also implemented something that's called geofencing, so if you try to run a transaction and you are not on the site, then we simply decline even the transaction attempt because we want to protect our site." (Product owner of B2B digital payments, IN1-03)

Scalable capability

In order to successfully implement the digital service, FuelRetailCo has to adopt scalable capabilities to upscale their service across the markets. This could be a challenge for FuelRetailCo as the different markets have different POS solutions and software vendors. As the product owner of B2B digital payments (IN1-03) mentioned:

"…the issue is that this POS solution differs country by country and you always need to go to the vendor, give him specifications,… please develop or enhance your POS solution, according to specs. Then, when this is developed, and tested, then we do the deployment. So this is kind of the bottleneck I would say that is preventing us from running across the whole of Europe now straight away."

5.3.5.3 On-demand food delivery

5.3.5.3.1 Sensing capabilities

Regarding sensing market opportunities for on-demand food delivery, this involved the ability to identify the change in customer's behaviour and the current trends (i.e. the lower number of people who now own cars) and trying to offer solutions or add-on services to support this change. As the digital transformation manager (IN1-09) explained:

"...we saw that more and more people, especially in the UK, have changed their shopping behaviour from shopping once a week to shopping more frequently to shopping more on-demand. And so this whole on-demand economy is really growing globally and in some markets is more than in others. ...now the customer journey is completely different. We are trying to reach people who are not coming to our sites and are probably not even owning a car and so that's quite different." (Digital Transformation Manager, IN1-09)

"So, it tends to come from a market pull so we really know that it's going to be something that's a value to the market and the customers." (Business PMO, IN1-06)

In terms of exploring technological possibilities, the digital transformation manager (IN1-09) looked for partners to provide the delivery platforms. This is because, in the landscape of online delivery, many companies are already established in the market. Accordingly, this means that FuelRetailCo does not necessarily have to develop the IT system and online platform themselves.

"…and so we then looked at the landscape of online food delivery and found out that there are different partners, different business models out there. And so that was the kind of first entry point in this whole business model." (Digital Transformation Manager, IN1-09)

5.3.5.3.2 Seizing capabilities

Digital service development capability

After the opportunities have been sensed and identified, it is important to establish a new value proposition through the digital service, as well as the business models to be supported. FuelRetailCo is relatively new to the on-demand economy market and hence in order to develop this business model, it requires experimentation. This means FuelRetailCo should develop their business model on a small scale to test out the market and technology integration before investing in the full solution.

"So, we addressed those customers correctly and also we're still in a trial and error phase. We want to experiment with them. Let's say the product range and those platforms, to really find out what it is that people like. What it is that people are buying. So we still need to develop the capability of experimentation and be willing to try something and then adjust it. Because in that case, it's quite easy to have more of other products on the platform." (Digital Transformation Manager, IN1-09)

In addition, this experimentation has benefits in terms of assessing the customer demand and feasibility of technology integration, and other associated requirements, before deploying a full scale investment in the business model.

"We could test out and produce a prototype in order to understand a little bit more what that customer journey would look like and what the feasibility of integration might be with other parts of our technology stack in order to estimate how easy or how complex that would be based on outcomes from that. It would help to steer a decision on an investment case, on whether it goes to a full project for delivery with full integration." (Business PMO, IN1-06)

Mass customisation capability

By implementing this business model, FuelRetailCo should be able to have a record of purchasing data from different sites which would help to provide the promotions according to the product popularity for different site areas. In addition, FuelRetailCo is now exploring the opportunity to link this system with the customer loyalty account which allows the company to provide personalised offers for individual customers.

"...especially because we learn a lot about what people are buying, we could probably find out what kind of products go well with each other and if we could probably link that with our loyalty system in the future. We could then really have targeted or personalised offers for people, suggesting some offering, something that suits their preferences and in that case, I don't even need you to leave the couch as you can just get it delivered." (Digital Transformation Manager, IN1-09)

Digitalisation capability

The digitalisation capabilities to implement this business model are mainly focused on the ability to connect their existing IT system to the platforms of their service delivery partners as they did not develop their own platforms to offer this service to customers.

"...And then in order to support that, then we've also been looking at and started a pilot on digital capability building, using a third-party organisation partner in order to run through some of those key skills that are needed." (Business PMO, IN1-06)

Network management capability

In order to implement this business model, FuelRetailCo strategically chooses their partner to be part of their service network. Some key considerations include the number of users on their platform, their market share and their driver networks. These also depend on the maturity of a particular market, meaning their partners are different in different countries.

"....we always looked at who's big in terms of customer, in terms of driver network and biggest market share literally and per market. And then we partner up with them locally so that, that's why we have different partners and in different countries." (Digital Transformation Manager, IN1-09)

In addition to partnering with an online delivery platform, FuelRetailCo also partners with the local market food shop as part of its co-location partners. This means the customers might also order the product on the platform directly from the shop but this is delivered from FuelRetailCo's site as it is used as a pick-up location. Therefore, FuelRetailCo needs to adopt capabilities in managing their partners and understand their position within the service network.

Capability related to staff training on digital knowledge

When implementing the on-demand food delivery business model, it is important to train the staff on retail sites to understand how the order system works and how to deal with or respond to customer orders on the system of their platform service delivery partners. Accordingly, FuelRetailCo has to develop the capabilities related to these areas.

"…..we need to have really addressed the customers and reached the customers in a completely different way – what we've done so far. We need to get… to train the operations right. So the capability to explain to our site staff and train our site staff about how to deal and how to work with the device from the (platform delivery partners) on site …and how to put the products into our point-of-sale system in the correct way." (Digital Transformation Manager, IN1-09)

5.3.5.3.3 Transforming capabilities

Service methodologies and process for developing gains capability

Currently, this business model relies on the integration of FuelRetailCo with their platform service delivery partners. In order to find an efficient way of operating the business model, FuelRetailCo aims to explore the IT solution that could be easiest in connecting with their partners' delivery platforms.

"…So, another point and… I think the IT solution in a more long-term way, to find something. This is even a better workaround or even easier way to connect our system to a delivery platform system like API." (Digital Transformation Manager, IN1-09)

Service culture capability

These capabilities related to embedding the service mindset within the organisation to successfully implement the business model. Regarding the on-demand food delivery, this changes the mindset internally from getting the customers to come to the store, to delivering the products to them through the leverage of digitalisation. Accordingly, the key is to be customer-centric and able to reach new customers by addressing the market demand correctly.

"…we've been selling our stuff offline, trying to get people to come to our premises. And now it's the other way round - suddenly selling it online and people are not coming to our site any more and but we're going to them. So, that really needs to be shifted, in terms of the mindset, internally as well as to really address the customer demand correctly." (Digital Transformation Manager, IN1-09)

Risk management and mitigation capability

In order to successfully implement this business model, FuelRetailCo needs to identify the main risks associated with it and these involve the management of customer data. First, the customer data are owned by FuelRetailCo's partners, and this has made it difficult for FuelRetailCo to stay in touch or establish a relationship with the customer due to GDPR issues. Accordingly, FuelRetailCo has to try to establish incentives with their partners to help FuelRetailCo develop customer relationships with their end customers.

"…the platform service delivery companies, whom FuelRetailCo partner with, already have thousands of millions of customers registered on their platforms but it's not our customer relationship. …So we can't target that and we can't send an email to those customers obviously. So, we need to find ways to reach out to their customers. And that is currently definitely a challenge but we're trying to work through it together because it's definitely a big opportunity for us, and for them obviously as well." (The digital transformation manager, IN1-09)

"But obviously we are always really looking at (using) GDPR kind of forms, so, we were just able to use obviously the data we're allowed to use and the use the data

that people are willing to share with us. So, but it's definitely an opportunity." (The digital transformation manager, IN1-09)

Scalable capability

In addition, this could be a challenge for FuelRetailCo to upscale from their small scale of current offerings to be offering across the markets as the maturity of the on-demand food delivery is different and, hence, FuelRetailCo has to have the capabilities to offer the full scale of business model across multiple markets.

"…then we see whether there's an opportunity to scale and replicate across multiple markets in order to get more value and over the longer term." (Business PMO, IN1-06)

5.3.5.4 On-demand Fuelling service

5.3.5.4.1 Sensing capabilities

The sensing capabilities required in order to enable an on-demand fuelling service is to be innovative in creating the demand that the customers might not know that they want. This is by also looking at the current customers' pain points when purchasing the product. Hence, this allows FuelRetailCo to improve the current offering by providing more options for their existing customers as well as obtaining new customers. As the CEO of on-demand fuelling service (IN1-10) stated:

"…we really think there is enough demand, it's just that people don't know. So, we need to create demand that's not already existing, we are selling here something which people don't think… they don't know what it is. They've never explored that. It's a new opportunity and you need to create the demand." (CEO of on-demand fuelling service, IN1-10)

He also mentioned:

"…you get to a customer group which you might lose or you never got because this is something that they have really at the forefront. They have a pain point here and if someone else like a competitor comes, these customers are gone… that's one…

so it's keeping or getting new customers in an area which is very open to the service." (The CEO of on-demand fuelling service, IN1-10)

In addition, FuelRetailCo has explored the technological possibilities in order to support market opportunities. The CEO of the on-demand fuelling service mentioned that if the customers have a mobile phone, the company will know where the customer's vehicle is, hence, this gives them the possibility to build a flexible, digital infrastructure by delivering the fuel products to the customers.

"Because it's also a digital invention – let's say if you've got a mobile phone, we know where you are, where your vehicle is, and then we fill it up." (The CEO of on-demand fuelling service, IN1-10)

5.3.5.4.2 Seizing capabilities

Digital service development capability

The main capabilities associated with any category are to be able to understand the customer demand and target the digital service to the right customer segments in different markets. For example, in the US, people commonly use personal vehicles and not public transportation, and hence FuelRetailCo targeted the B2C market. On the other hand, in the Europe market, FuelRetailCo started with the B2C segments and this is not quite as profitable and hence they changed the target to B2B segments, such as construction companies and fleet companies and this started to generate positive outcomes.

"And the question was, again, about taking fuel to the customer and the customer not coming to our service station. ....So, we started in the Netherlands with a B2C business to customer position but quite soon we noticed that was, at the beginning, not very profitable so then we moved into the B2B area which is still the case in the Netherlands" (The CEO of on-demand fuelling service, IN1-10)

He also explained that:

"...there is B2C because in the United States customer groups and customers' behaviours are different (from Europe). So, they're people going to work and back

by car - not much public transport. So, the CVP is a little bit different, like in Europe."

In addition, the CEO of on-demand fuelling service mentioned that this business model is fully funded by FuelRetailCo as a start-up company to develop the service on a small scale to prove the concept that there is a demand for it as well as to assess the suitable pricing model for particular customer segments in order to generate profits from offering this service.

Mass customisation service capability

Through the implementation of this business model, FuelRetailCo can see the opportunities to provide additional services for customers. Since, FuelRetailCo knows the vehicles better than the customers (from providing the fuel for the customers' vehicles), it is possible to offer additional services, i.e. maintenance, vehicle cleaning or tyre pressure checks, to customers based on individual needs.

"…if you start with the basic service that's, for example, the fuel and the energy, but additionally we are also taking care of the maintenance with our partner, including tyre changes, if the windscreen is broken, and you could think about car wash, we can do car wash on the spot, which we are already doing in the United States. So there's a whole bunch of additional services if the customer would like to have that because we know the vehicle better than the customer because we're filling up the vehicle every week." (The CEO of on-demand fuelling service, IN1-10)

In addition, as the requirement for on-demand fuelling service can be largely varied in terms of time, location and the amount and type of fuel, FuelRetailCo has to develop capabilities in responding to these varieties of demand in a more efficient way.

Digitalisation capability

In order to implement the business model, FuelRetailCo has to be able to leverage the digitalisation capabilities in creating the value proposition for the customers. Currently, the customers purchase the service through a mobile app. Hence, FuelRetailCo needs to have the infrastructure to store the large amounts of transactions online and in real-time.

"We have an infrastructure, so very transparent if you know exactly which vehicle is filling up at what time at which place, and then it goes into the cloud. And every evening we can collect from the clouds the transactions to a customer, which is leading in a sort of invoice or pre-invoice that you know exactly and directly from the customer."

In addition, FuelRetailCo should also develop analytic capabilities in order to leverage the data stored in the cloud to produce additional value for customers. For example, FuelRetailCo has an opportunity to share some insight information, such as the volume of fuel or fuel mileage used by each vehicle, with the customers or provide data as a service. This will enable a more advanced business model (i.e. solution-oriented business model), as the CEO of on-demand fuelling service (IN1-10) claimed:

"…but also data management, if you take just the mileage you know how much fuel consumption they have, you could even add, you know, a chip and read it out for giving some intelligence on how the driver drives the vehicle. So, all this data is an important piece… and a big value stream for the future. …there's also an opportunity to provide data services to customers but that comes later."

Network management capability

The on-demand fuelling service also requires strategic development of network management capabilities as the development of this business model involves working not only with the large companies but also with new small partners (i.e. start-up companies). As the digital transformation manager, (IN1-02) mentioned:

"We are potentially using new, relatively immature technologies. So we're bringing in lots of new suppliers or partners into our ecosystem, many of whom are smaller than the companies that we would have traditionally worked with for big global deployments of our IT system, and they're relatively small companies. So we're

finding our way in terms of how we contract and partner with start-ups and smaller companies."

Capability related to staff training on digital knowledge

Furthermore, FuelRetailCo is not only required to train the staff to have fundamental digital knowledge in providing the service but also to build strong operational excellence. This involves strong teamwork and also having experts in providing the service as it is required to have sophisticated skills in operating the service safely. As the CEO of on-demand fuelling service (IN1-10) mentioned:

"...a strong knowledge about how to build the business first, right now. Then you need to have a strong operational experience, if that is not to be just a venture where you have an app and then, you know, you go to the Bahamas and you get a lot of money; this is hardcore operationalisation every day. It's a service station on four-wheels with a lot of risks."

5.3.5.4.3 Transforming capabilities

Service methodologies and process for developing gains capability

In order to successfully transform and sustain this business model, the CEO of on-demand fuelling service (IN1-10) suggested that they need to further explore the right infrastructure, such as machine learning, which could be the new technological possibilities to support individual customer needs as well as develop efficient gains internally.

"In the future, we need to create the right infrastructure for that and ongoing being close to customers because they are asking us right now, hey if you control, let's say, the car, can you offer us the maintenance? That's a very obvious one, but machine learning could also be How can you help us to be more efficient? Can you help us by doing preventive maintenance for our vehicles?" (The CEO of on-demand fuelling service, IN1-10)

Service culture capability

The CEO of on-demand fuelling service suggested that the culture that should be embedded within the organisation is always to look at the new opportunities to reduce the risks of being unprofitable in the long term. As a result, FuelRetailCo is required to develop the culture embedded within the organisation of being an internal start-up and having an innovative mindset to respond to the digital disruption as he mentioned:

"I think the other one is to never lose this capability to re-question yourself to look to new opportunities because very soon you'll get into at the risk that you need to be profitable by not reaching out or looking for opportunities in the longer term. …I think, we did the right call by saying this is an internal start-up and it can… it can act outside of the FuelRetailCo framework. Because you create a culture in your organisation, and have started disrupting yourself, that is important here. If you miss that then the risk is that you're just going too fast for the old habits of a big company and you lose this agility. The challenge for us is to do both strengthen our operational performance by not letting go this innovative thinking and disrupt also ourselves." (The CEO of on-demand fuelling service, IN1-10)

Risk management and mitigation capability

FuelRetailCo has identified regulatory and safety as two of the main risks which affect the implementation of this business model in different markets and this needs to be overcome as the CEO of on-demand fuelling service (IN1-10) stated:

"The main challenges are, of course, the regulatory ones. You're depending big time on the regulatory but this and that are changing. So, if there's a grey zone, it's not really established – so, HS (health and safety) is a regulatory, operating safely is the main risk that we have."

Scalable capability

In order to successfully transform the business model, FuelRetailCo needs to assess their existing capabilities as well as develop a new set of capabilities at the right time to scale the resources up, including the investment of more mobile fuelling vehicles from their start-up phase in order to implement the service across the different markets as well as introducing a similar business model to other markets.

"We are in the start-up phase but those are opportunities if you really scale it up big. So, what is your future planned about this service? …We will stabilise the business by ordering another bunch of cars and we'll focus on three new market entries city entries in the US. And if this is going successfully, then we will have a stage gate in 2020 where we will assess that and then we will decide are we going forward with other countries? So, it's all depending on profitability and scale and opportunity." (The CEO of on-demand fuelling service, IN1-10)

He also added:

"…there's also this integrated data management with OEMs which could be a tremendous opportunity that's all coming with scale because our one vehicle… you need to have a lot of vehicles to justify the demand at the moment."

The summary of the key dynamic capabilities required to develop the FuelRetailCo's add-on business models is illustrated in Table 5.6.

Table 5.6: Dynamic capabilities: FuelRetailCo's add-on business models

	Theory	Actual and key insights Fill up and Go	Actual and key insights Digital payments for Fleet solutions	Actual and key insights On-demand food delivery	Actual and key insights On-demand fuelling
Sense	Market sensing capability	• Identification of customer pain points and business challenges • Identification of alternative purchasing options for customers	• Extend the market opportunities to B2B customers • Identification of specific customer pain points to address	• Identification of the market trends (market pull) • Identification of alternative purchasing options for customers	• Identification of the customer demand which might not yet be discovered
	Technology sensing capability	• Exploration of the internal technological capabilities	• Exploration of viable technological options to integrate with third-party partners	• Explore technological possibilities from external partners	• Exploration of the internal technological capabilities
Seize	Digital service development capability	• The development of a small scale full service version to assess and test the concept	• The development of a small scale full service version to assess and test the concept • A balance between service design and complexity of IT process required	• The development of a small scale full service version to assess and test the concept	• The development of a small scale of full service version to assess and test the concept • Target different customer segments in different market
	Mass service customisation capability	• Leverage customer data for CRM or marketing purposes (i.e. personalised offers and promotions)	• Leveraging customer data to be offered as an additional service	• Leverage customer data for CRM or marketing purposes (i.e. personalised offers and promotions)	• Leverage customer data to provide additional customised service offering
	Digitalisation capability	• Interoperability of IT systems within the service network • Data management and descriptive analytics to extract useful information to support offerings • Connectivity and Internet network coverage	• Interoperability of IT systems within the service network to support offerings • Data management and descriptive analytics to extract useful information • Connectivity and Internet network coverage	• Interoperability of IT systems within the service network	• Build the IT infrastructure to support the implementation of a business model • Data management and descriptive analytics to extract useful information
	Network management capability	• Co-location with their partners • Strategically choose and assess the partners to be part of the service ecosystem	• Collaborate closely with their B2B customers and partners • Strategically choose and assess the partners to be part of the service ecosystem • Identify the mutual benefits	• Strategically choose and assess the partners to be part of the service ecosystem • Identify the position within the different service network	• Strategically choose and assess the partners (including large and small size) to be part of the service ecosystem
	Other capabilities - Capability related to staff training on digital skills	• Training the front-office staff on digital skills to remotely support customers in real-time • Training the back-office staff on working in a cross-functional team, agile methodologies and having hybrid skills (IT expert and business understandings)	• Training the front-office staff on digital skills to remotely support customers in real-time and sell digital service to partners • Recruiting and attracting the right IT or technology experts with business understandings (hybrid skills)	• Training the front-office staff on digital skills to remotely support customers in real-time	• Training on strong operational excellence and leverage the staff's expertise to offer service
Transform	Service methodologies and process for developing efficiency gains capability	• Focus on customer feedback and iterate the change in sprint • Simplify the service delivery process	• Continuously update skills in technology to explore better support in terms of efficiency for the service offerings	• Continuously update skills in technology to explore better support in terms of efficiency for the service offerings	• Continuously update skills in technology to explore better support in terms of efficiency for the service offerings
	Service culture capability	• Embed digital and agile mindset • Develop customer-centric culture	• Embed digital and agile mindset • Develop customer-centric culture	• Embed digital and agile mindset • Have customer-centric culture	• Embed start-up and innovation mindset
	Risk management and mitigation capability	• GDPR and the privacy of customer data • Data security	• GDPR and the privacy of customer data • Data security	• GDPR and the privacy of customer data owned by partners	• Regulatory compliance and safety aspects
	Other capabilities - Scalable capability	• Be able to scale the resources up to implement the business model in full scale	• Be able to scale the resources up to implement the business model in full scale	• The capabilities related to scale the resources up to implement the business model in full scale	• The capabilities related to scale the resources up to implement the business model in full scale

5.4 Summary of the Chapter

This chapter provides an overview and the case study findings of FuelRetailCo for implementing the add-on business models. Consequently, the results of the case study analysed the constructs developed during the template analysis. The results started with the analysis of the characteristics of four of FuelRetailCo's different add-on business models, i.e. Fill up and Go, digital payments for fleet solutions, on-demand food delivery and on-demand fuelling, based on the conceptual framework. The findings showed that add-on business models correspond to a product-oriented servitized business model which focuses on the ownership of products with a good overall digital service experience. Depending on the customer segments, FuelRetailCo tends to establish a long-term relationship with their B2B customers, and a transactional relationship with B2C customers in all types of offerings. In terms of pricing, customers either receive the digital service as a complement or pay for it as a service fee. The OW criteria focus on delivering convenience for customers through the digital service.

Regarding the firm's resources, the main assets and locations that support the add-on business models are mainly the large network of retail stores, allowing the customer to purchase the product with the digital service experience, while the on-demand fuelling service tends to bypass the service station, and the hybrid IoT network and low skilled staff on-site but highly skilled workers (i.e. CSC) with the technical expertise required to support customers, as on-demand fuelling requires highly skilled staff to serve customers. FuelRetailCo is vertically integrated for product manufacture but has integrated strategic partners to deliver services or additional services.

Regarding the operational capabilities, the business process that supports the add-on business models is a mix of lean and agile, which aims to leverage the IoT to drive the efficiency internally (i.e. streamline the upstream business) as well as agility and innovation to quickly adapt and respond to market demand (i.e. agile in the downstream business). The main type of governance and decision rights is a mix of hierarchy and heterarchy, meaning the key staff (i.e. product owner) and the subsidiary company (i.e. start-up company) are empowered to take responsibility for delivering the service with the directives of top management. The type of organisation design that supports the add-on business model can be either value-facilitation or value co-creation, which are suggested from the level of customer engagement. Regarding the performance measurement, the KPI metric adopted by the add-on business model tends to be customer-centric, focusing mainly on the cost (i.e. the number of products sold using the digital service), quality (i.e. customer satisfaction and retention) and time (i.e. time to complete the service) of the service delivery.

In terms of the network configurations, the type of coordination that supports add-on business models is a mix of a value chain and business ecosystems. Specifically, the upstream business, which focuses on manufacturing and delivering product to the distribution centres and retail stores followed the traditional value chain, and the downstream business, which focuses on delivering the products and digital service, are set up as business ecosystems where the partners are working together and digitally interconnected to deliver services that are interconnected.

Regarding the dynamic capabilities, which focus on the particular capabilities required by firms to successfully transition from product to add-on business model, these were analysed in accordance with sensing, seizing and transforming capabilities with the key additional insights. The sensing capabilities focus on the identification of market opportunities through market trends and customer pain points, while the technological possibilities focus on exploring the internal technological capabilities or external partners. In terms of seizing capabilities, the capabilities required include the digital service development, which focuses on developing the service in a small scale, mass customisation, which focuses on leveraging customer data for CRM and providing data as a service, digitalisation which focuses on descriptive analytics, interoperability of the system and connectivity, and Internet network coverage, and network management, which focuses on strategically choosing key partners and establishing mutual benefits for delivering service. In addition, the capabilities related to staff training on digital skills also emerged as part of the seizing capabilities, focusing on training the front-office staff to support the customer remotely in real-time as well as selling the service to their integrated partners, and back-office on working cross-functionally, with agile methodologies and hybrid skills. Regarding the transforming capabilities, these require service methodologies and processes for developing efficiency gains capability, which focus on continuously improving the service from customer feedback, updating new technological skills and simplifying the delivery service process; service culture capability, which focuses on a customer-centric culture with innovative, agile and start-up mindsets and risk (related GDPR and data security) and mitigation; and the scalable capability was also emerged during the empirical analysis, which focus on scaling the resources up to implement the business model in full scale.

6 Case 2: PrintCo – Investigation of the Usage-based and Solution-oriented Business Model

6.1 Introduction to the Chapter

This chapter investigates two embedded units of analysis within PrintCo. It focuses on the characteristics of business model firm resources, operational capabilities, network configurations and the dynamic capabilities required to implement the usage-based and the solution-oriented business model.

There are three parts to this chapter following the introduction. The overview of PrintCo and their product-offerings is presented in Section 6.2. Section 6.3 presents the results of the case study and discusses the results based on the template (template analysis) developed against the conceptual framework for the case study. Section 6.4 presents the summary of the chapter.

The structure of Chapter 6 is shown in Figure 6.1.

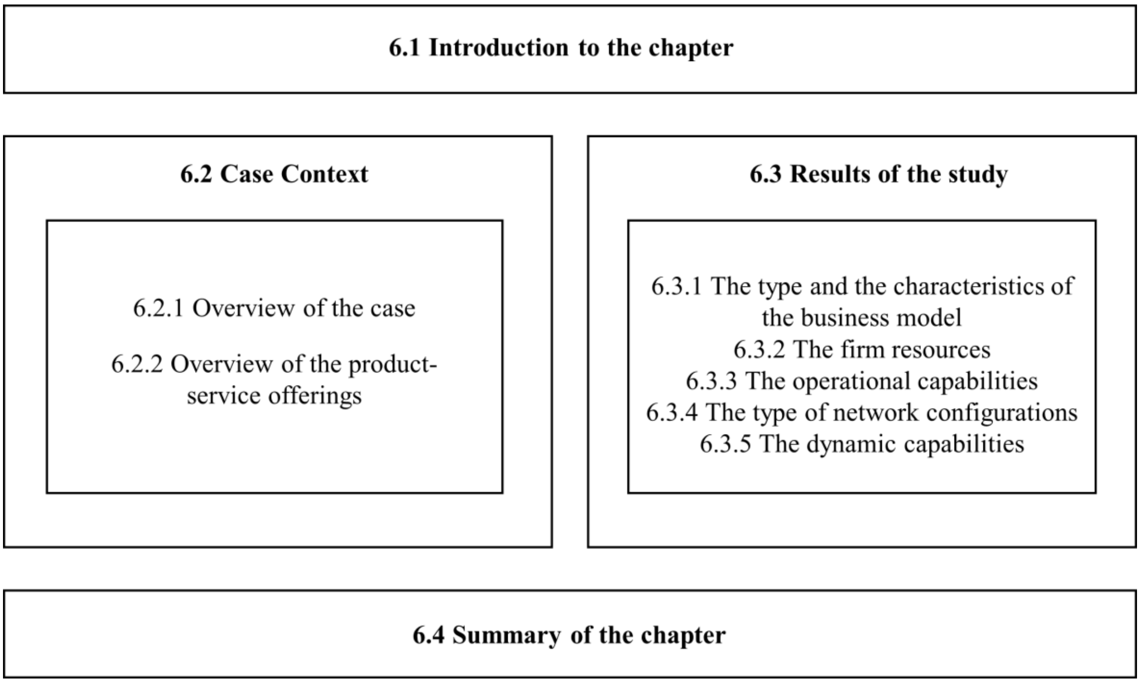


Figure 6.1: Structure of Chapter 6

6.2 Case Context

6.2.1 Overview of the case

PrintCo is an American multinational information technology company which has its business presence globally, including the Americas, Europe, Middle East, Africa and Asia-pacific. PrintCo was formerly the personal computers and printer division of their company's headquarters, before splitting away as a separate company in 2015. They deliver a wide range of hardware and software products and related services to consumers, small and medium-sized businesses and large business customers, including customers in the healthcare and education sectors. The business operates through three business segments: personal systems, printing, and corporate investment, as illustrated in Figure 6.2. The personal systems segment focuses on commercial and consumer personal computers (PCs), tablets and other related accessories, the revenues from which accounts for 64.4% of the company's total revenue. The printing segment offers commercial and consumer printer hardware, software and services, scanning devices and supplies (i.e. ink and toner). The revenues of the printing segment account for 35.6% of the company's total revenue. The corporate investments focus on the company research and development and certain business incubation projects.

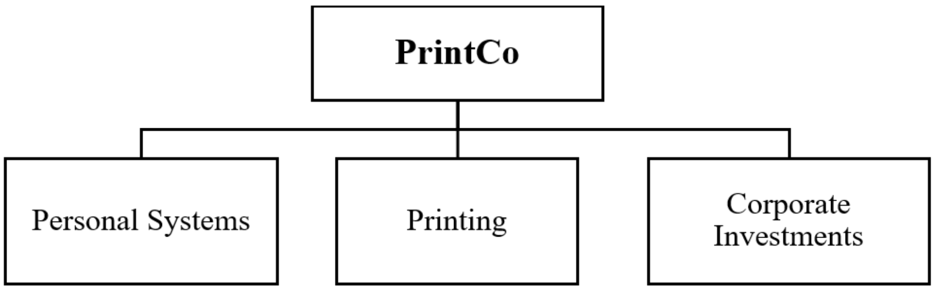


Figure 6.2: PrintCo's three main business groups

This thesis focuses on PrintCo's printing segment in which the IoT is leveraged to offer product and service offerings to end customers. Currently, PrintCo's business is considered as stable since the printing industry is relatively stagnant and the market is relatively mature. Accordingly, PrintCo aims to differentiate their strategy and develop innovative product and service offerings in order to increase their share and stay competitive in the market.

In order to understand the business context of the case, two key elements were investigated and explored. First, the company mission was thoroughly explored to understand how PrintCo position the strategy of their retail business. Secondly, an overview of the firm's environment in which FuelRetailCo operates based on a SWOT analysis was examined.

6.2.1.1 Company mission

From PrintCo's official website, the core mission of PrintCo is described as *"to create technology that makes life better for everyone, everywhere, every person, every organisation, and every community around the globe. This motivates us, inspires us, to do what we do. To make what we make. To invent, and to reinvent. To engineer experiences that amaze. We won't stop pushing ahead, because you won't stop pushing ahead. You're reinventing how you work. How you play. How you live. With our technology, you'll reinvent your world."*

Based on this mission statement, it can be understood that PrintCo aims to be a technological pioneer in the printing industry. This also illustrates that PrintCo will focus on research into new and innovative technology that can add value to their existing product and service offerings. Nevertheless, this mission statement also highlights that the product and service offerings developed should be inspired and driven by customers' requirements while incorporating technology to provide better customers' experience.

6.2.1.2 Overview of the firm's environment

PrintCo currently holds the largest market share in the electronic devices and printing industry. PrintCo is in high competition with other manufacturers of software, personal computers and other related technology-oriented services. They are currently under market pressure in terms of price and also the launch of a new product. Other competitors include independent suppliers who offer alternatives for PrintCo's ink and toner supplies at lower prices and also those competitors who develop and manufacture new cartridges to be compatible with PrintCo's products.

In order to understand PrintCo's business environment, it is important to look at the company from both internal (strengths and weaknesses) and external (opportunities and threats) perspectives through a SWOT analysis which was undertaken as follows:

Strengths: The main strength of PrintCo is the breadth and scale of their product portfolios, which not only include a wide ranges of laptops and PC models but also the provision of printing and imaging solutions, 3D printing and related technologies. This allows PrintCo to target diverse customer segments on a global scale, helping to respond to any rapid and unexpected economic changes. In addition, brand reputation is one of PrintCo's main strengths. PrintCo has continuously maintained their good image in the PC market through the reputation of their reliable and high quality products and service offerings. Accordingly, PrintCo tends to develop a high level of customer trust and loyalty. Another main strength of PrintCo is their strong focus on innovation. They heavily invest in research and design to keep up with the competitive market and customer engagement through their new development of products and service offerings.

Weaknesses: PrintCo's revenues mainly come from its personal system division, including sales from PCs and laptops. However, the PC market is relatively mature and tends to grow slowly. Therefore, this gradually becomes the main weakness of PrintCo. PrintCo also have a weakness in terms of their competency and decisions on acquisition. They have acquired many technology companies for their own benefit. However, PrintCo did not only buy some of them at a highly overvalued price but they also created no value or even had a detrimental impact on the company. This illustrates the lack of PrintCo's competency in acquiring companies. In addition, PrintCo relies heavily on external suppliers for their product manufacture and merchandise. These lead to the high bargaining power of their suppliers and may negatively affect the company under some unexpected circumstance. Hence, this becomes one of the main PrintCo weaknesses.

Opportunities: Product and service innovation are two of the major opportunities within this industry. This is because customer behaviour and market demand are changing continuously. Accordingly, PrintCo has to focus on innovative offerings (i.e. Device-as-a-Service (DaaS)) to personalise customers' individual preferences, in order to continue their business growth. Supply chain digitalisation is also one of the opportunities for PrintCo. As PrintCo is in a highly competitive environment, strategic management of their supply chain is one of the keys to creating a competitive advantage. Therefore, digitalising their supply chain will help PrintCo to better engage with their suppliers and customers as well as reduce their operational costs. In addition, PrintCo can leverage digitalisation in their marketing activities to create a better customer experience. PrintCo can utilise new technology such as AI technology or machining learning to deliver better customer engagement or even extend their current customer base.

Threats: The main threat comes from the slow growth rate of the PC market and there is the potential for the computer market to become saturated in the near future. PrintCo also faces intense competition from its competitors in all business areas. This results in PrintCo in facing price pressures, which may negatively impact the financial position and decline in the market share of the company. Furthermore, due to rapid technological change, PrintCo needs to seek to continually offer innovative products or service offerings that serve current customer needs. This requires PrintCo to undergo a business model change and align their new product and offering in order to respond to market demand and industry trends. In addition, many products offered by PrintCo are subject to regulations associated with the safe use of certain chemical substances and environments, which make all producers of electrical products responsible for the recycling and disposal of their past and future products. Accordingly, PrintCo needs to improve the efficiency of the energy and carbon emissions of their products and services offerings. These can cause complexity and incur costs for their operations in order to comply with all the regulations.

6.2.2 Overview of the product-service offerings

PrintCo's main product and services include selling PCs, printers and associated products (e.g. toners and ink). Currently, PrintCo has utilised IoT to monitor their products used by end customers, helping them to provide innovative service offerings based on individual product usage. This research will focus on two of PrintCo's IoT-enabled servitized offerings: Instant Ink and managed print services (MPS). These will be described in Section 6.2.2.1 and 6.2.2.2.

6.2.2.1 Instant Ink

Instant Ink is the ink replacement service launched by PrintCo in 2013. This service enables customers' printers to automatically order ink when it is running low and have it delivered to their home address. PrintCo also provides prepaid envelopes, encouraging customers to return their used ink cartridges for recycling. In order to enable this service, customers need to purchase compatible PrintCo printers, which PrintCo fitted with IoT, allowing PrintCo to monitor ink levels remotely. Customers can subscribe to the plan based on the amount of pages they print, regardless of colour or amount of ink used, while PrintCo takes responsibility for ensuring that their customers never run out of ink. Instant Ink helps PrintCo's customers to eliminate trips to purchase ink at the store or from independent suppliers, which are possibly cheaper but have a lower quality.

In terms of the strategic role of IoT used to enable Instant Ink, PrintCo leveraged the adaptation role of IoT as suggested by Gerpott and May (2016). This means IoT helps to add the additional functionalities (i.e. ink replacement service) to the standalone products (i.e. printer). Regarding the operational roles of IoT discussed in Suppatvech et al. (2019), the roles of IoT in Instant Ink are remote control (i.e. remotely monitoring the ink level and delivering the ink before it runs out) and monitoring customers' usage behaviour (e.g. monitoring individual customer's ink usage patterns, allowing PrintCo to tailor the subscription plans to suit those needs).

6.2.2.2 Managed Print Services (MPS)

PrintCo has offered MPS to B2B as part of their DaaS model. Rather than owning printers, PrintCo's business customers only pay for the service of on-site printing, including imaging and printing devices, supplies (i.e. ink, toner and paper), document workflow management, maintenance and other support. By leveraging IoT, PrintCo is able to gain visibility and control over their customers' printing technology and understand individual business organisations' printing environments. These allow PrintCo to provide customised sets of printing solutions, based on different business needs. For example, PrintCo can determine the numbers of printer required in different departments within a particular organisation, and the printer model which is most appropriate and efficient for a particular usage. Accordingly, PrintCo can help their business customers to optimise their printing costs, which results in a reduction in their printing costs through saving energy usage and paper waste, and an improvement in their productivity. To conclude, the MPS has mainly focused on three propositions: optimisation of the infrastructure, management of the environment, and improvement in the workflow.

In terms of the strategic role of IoT used to enable MPS offerings, PrintCo leveraged the innovation role of IoT, as suggested by Gerpott and May (2016). This means that IoT aids PrintCo in delivering novel offerings (i.e. customised printing solutions and fleet management). Regarding the operational roles of IoT discussed in Suppatvech et al. (2019), the roles of IoT in MPS are remote control (i.e. remotely controlling the business customers' printers and managing the consumables), proactive maintenance (e.g. to allow fleet predictability and increase the printer's uptime) and optimisation of operations (i.e. optimising the customer's printing environment).

The summary of PrintCo's two main digital product and service offerings are illustrated in Table 6.1.

Table 6.1: IoT-enabled product and service offerings provided by PrintCo

Service offering	Description	Customer(s)	Role of IoT	
			Strategic	Operational
Instant Ink	An ink cartridge replacement service. The customers subscribe to the plan, based on the number of pages printed monthly, regardless of the type and amount of ink they used. They will receive ink deliveries before they are running low. The monthly fee includes ink, shipping and recycling costs.	B2C/SMBs	Adaptation	• Remote control • Monitor customer's usage behaviour
Managed print services (MPS)	MPS provides customisable printing solutions for business customers. The service includes fleet predictability, document management and process automation, aiming to reduce their printing costs and improve productivity.	B2B	Innovation	• Remote control • Proactive maintenance • Optimisation of operations

6.3 Results of the Study

6.3.1 The Type and the Characteristics of the Business Model

This section will focus on the main characteristics of different types of IoT-enabled servitized business model: usage-based and solution-oriented business models. These characteristics will be discussed in Sections 6.3.1.1 and 6.3.1.2.

6.3.1.1 Instant Ink

The main type of Instant Ink's business model is the servitized business model, as mentioned by PrintCo's environmental leadership programme manager:

"We're moving to a service-based economy, and that's creating incentives for companies to design more efficiently." (DC2-12)

In addition, Instant Ink is considered as the ink subscription service where customers subscribe to the printing plans based on their actual usage, Therefore, Instant Ink illustrates a usage-based business model within the IoT-enabled servitized business model archetypes. As part of the subscription, PrintCo provides the continuous ink replenishment to the customer's printer. Hence, Instant Ink also illustrates the result-oriented business model suggested by Tukker's (2004) traditional servitization literature.

The main value proposition of Instant Ink is to deliver availability, as mentioned in document DC2-06:

"This program may also increase the usage of ink by customers since it promises 100% ink availably (e.g. avoiding those instances customers do not print or use alternative methods since they run out of ink)."

PrintCo's director of global sustainability operations (IN2-01) admitted that Instant Ink allows PrintCo to shift from transactional relationships to a contractual relationship with customers which customers need to subscribe to monthly for the service. This was also discussed in document DC3-02 as follows:

"Very few companies would refuse to serve customers because their thinking is outdated, but I do see a shift within PrintCo, that is very clear, to look at how we generate our revenue. We predict that more of our revenue will be generated from contractual work rather than transactional work."

In terms of pricing, Instant Ink offers customers five different monthly subscription plans based on the number of pages printed (15, 50, 100, 300 and 700 pages) regardless of the amount or colour of ink used. All plans include ink, shipping and prepaid recycling envelopes. Accordingly, the pricing is considered as pay-per-use.

One of the main OW criteria of Instant Ink is the availability of the product, as PrintCo guarantees 100% ink availability throughout the subscription. PrintCo also helps customers to save on the overall costs of printing, as mentioned in document DC2-24:

"PrintCo claims that the £1.99 per month plan can save £78 annually, the £3.49 per month plan saves £162 annually and the £7.99 plan saves customers £516 annually. These estimates are all based on the Instant Ink subscription prices for one year, in comparison to the average cost of a selected OEM ink."

Customers not only benefit from savings on their printing costs but also obtain a better experience in printing by ensuring that they will always receive ink before their supply has run out. Hence, besides product availability and cost reduction, the secondary OW criteria of *Instant Ink* also includes convenience and capacity to deliver a service.

"Instant Ink certainly simplifies the print experience and will appeal to consumers who are often frustrated with the high cost of ink and the inconvenience of ordering ink after it has run out." (DC2-24)

The main characteristics of the usage-based business model, MPS, compared to the theory are illustrated in Table 6.2.

Table 6.2: Main characteristics of PrintCo's Instant Ink Business Model

Characteristics of business model	Theory	Actual Instant Ink
Type of business model	Servitized business model: Usage-based	Servitized business model: Usage-based and result-oriented
Value proposition	Delivery availability	Delivery availability
	Deliver the outcomes of products	Deliver the outcomes of products (replenishment of ink cartridge)
Customer relationship	Transactional and relationship-based	Contractual relationship
Pricing	Subscription-based on a pay-per-use	Subscription based on pay-per-use (subscription to the plan, based on the number of pages printed)
Order winning criteria	Availability of products or services	Availability of product or services (the continuous replenishment of ink) and cost reduction

6.3.1.2 Solution-oriented business model: MPS

The main type of MPS business model is the servitized business model as PrintCo integrates services into their printing products by developing the product-as-a-service business model. Specifically, MPS is considered as a solution-oriented business model. These are explained in PrintCo's list of printing products and solutions (DC2-01):

"Through PrintCo Managed Print Services (MPS), we are taking steps towards the "circular economy" with a product-as-a-service *business model. MPS provides a customisable set of solutions including imaging and printing devices, network print management software, supplies (including paper), support, professional services, and document workflow management."*

Accordingly, the main value proposition of MPS is to deliver the specified performance of the products and services including printers, the supplies related to the printers (i.e. paper, toners) and consultations, based on a mutual agreement with the particular customer. Therefore, this allows PrintCo to tailor customised solutions based on individual customers' needs.

Regarding the pricing of MPS, similarly to Instant Ink, business customers pay for the number of pages printed. However, PrintCo tends to establish long-term agreements with their business customers as they have to pay quarterly in advance based on the forecast volumes accumulated remotely from the first 30 days volume printed from networked printers. Consequently, PrintCo has established long-term relationships with these long-term contracts.

"PrintCo invoices for service, supplies, and support on an all-inclusive, cost-per-page basis. MPS is a true pay-for-print model, meaning you pay only for the pages you print. Our agreements do not include minimums or average charges. Client costs are based on a single black and/or colour page rate per printer engine. Invoicing typically takes place quarterly in advance and is itemized by the asset. Quarterly bills are forecasted for 90 days based on the first 30 days of volume and are trued-up each quarter." (DC2-14)

However, PrintCo also offers flexible billing options for customers to suit their specific service requirements.

"PrintCo will work with clients to design a customer billing program to meet their needs." (DC2-30)

The order winning criteria of MPS is to deliver the performance of products, which includes the performance of the printers, by increasing the uptime of the printers, and continuously replenishing the supplies. In addition, PrintCo offers a client-oriented consultative approach by giving advice and flexible solutions to suit individual customers' business environments, with the aim of improving the efficiency of their document workflows.

"…Managed Print Services (MPS) is a suite of scalable and flexible solutions for office and production printing environments that help organisations productively and profitably manage paper and digital document workflows." (DC2-05)

The main characteristics of the solution-oriented business model, Instant Ink, compared with the theory, are illustrated in Table 6.3.

Table 6.3: Main characteristics of PrintCo's MPS Business model

Characteristics of business model	Theory	Actual Managed printed services (MPS)
Type of Business model	Servitized business model: Result-oriented	Servitized business model: Result-oriented
Value proposition	Deliver specified performance of products	Deliver specified performance of products (printer)
	Deliver solutions for individual needs	Deliver solutions for individual needs
Customer relationship	Long-term relationship	Longer-term relationship through long-term contracts
Pricing	Customers pay for the performance of the product based on mutual agreements	Invoices quarterly in advance for an all-inclusive services, cost-per-page basis or based on mutual agreements
Order winning criteria	Performance of products	Performance of products (printers and other supplies)
	Customised solutions	Customised solutions

6.3.2 The Firm Resources

This section will focus on the alignment between the firm resources and PrintCo's different IoT-enabled servitized business models. It will focus on assets and their location, and the ownership of particular resources required for implementing the different types of PrintCo's business models.

6.3.2.1 Usage-based business model: Instant Ink

In terms of the asset and locations, the Instant Ink business model utilises PrintCo's multiple manufacturing and warehouse facilities to directly deliver the product and services to customers and bypass the intermediaries (i.e. retailers), which can be considered as PrintCo's strategic resources.

"*…this program is a direct benefit of PrintCo's economics of scale. PrintCo holds manufacturing factories and warehouses in multiple locations. Without the large distribution capabilities, these direct to consumer, JIT shipments, could not have existed."* (DC2-06)

The IoT network is considered to be a hybrid since PrintCo allows specific service partners (i.e. independent software vendors) to access the integrated system in delivering instant ink. In order to implement Instant Ink, the front-office staff (i.e. customer services and technical support) must have the technical knowledge and experience to help support customers remotely throughout their subscription.

In terms of the ownership, PrintCo is vertically integrated in product manufacture and service provision, meaning they own the supply chain and leverage their expertise to deliver services, in order to control the quality and price of delivering the products and services. In addition, by offering instant ink, PrintCo encourages customers to recycle the ink cartridges by sending them back to PrintCo for creating recycled content, hence PrintCo has better visibility and control throughout their product life cycles.

"PrintCo's use of its own products to create recycled content gives the firm greater control over quality and price." (DC2-02)

However, PrintCo has also outsourced with non-core business activities, including logistics and developed partnerships with service providers such as software vendors. As PrintCo's Vice President and Head of Supply Chain mentioned:

"Orders are manufactured by a network of factories across the world, with the company's largest factory base being in Asia. Regional factories nearer to key customers handle more specific, complex requirements. Distribution is handled through a network of distribution hubs and subcontracted logistics activities." (DC2-08)

The firm resources of the usage-based business model, Instant Ink, compared with the theory are illustrated in Table 6.4.

Table 6.4: Firm resources of PrintCo's usage-based business models: Instant Ink

Firm Resources		Theory	Actual Instant Ink
Assets and their locations	**Facilities**	• Bypassing intermediaries • Multiple facilities close to market for supplying product	• Bypassing intermediaries (i.e. retailers) • Multiple facilities close to market for supplying product
	IoT network	Closed network	Hybrid network
	People and skills	Highly skilled worker with technical knowledge of product and service	Highly skilled worker with technical knowledge of product and service
Ownership	**In-house**	Vertically integrated in product manufacture and service provision to control quality, and minimise the cost of both product and service	Vertically integrated in product manufacture and service provision to control quality, and minimise the cost of both product and service
	Outsource/ partnerships	Non-core products or service operations	Non-core products or service operations such as logistic activities and partnerships with software vendors

6.3.2.2 Solution-oriented business model: MPS

In terms of the main assets required, PrintCo leverage their multiple field facilities close to markets. In addition, they have service vans, which act as an extension of the warehouse, distributed close to the market. These service vans are stocked with inventory supplies to the customer when needed based on the forecast of the demand which is shared across territories to optimise inventory.

"Coordinated Inventory System Service vans are considered an extension of our warehouse. Inventoried items are shared across territories when needed. Dispatchers sometimes send technicians into the field to meet up with other technicians to fill short-term inventory needs, eliminating the need to return to the warehouse for supplies fulfilment." (DC2-14)

In terms of the IoT network, this is currently considered as hybrid, while prior to which it was a closed network. This is because PrintCo does not only use their own internal system to manage and deliver the service for their customers, but they also allow their third-party developers to run the system on the open platforms in order to develop a customised app to suit the needs of particular business customers' environments. In terms of the people and skills required, the field service technicians need to have the technical knowledge and expertise to remotely access the device at the customer's site and immediately respond to support the customer.

"*PrintCo's field service technicians that provide onsite break-fix services and support are supported by even more experienced Tier II engineers that are assigned to the PrintCo National Technical Support (NTS) group."* (DC2-14)

Regarding ownership, PrintCo is vertically integrated in their product manufacture and service provision. This means they own their supply chain and leverage their expertise in their devices to deliver reliable service as well as control the quality and cost of delivering the products and services to the end customers. However, PrintCo develops partnerships with software vendors or developers related to printing and document management to support their non-core products and services operations, which are not within PrintCo's expertise.

"PrintCo also has strong partnerships with other solutions providers to provide a wide range of software and services to meet your workflow needs. These partnerships include

alliances with Pape(secure printing and print waste reduction for multivendor fleets) and DocuWare (document workflow management).” (DC2-14)

The firm resources of solution-oriented business model, MPS, compared with the theory are illustrated in Table 6.5.

Table 6.5: Firm resources of PrintCo’s solution-oriented business models: MPS

Firm Resources		Theory	Actual Managed print services (MPS)
Assets and their locations	**Facilities**	• Bypassing intermediaries • Multiple field facilities and close to market for product maintenance and repair, and supply	• Bypassing intermediaries (i.e. retailers) • Multiple field facilities close to market for product maintenance and repair, and supply
	IoT network	Closed network	Hybrid network
	People and skills	Highly skilled workers with technical knowledge of product and service	Highly skilled workers with technical knowledge of product and service
Ownership	**In-house**	Vertically integrated in product manufacture and service provision to control quality, and minimise the cost of both product and service	Vertically integrated in product manufacture and service provision to control quality, and minimise the cost of both product and service
	Outsource/ partnerships	Non-core products or service operations	Non-core products or service operations, including software vendors related to printing and document management

6.3.3 The Operational Capabilities

This section will focus on the alignment between the operating model and PrintCo’s different IoT-enabled servitized business models. This will focus particularly on the operational capabilities required for implementing the different types of PrintCo’s business model, including business process, governance and decision rights, organisational design and performance measurement.

6.3.3.1 Usage-based business model: Instant Ink

In terms of the process of this business model, PrintCo follows lean practices in supplying the product to customers. By leveraging IoT, PrintCo has better visibility of customer demand and be able to deliver ink to customers just-in-time and only when needed, which helps to streamline their service operations. However, PrintCo also follows the agile practice by developing the capability to act with agility and responsiveness to the variety of customer demand (i.e. pay-per-use based on different subscription plans) in the volatile market. This can be achieved through the enablement of IoT. Therefore, the process is a mix between lean and agile, which is also known as a bi-modal supply chain, as described by the vice president and head of EMEA supply chain.

"To operate a supply chain as described, it is also important to spend sufficient time and energy on innovation and improvements – this is what is often called 'Bi-modal'. (DC2-08)

In terms of the governance and decision rights, this is a mix between hierarchy and heterarchy as the director of global sustainable operations (IN2-01) mentioned that the staff are empowered to make quick decisions on delivering the business model while obtaining direct support from the senior management. This also supported by the vice president and head of EMEA Supply Chain's statement in DC2-08:

"There are fewer organisational layers to navigate, so quick decision making between strategically aligned senior management has facilitated flexible, rapid development." (DC2-08)

Regarding the organisational design, Instant Ink allows PrintCo to leverage the IoT to engage customers through continuously monitoring their ink usage in real-time, and supplying ink before it runs out. This aims to deliver value in use, while locking the customer in from buying ink from third party suppliers, through a subscription model. Hence, the type of organisation that supports the Instant Ink business model is value co-creation.

"For PrintCo, engaging customers in this way, secures revenue for PrintCo OEM supplies while offering a different value proposition to customers - to reduce the likelihood that they would want to use aftermarket suppliers due to lower prices" (DC2-15)

In terms of performance measurement, the main KPIs focus on the quality, dependability dimensions, including customer satisfaction, which could be measured through retention rates and adoption rates, and JIT delivery, which could be measured as the accuracy of the ink replenishment service. The time dimension is associated with the service response time from when the customers required the support. The flexibility tends to focus on the service delivery, where PrintCo has the ability to provide a sufficient range of service options to suit customers' needs.

"Customer retention rates continue to be very strong, coming in at over 90%. We also continue to see positive growth in cumulative enrollee counts, both yearly and quarterly. Customer adoption rates, among participating retailers in particular, are currently greater than 20%." General Manager and Global Head, Supplies Printing Business (DC2-10)

The operational capabilities of the usage-based business model, Instant Ink, compared with the theory are illustrated in Table 6.6.

Table 6.6: Operational capabilities of PrintCo's usage-based business models: Instant Ink

Operational capabilities	Theory	Actual Instant Ink
Process	Lean-agile	Lean-agile
Governance and decision rights	Hierarchy-Heterarchy	Hierarchy-Heterarchy
Organisational Design	Value co-creation	Value co-creation
Performance Management	Service quality	Customer satisfaction – retention rates and adoption rates
	Service response time	Service response time
	Product availability	JIT delivery – the accuracy of the replenishment service
	Product/service range	Service range

6.3.3.2 Solution-oriented business model: MPS

In terms of the process of this business model, PrintCo adopts both lean and agile practices in order to implement this model. By leveraging IoT this allows agility in responding to the variety of customer demands quickly as well as tailoring the solutions to fit with individual needs. On the other hand, the data collected from the printing device also help PrintCo to optimise inventory supplies and allow the predictive maintenance to support the individual customer demand in an efficient way which complements the lean practices.

Regarding the governance and decision rights, in order to implement this business model, it was mentioned by the director of global sustainable operations (IN2-01) that the staff was fully empowered in delivering the MPS to promote an agile way of working. Nevertheless, this still has to be directed by the senior management. Hence, the type of governance and decision rights are a mix of hierarchy and heterarchy.

In terms of organisational design, PrintCo engages their customers in order to implement MPS. PrintCo collaborates with its customers in order to understand their business environments and help tailor solutions to fit their requirements. In addition, PrintCo helps its customers to implement changes according to the plan. Accordingly, this type of organisation is value co-creation. As stated in the MPS brochure (DC2-14):

"(PrintCo's) Client Communications will help customers prepare employees for the transition, address concerns, and provide assistance around process changes. PrintCo will collaborate with customers to develop an internal communications plan to keep users informed of changes prior to implementation. PrintCo will also work together with customers to define the Service Request Process and communicate this information to end-users."

Regarding the performance measurement, similarly to Instant Ink, the key KPIs of the MPS are focused on the quality, speed and dependability dimensions of services, including customer satisfaction, service response time and service reliability. In addition, PrintCo tends to have the metrics specifically associated with individual customers; hence this refers to the performance of services specified by individual customers which are measured by the metrics specified in the service-level agreement.

"Different customers have different expectations. ...In some areas predictability is the key to customer satisfaction, in others it is about speed or special services. As well as using our own internal metrics, we communicate a lot with customers about their metrics of evaluating us to see whether we are performing the best we can." (The Vice President and Head of Supply Chain, DC2-08)

The operational capabilities of solution-oriented business model, MPS compared with the theory are illustrated in Table 6.7.

Table 6.7: Operating capabilities of PrintCo's solution-oriented business models: MPS

Operating model	Theory	Actual Managed print services (MPS)
Process	Agile	Lean-agile
Governance and decision rights	Hierarchy-Heterarchy	Hierarchy-Heterarchy
Organisational Design	Value co-creation	Value co-creation
Performance Management	Service quality	Customer satisfaction
	Service response time	Service response time
	Service reliability	Service reliability
	Service performance of individual customers	Service performance of individual customers – SLA

6.3.4 The Type of Network Configurations

6.3.4.1 Usage-based business model: Instant Ink

The coordination of different actors for implementing the Instant Ink business model is interconnected as business ecosystems within the value chain in order to support the model. This involved the alignment of shared interests in order to involve the actors working together to achieve the same goal. In order to implement the Instant Ink business model, PrintCo set up a service ecosystem internally within their value chain, the actors in which involve the compatible connected printers, the OEM to supply the special size of ink cartridges, the channel service partners, the software vendors, as well as the partners to support ink cartridge return and recycling. Accordingly, the type of network configurations is considered as the mix of a value chain and the business ecosystems.

"Through the Internet of Things (IoT), printer can interact with printer and order the correct cartridge without having to involve the customer. This is part of a targeted approach from PrintCo to ensure that customers and partners come with them on the circular journey." (DC2-02)

The network configurations of the usage-based business model, Instant Ink compared with the theory are illustrated in Table 6.8.

Table 6.8: Network configurations of PrintCo's usage-based business models: Instant Ink

Network configurations	Theory	Actual Instant Ink
Type of coordination	Value chain – Business Ecosystem	Value chain – Business Ecosystem

6.3.4.2 Solution-oriented business model: MPS

In order to implement MPS and provide tailored solutions for individual business customers within the specific industry, PrintCo has to establish a contractual ecosystem in which the different PrintCo partners are digitally connected within the service ecosystem in order to create customised value to the end users. These partners involve system integrators/resellers (who can be considered as the channel to market for PrintCo), the independent software vendors (who provide the software tools to use in the print environments) and OEM partners (who have the expertise in a particular industry). PrintCo and these partners work together at the beginning of the design of the value and identify the joint benefits and incentives or even joint business plans in creating customised solutions through the MPS offerings. Accordingly, the main focus of this type of coordination that supports the implementation of MPS is business ecosystems. As mentioned in the MPS brochure (DC2-14):

"PrintCo is responding with our trusted and valued reseller Sample Partner. Sample Partner offers comprehensive consulting, hardware, software, project and support services for organisations looking to upgrade, enhance or support their current informant technology needs. Sample Partner understands your IT needs. PrintCo brings expertise and value in an MPS offering to fit the unique needs of Sample Client. PrintCo will provide the MPS service, support and account management and Sample Partner will bring its knowledge of your organisation, and procure the print hardware as needed."

The network configurations of the solution-oriented business model, MPS, compared with the theory are illustrated in Table 6.9.

Table 6.9: Network configurations of PrintCo's solution-oriented business model: MPS

Network configurations	Theory	Actual Managed print services (MPS)
Type of coordination	Business Ecosystem	Business Ecosystem

6.3.5 The Dynamic Capabilities

This section explores the specific capabilities required in order to successfully transform different types of IoT-enabled servitized business models. Different capabilities were categorised according to the different dimensions or stages of dynamic capabilities. These will be discussed in Sections 6.3.4.1 and 6.3.4.2.

6.3.4.1 Usage-based business model: Instant Ink

6.3.4.1.1 Sensing capabilities

PrintCo sensed the market opportunities for the Instant Ink business model from the MPS which has been offered to the B2B customers. Instant Ink was then developed as the market expansion and a simplified offer from the MPS and PrintCo leveraged the similar sets of capabilities used to implement the MPS business model in providing similar offerings to household consumers and the SMBs markets.

"Through managed print services (MPS), the "as-a-service" model is already well established, at least among larger businesses. PrintCo continues to expand and deepen its MPS competencies and seek untapped opportunities in the SMB markets." (D3-11)

In addition, the director of global sustainable operations (IN2-01) suggested that the business model is driven by customer pain points or market pull. The subscription plans are characterised based on the customer's printing usages.

"…a lot of the desire for business model change within PrintCo is "driven by customer requirements". Customers now want more ink in each cartridge and shorter waiting and transportation time."

In terms of the technological possibilities, the director of global sustainable operations (IN2-01) mentioned that due to the evolution of the Internet, PrintCo has been offering a wireless printing service in B2C space, where customers can print remotely from their laptops. Hence, this gives them opportunities for PrintCo to leverage Internet-connected printers to notify them when the ink is running low.

According to the director of global sustainable operations (IN2-01), PrintCo has their own innovation research on the megatrends, which are available publicly. This research involves exploration to understand the social shifts, and the changes in demographic and technological forces to sense the new opportunities.

6.3.4.1.2 Seizing capabilities

Digital service development capability

PrintCo has to develop the capability to develop a profitable IoT-enabled servitized business model as this could be complicated and require significant investment. Accordingly, the business model of Instant Ink is initially designed to give the customer value and create customer loyalty. On the other hand, PrintCo also gains benefits from locking customers in with the purchase of PrintCo's printers and their OEM supplies. Hence, PrintCo can generate additional revenue from its printer and OEM supplies business as well as stable revenues from the contractual subscription plans.

"Bain and Company recently reporting that 60-80% of customers who feel satisfied with a business won't necessarily go back for further transactions. PrintCo is keen to put customers in the front and centre of its business model to ensure they are not lost. …To create loyal happy customers, you need to give them value – whether this is through a

cartridge or a PC as a service, it drives everything else and it's up to us to make it as attractive as possible. Our customers and other companies push us hard, which is great. It's important to be challenged." (The Director of Global Sustainable Operations, DC2-02)

"From the top-line perspective, in brief, the service enables PrintCo to create customer "stickiness" and ensures the ink will be purchased through PrintCo and not through the competition." (DC2-06)

Mass customisation service capability

The capability related to this category involves leveraging customer usage data in order to tailor the offerings to suit the large variety of customer needs. The main focus specifically for implementing Instant Ink is to offer different subscription plans that match the individual printing behaviours as well as offering tailored promotion plans based on specific customer usage.

"To further increase customer loyalty, PrintCo can offer promotions and tailored plans based on the specific customer needs and production benefits." (DC2-06)

Digitalisation capability

This capability is related to utilising the connected product and digital technologies to facilitate service delivery. Previously, PrintCo has managed their inventory of supplies based on the estimation or forecast demand, but now they do this by leveraging the data collected from the customer's connected printer to accurately predict the inventory of ink supplies at the strategic location, which helps to eliminate the bullwhip effect. Accordingly, PrintCo has to have the ability of using data analytics to extract useful information from the customer data as well as spotting the trends to increase and optimise customers' experience.

"If before the program the company could only estimate, based on the past, when customers will purchase PrintCo ink and when they will turn to competition, the program now guarantees a known stream of ink based on the exact location. PrintCo can use that information to pre-stock needed cartridges in strategic locations and really smooth manufacturing and distribution demand over time, eliminating the bullwhip effect." (DC2-06)

"In the supply chain it is very important that we have specific skills and capabilities, and to ensure that we have very targeted development programmes, whether they be on analytics and spotting trends in data or being certified to run big projects." (The Vice President and Head of Supply Chain, DC3-08)

Network management capability

As Instant Ink is an auto-replenishment service, PrintCo has to proactively deliver the ink directly to customers before they run out. This requires PrintCo to have the capability to effectively communicate and collaborate with their partners, and ensure the visibility of real-time customer demand among the actors involved in the service ecosystem in order to supply the ink through JIT delivery. The main actors involved are PrintCo's OEM manufacturers, the distributors, their channel and service partners, technical and customer supports, as well as recycling partners, which they need to align with the business model change.

"We're nowhere near finished. This is truly the beginning of our journey and there's no way we can do this on our own. ...we need our suppliers and partners to work with us, our retail and commercial channel partners to understand what we're trying to achieve and how to come with us on it." (DC2-02)

Capability related to staff training on digital knowledge

These capabilities mainly focus on training the front-office (i.e. technical support) in order to be able to tackle the problems and support the customers remotely in real-time. Regarding, the back-office staff who are behind the scenes of implementing the service, PrintCo produces new interactive ways for the staff to learn, which include a fail-fast philosophy that focuses on encouraging staff to put new ideas into practice quickly, to see failure as a learning curve for radical innovation and to focus on the iterative improvement from market feedback.

"As a company, we have a new learning concept which involves a greater focus on interactive ways of learning, not just training classes but online support and groups which connect people looking for the same outcomes." (The Vice President and Head of Supply Chain, DC-08)

6.3.4.1.3 Transforming capabilities

Service methodologies and process for developing efficiency gains capability

PrintCo has adopted the ability to optimise the process of service delivery in order to increase profit margins. This process optimisation includes cost reduction from producing their special large sized ink cartridges, which help to reduce the frequency and cost of ink shipments to the customers, as well as the overall cost of the ink's housing and packaging material. These help to compensate for the costs associated with the Instant Ink service.

"PrintCo believes this program offers real cost savings to them from the utilisation of jumbo-sized ink cartridges to the reduction in shipment expenses, to the housing of ink cartridges and cost of packaging material. Overall, they believe the benefits outway the upfront costs." (DC2-15)

In addition, Instant Ink supports the closed-loop business model where the customers are encouraged to return the empty ink cartridge after use using PrintCo's postage-paid envelopes. The Instant Ink cartridges have been manufactured using recycled contents which reduces the cost of manufacture. This helps to streamline the internal process of service delivery.

"Device-as-a-service dovetails with this closed loop. Instant Ink ships out postage-paid envelopes with replacement cartridges for sending back used cartridges, so people with Instant Ink subscriptions are more likely to recycle. The Instant Ink cartridges contain 50 percent to 75 percent recycled content. That service helps cut the energy used to make cartridges by 86 percent, and water use is slashed by 89 percent." PrintCo's environmental leadership program manager (DC2-12)

Service culture capability

It is mentioned in the company's 2019 annual report (DC2-07) that PrintCo predicts that more of their revenues will be generated from contractual work, which means PrintCo focuses on the development of "Product-as-a-Service" or PaaS across all of their range of products and services. Accordingly, they tend to embed the mindset of PaaS in their business culture. In addition, PrintCo focuses on meeting customer demand while responding to emerging technological trends, hence, they need to have an agile culture in order to continuously improve their offering and keep up with the dynamic market needs and technological trends.

"…the development and transition of new products and services and the enhancement of existing products and services to meet customer needs and respond to emerging technological trends." (DC2-07)

Risk management and mitigation capability

The main risk associated with the implementation of this business model is the privacy of customer data, as this service requires remote access to some sensitive data (e.g. printing usage, cartridge information, types of document printed). Hence, the process has to be established in order to ensure the customers that this privacy concern has been addressed.

"There is a privacy tradeoff, and many consumers will be reluctant to allow PrintCo or other companies such intimate access to their data. I think those concerns will diminish over time as the normalisation of IoT progresses and cost savings materialise." (DC2-06)

According to the director of global sustainable operations (IN2-01), there is also the external risk associated with the clone or counterfeit cartridges sold by third parties which could be compatible with PrintCo's printers. Therefore, intellectual property (IP) has to be taken into consideration to ensure that only original cartridges can be recognised.

In addition, there is a risk associated with spending a significant amount of money on delivering the service due to the small task required which could outweigh the benefits to PrintCo. Accordingly, it is important that the whole process is as fully automated as possible in order to reduce the incurred cost of human intervention. This is the reason why PrintCo is limited to two printer models due to compliance.

"Automatic order fulfilment: a small ticket program like this can become a huge problem if it ends up to be successful, due to the amount of small tasks that need to be performed and the cost of which has to be covered with monthly rents of 2 digits. Therefore, the whole recurrent process of billing pages, triggering the need for a cartridge, processing the order and delivering it has to be fully automated. Should human intervention be required, the profit would be cleared. The compliance of the printer influences the capacity to auto-fulfil it. This is certainly the reason why Instant Ink is limited to two printer models." (D2-33)

The dynamic capabilities of the usage-based business model, compared with the theory are illustrated Table 6.10.

Table 6.10: Dynamic capabilities of PrintCo's usage-based business model: Instant Ink

	Theory	Actual Instant Ink
Sense	Market sensing capability	• Driven by customer pain points or market pull • Research about market trends
	Technology sensing capability	• Exploration of internal technological capabilities • Extend the use of IoT as technological capabilities from B2B to B2C
Seize	Digital service development capability	• Develop the service that locks customers into their products • Focus on generating stable revenues for services
	Mass service customisation capability	• Leverage customers' usage data to tailor appropriate service plans and CRM
	Digitalisation capability	• Data management and predictive analytics to extract useful information to support offerings and SC management
	Network management capability	• Increase the visibility and strategically share data to the members of the network ecosystem
	Other capabilities - Capability related to staff training on digital skills	• Training the front-office staff on digital skills to remotely support customers in real-time • Provide new ways of training for staff (online and interactive)
Transform	Service methodologies and process for developing efficiency gains capability	• Optimise the process of service delivery • Promote close-loop to achieve internal efficiency
	Service culture capability	• PaaS and agile culture
	Risk management and mitigation capability	• GDPR and privacy of customer data • Required intellectual property (IP) plan • Cost-benefit analysis

6.3.4.2 Solution-oriented business model: MPS

6.3.4.2.1 Sensing capabilities

According to the director of global sustainable operations (IN2-01), MPS initially originated from addressing business customer's pain points as these business customers have large fleets of printers to manage. Accordingly, PrintCo started to offer MPS from the idea of leasing products, where PrintCo retains the ownership of the printing and servicing devices and ensures that the consumables (e.g. ink and toners) are always in supply.

"Managed Printed Services started from addressing customer's pain points. MPS has been offered to B2B customers for 20 years (e.g. university and large size of companies)

which originated from the idea of leasing products." (The Directors of Global Sustainable Operations, IN2-01)

However, the MPS has been continuously evolving according to emerging and technological trends. Regarding the technological possibilities, the multifunctional printers (MFPs) are currently equipped with IoT sensors allowing the printer to generate a wealth of data which can help to further tailor solutions to address more customer-specific needs.

6.3.4.2.2 Seizing capabilities

Digital service development capability

This capability focuses on introducing new lines of products and services in accordance with market opportunities and technological possibilities. Specifically to the MPS business model, PrintCo has leveraged their MPS infrastructure to develop flexible channel-led MPS offerings. PrintCo recognises the need to develop a broad range of modular services with the option to suit the expertise and maturity of each of their channel partners as well as provide more service portfolios to be tailored as part of the MPS offered for the end customers.

"PrintCo is catching up, having spent the past few years refining and simplifying its channel-led MPS programmes. From simple 'print-as-a-service' to broader MPS offerings, PrintCo has removed the complexity of its previous patchwork model for MPS." (DC-28)

Accordingly, PrintCo has offered flexible packages of MPS which include a basic MPS and a value MPS approach. The former includes maintenance, supplies and support while the latter includes assessment, optimisation of printing volume, and the improvement of workflow and mobile printing, which can be delivered by PrintCo, their channel partners or co-delivered, in order to address the different needs of the end customers.

Mass service customisation capability

This capability is related to leveraging the customer's usage data in order to customise the solutions to suit the large variety of customers' specific needs. Accordingly, PrintCo has to closely communicate with their customers, for them to understand the company's goal and objectives, and leverage the usage data to serve different customers' preferences and objectives. In addition, PrintCo is currently focused on providing end-to-end solutions, specialising in a wide ranges of industries, such as medical, manufacturing and education, to address their key business priorities.

"Customised Approach PrintCo will meet with you to discuss your optimization goals and objectives. We will take into consideration your company culture, end-user needs and any other preferences you state. This customised approach sets PrintCo apart from our competition." (DC2-14)

Digitalisation capability

This capability involves the ability to utilise the connected products and the data generated in which to facilitate the MPS business model. An account delivery manager is individually assigned to business customers in order to monitor printer fleets through remote management service and leverage the data analytics supported by the business intelligent (BI) tools to help interpret and analyse the fleet data in order to provide key information and deliver insightful optimisation recommendations to the customers.

"As PrintCo monitors, services, and collects page counts for your fleet, we gather key information to make insightful optimisation recommendations. After an initial service period (at least three months), your account delivery manager will analyse gathered information and present strategic recommendations during a Customer Business Review meeting. PrintCo approaches optimisation over the length of your contract to continually drive down costs." (DC2-14)

Network management capability

These capabilities are important for PrintCo to implement the MPS business model which focuses on managing the knowledge-sharing as well as the shared resources and capabilities between the partners within the service network, as 80% of PrintCo's sales revenue comes from the 250,000 channel partners it has worldwide. PrintCo strategically chooses their channel partners, which include industry-specific system integrators, independent software vendors and value those who have different expertise in delivering broader solutions and services of MPS to the end customers, to be part of their service ecosystem.

"To make the most of these benefits, businesses need a partner and devices whose capabilities align with their needs. While it's tempting to stick with what you know or

focus down on cost-per-page, it makes more long-term sense to think about the whole portfolio of printers and services, and about having the right ecosystem in place to support your business needs." (DC2-03)

In addition, PrintCo has developed a partnership programme which includes solid engagement and transparency with their partners in the service ecosystem. PrintCo has developed a service infrastructure, which facilitates their partners with their printing hardware and supplies products, software tools, sale and technical service support, while PrintCo also leverages their partner resources and their industry-specific expertise to deliver tailored MPS offerings to distinct customer bases.

"PrintCo has developed a robust service infrastructure to support its partners and service delivery technicians. PrintCo's cloud-based Express Decision Portal handles new account opportunity analysis, proposal generation, ongoing management and reporting, and fleet optimisation. PrintCo also enables partners to take advantage of a broad array of business intelligence tools. These offer mapping and visualisation, core status and reporting, fleet utilisation, modelling, and insights and predictive analytics." (DC3-28)

Depending on the level of partnership with them, PrintCo gives opportunities to the resellers to own the contract of the customers as well as co-marketing and co-branding with them as business partners. Consequently, PrintCo has established mutual incentives with their partners to further expand the MPS business model. As mentioned on the official website:

"Our commitment to the channel has never been stronger. Together, we will advance our leadership in Personal Systems and Print, leverage our technology to disrupt new markets, and transform the way we work, to drive our mutual success."

Capability related to staff and customer training on digital knowledge

These involve PrintCo's ability in the training of their staff and customers in order to implement this business model. Since there are comprehensive ranges of services offered as part of the MPS business model, as well as training the key front-office staff on the continuously customised support model to comply with the needs of individual customers, they should have the capability to train their customers to have a fundamental understanding of the printing devices and facilitate the transition by organisations.

"As devices are installed and configured, technicians or the PrintCo partner will conduct an informal walk-around training. This training covers the key features and benefits as well as performance capabilities of new devices including basic printing, fax, and scanner features, as applicable. This is a high-level overview training designed to provide a basic understanding of the device functionality such as how and where to load consumables, how to clear paper jams, how to access toner cartridges for changing, and a simple front-panel tutorial." (DC2-14)

In addition, training is also required for PrintCo's partners to focus on transitioning from transactional-based to contractual or solution-based selling. The training plan is customised to fit the different audiences within the organisation (i.e. sale teams, pre-sales solution architect, consultant and account manager).

"PrintCo is committed to providing partners with a modular training plan with a path to move up from transactional-based selling to contractual and solutions-based selling. …PrintCo's commitment to partners is to provide cutting edge training to ensure success." (DC2-36)

6.3.4.2.3 Transforming capabilities

Service methodologies and process for developing efficiency gains capability

These capabilities involved the ability to streamline the process of service delivery in order to deliver a cost-effective MPS offering. Since PrintCo has full responsibility and control on delivering the service and maintaining their printing fleets, they can simplify the design of their printers and consumables to use less energy and take up less space. In addition, PrintCo leverages IoT to help them be more proactive in fixing potential faults before breaking down, and hence reduce the frequency of engineers required on sites.

"…PrintCo has designed its printers and consumables to use less energy, take up less space and be as reliable and efficient as possible. …The simplified, streamlined mechanisms use a smaller number of highly modular components, fitted with embedded sensors. …This enables MPS providers to be more proactive, fixing potential faults before you've even noticed them. What's more, the faulty component can be set to run at, say, a lower speed, keeping the MFP up and running until an engineer arrives with a fix. It's this sort of intelligence that can make downtime a thing of the past while improving the chances of a first-time fix when the engineer arrives." (DC2-13)

Service culture capability

In order to successfully transform the MPS business model, PrintCo tends to focus on embedding the service mindsets as part of a customer-centric culture. In addition, PrintCo focuses on fostering continuous learning to help their staff embed the growth mindset and encourage them to be more innovative and resilient to keep up with the pace of change and the disruption.

"While there are many moving parts in the shift from products to smart services, fundamental to success is a shift in mindset. As PrintCo and (PrintCo's partner) have partnered together to deliver these smart services across multiple industries, the underlying cultural theme is a focus on the customer and realisation of the outcomes they are targeting. This is a big step from the historical separation of product and services and fundamentally changes not only the approach but the value that can be realised." (DC2-34)

Risk management and mitigation capability

The main risk concern associated with the MPS business model is that of security threats which could arise from those posed by the documents that print devices produce and the vulnerability of the print infrastructure itself. The former include confidential documents which could lead to a privacy and compliance problem while the latter include attempts at hacking the printer infrastructure, targeting the documents waiting in the queue. Accordingly, PrintCo has to invest in the resources (i.e. technology and software) and deepen their cybersecurity expertise to establish the assessment associated with a diverse range of security issues.

"PrintCo continues to invest heavily in resources to support its diverse range of security assessment services, which range from basic assessments to ongoing monitoring to support SLAs on security governance and compliance. PrintCo prides itself on its deep analytic expertise, helping organisations to understand their security risk profile and determine the best approach to controlling and securing their print infrastructure." (DC2-29)

The dynamic capabilities of the solution-oriented business model, MPS, compared with the theory are illustrated in Table 6.11.

Table 6.11: Dynamic capabilities of PrintCo's solution-oriented business model: MPS

Theory		Actual and insights Managed print services (MPS)
Sense	Market sensing capability	• Identification of B2B customer pain points • Further extend from traditional servitized business model (i.e. leasing) • Research about market trends – go-to-market strategy
	Technology sensing capability	• Exploration of the emerging IoT as technological trends to further address customers' specific needs
Seize	Digital service development capability	• Development of the flexible and broad ranges of product and service portfolio
	Mass service customisation capability	• Leverage customer data to offer customised solutions, aligning with specific needs
	Digitalisation capability	• Data management, proactive analytics and BI tools to extract useful information to support offerings and SC management
	Network management capability	• Strategically choose and align partners to support specific customer needs • Establish mutual incentives with the partners
	Other capabilities - Capability related to staff and customer training on digital skills	• Different levels of training for both staff and partner within the business ecosystem • Basic training for customers on the functionality of products and digital services
Transform	Service methodologies and process for developing efficiency gains capability	• Utilise IoT to be more proactive to help in optimising service delivery
	Service culture capability	• Service and growth mindset • Develop a customer-centric, innovative and resilient culture
	Risk management and mitigation capability	• Invest in resources to deal with data security threats • Regulatory compliance

6.4 Summary of the Chapter

This chapter provides an overview and the case study findings of PrintCo for implementing the usage-based and solution-oriented business models. Consequently, the results of the case study analysed the constructs developed during the template analysis. The results started with the analysis of the characteristics of PrintCo's two different business models: usage-based (Instant Ink) and solution-oriented business model (MPS) based on the conceptual framework. The findings showed that the usage-based business model corresponds to a usage-based servitized business model that focuses on delivering the availability and outcomes of products, and establishes a contractual relationship with customers. The pricing is subscription-plan based on pay-per-use and the main OW criteria is the availability of products or services. On the other hand, the solution-oriented business model focuses on delivering specified performance and solutions that suit individual needs and establish a long-term relationship through long-term contracts. The pricing is based on a pay-per-use basis quarterly in advance, all-inclusive, as well as flexible billing options based on mutual agreement, and the main OW criteria are the performance of products and customised solutions tailored to suit specific business needs.

Regarding the firm resources, the main assets and locations that support the usage-based business models are the multiple facilities close to markets that can deliver the products JIT, hybrid IoT network and highly skilled workers with the technical expertise to support customers. PrintCo is vertically integrated for both product manufacture and service provision, and outsources with non-core business activities, e.g. logistics and partnerships with software vendors. The firm resources required to support the solution-oriented business models are similar to those that support the usage-based business model.

Regarding the operational capabilities, the business process that supports the usage-based business models is a mix of lean and agile, which aims to leverage the IoT to drive the efficiency as well as agility and innovation to quickly adapt and respond to market demand. The main type of governance and decision rights is a mix of hierarchy and heterarchy, meaning the staff are empowered to take the responsibility for delivering the service with the directives of senior management. The type of organisation design is value co-creation, requiring customer engagement in delivering the service. Regarding the performance measurement, the KPI metric is adopted by focusing mainly on quality (i.e. customer satisfaction and retention rates) and dependability (i.e. accuracy of the replenishment) of service delivery, as well as service response time and service range. These are the same as the solution-oriented business model, apart from the KPIs where the dependability and flexibility dimensions focus on service reliability and SLAs.

In terms of the network configurations, the type of coordination that supports usage-based business models is a mix of value chain and business ecosystems, where PrintCo sets up the service ecosystems and is digitally interconnected with their partners to deliver services within the value chain. On the other hand, the type of coordination that supports solution-oriented business models is the business ecosystem where PrintCo and the partners are integrated as business partners in order to design and create a value customised to meet exactly individual customers' objectives.

Regarding the dynamic capabilities, which focus on the particular capabilities required by firms to successfully transition from product to usage-based and solution-oriented business models, were analysed in accordance with sensing, seizing and transforming capabilities with the key additional insights. In terms of the sensing capabilities, MPS started by addressing market opportunities through the traditional leasing model where the IoT and MFPs are further leveraged as technological possibilities to specific end-to-end solutions for customers. Instant Ink was developed as a simplified offer from MPS, driven by the market pull. In terms of seizing capabilities, the capabilities required include the digital service development, which focuses on locking customer in with PrintCo's product and generates stable revenues through a monthly subscription in the usage-based business model, while the solution-oriented business model focuses on providing broad ranges of products and services; mass customisation which focuses on leveraging customer data to tailor subscription and CRM plans in the usage-based business model while leveraging customer data to deliver customised solutions; digitalisation which focuses on data management and predictive analytics in the usage-based business model while proactive analytics and BI tools focus on the solution-oriented business model; and network management which focuses on increasing the visibility of data-sharing among partners within the service ecosystem while strategically choosing key partners and establishing mutual incentives for delivering service are mainly focused on the solution-oriented business model. In addition, the capabilities related to staff and customer training in digital skills also emerged as part of the seizing capabilities, focusing on providing training for both front-office staff on supporting the customer remotely in real-time in the usage-based business model, while the solution-oriented business model further focuses on providing different levels of training for both staff and their partner as well as basic customer training. Regarding the transforming capabilities, the capabilities required include service methodologies and processes for developing efficiency gains which focus on optimising the service delivery through the development of the closed-loop model for both usage-based and solution-oriented business models; service culture which focuses on PaaS and agile culture for the usage-based business model while the solution-oriented model further focuses on having a service and growth mindset embedded within a customer-centric, innovative and resilient culture; and risk (related to GDPR, IP and cost-benefit analysis) and mitigation in the usage-based business model, while the risk and mitigation in the solution-oriented model is focused on data security and regulatory compliance.

7 Discussion

7.1 Introduction to the Chapter

The aim of this chapter is to discuss the case study findings with respect to the extant literature. Specifically, this chapter serves as a synthesis of the literature and emerge the findings from the empirical research to draw conclusions and establish the emerging conceptual framework – as part of the iterative process supported by critical realism. Accordingly, the discussion of the findings with respect to the extant literature will provide the foundations for the contributions to be identified. The structure of the discussion chapter reflects the conceptual framework and the research aims and questions.

Section 7.2 focuses on answering the first research question which involved identifying the different types of the business model and the characteristics of the business model based on the empirical findings. Sections 7.3 and 7.4 and 7.5 focus on answering the second, the third, and the fouth research question, respectively. These involved the discussion of the firms resources, the operational capabilities and the type of network of each business model based on the empirical findings of two case studies. In addition, a cross-case analysis was conducted to compare these constructs within the same archetype. Section 7.6 focuses on answering the fifth research question which discusses the particular dynamic capabilities of the three dimensions: sensing, seizing and transforming, required to implement the IoT-enabled servitized business models which emerged in the context of the FuelRetailCo and PrintCo case studies.

As this research is exploratory in nature, it was crucial to revisit the literature associated with the emergent findings. This is considered to be a part of the abductive research approach. Hence, Section 7.7 concludes the emerging findings of the study with the modified conceptual framework. Section 7.8 presents the summary of the chapter.

The structure of Chapter 7 is shown in Figure 7.1.

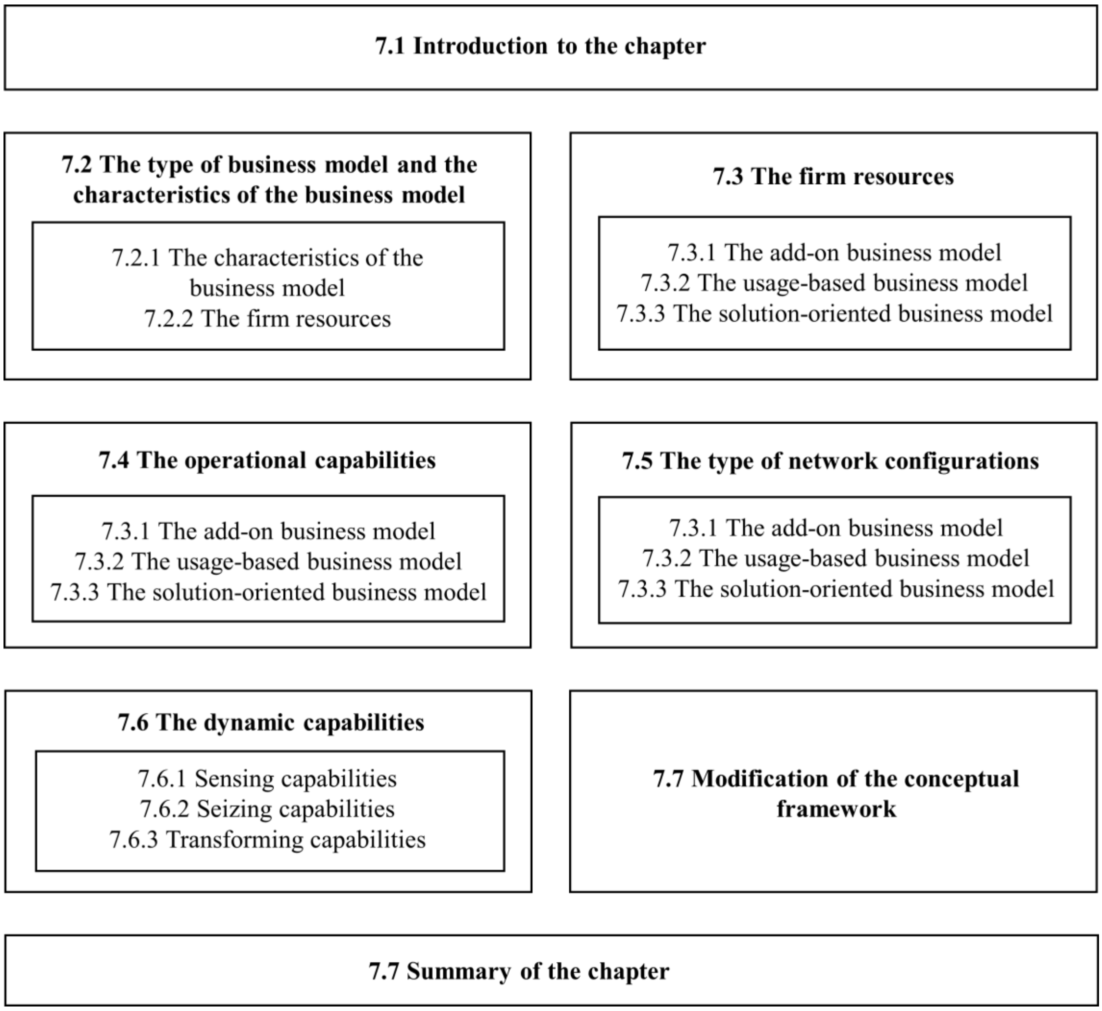


Figure 7.1: Structure of Chapter 7

7.2 The Type of Business model and the characteristics of the business model

This section mainly focuses on discussing RQ1: What are the different types of IoT-enabled servitized business models and what are their characteristics?, based on the results of two case studies and six embedded units of analysis. Section 7.2.1 focuses on answering the type of business model and section 7.2.2 focuses on answering the characteristics of the business model by comparing the empirical findings to the theory and conducting the cross-case analysis of the same archetype of business model.

7.2.1 The Type of IoT-enabled servitized business model

Based on the literature related to IoT-enabled servitazion suggested by Suppatvech et al. (2019), there are four types of IoT-enabled servitized business models including add-on, sharing, usage-based and solution-oriented business model. The empirical evidence suggested that the four IoT-enabled business models implemented by FuelRetailCo, including Fill up and go, digital payments for fleet solutions, on-demand food delivery and on-demand fuelling service are considered as add-on business model where the digital service is integrated to improve the sale of products. This corresponds to the product-oriented business model, based on Tukker's (2004) classification. However, one of the FuelRetailCo's business models, on-demand fueling business model has the potential to offer more personalised services based on the customer's usage and may upgrade to the usage-based model or solution-oriented business model in the the future.

On the other hands, the two IoT-enabled businsss models implemented by PrintCo including Instant ink and MPS. Instant Ink is considered as the usage-based business model as the service is charged based on the actual usage of the product. This corresponds to both the use-oriented and result-oriented business model, based on Tukker's (2004) classification as the customers are guaranteed for the accessibility of the IoT-enabled service throughout the subscription plan while the firms provide the outcome of the products. The summary of the type of business model based on the empirical analysis across the six embedded units of analysis is illustrated in Table 7.1.

Table 7.1: The type of IoT-enabled business model based on six embedded units of analysis

Case	**FuelRetailCo**				**PrintCo**	
Business model	**Fill up and go**	**Digital payments for fleet solutions**	**On-demand food delivery**	**On-demand fueling service**	**Instant Ink**	**Managed Print Services (MPS)**
Type of IoT-enabled business model	Add-on	Add-on	Add-on	Add-on	Usage-based	Solution-oriented
Type of servitized business model based on Tukker's (2004) classification	Product-oriented	Product-oriented	Product-oriented	Product-oriented	Use-oriented and Result-oriented	Result-oriented

The insight from the empirical findings suggested that the product-based firms who tend to start with the add-on business models and try out different types of digital service as an add-on to test the feasibility and the customer demand before upgrading to more complicated business models (i.e. usage-based and solution-oriented business models). This was ascertained by the results from the FuelRetailCo's case. On the other hand, the product-based firms who have experience in technology and the provision of servitized offerings tend to leverage their expertise in adopting IoT to implement more complicated business models including usage-based business model and solution-oriented business model. This was ascertained by the results from PrintCo's case. However, the sharing business model which was initially identified in the existing literature was not found in the empirical findings from two cases. This could because the sharing business model was industry-specific in practice and mainly implemented within the automotive industry (i.e. car-sharing service) (Cusumano, 2014; Nishino et al., 2017).

7.2.2 The Characteristics of the Different Types of the Business Model

As discussed in section 7.2.1, the empirical findings suggested that the four embedded units of analysis represent the add-on business models and hence the cross-case analysis was conducted in order to discuss the similarities and the differences of the characteristics of the add-on business model (section 7.2.2.1). The other two units of analysis represent the usage-based and solution-oriented business model, and these were discussed in comparison to the theory (section 7.2.2.2 and section 7.2.2.3).

7.2.2.1 The Add-on Business Model

The characteristics of the add-on business model across the four units of analysis were determined. Based on the empirical evidence, it can be concluded that the characteristics of the add-on business model are uniform across all four FuelRetailCo's business model. However, there are slight variations, depending on the type of customer. The characteristics of the business model across FuelRetailCo's four add-on business model are presented in Table 7.2.

Table 7.2: The characteristics of the business models across four add-on business models of FuelRetailCo

Characteristics of the business model	Fill up and go	Digital payments for fleet solutions	On-demand food delivery	On-demand fueling service
Value proposition	Ownership of the product with digital service (a range of purchasing options) as an add-on	Ownership of the product with digital service (a range of purchasing options) as an add-on	Ownership of the product with digital service (a range of purchasing options) as an add-on	Ownership of the product with digital service (a range of purchasing options) as an add-on
Customer relationship	Transactional	Tends to develop long-term relationships with B2B customers	Transactional	Transactional for B2C and tends to develop long-term relationship for B2B
Pricing	Normal product price	Monthly subscription fee or a fee per transaction, depending on negotiation	Put a premium price on) products plus delivery fee	Normal product price plus service fee and flexible invoicing for B2B
OW criteria	A good overall service experience	A good overall service experience	Convenience and speed of purchasing products or service	Convenience and speed of purchasing products or service

As illustrated in Table 7.2, the value proposition is the same across Fill up and Go, digital payments for fleet solutions, on-demand food delivery and on-demand fueling service which is to provide a range of options in purchasing the products with the digital service. In the case of the customer relationship, all four business models suggested that FuelRetailCo has a transactional relationship with customers. However, they tend to establish a long-term relationship with their B2B business model even from the digital add-on service.

In the case of pricing, the empirical evidence across four FuelRetailCo’s business models suggested that there are several ways to monetise the add-on service including provide the add-on service for free (but the company may get higher profits from improving the product sales), provide the add-on service for a fee or allows the customer to pay for a fixed monthly subscription or flexible invoicing for B2B customer. Finally, in terms of the OW criteria, as the fill up and go and digital payments for fleet solutions required the customers to come to the retail stations to purchase the products, the OW criteria is to deliver a good service experience to the customer. However, on-demand food delivery and on-demand fuelling service focus on delivering products and services directly to the customers, hence, OW criteria is the convenience and speed for the customer to purchase the products.

7.2.2.2 The Usage-based Business model

The characteristics of the usage-based business model were determined based on the empirical findings with regard to those suggested by the existing literature. Based on the empirical analysis shown in Table 7.3, the characteristics of PrintCo’s usage-based business model emerged from the data and in line with the literature (Gebauer et al., 2017; Gerpott and May, 2016; Kohtamäki et al., 2019).

Table 7.3: The characteristics of the usage-based business model of PrintCo: extant literature and case study findings

Characteristics of business model		Gebauer et al. (2017)	Gerpott and May (2016)	Kohtamäki et al. (2019)	Results of the study
Value proposition	Delivery availability	✓	✓	✓	✓
	The outcomes of products	✓	✓	✓	✓
Customer relationship	Transactional		✓		✓ Contractual Relationship
	Relationship-based	✓	✓	✓	
Pricing	Subscription-based		✓	✓	✓
	Pay-per-use	✓	✓	✓	✓
OW criteria	Availability of products or services	✓	✓	✓	✓
	Cost reduction				✓

Table 7.3 illustrates that the main value proposition of the usage-based business model is to deliver the availability and outcome of the product throughout the period of subscription. Hence, the relationship with customers is shifting from transactional towards relationship-based through automatically renewing the product-service offering by the end of subscription. This type of relationship is called a contractual relationship which involved a month-to-month commitment under specific terms and conditions.

In the case of pricing, the empirical findings also supported the literature by suggesting that the usage-based business model monetise their offerings through flexible subscription plans based on the customer's product usage for their business model, while IoT helps PrintCo to accurately monitor the usage and ensure that their customers do not exceed the limit of the plan that they subscribe to. In terms of the OW criteria, the primary OW criteria are the availability of the products and the cost reduction for the customer was emerged during the analysis. The findings also mentioned secondary OW criteria which are to deliver convenience and the capacity to deliver a service.

7.2.2.3 The Solution-oriented Business model

The characteristics of the solution-oriented business model were determined based on the empirical findings with regard to those suggested by the existing literature. Based on the empirical analysis shown in Table 7.4, the characteristics of PrintCo's solution-oriented business model emerged from the data and were in line with the literature (Gebauer et al., 2017; Gerpott and May, 2016; Kohtamäki et al., 2019).

Table 7.4: The characteristics of the solution-oriented business model of PrintCo: extant literature and case study findings

Characteristics of business model		Green et al. (2017)	Grubic and Jennions (2018)	Kohtamäki et al. (2019)	Results of the study
Value proposition	Deliver specified performance of products	✓	✓	✓	✓
	Deliver solutions for individual needs	✓	✓	✓	✓
Customer relationship	Long-term relationship	✓	✓	✓	✓
Pricing	Customers pay for the performance of the product based on mutual agreements	✓	✓	✓	✓
OW criteria	Performance of products	✓	✓	✓	✓
	Customised solutions	✓	✓	✓	✓

As illustrated in Table 7.4, the main value proposition of the solution-oriented business model is to deliver the performance of products and individual solutions which is in line with the existing literature. By adopting this type of business model, firms have to focus on selling the performance and value created by the product to support individual customers' requirements. Accordingly, the empirical findings ascertained the literature which indicates that firms tend to establish long-term relationships and close collaboration with their customers.

In the case of pricing, the empirical findings supported the literature by indicating that the solution-oriented business models monetise their product-service offerings through performance-based contracts where the customers purchase the functional results or performance of the products. In terms of the OW criteria, the empirical findings supported the literature that the solution-oriented business model aims to deliver the specified printing performance as agreed with specific customers. In addition, this business model allows the customers to specify their business or industrial needs while PrintCo tailors the range of service to suit those needs. This means the overall OW criteria of the solution-oriented business model is to deliver the performance of the products as well as the customised solutions that suit individual needs.

7.3 The Firm Resources

This section focuses on discussing RQ2: What are the resources required for product-based firms to implement IoT-enabled business models? by considering the assets and their locations (i.e. facilities, IoT network, and people and skills) and the ownership of assets based on the results of two case studies and six embedded units of analysis.

7.3.1 The Add-on Business Model

The firm resources required to implement the add-on business model across the four units of analysis were determined. Based on the empirical evidence, it can be concluded that the firm resources are uniform across all four FuelRetailCo's business model. However, there are slight variations in the on-demand fueling service. The firm resources required to implement the add-on business model across FuelRetailCo's four business models are presented in Table 7.5.

Table 7.5: The firm resources required to implement the add-on business model across four business models of FuelRetailCo

The Firm resources		Fill up and go	Digital payments for fleet solutions	On-demand food delivery	On-demand fueling service
Assets and their locations	Facilities	The large network of retail stations distributed close to market	The large network of retail stations distributed close to market	The large network of retail stations distributed close to market	• Bypass retail stations and service directly to customers. • Sufficient mobile facilities close to the market
	IoT network	Hybrid network	Hybrid network	Hybrid network	Hybrid network
	People and skills	Low skilled workers with fundamental IoT-enabled product or service knowledge on front line/customer service	Low skilled workers with fundamental IoT-enabled product or service knowledge on front line/customer service	Low skilled workers with fundamental IoT-enabled product or service knowledge on front line/customer service	Highly skilled workers are required (service champions are selected to deliver fuelling service to customers)
Ownership	In-house	Vertically integrated to control quality and minimise cost	Vertically integrated to control quality and minimise cost	Vertically integrated to control quality and minimise cost	Vertically integrated in all operational activities including product manufacturing and service delivery
	Outsource/ partnerships	Integrated partners to deliver service	Integrated partners to deliver service	Integrated partners to deliver service	Integrated partners to deliver additional service

As presented in Table 7.5, in terms of the assets and their locations, the main resource for the add-on business model is to have a large network of retail stores close to the market. However, the empirical evidence also suggested firms may try to bypass the retail stores and develop mobile facilities to directly deliver products and services to the customers. In addition, IoT network adopted is a hybrid network and the low skilled worker with fundamental IoT knowledge are required at the front-line but highly skilled workers may be required if the products and services are delivered directly to the customers. In addition, in order to implement the add-on business model, firms still retain their product manufacture, but integrate a range of third party partners (i.e. software vendors, additional service providers to deliver the service.

7.3.2 The Usage-based Business model

The firm resources of the usage-based business model were determined based on the empirical findings with regard to those suggested by the existing literature. Based on the empirical analysis shown in Table 7.6, the firm resources of PrintCo's usage-based business model emerged from the empirical data and mostly in line with the existing literature (Baines and Lightfoot, 2013; Herterich et al., 2015a; Porter and Heppelmann, 2015).

Table 7.6: The firm resources of the usage-based business model of PrintCo: extant literature and case study findings

The firm resources		Baines and Lightfoot (2013)	Herterich et al. (2015a)	Porter and Heppelmann (2015)	Results of the study
Assets and their locations					
Facilities	Bypassing intermediaries	✓	✓	✓	✓
	Multiple facilities close to market for supplying product	✓		✓	✓
IoT network	Closed network		✓	✓	Hybrid network
People and skills	Highly skilled worker with technical knowledge of product and service	✓	✓	✓	✓
Ownership					
In-house	Vertically integrated in product manufacture and service provision	✓	✓	✓	✓
Outsource/ partnership	Non-core products or service operations	✓	✓	✓	✓

As presented in Table 7.6, in terms of the assets and their locations, the main resource for the usage-based business model is to leverage their manufacturing and warehousing facilities in various locations close to the market to efficiently deliver and supply the product-service offerings directly to the customers. This means PrintCo bypasses their intermediaries and establishes a relationship directly with customers. In addition, the IoT network adopted is the hybrid approach, meaning specific partners are allowed to access the smart product-service system to deliver the usage-based business model but retain control on the product-service functionalities. Furthermore, firms require highly skilled workers with technical knowledge to ensure the continuous supply of the product and remotely monitor and assist with individual customer's problems. In addition, firm retained and renewed the design and manufacture of their products as well as the service delivery to control and leverage customer data generated from IoT. On the other hand, firms may outsource their non-core service activities such as logistic activities and partners with the software vendors to deliver particular functionalities of product-service offerings.

7.3.3 The Solution-oriented Business model

The firm resources of the solution-oriented business model were determined based on the empirical findings with regard to those suggested by the existing literature. Based on the empirical analysis shown in Table 7.7, the firm resources of PrintCo's solution-oriented business model emerged from the data and were in line with the literature (Gebauer et al., 2017; Gerpott and May, 2016; Kohtamäki et al., 2019).

Table 7.7: The firm resources of the solution-oriented business model of PrintCo: extant literature and case study findings

The firm resources		Baines and Lightfoot (2013)	Herterich et al. (2015a)	Porter and Heppelmann (2015)	Results of the study
Assets and their locations					
Facilities	Bypassing intermediaries	✓	✓	✓	✓
	Multiple field facilities and close to market for product maintenance and repair, and supply	✓		✓	✓
IoT network	Closed network		✓	✓	Hybrid network
People and skills	Highly skilled workers with technical knowledge of product and service	✓	✓	✓	✓
Ownership					
In-house	Vertically integrated in product manufacture and service provision	✓	✓	✓	✓
Outsource/partnership	Non-core products or service operations	✓	✓	✓	✓

As presented in Table 7.7, in terms of the assets and their locations, the main resources for the solution-oriented business model are the manufacturing and warehousing facilities in various locations close to the market. The insights from empirical findings also suggested that firms may also develop the mobile facilities as the extension of their warehouses which stock the inventory supplies that can be shared across the territories to efficiently and quickly deliver and supply the product-service offerings. In addition, firms adopt a hybrid approach to include the specific partners who have particular expertise in helping meet PrintCo's customer' business needs. Firms are required to have highly skilled workers with technical knowledge in order to provide customers with continuous and remote support and instantly respond to the customers' problems, as well as providing an insight into the individual business needs to help them optimise their business operations. Furthermore, firms who adopt the solution-oriented business model tend to vertically integrate for both product manufacture and service design and delivery in order to have full control of manufacturing products to ensure the quality and minimise internal cost while delivering the customised solutions specified by customers. Particular partners, such as software vendors, OEM partners and system integrators are also incorporated to help firms deliver the product or service features and functionalities that are not their expertise but are required to meet the customers' business or industrial desires.

7.4 The Operational Capabilities

This section focuses on discussing RQ3: What are the operational capabilities required for product-based firms to implement IoT-enabled servitized business models? by considering the process, governance and decision rights, organisational design and performance measurement based on the results of two case studies and six embedded units of analysis.

7.4.1 The Add-on Business Model

The operational capabilities required to implement the add-on business model across the four units of analysis were determined. Based on the empirical evidence, it can be concluded that the operational capabilities are uniform across all four FuelRetailCo's business model. However, there are slight variations in the on-demand fueling service. The operational capabilities required to implement the add-on business model across FuelRetailCo's four business models are presented in Table 7.8.

Table 7.8: The operational capabilities required to implement the add-on business model across four business models of FuelRetailCo

The operational capabilities		Fill up and go	Digital payments for fleet solutions	On-demand food delivery	On-demand fueling service
Process		Lean-Agile	Lean-Agile	Lean-Agile	Lean-Agile
Governance and decision rights		Hierarchy - Heterarchy	Hierarchy - Heterarchy	Hierarchy - Heterarchy	Hierarchy - Heterarchy
Organisational Design		Value facilitation	Value facilitation	Value facilitation	Value co-creation
Performance Management	Quality	✓	✓		✓
	Speed	✓	✓		✓
	Dependability				
	Flexibility				
	Cost	✓	✓	✓	

As illustrated in Table 7.8, the operational capabilities required for firms to implement the add-on business are to adopt lean practices in the upstream business, which involve product manufacture and efficiently delivering products to the distribution channels, while it focuses on the adoption of agile practices in delivering digital services or the downstream business. In the case of the governance and decision rights, firms should adopt a hybrid approach between hierarchy and heterarchy. This means that the firm assigns the decision rights to the staff who have closely interacted or collaborated with the customers in each market while obtaining support from top-down directives. The insights from FuelRetailCo also suggested that empowerment is given to the product owners who have autonomy in making the decisions related to the digital service.

In terms of the organisation design, firms may start with the role of value facilitator to identify the potential IoT-enabled offering that the customer may need and later shift to the value co-creator when they see the opportunities in leveraging IoT in collecting the insights from fleet customers' usage to offer more advanced servitized offerings. Regarding the performance measurement, the performance measures adopted in add-on business models are relatively customer-facing, measurable measures, and focuses on the cost, quality and speed in providing the products and services.

7.4.2 The Usage-based Business model

The operational capabilities of the usage-based business model were determined based on the empirical findings with regard to those suggested by the existing literature. Based on the empirical analysis shown in Table 7.9, the operational capabilities of PrintCo's usage-based business model emerged from the data and showed similar patterns to the extant literature (Kohtamäki et al., 2019; Parida et al., 2019; Sjödin et al. 2020).

Table 7.9: The operational capabilities of the usage-based business model of PrintCo: extant literature and case study findings

The operational capabilities		Kohtamäki et al. (2019)	Parida et al. (2019)	Sjödin et al. (2020)	Results of the study
Process	Lean-agile	✓	✓	✓	✓
Governance and decision rights	Hierarchy-Heterarchy	✓	✓	✓	✓
Organisational Design	Value co-creation	✓	✓	✓	✓
Performance Management	Quality	✓		✓	✓
	Speed		✓		✓
	Dependability	✓	✓	✓	✓
	Flexibility	✓	✓	✓	✓
	Cost				

As presented in Table 7.9, the operational capabilities required for firms to implement the usage-based business model is to adopt a combination of lean and agile practices where lean practices are adopted to efficiently manufacture products and manage the inventory while the agile practices are adopted in order to be more dynamic and quickly respond to a radical and disruptive technological innovation. In the case of the governance and decision rights, firms tend to promote heterarchy, where the senior management distributes the decision rights to the staff who work closely with the market to deliver a good service experience while these staff can still receive top-down support from them.

Regarding the organisational design, firms adopt the value co-creation approach in order to engage with the individual customer through monitoring the customer's product usage and providing subscription plans that suit a large number of customers. In the case of the performance measurement, the main KPIs adopted for the usage-based business model focus on the quality, speed, dependability and flexibility dimensions with the details of quantifiable measures.

7.4.3 The Solution-oriented Business model

The operational capabilities of the solution-oriented business model were determined based on the empirical findings with regard to those suggested by the existing literature. Based on the empirical analysis shown in Table 7.10, the operational capabilities of PrintCo's solution-oriented business model emerged from the data and illustrated some similar patterns to the extant literature (Kohtamäki et al., 2019; Parida et al., 2019; Sjödin et al. 2019). However, there are some slight differences in the results of the study in the process and the governance and decision rights compared with the literature.

Table 7.10: The operational capabilities of the solution-oriented business model of PrintCo: extant literature and case study findings

The operational capabilities		Kohtamäki et al. (2019)	Parida et al. (2019)	Sjödin et al. (2020)	Results of the study
Process	Agile	✓	✓	✓	Lean-agile
Governance and decision rights	Heterarchy	✓	✓	✓	Hierarchy-Heterarchy
Organisational Design	Value co-creation	✓	✓	✓	✓
Performance Management	Quality	✓		✓	✓
	Speed	✓	✓		✓
	Dependability		✓	✓	✓
	Flexibility	✓	✓	✓	✓
	Cost				

As illustrated in Table 7.10, the operational capabilities required to implement the solution-oriented business model is the adoption of lean and agile practices in order to offer individual customers a great variety of printing services and functionality to suit their business requirements, while IoT is also leveraged to optimitise and increase the efficiency of the internal operations. In the case of the governance and decision rights, firms adopted a mix of heterarchy and hierarchy since, although the staff (i.e. account delivery manager) assigned to work directly with individual customers have a direct responsibility to help customers achieve specified performance, they still receive support from top-down directives.

Regarding the organisational design, firms adopted the value co-creation approach by organising themselves to work with individual customers to understand their business environments and requirements and facilitate them to change their printing environments. In terms of the performance measurement, the literature indicates that the performance measures tend to focus on the quality, speed, dependability and flexibility of product and service and the details tend to be specified by the individual customer through SLA.

7.5 The Type of Network Configurations

This section focuses on discussing RQ4: What is the view of network configurations required to support IoT-enabled servitized business models?, based on the results of two case studies and six embedded units of analysis.

7.5.1 The Add-on Business Model

The type of network configurations required to support the implementation of the add-on business model across the four units of analysis was determined. Based on the empirical evidence, it can be concluded that the type of network configurations are uniform across all four FuelRetailCo's business model. These are presented in Table 7.11.

Table 7.11: The type of network configurations that supports the add-on business model across four business models of FuelRetailCo

Type of network configurations	Fill up and go	Digital payments for fleet solutions	On-demand food delivery	On-demand fueling service
Coordination	Value chain – Business ecosystems	Value chain – Business ecosystems	Value chain – Business ecosystems	Value chain – Business ecosystems

As illustrated in Table 7.11, in order to implement the add-on business model, firms are required to organise the business ecosystems to deliver digital services to the end customers (i.e. downstream business) while the upstream business is still coordinated as a traditional value chain. The actors within the business ecosystem may include the platform provider and software providers who are digitally and interdependently connected to create mutual value for the end customers. Hence, the type of network configuration that supports the add-on business model is a mix of the traditional value chain and business ecosystems. The additional insights from the empirical findings further suggested that the position of the firm within the business ecosystems should be specified. For example, firms' partners may act as complementors to help firms deliver the value proposition of digital services directly to the end customers. On the other hand, firms may act as complementors to the other companies to supplement the main value chain proposition for those companies while firms can receive the mutual benefits from selling more products indirectly to the end customers.

7.5.2 The Usage-based Business model

The type of network configurations required to support the implementation of the usage-based business model were determined based on the empirical findings with regard to those suggested by the existing literature. Based on the empirical analysis shown in Table 7.12, the type of network configurations of PrintCo's usage-based business model emerged from the data and showed the similar patterns to the extant literature (Harmon, 2017; Kapoor, 2018; Valdez-De-Leon, 2019).

Table 7.12: The type of network configurations that supports the usage-based business model of PrintCo: extant literature and case study findings

Type of network configurations		Harmon (2017)	Kapoor (2018)	Valdez-De-Leon (2019)	Results of the study
Coordination	Value chain – Business Ecosystem	✓	✓	✓	✓

As presented in Table 7.12, in order to implement the usage-based business model, firms are required to organise the business ecosystems internally within their traditional value chain in order to provide proactive supplies to the end customers which are supported by the literature. The actors within the business ecosystem may include the software providers, channel partners or resellers and the system integrators who are digitally and interdependently connected to create mutual value to the end customers. Hence, the type of network configuration is a mix of the traditional value chain and the business ecosystems.

7.5.3 The Solution-oriented Business model

The type of network configurations required to support the implementation of the usage-based business model was determined based on the empirical findings with regard to those suggested by the existing literature. Based on the empirical analysis shown in Table 7.13, the type of network configurations of PrintCo's usage-based business model emerged from the data and showed the similar patterns to the extant literature (Harmon, 2017; Kapoor, 2018; Valdez-De-Leon, 2019).

Table 7.13: The type of network configurations that supports the solution-oriented business model of PrintCo: extant literature and case study findings

Type of network configurations		Harmon (2017)	Kapoor (2018)	Valdez-De-Leon (2019)	Results of the study
Coordination	Business Ecosystem	✓	✓	✓	✓

As illustrated in Table 7.13, the empirical evidence supports the literature by suggesting that in order to implement the solution-oriented business models, firms tend to establish business ecosystems, including different partners who are digitally connected and work together at the initial value design, and determine the mutual benefits and incentives as well as the joint business plans, in order to deliver the customised printing solutions for individual customers. Accordingly, this type of coordination that supports the implementation of the solution-oriented business model is business ecosystems.

7.6 The Dynamic Capabilities

This section focuses on discussing RQ5: What are the dynamic capabilities required by firms to upgrade from their product-based to IoT-enabled business models? The emerging case study findings from two case studies, FuelRetailCo and PrintCo will be discussed with reference to the extant literature and the dynamic capabilities view, focusing on three dimensions of dynamic capabilities: sensing, seizing and transforming capabilities.

7.6.1 Sensing Capabilities

The sensing capabilities required to implement the IoT-enabled servitized business model across the six units of analysis were determined. Based on the empirical evidence, it can be concluded that the sensing capabilities are uniform across all four FuelRetailCo's business models and two PrintCo' business models. The sensing capabilities required to implement the IoT-enabled servitized business models across six business models are presented in Table 7.14.

Table 7.14: The sensing capabilities across six business models of FuelRetailCo and PrintCo

Dynamic capabilities: Sensing capabilities	FuelRetailCo				PrintCo	
	Fill up and go	Digital payments for fleet solutions	On-demand food delivery	On-demand fueling service	Instant Ink	Managed Print Services (MPS)
Market sensing capability	✓	✓	✓	✓	✓	✓
Technology sensing capability	✓	✓	✓	✓	✓	✓

As illustrated in Table 7.14, firms need to possess both market sensing and new technology capabilities in order to start implementing the IoT-enabled servitized business models. The empirical findings outline the details of market sensing capability by underlining that firms should start by identifying the customer pain points or business challenges, also known as the market pull, and firms may also pursue the go-to-market strategy which involves the research market trends in order to see the feasibility. In addition, firms may try to offer more options for customers in purchasing product-service offerings, expanding from their traditional product or service offerings which have already been offered to B2C or B2B and to offer products or services that the customers might not yet realise that they need.

In terms of the technology sensing capability, the emerging results outline three main ways of exploring technological possibilities that can be adopted in order to help support the market requirements. First is to explore the existing IT infrastructure and technology stack in order to deliver customers' requirements. Second is to identify the viable options of technology in involving and integrating external partners to co-design and help to deliver the services that support particular customers' requirements, i.e. the use of the web-interface of API. Third is to leverage the external partners' IT infrastructure and technology resources which are not the focal firm's expertise. An overview of the findings and the additional insights with respect to the literature is illustrated in Table 7.15.

Table 7.15: Sensing capabilities: extant literature and results of the study

Sensing capabilities	Extant Literature	Additional insights from the results of the study
Market sensing capability	The firm's ability in identifying new market opportunities and recognising the current market trends and requirements. (Day, 1994; Helfat and Winter, 2011; Teece, 2012; 2017)	- Identify market opportunities through customer pain points and business challenges and provide more options for customers to purchase the products. - Identify the demand that has not yet been realised. - Research market trends (go-to-market strategy). - Extending the offering from B2B to B2C and vice versa.
Technology sensing capability	The firm's ability in exploring and recognising the IoT as a technological possibility to support market needs. (Teece, 2012; 2017)	- Internally explore the existing IT capabilities and upgrade as needed. - Identify new viable IT options to integrate partners in support of the service (e.g. API and web-interface). - Leverage external partners' IT expertise.

7.6.2 Seizing Capabilities

The seizing capabilities required to implement the IoT-enabled servitized business model across the six units of analysis were determined. Based on the empirical evidence, it can be concluded that the seizing capabilities are uniform across all four FuelRetailCo's business models and two PrintCo' business models. The seizing capabilities required to implement the IoT-enabled servitized business models across six business models are presented in Table 7.16.

Table 7.16: The seizing capabilities across six business models of FuelRetailCo and PrintCo

Dynamic capabilities: Seizing capabilities	FuelRetailCo				PrintCo	
	Fill up and go	**Digital payments for fleet solutions**	**On-demand food delivery**	**On-demand fueling service**	**Instant Ink**	**Managed Print Services (MPS)**
Digital service development capability	✓	✓	✓	✓	✓	✓
Mass service customisation capability	✓	✓	✓	✓	✓	✓
Digitalisation capability	✓	✓	✓	✓	✓	✓
Network management capability	✓	✓	✓	✓	✓	✓
Capability related to the staff and customer training on digital knowledge	✓	✓	✓	✓	✓	✓

As presented in Table 7.16, firms need to develop five seizing capabilities in der to implement the IoT-enabled servitized business model. First is digital service development capability which involves the ability to offer customers a unique value proposition and develop a corresponding business model as well as appropriately communicating customer value from emerging the value of IoT. Second is mass service customisation capability which is defined as the firm's ability to leverage IoT to integrate the knowledge of individual customers in order to tailor the product-service offerings to fit a great variety of customer needs. Third is digitalisation capability which refers to the firm's ability to use smart, connected products and data analytics in order to facilitate the service development and delivery. Fourth is network management capability which involves the firm's ability to effectively manage and share knowledge with the partners within their service delivery network.

Fifth is the capability related to the staff and customer training on digital knowledge which emerged during the empirical analysis. It is suggested that firms need to train both front-office and back-office staff in digital skills in order to understand how to create value and sell the IoT-enabled service offerings; the former needs to be trained on how to support staff remotely and through the digital platform and the latter needs to be trained on how to work cross-functionally, with agile methodologies and hybrid skills (i.e. having both IT skills and business understanding). In addition, the different levels of training should be given to both staff and their partners, depending on the level of digital knowledge required, while basic training should also be given to customers so they have a fundamental understanding of how the digital service works. An overview of the findings and the additional insights with respect to the literature is illustrated in Table 7.17.

Table 7.17: Seizing capabilities: extant literature and results of the study

Seizing capabilities	Extant Literature	Additional insights from the results of the study
Digital service development capability	The ability to offer customers a unique value proposition and develop a corresponding business model as well as appropriately communicating customer value from emerging the value of IoT. (Hasselblatt et al., 2018; Huikkola and Kohtamäki, 2017; Ulaga and Reinartz, 2011)	- The deployment of full-service on a small scale. - The balance between IT process and service delivery process. - Develop a unique value proposition and pricing models to fit with individual needs of customers.
Mass service customisation capability	The firm's ability to leverage IoT to integrate the knowledge of individual customers in order to tailor the product-service offerings to fit a great variety of customer needs. (Matthyssens and Vandenbempt, 2010; Sjödin et al., 2016)	- Leverage customer data for CRM and marketing purposes. - Leverage customer's usage data to tailor the customised service to suit a large variety of individual needs.
Digitalisation capability	The firm's ability to use smart, connected products and data analytics in order to facilitate service development and delivery. (Coreynen et al., 2017; Lenka et al., 2017; Parida et al., 2019; Sjödin et al., 2016).	- Interoperability of IT infrastructure. - Data management and analytics to support service delivery. - Utilise predictive and proactive analytics and BI tools to support the service delivery and optimise internal operations.
Network management capability	The firm's ability to effectively manage and share knowledge with the partners within their service delivery network. (Gebauer et al., 2017; Huikkola and Kohtamäki, 2017; Sjödin et al., 2016)	- Develop co-location themes for close collaboration with partners and customers and strategically align them to support specific offerings. - Establish mutual incentives and joint benefits with their partners and customers. - Increase the visibility of data among service network partners.
<u>**Capability emerged during empirical analysis**</u> **Capability related to the staff and customer training on digital knowledge**		The firm's ability to establish the different levels of training for staff personnel, partners and customers based on the different levels of digital and service knowledge required. - Different levels of training for staff and partners. - Basic level training for the customer should be considered.

7.6.3 Transforming Capabilities

The transforming capabilities required to implement the IoT-enabled servitized business model across the six units of analysis were determined. Based on the empirical evidence, it can be concluded that the transforming capabilities are uniform across all four FuelRetailCo's business models and two PrintCo' business models. The transforming capabilities required to implement the IoT-enabled servitized business models across six business models are presented in Table 7.18.

Table 7.18: The transforming capabilities across six business models of FuelRetailCo and PrintCo

Dynamic capabilities: Transforming capabilities	FuelRetailCo				PrintCo	
	Fill up and go	Digital payments for fleet solutions	On-demand food delivery	On-demand fueling service	Instant Ink	Managed Print Services (MPS)
Services methodologies and processes for developing efficiency gains capability	✓	✓	✓	✓	✓	✓
Service culture capability	✓	✓	✓	✓	✓	✓
Risk management and mitigation capability	✓	✓	✓	✓	✓	✓
Scalable capability	✓	✓	✓	✓		

As presented in Table 7.18, firms need to develop four transforming capabilities in order to eventually transform and sustain the IoT-enabled servitized business model. First is the capabilities related to services methodologies and processes for developing efficiency gains which involve the firm's ability to develop economies of scale or skill. Second is the service culture capability which is defined as the firm's ability to develop a business model with a service culture as well as the innovative and start-up mindset to quickly respond to the disruptive innovation. Third is risk management and mitigation capability which refers to the firm's ability to manage risk for service provision involving risk and reward sharing contracts, privacy and security of the customer data, execution risk assessment and mitigation capability.

Fourth is scalable capability which emerged during the empirical analysis. It is suggested that firms have to be able to upscale their resources to deploy full-scale service solutions and expand the same IoT-enabled servitized business model in the different markets after the feasibility of the pilot experiment has been tested. An overview of the findings and the additional insights with respect to the literature is illustrated in Table 7.19.

Table 7.19: Transforming capabilities: extant literature and results of the study

Transforming capabilities	Extant Literature	Additional insights from the results of the study
Services methodologies and processes for developing efficiency gains capability	The firm's ability to develop the economies of scale (i.e. high volumes, low variable costs and intensive use of fixed assets) or skill (i.e. developing process innovations and/or identifying, deploying and replicating scarce capabilities). (Auguste et al., 2006; Coreynen et al., 2017; Paiola et al., 2013)	- Focus on customer feedback and quickly iterate change for product-service improvement. - Continuously update technological skills. - Simplify the service delivery process to reduce internal costs. - Optimise the service delivery process through the closed-loop supply chain and proactive customer service
Service culture capability	The firm's ability to develop a business model with a service culture and mindset. (Neely, 2008; Ostrom et al., 2010; Story et al., 2017)	- Digital/innovation/start-up/agile/ growth and resilient mindset. - Customer-centric and PaaS culture.
Risk management and mitigation capability	The firm's ability to manage risk for service provision involving risk and reward sharing contracts, execution risk assessment and mitigation capability. (Baines and Lightfoot, 2013; Cova and Salle, 2008; Ulaga and Reinartz, 2011)	- GDPR and the privacy of customer data. - Data security and investment in the resource to deal with security threats. - Development of IP plan. - Cost-benefit analysis. - Regulatory compliance.
Capability emerged during empirical analysis **Scalable capability**		The firm's ability to upscale their resources to deploy the full-scale of service solutions and expand the same IoT-enabled servitized business model in different markets.

7.7 Modification of the Conceptual Framework

The conceptual framework was developed based on the reviewed literature, the underpinning theories and the resultant research questions. Essentially, there were five main areas of inquiry in the framework: characteristics of business models, firm resources, operational capabilities, type of network configurations and dynamic capabilities required in order to transition from product-based to IoT-enabled servitized business models. Based on the emerging results which are discussed in Sections 7.2, 7.3, 7.4, 7.5 and 7.6, the conceptual framework has been modified to accommodate the contributions of the study to the extant knowledge. These emerging results are illustrated in Figure 7.2 in red.

		Add-on	Sharing	Usage-based	Solution-oriented
RQ 1	**Characteristics of business model**				
	Type of business model	Product-oriented	Use-oriented	Use-oriented and Result-oriented	Result-oriented
	Value proposition	Ownership of products with digital service as an add-on	Deliver accessibility of products	Availability and outcome of products	Performance of the product and solutions for individual needs
	Customer relationship	Transactional	Transactional	Contractual relationship	Long-term relationship
	Pricing	Normal product price or premium price to get service as a complimentary	Pay-per-use	Subscription based on pay-per-use basis	Performance-based contracts
	Order winning criteria	Convenience and speed with the digital service experience	Ease of product accessibility, capacity to deliver service	Availability of products and services Cost reduction	Performance of products Customised solutions
RQ 2	**Firm's resources**				
	Asset and its location – Facilities	Multiple distribution channels closed to market	Multiple distribution channels and products closed to market	Multiple field facilities closed to market for supplying product	Multiple field facilities closed to market for product maintenance and repair and supply
	IoT network	Hybrid network	Open network	Hybrid network	Hybrid network
	People and skills	Low skilled workers with fundamental knowledge of IoT-enabled service	Low skilled workers with fundamental knowledge of IoT-enabled service	Highly skilled workers with technical knowledge on product and IoT-enabled service	Highly skilled workers with technical knowledge on product and IoT-enabled service
RQ 3	**Operational capabilities**				
	Process	Lean – Agile	Lean – Agile	Lean – Agile	Lean – Agile
	Governance and decision rights	Hierarchy – Heterarchy	Hierarchy – Heterarchy	Hierarchy – Heterarchy	Hierarchy – Heterarchy
	Organisational design	Value facilitation (B2C) Value co-creation (B2B)	Value co-creation	Value co-creation	Value co-creation
	Performance management	Quality/Speed/Cost of products	Quality/Speed/Dependability/Flexibility of products and service	Quality/Speed/Dependability/Flexibility of products and service	Quality/Speed/Dependability/Flexibility of service
RQ 4	**Network configurations**				
	Type of coordination	Value Chain – Business ecosystem	Mixed value chain – Business ecosystem	Mixed value chain – Business ecosystem	Business ecosystem

RQ 5 – **Dynamic capabilities**

Sensing	***Seizing***	***Transforming***
• Market sensing Focus on customer pain points and go-to-market strategy • IoT Technology sensing Leverage viable IT options to deliver service	• Digital service development • Mass service customisation – personalised service and solutions • Digitalisation – Data analytics and management • Network management – close collaboration and data visibility • Staff and customer training on digital skills	• Services methodologies and processes for developing efficiency gains • Service culture, innovative and start-up mindset • Risk management and mitigation (associated with customer data) • Scalability – upscale the resources to deploy full business model

Figure 7.2: Modified conceptual framework for this study

Overall, there are five main areas of modifications to the framework. The first modification is the characteristics of the IoT-enabled servitized business model where the relationship between customers and providers tends to move towards being relationship-based. Although the add-on business model tends to correspond to Tukker's (2004) product-oriented business model where firms develop a transactional relationship with their customers, the case study findings illustrate that firms stay transactional with B2C customers but have a long-term relationship with their B2B customers. This shows that even though the digital service can be considered as an add-on to the product, the firm is trying to establish the relationship through the utilisation of the IoT. In addition, the usage-based business model incorporated the result-oriented business model and the contractual relationship is added to which in order to describe the relationship between customer and service provider through the monthly subscription. Furthermore, the specific OW criteria are added to the add-on business models, which focus on the delivery of convenience and speed with the digital service experience, whereas cost reduction is added as one of the main OW criteria of the usage-based business model.

The second modification of the framework involves the firm resources related to the IoT network in which the literature originally indicated that the IoT network for add-on business models tends to be an open network in order to allow third-party partners to participate and quickly create add-on service value for their customers while usage-based and solution-oriented business models tend to be closed networks in order to achieve competitive advantage through controlling and optimising all parts of the system (Porter and Heppelmann, 2014). However, the case study findings illustrate that firms tend to adopt a hybrid network approach for add-on, usage-based and solution-oriented business models in order to allow specific partners to participate in the service system and facilitate the service delivery where firms obtain benefits from both closed and open approaches.

The third modification of the framework involved the operational capabilities related to the business process, governance and decision rights and the organisational design. In terms of the business process, the literature indicates that the add-on business model tends to adopt lean practices to increase the efficiency of product manufacture, while the solution-oriented model adopts the agile practices to leverage IoT in tailoring the service to fit the large variety of customer demand. However, the case study findings suggested that the add-on and solution-oriented business models tend to adopt a combination of lean and agile approaches while the former helps firms to efficiently manufacture and deliver products while the latter practices focus on delivering customised service and solutions and keeping up with the pace of demand changes. Regarding the governance and decision rights, the add-on business model tends to adopt the hierarchy governance and solution-oriented business model required the heterarchy governance. Nevertheless, the results of the case studies illustrate that the combination of hierarchy and heterarchy governance is required for both types of business models. This means that the particular staff personnel (i.e. product owner and key account manager) are fully empowered to take responsibility for the product-service offerings or individual customers with support from top management. In terms of the organisational design of the add-on business models, firms tend to perform the role of value facilitator where the firm leverages IoT to create potential value for its customers. However, the case study findings illustrate the change towards the value co-creator with B2B customers as IoT allows firms to obtain additional insights of service (e.g. fleet data and product usage) where the customers can specify the additional requirements to suit their needs.

The fourth modification of the framework is the refinement of the network configurations of the add-on business model. The literature indicates that the network configuration tends to focus on the product value chain. However, the case study findings show that the business ecosystem is organised to deliver digital add-on services while the upstream business tends to be coordinated as a traditional value chain and hence the network configurations tend to be a mix of value chain and business ecosystems.

The fifth and final modification to the framework is the addition of the dynamic capabilities related to three dimensions of Teece's (2007; 2012; 2017) dynamic capabilities, i.e. sensing, seizing and transforming capabilities, which are required by product-based firms to implement an IoT-enabled servitized business model. The study further refines these three dimensions to uncover the actual meanings in practice within the context of IoT-enabled servitization as well as emerging new capabilities resulting from the case study analysis. The sensing capabilities are in line with the literature focusing on market and technology sensing. The capability related to the staff and customer training on digital knowledge emerges as the seizing capabilities and the scalable capability emerges as the transforming capabilities.

7.8 Summary of the Chapter

This chapter discusses the key findings that emerged from the empirical data with respect to the extant literature. Consequently, the conceptual framework developed from the underlying theories, SLR and extant literature is modified and further extended by integrating the empirical findings from two case studies: FuelRetailCo and PrintCo. These provide insightful data that support certain aspects and contradicts or extends various others in relation to the current body of knowledge. In addition, the cross-case analysis was conducted to discuss the similarities and differences of the same archetype.

From the empirical analysis in the context of FuelRetailCo and PrintCo, it is shown that the characteristics of the business model mostly support the literature where there are some attributes, including customer relationship and OW criteria, that are refined and further added to from the analysis of the case study results. In terms of the firm resources, the case study findings indicate that the majority of the findings are in line with the literature that accepts the IoT network as being refined based on the empirical analysis. Regarding the operational capabilities of the business process, the governance and design rights and organisational design are refined based on the case study findings while the performance measurement supports the literature for all types of business models. Regarding the network configurations, the findings are in line with usage-based and solution-oriented business models, while the type of network configurations that support the add-on business model are modified according to the analysis of case study results. Finally, in terms of the capabilities related to the three main dimensions of dynamic capabilities (i.e. sensing, seizing and transforming capabilities), the two capabilities are emerged to seizing and transforming capabilities during the empirical analysis.

8 Conclusion

8.1 Introduction to the Chapter

This chapter outlines the conclusions that were drawn from this thesis. Section 8.2 reviews each research question and emphasises how each one that emerged from the empirical findings was answered.

Section 8.3 discusses the theoretical and practical contributions of this thesis in which the implications of the study are documented both in terms of academia and practice. Subsequently, the limitations of the study and the recommendations for future research are detailed in Section 8.4.

Section 8.5 presents a summary of the chapter.

The structure of chapter 8 is shown in Figure 8.1.

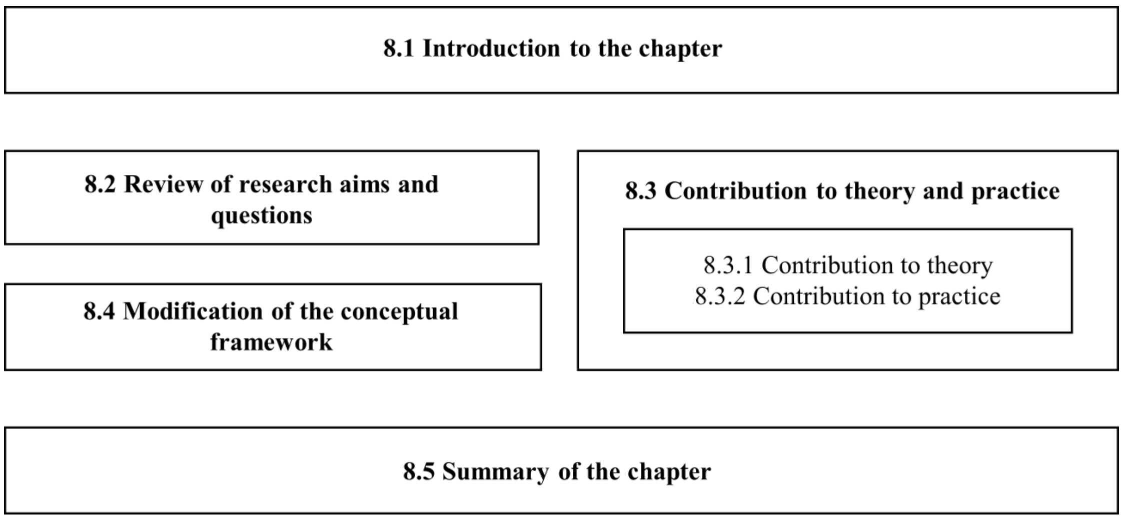


Figure 8.1: Structure of Chapter 8

8.2 Review of Research Aims and Questions

This research aims to establish the empirically tested conceptual framework which enables product-based firms to implement different types of IoT-enabled servitized business model. In this thesis, the types of IoT-enabled servitized business model are limited to the add-on, usage-based and solution-oriented business models. This thesis also identifies the characteristics of the business models, firm resources, operational capabilities and network configurations which align with the three types of IoT-enabled servitized business models. In addition, the particular dynamic capabilities required to help product-based firms to transition to IoT-enabled servitized business models are investigated. Accordingly, the overarching question was to explore how firms reconfigure and renew their resources, capabilities and network configurations in order to help the product-based firms to enable the different types of IoT-enabled servitized business model.

In this thesis, fresh empirical evidence is provided regarding the product-based firms who wish to respond to the digital disruption and leverage IoT in order to upgrade their existing business model to a servitized business model. The research aim and questions are detailed below:

The aim of this thesis is: *To explore how firms reconfigure their resources and capabilities to transition from product-based to different types of IoT-enabled servitized business model.*

RQ1: What are the different types of IoT-enabled servitized business models and what are their characteristics?

RQ2: What are the resources required for product-based firms to implement IoT-enabled business models?

RQ3: What are the operational capabilities required for product-based firms to implement IoT-enabled servitized business models?

RQ4: What is the view of network configurations required to support IoT-enabled servitized business models?

RQ5: What are the dynamic capabilities required by firms to upgrade from their product-based to IoT-enabled business models?

In line with the arguments proposed by Coreynen et al. (2017) and Kohtamäki et al. (2019), this thesis presented a comprehensive review of IoT-enabled servitized business model configurations for describing the concept of IoT-enabled servitization and business models. It also reviewed the resources, capabilities and network configurations within the context of digital servitization, as discussed by Schroeder and Kotlarsky (2015), Coreynen et al. (2017), Lenka et al. (2017), Kohtamäki et al. (2019), Lütjen et al. (2019), and Sklyar et al. (2019b). The SLR conducted as a part of this thesis suggested four main archetypes of IoT-servitized business model: add-on, sharing, usage-based and solution-oriented business models. The evidence collected and analysed during the SLR indicated the characteristics of each archetype of business model and how this corresponds to

Tukker's (2004) classification of servitization which guides the empirical testing in order to address RQ1. In line with the servitization literature, add-on, usage-based and solution-oriented business models correspond to the product-oriented, use-oriented and result-oriented business models, respectively. Moreover, the empirical findings provide additional insights for the customer relationship, suggesting that by utilising IoT, firms look for a shift from a transactional to a contractual or long-term relationship with customers, even for add-on business models. In addition, the findings further provide the OW criteria where the add-on business model focuses on offering convenience and speed in purchasing the products while the usage-based and solution business models focus on increasing the additional digital value for the individual customer through providing the availability of products and customised solutions, as well as reducing costs of operations to meet different market needs.

The literature also suggested that firms need to align their resources and capabilities with the product-service strategy in order to achieve competitive advantage in competitive environments (Godsell et al., 2010). Accordingly, the theories of RBV and dynamic capabilities underline the particular resources, operational and dynamic capabilities (Barney, 1991; Teece, 2007; Winter, 2003) that help product-based firms to leverage IoT in implementing a new business model, which helps to address RQ2, RQ3 and RQ5, respectively. In terms of the firm resources, the literature focused on the assets and their locations (facilities, IoT network, people and skills) and the ownership of those assets (e.g. Baines et al., 2009a; Bustinza et al., 2019; Kohtamäki et al., 2019; Porter and Heppelmann, 2014). The empirical findings were in line with the literature where the multiple distribution channels close to the market and staff with fundamental digital skills are strategic resources for add-on business models, while for usage-based and solution-oriented business models, they bypass the intermediaries (i.e. retail stores) but have multiple field facilities close to customers in order to continuously supply the product and provide product maintenance and repair and highly skilled workers with the technical knowledge as the main resources. The empirical evidence further discussed that firms adopt a hybrid approach for their IoT network which can be considered as the firm's digital resource to implement add-on, usage-based and solution-oriented business model approaches to obtain the benefits from both open (e.g. speed of launching new IoT-enabled product and service offering) and closed networks (e.g. security and system control). Furthermore, regarding the ownership, the empirical evidence is in line with the literature, suggesting that the add-on business models require integrating the partners to deliver the add-on digital service but this could be done in-house if the add-on digital service required the firm's expertise. On the other hand, the usage-based and solution-oriented business models only integrate the partners to deliver non-core service operations.

Regarding the operational capabilities which draw on firm resources, the literature suggested the focus should be on firm process, governance and decision rights, organisational design and performance measurements (Espinosa et al. 2007; Grönroos and Voima, 2013; Hill, 2000; Leminen et al., 2018; Qi et al., 2011; Slack and Lewis, 2015). The empirical findings are mostly in line with the literature. The empirical evidence collected indicates that firms adopt both lean and agile practices to help facilitate the implementation of all three types of IoT-enabled business model in order to respond quickly to the evolving market demand as well as increasing the efficiency internally. In addition, it is evident that firms have adopted a combination of hierarchy and heterarchy as their type of governance decision rights, where the key personnel (i.e. product-owner and key account manager) are assigned and empowered to work cross-functionally and closely collaborate with the market and the customers in designing and implementing the IoT-enabled servitized business model. Furthermore, although firms may start by performing the role of value facilitator to design the potential value of IoT for the add-on business model, it is evident that IoT directly and indirectly engages customers in the delivery of IoT-enabled services. Hence firms tend to perform the role of value co-creator in creating value through IoT in all three types of IoT-enabled servitized business model. The performance measurement system used to evaluate the IoT-enabled servitized offering focuses on the measurable service dimensions, such as customer satisfaction, service reliability and time to complete the service. However, the performance measures adopted become more customer-centric towards advanced IoT-enabled service offerings (i.e. the solution-oriented business model) to measure the customised service offered to the individual customer. Hence, the performance measurement can be different, depending on the service-level agreement and how the individual customer defines it.

In terms of the dynamic capabilities which are the high-order capabilities, the digital servitization literature indicated the particular capabilities which have to be adopted by the product-based firms to implement IoT-enabled servitized business models (cf. Hasselblatt et al., 2018; Huikkola and Kohtamäki, 2017; Lenka et al., 2017; Story et al., 2017). These capabilities are also associated with Teece's (2007) three dimensions of dynamic capabilities (i.e. sensing, seizing and transforming capabilities). The empirical data collected are in line with the literature and further emerged the capability related to the staff and customer training on digital knowledge, to seizing capabilities and scalable capabilities, to transforming capabilities, as well as outlining the details and providing the insights of each capability based on the empirical analysis.

Finally, the literature proposed that the IoT-enabled servitization tends to extend the focus of the focal firm and supply chain partners' coordination (also known as the value chain) to the concept of the business ecosystem (the interdependencies between a firm and ecosystem in value creation (cf. Adner, 2016; Rabetino and Kohtamäki, 2018; Valdez-De-Leon, 2019) – the empirical investigation of which helps to address RQ4. The empirical findings stated that the product-based firms organised the business ecosystems within their value chain in order to deliver an IoT-enabled service and they tend to move towards pure business ecosystems when a higher level of customisation of the focal service (i.e. solution-oriented business model) is offered.

8.3 Contribution to Theory and Practice

8.3.1 Contribution to Theory

According to the strategic management theory, a firm needs to align its resources and capabilities with the changing business environment in order to deliver a competitive business model. This concept is underpinned by the RBV and the DC view theories. The DC view is seen as an extension of the RBV, focusing on the dynamism of the business environments and particular resources that help firms to achieve a sustained competitive advantage (Barney, 1991; Wernerfelt, 1984). According to the underpinning theory, the DC view discusses how firms evolve not only to respond to the change of market requirements in a dynamic environment but also to the small changes in static environments (Ambrosini et al., 2009). The incremental dynamic capabilities are required to adjust the resource base to meet the market demand in static environments while the renewing capabilities help firms to upgrade their resource base to provide the new service offering by responding to the new market needs. Hence, the rationale behind this thesis is to contribute to the dimension of renewing dynamic capabilities that help to upgrade the existing resource base and enhance the firm's operational capabilities to offer new services, and strategically align with the corresponding business models.

According to the empirical evidence, the disruption from IoT and digitalisation has led to the market needing to evolve in the dynamic environments. This requires firms to upgrade their resource base and have a new set of operational capabilities in order to transition to an IoT-enabled servitized business model. Accordingly, the theoretical contributions of this thesis are established from the emergent underpinning theoretical lens and the empirical evidence from the case study findings.

Based on the empirical findings, this study makes three theoretical contributions to the servitization and digital servitization literature. First, it has provided a systematic review of the emerging concept of IoT and servitization and extended the view of current knowledge of digital servitization, which is still in its infancy (e.g. Coreynen et al., 2017; Kohtamäki et al., 2019; Story et al., 2017; Ulaga and Reinartz, 2011) by presenting a typology of four archetypes of the IoT-enabled servitized business model and the associated characteristics based on the roles of IoT in value creation. This was published in the IMM journal (see Appendix G) and three of those archetypes (add-on, usage-based and solution-oriented business models) are selected to serve as the main focus for this study.

Second, by using the theoretical lenses of the RBV and DC view to study the emerging concept of IoT-enabled servitization, this study revealed the strategic requirements (i.e. firm resource configurations and operational capabilities) that help to implement different archetypes of the IoT-enabled servitized business model. This study suggests that leveraging firms' existing resources and capabilities or renewing and reconfiguring those resources and capabilities to align with the product-service strategy or each business model archetype, helps product-based firms to generate a competitive advantage. In the case of the add-on business model, firms start by leveraging their existing resources (i.e. large network distribution channels) and undertake the small adjustments to their resources (i.e. low skilled staff with fundamental digital knowledge). On the other hand, in order to implement the usage-based and solution-oriented business models, firms are required to renew their existing resources (i.e. bypass the intermediaries, leverage the multiple facilities close to market and highly skilled field staff). The empirical evidence also suggests that a similar set of operational capabilities (i.e. business process, governance and decision rights, organisation design) needs to be developed to implement all three types of IoT-enabled servitized business model as the same desired goal is to be flexible and quickly respond to the evolving market demand.

In addition, this research structures the key dynamic capabilities that help product-based firms to transform to IoT-enabled servitized business models around Teece's (2007) three dimensions of dynamic capabilities (i.e. sensing, seizing and transforming) which relies on different studies of the current servitization and digital servitization literature (e.g. Hasselblatt et al., 2018; Huikkola and Kohtamäki, 2017; Kohtamäki et al., 2019; Schroeder and Kotlarsky, 2015; Story et al., 2017; Ulaga and Reinartz, 2011). This study emerged two new capabilities during empirical analysis, contributing to the digital servitization literature: (1) the capabilities related to the staff and customer training on digital skills to the seizing capabilities and (2) scalable capabilities to the transforming capabilities. Furthermore, the additional insights of the key processes embedded within each capability are provided.

Finally, this study draws upon the study of Kohtamäki et al. (2019) and Rabetino and Kohtamäki (2018), who suggest the conceptualisation of IoT-enabled servitized business model beyond the boundaries of a single firm and adopt the view of a business ecosystem. This study contributes to the understanding of network configurations and firm boundaries through exploring the coordination and interplay between the IoT-enabled servitized firm and their associated internal and external partners in order to implement particular types of business model. The empirical evidence supports the literature by highlighting the importance of the view of the ecosystem when organising the IoT-enabled servitization to create and capture value between the interrelated firms that play different roles within the service ecosystem.

These theoretical contributions are translated into the managerial implications, leading to the generation of several contributions to practice.

8.3.2 Contribution to Practice

This study suggested the importance of product-based firms responding to the trend of the industry and the digital disruptions, by leveraging IoT in order to develop a novel servitized business model. More specifically, four key practical contributions emerged from the theoretical and empirical findings to provide insights to the managers or key personnel in the product-based firms who are responsible for the IoT initiatives in implementing servitized business models.

First, the study highlighted the importance of the linkages between IoT and servitization and hence, the product-based firms are recommended to look at both concepts together in order to capture the most benefits from IoT initiatives. A taxonomy of IoT-enabled servitized business model archetypes is developed along with the associated characteristics (i.e. the customer relationship, pricing logic and OW criteria) to provide potential avenues for product-based firms to make a decision based on their current offerings, industrial contexts and external market environments. The principal contention of this research is that the managers need to be aware of different customer requirements related to different IoT-enable servitized business models and how these business models can be monetised in order to generate profits and competitive advantage for firms.

Second, the implementation and adoption of IoT in product-based firms does not guarantee a competitive advantage. In order to reap the benefits of IoT and turn this into meaningful services and profitable business models, they need to develop certain resources and capabilities. This research offers practical insights into the necessary resources and capabilities specific to each type of IoT-enabled servitized business model. These include the main assets, IoT network strategy, staff skills, and the particular capabilities that are required by firms to initiate and sense the opportunity of IoT until successfully shift from product-based to the IoT-enabled servitized business model by considering the identification of market demand, the management and utilisation of the customers' product usage data as well as the associated risks.

Third, this research recommends that product-based firms adopt the view of the business ecosystems in order to understand and critically evaluate their firm boundaries and their position within the service network as well as identifying all the relevant actors who directly and indirectly contribute to the value of focal offerings, when organising the IoT-enabled servitized business model. For example, in the context of this thesis, FuelRetailCo acts as the complementor for the connected car companies and car-sharing companies by integrating digital payments within the connected car dashboard and the car-sharing app. On the other hand, in order for PrintCo to implement the MPS service, it requires a value contribution from paper and ink suppliers, system integrators and the independent software vendor in order to tailor customised printing solutions to address the specific industrial needs. Accordingly, product-firms are required to not only focus on their internal resources and capabilities in implementing IoT-enabled servitized business but also have the extensive understanding of those required by their network partners. In addition, they should take the ecosystem perspective to strategically analyse their position, and their strategic alliances and partners within the service ecosystem, and establish mutual incentives from creating value through IoT-enabled product-service offerings.

Finally, the conceptual framework (Figure 7.2) is developed as a guide for product-based firms to upgrade from a traditional, product-based business model to IoT-enabled servitized business models. The modified conceptual framework provides a comprehensive and consolidated view of the main characteristics of business models, resources, operational capabilities, network configurations and dynamic capabilities corresponding to each type of IoT-enabled servitized business model. Based on the empirical evidence, product-based firms should be able to use this framework to help them upgrade from traditional product-based to IoT-enabled servitized business models. In addition, product-based firms can evaluate and adjust or upgrade their existing resource configurations and internal capabilities to fit the requirement underlined by the particular type of IoT-enabled servitized business model that they want to implement or achieve, by using the framework as the starting point and guideline.

8.4 Limitations and Future Research

Although every step of conducting research has been taken into consideration in order to ensure rigour and reliability, this study contains several limitations. These are reflected in the methodological design and how this research was conducted. Nevertheless, these limitations also present opportunities to further advance the area of IoT-enabled servitization and will, therefore, be supplemented with future research avenues.

First is the limitation in terms of internal validity due to the small number of expert interviewees drawn upon. In order to address these limitations, secondary sources of data such as company official websites, brochures, company research journals and practice-oriented reports are used to validate the interviewees' responses and aid data triangulation. (cf. Boehmer et al., 2020; Coreynen et al., 2017; Naik et al., 2020). Furthermore, although the empirical findings from the PrintCo case study mainly relied on secondary data, this case study is considered an exemplar case study in the field of digital servitization. The expert interviewee was approached, suggesting that many secondary data sources are publicly available for the study. The key interviewees agreed to validate the findings and fill in the gaps that were unavailable or unclear from the secondary data sources to ensure the rigour of the author's findings.

Second, as this thesis used the purposive sampling method, six IoT-enabled business models of two case studies from the fuel retail industry and printing industry were selected to investigate and explore the research questions. This naturally limits the generalisability of the case study findings and the resultant framework and investigating cases from different industries could lead to different resources and capabilities which need to be discovered. Hence, a further study can address this issue by identifying and analysing the empirical data from the product-based firms in different industries (e.g. automotive, equipment manufacturing and medical) that are disrupted by the IoT and shift towards the servitized business models.

Third, based on the output of the study, three archetypes of IoT-enabled servitized business model (i.e. add-on, usage-based and solution-oriented) which were initially identified from conducting an SLR has been evident within the case study findings of two cases and have been analysed. This limits the generalisations across various archetypes of IoT-enabled servitized business model within the conceptual framework. The conceptual framework has been provided in this thesis for another business model (i.e. sharing business model) which could be evaluated and validated further. Nevertheless, as firms mature in their ability to combine IoT and the servitized business model, this may advance the adoption of IoT in providing servitized offerings and the innovative servitized business model in practice beyond four archetypes of IoT-enabled servitized business model identified in this thesis. Accordingly, future research can empirically investigate and conceptualise the IoT-enabled business model archetypes which have not yet been discovered or have been captured differently in the existing literature and academic research. In addition, the implications of these business models on the associated characteristics, the firm resources, capabilities and the type of network configurations should be investigated in order to compare the emerging findings with the results of this thesis.

Fourth, this thesis identifies the underlying main firm resources (i.e. facilities, IoT network and people and skills) and capabilities (i.e. operational capabilities and dynamic capabilities) which contribute to the implementation of different archetypes of IoT-enabled servitized business model found in the empirical findings. However, according to the theory of RBV and DC view, these resources may exhibit the VRIN characteristics which are considered as the sources of competitive advantage. However, this research did not investigate and provide sufficient details of the level of VRIN characteristics in those firm resources identified from the empirical study. Hence, future research can address this by identifying the VRIN resources criteria to evaluate the associated resources and capabilities identified in the conceptual framework.

Fifth, the research findings suggest that the adoption of IoT in enabling servitization tends to shift the view from the traditional value chain to the business ecosystems. However, this research only focuses on the individual firm level and does not consider the resources and capabilities required by the associated partners within the service ecosystem who contribute to the value creation process of the IoT-enabled servitized offerings. Accordingly, the future study should extend the focus from the single focal firm to the different actors in the business ecosystem level. In addition, the details of the relationship between these actors and a focal firm of different types of IoT-enabled servitized business model should be further investigated.

Finally, there is a limitation related with the methodological approach chosen for the study. This research adopted an abductive research approach which was underpinned by critical realism and hence the emerging conceptual framework required further validation. This can be undertaken by empirically testing the framework, using either a qualitative (to further explore and provide additional insights of the details of the research constructs presented in the emerging framework) or quantitative method (to further identify the relationship between each resource and capability and the implementation of each type of IoT-enabled servitized business model).

8.5 Summary of the Chapter

This chapter concludes this thesis. The main findings of the thesis were summarised by reviewing the research aim and research questions with respect to the empirical evidence that emerged.

Subsequently, the contribution to both theory and practice are identified. This research contributes to the servitization and digital servitization literature by taking the perspective of RBV and DC view theories to study the transition from a product-based to an IoT-enabled servitized business model.

Regarding the practical contribution, the chapter addresses how this research contributes knowledge to the product-based firms planning to leverage IoT in implementing a servitized business model. Additionally, the conceptual framework presents a taxonomy of IoT-enabled servitized business models and the underlying resources, operational capabilities, network configurations and dynamic capabilities that serve as guidance for product-based firms to implement IoT-enabled servitized business models.

Finally, a number of the limitations of the study have been outlined, and how these limitations suggest the opportunities for future research which may complement what has been found in this thesis.

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Appendices

Appendix A: Interview Protocol

Semi- structured Interview Schedule

Introduction

My name is Chutikarn Suppatvech and I am a doctoral researcher at Warwick Manufacturing Group. Thank you for agreeing to participate in this study. This interview generally takes place in approximately 60-90 minutes. (Personal note: clarify if the interviewee is comfortable with the duration of the interview in terms of her/his schedule and briefly explain the purposes of the research)

With your agreement, I would like to record this interview. All of the information from this interview will be kept confidential and will not be used for another purpose. Your name (or your organisation's name) will never be mentioned without your consent in any of the analysis or resultant publications. Are you comfortable for me to record the interview?

Interview Questions

Scoping Study – Background of the case company

Section	Topic	Points to address
1	**Personal History**	Name of the interviewee: Background: Amount of time with the company: Job role/main responsibility:
2	**Organisational/ Business strategy/ Operating environments**	**Operating company's mission, vision and company values** **Business strategy at group, operating company and functional level:** - Strategic objectives (relative to scope) - Drivers **Industry structure** - Sectors and where they operate - Growing, stable or declining - Sectors operating company supply to **Competitors (SWOT)** - Major competitors - Strengths - Weaknesses - Opportunities - Threats for operating company and the two key competitors
3	**Characteristics of Business model**	**Lists of business model elements as provided by Schon (2012)** **Value proposition** - *Product/services:* The product/service offering with which you want to address customer needs - *Customer needs:* The customers and their needs that the company wants to serve/ what is the order winning criteria?

		- *Geography:* The countries and areas you want to do business in **Revenue model** - *Pricing Logic:* The general pricing logic applicable and suitable given clients, products, value creation and interaction - *Channels:* The channels through which the interaction is facilitated and the value delivered in the best way - *Customer Interaction:* The base and way of the interaction with the client

Main Study

Section	Topic	Point to address
1	**Firm Resources**	**Firm Resources** - *Type of assets:* Physical (e.g. factories, distribution centre, equipment, its access to raw material), Human (e.g. training, experience, staff's knowledge) Organisational (e.g. formal and in formal reporting structure, its formal and informal planning, IoT network) - *Location of asset* (e.g. location of factories, products, partners) - *Ownership* (e.g. what are produced in-house and what are outsourced)
2	**Operational capabilities**	**Operational capabilities: What are the operational activities in operating this business model?** - *Processes:* Bus (lean, agile, hybrid) - *Governance* (Hierarchy (closed mode and assigns more power and privilege to the members high in the structure), Heterarchy (openness of operation and distributes decision-making among participants) - *Organisational design* (e.g. value-facilitation, value co-creation) - *Performance management* (What are the KPIs? e.g. cost, quality time customer satisfaction, availability, response time)
3	**Network configurations**	- *Core activities:* The specific activities and processes that link assets and partners in value creation and which need to be mastered - *Partner network:* The depth and breadth of the partner network ideal for sustainable value creation - *Coordination* (e.g. traditional value chain or networked ecosystem)
4	**Upgrade (dynamic) capabilities**	**Sense: is defined as the ability to spot, interpret, and pursue opportunities in the environment** - *Identify new market opportunities* How can you identify the new opportunities in the market from the traditional offerings? - *Explore technological possibilities* How does firm introduce IoT to their product-service offerings? Are there any other capabilities related to this category?

	Seize: refers to the implementation of a sensed opportunity, the mobilizing of resources in order to address an opportunity and capture its value - *Digital service development capabilities* How do you create services that aligns with new market opportunities and IoT development? - *Mass service customisation capabilities* How do you ensure that the service offered fits with customers' individual needs? - *Digitalisation capabilities* How does firms utilized IoT technology to fit with service offerings - *Network management capabilities* How firms manage the knowledge sharing and collaboration with the service partner in there service network? Are there any other capabilities related to this category? **Transform: the activity by which organiwations continuously reconfigure its resource base by altering its resources and operating capabilities as needed** How do your organisation continuously re-align/reconfigure the current resources or improve the current set of capabilities in order to successfully implement the IoT-enabled business model? (e.g. develop economies of scale, develop service culture, mitigate risks) Are there any other capabilities related to this category?

Ending the interview

In your opinion, are there other information that I have overlooked and should have covered?

Would you like to be informed about the results of this research?

Could I contact you in case I need to ask further questions to clarify my understanding?

Thank you very much for participating in this research.

Appendix B: Case Study database

B.1 FuelRetailCo's database

Interviewee	Role of interviewee	Date and Location	Duration (hr and min)	Reference	Documentary evidence
IN1-01	Global digital payments manager and chief product owner	15/05/2019, Skype meeting	1.08	R1-01, F1-01, T1-01, C1-01	Company's official website (DC1-01)
IN1-02	Digital transformation lead	24/05/2019, Skype meeting	0.45	R1-02, F1-02, T1-02, C1-02	Company's official website (DC1-02)
IN1-03	Global B2B digital payment product owner	30/05/2019, Skype meeting	1.14	R1-03, F1-03, T1-03, C1-03	Company's presentations and process map (DC1-03)
IN1-04	Digital transformation manager	10/06/2019, Skype meeting	0.55	R1-04, F1-04, T1-04, C1-03	Company's official website (DC1-04)_
IN1-05	Global innovation manager	03/07/2019, Skype meeting	0.53	R1-05, F1-05, T1-05, C1-04	Company's brochure (DC1-05)
IN1-06	Business PMO	10/07/2019, Skype meeting	1.00	R1-06, F1-06, T1-06, C1-06	
IN1-07	Head of digital Channels	12/07/2019, Skype meeting	0.49	R1-07, F1-07, T1-07, C1-07	
IN1-08	IT manager	01/08/2019, Skype meeting	0.57	R1-08, F1-08, T1-08, C1-08	
IN1-09	Digital transformation manager	01/10/2019, Skype meeting	0.49	R1-09, F1-09, T1-09, C1-09	Company's official website (DC1-09a), News article (DC1-09b)
IN1-10	CEO of a digital service	04/10/2019, Skype meeting	0.45	R1-10, F1-10, T1-10, C1-10	Company's official website (DC1-10a), company's video presentations (DC1-10b)
IN1-11	Global CR commercial manager	29/11/2019, Skype meeting	0.30	R1-11, F1-11, C-11	

R - Recorded audio file, F –Field notes, T- Transcript, C – Contact Sheets, DC - Documentation

B.2 PrintCo's database

Interviewee/ Document no.	Role of interviewee/ Title of document	Date and Location/ Date of publication and Type of document	References	Duration (hr and min)
IN2-01	Director of Global Sustainability Operations	20/11/2019 Phone interview	Unrecorded, F3-01, C3-01 + Secondary data	0.45
DC2-01	HP Eco solutions	24/05/2019 Company document	https://www8.hp.com/h20195/v2/GetPDF.aspx/c05968416.pdf	
DC2-02	Customers at the heart of sustainable business model tr ansition, says HP	20/06/2017 Business media	https://www.edie.net/news/12/HP-circular-economy-servitisation-business-model-sustainability-Kirstie-McIntyre/	
DC2-03	Exploiting the "Printernet" of Things	26/05/2016 Consulting report	https://quocirca.com/content/exploiting-printernet-things/	
DC2-04	How MPS providers can leverage an IoT maturity model	23/09/2019 Consulting report	https://quocirca.com/content/mps_iot/	
DC2-05	HP Managed Print Services	05/2018 Company document	https://www8.hp.com/h20195/v2/GetPDF.aspx/4AA0-1414ENW.pdf	
DC2-06	How to revolutionize a "dying" industry by attacking simultaneously top and bottom line – HP's "instant ink" success of implementing IoT into supply chain and creating customer value	15/11/2019 Practice-oriented article	https://digital.hbs.edu/platform-rctom/submission/how-to-revolutionize-a-dying-industry-by-attacking-simultaneously-top-and-bottom-line-hps-instant-ink-success-of-implementing-iot-into-supply-cha/	
DC2-07	HP Inc. Reports Fiscal 2019 Full Year and Fourth Quarter Results	01/08/2019 Company report	https://press.ext.hp.com/us/en/press-releases/2019/hp-inc-reports-fiscal-2019-full-year-and-fourth-quarter-results.html	
DC2-08	Hewlett Packard: Supply chain, the great enabler	05/04/2017 Practice-oriented article	https://www.supplychaindigital.com/company/hewlett-packard-supply-chain-great-enabler#	
DC2-09	HP 2018 Annual Report	31/10/2018 Company report	https://s2.q4cdn.com/602190090/files/doc_financials/annual/e31dddb7-0e0e-4617-8426-8e1889889288.pdf	
DC2-10	Big Interview: The reinvention of HP Inc	01/03/2019 Business media	https://www.opi.net/magazines/archive/2019/march-2019/top-picks-march-2019/the-reinvention-of-hp-inc/	
DC2-11	3PL Summit: from employees forming a bottleneck to the digital value chain	15/11/2018 Business media	https://www.supplychainmovement.com/3pl-summit-from-employees-forming-a-bottleneck-to-the-digital-value-chain/	
DC2-12	The eco-karma of everything-as-a-service	05/04/2018 Company press release	https://garage.ext.hp.com/us/en/impact/sustainability-payoff-hp-instant-ink-subscription-services.html	
DC2-13	The evolution of managed print services	15/12/2018 Business media	https://www.itpro.co.uk/laser-printers/innovation-at-work/27788/the-evolution-of-managed-print-services	
DC2-14	Managed Print Services (Proposal)	Company document	https://www8.hp.com/h20195/v2/GetPDF.aspx/4AA7-1042ENUS.pdf	
DC2-15	HP Pilots Instant Ink Program	29/11/2011 Business media	http://blog.infotrends.com/hp-pilots-instant-ink-program/	
DC2-16	HP Announces Instant Ink Program in North America	28/09/2013 Business media	http://blog.infotrends.com/hp-announces-instant-ink-program-in-north-america/	

Interviewee/ Document no.	Role of interviewee/ Title of document	Date and Location/ Date of publication and Type of document	References	Duration (hr and min)
DC2-17	HP Workpath: Driving a new MFP and digital workflow ecosystem	29/10/2019 Consulting report	https://quocirca.com/content/hp-workpath-driving-a-new-mfp-and-digital-workflow-ecosystem/	
DC2-18	HP Business Intelligence	02/2017 Company document	http://h20195.www2.hp.com/v2/getpdf.aspx/4AA6-5638EEW.pdf	
DC2-19	Managed Print Services (MPS) and Instant Ink Service	Practice-oriented article	https://www.uschamberfoundation.org/managed-print-services-mps-and-instant-ink-service	
DC2-20	Subscriptions for Printer Ink? It's Business for the Future	12/01/2016 Practice-oriented article	https://www.uschamberfoundation.org/blog/post/subscriptions-printer-ink-its-business-future	
DC2-21	Achieving a circular economy: How the private sector is reimagining the future of business	11/2015 Practice-oriented article	https://www.uschamberfoundation.org/sites/default/files/Circular%20Economy%20Best%20Practices.pdf	
DC2-22	HP 2018 Sustainable Impact Report	Company Report	https://www8.hp.com/h20195/v2/GetPDF.aspx/c05179523.pdf	
DC2-23	HP Instant Ink: Bringing printing as a service to the home	09/2017 Practice-oriented article	https://www.ellenmacarthurfoundation.org/case-studies/bringing-printing-as-a-service-to-the-home	
DC2-24	HP Instant Ink: A Subscription Model for Print	06/05/2014 Consulting report	https://www.louellafernandes.com/2014/05/06/hp-instant-ink-subscription-model-print/	
DC2-25	Subscription models and the IoT – HP Instant Ink	13/04/2017 Business media	https://informationmatters.net/iot-subscription-models-hp-instant-ink/	
DC2-26	Using IoT Data to Understand How Your Products Perform	16/06/2016 Practice-oriented article	https://hbr.org/2016/06/using-iot-data-to-understand-how-your-products-perform	
DC2-27	HP Managed Print Services Topic of Influence: Financial Strength	02/2020 Company Report	http://h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA7-2596ENW	
DC2-28	Channels to MPS in Europe, 2017	01/2017 Consulting report	https://quocirca.com/content/channels-mps-europe-2017/	
DC2-29	Global Print Security Landscape, 2019	02/2019 Consulting report	https://quocirca.com/content/quocirca-global-print-security-landscape-2019/	
DC2-30	Managed Print Services Landscape, 2017	07/2017 Consulting report	https://quocirca.com/content/quocirca-mps-landscape-report-2017/	
DC2-31	HP JetAdvantage solution	Company document	https://www8.hp.com/uk/en/solutions/business-solutions/printingsolutions/jetadvantage-ondemand.html	
DC2-32	HP Managed Print Specialist Extended Models	Company document	https://www8.hp.com/h20195/v2/GetPDF.aspx/c06449984.pdf	
DC2-33	HP Instant Ink" – Has the future arrived?	11/09/2014 Practice-oriented article	https://nubeprint.com/hp-instant-ink-has-the-future-arrived/	
DC2-34	HP Innovation Journal : Issue 5 Winter 2016	2016 Company document	https://ij.ext.hp.com/hp-innovation-journal-issue-05-winter-2016/0976587001523391264	
DC2-35	HP Partner First Program FY2018	01/11/2017 Company document	http://www.hppartnerfirstguide.com/apj/en/files/assets/common/downloads/publication.pdf	
DC2-36	HP Partner First Services Program Guide	20/11/2019 Company document	https://www8.hp.com/h20195/v2/GetPDF.aspx/4AA7-6291ENW.pdf	
DC2-37	HP Innovation Journal : Issue 8 Winter 2017	2017 Company document	https://ij.ext.hp.com/hp-innovation-journal-issue-08-winter-2017/0107457001523391026	

F – Field notes, C – Contact sheet

Appendix C: Analysis Template

C.1 Analysis Template for Add-on Business Model

Characteristics of business model	Add-on Business Model	
	Theory	**Actual**
Type of Business model	Servitized business model: Product-oriented	
Value proposition	Ownership of the product with digital service as an add-on	
Customer relationship	Transactional	
Pricing	Customer pays for normal product price or at a premium price to get service as a complimentary	
Order winning criteria	Feature of products, deliver products with a digital service experience	

Firm Resources		Add-on Business Model	
		Theory	**Actual**
Assets and their locations	Facilities	Multiple distribution channels close to market	
	IoT network	Open network	
	People and skills	Low skilled workers with fundamental IoT-enabled service knowledge on product and service on front line/customer service	
Ownership Coordination	In-house	Vertically integrated in product manufacture to control quality and minimise the cost of product	
	Outsource/ partnerships	Integrated partners to deliver service	

Operational Capabilities	Add-on Business Model	
	Theory	**Actual**
Process	Lean	
Governance and decision rights	Hierachy	
Organisation Design	Value facilitation	
Performance Management	Cost of delivering products	
	Quality of products and service	
	Speed of product delivery	

Network configurations	Add-on Business Model	
	Theory	**Actual**
Type of coordination	Value Chain	

Dynamic Capabilities: Add-on Business Model		
	Theory	**Actual and key insights**
Sense	Identify new market opportunities	
	Explore technological possibilities	
	Other capabilities	
Seize	Service development capabilities	
	Mass service customisation capabilities	
	Digitalisation capabilities	
	Network management capabilities	
	Other capabilities	
Transform	Service methodologies and process for developing efficiency gains	
	Service culture	
	Risk management and mitigation	
	Other capabilities	

C.2 Analysis Template for Usage-based Business Model

Characteristics of business model	**Usage-based Business Model**	
	Theory	**Actual**
Type of Business model	Servitized business model: Usage-based	
Value proposition	Deliver availability	
	Deliver the outcomes of products	
Customer relationship	Transactional and relationship-based	
Pricing	Subscription-based on a pay-per-use	
Order winning criteria	Availability of products or services	

Firm Resources		**Usage-based Business Model**	
		Theory	**Actual**
Assets and their location	Facilities	• Bypassing intermediaries • Multiple facilities close to market for supplying product	
	IoT network	Closed network	
	People and skills	Highly skilled worker with technical knowledge of product and service	
Ownership	In-house	Vertically integrated in product manufacture and service provision to control quality, minimise the cost of both product and service	
	Outsource/ partnerships	Non-core products or service operations	

Operational Capabilities	Usage-based Business Model	
	Theory	Actual
Process	Lean-agile	
Governance and decision rights	Hierarchy-Heterarchy	
Organisation Design	Value co-creation	
Performance Management	Service quality	
	Service response time	
	Product availability	
	Product/service range	

Network configurations	Usage-based Business Model	
	Theory	Actual
Type of coordination	Value chain – Business Ecosystem	

Dynamic Capabilities: Usage-based Business Model		
	Theory	Actual and key insights
Sense	Identify new market opportunities	
	Explore technological possibilities	
	Other capabilities	
Seize	Service development capabilities	
	Mass service customisation capabilities	
	Digitalisation capabilities	
	Network management capabilities	
	Other capabilities	
Transform	Service methodologies and process for developing efficiency gains	
	Service culture	
	Risk management and mitigation	
	Other capabilities	

C.3 Analysis Template for Solution-oriented Business Model

Characteristics of business model	Solution-oriented Business Model	
	Theory	Actual and key insights
Type of Business model	Servitized business model: Result-oriented	
Value proposition	Deliver specified performance of products	
	Deliver solutions for individual needs	
Customer relationship	Long-term relationship	
Pricing	Customers pay for the performance of the product based on the mutual agreements	
Order winning criteria	Performance of products	
	Customised solutions	

Firm Resources		Solution-oriented Business Model	
		Theory	Actual
Assets and their locations	Facilities	• Bypassing intermediaries • Multiple field facilities and close to market for product maintenance and repair and supply	
	IoT network	Closed network	
	People and skills	Highly skilled worker with technical knowledge of product and service	
Ownership	In-house	Vertically integrated in product manufacture and service provision to control quality, minimise the cost of both product and service	
	Outsource/ partnerships	Non-core products or service operations	

Operational Capabilities	Solution-oriented Business Model	
	Theory	Actual
Process	Lean-agile	
Governance and decision rights	Hierarchy-Heterarchy	
Organisation Design	Value co-creation	
	Service quality	
Performance Management	Service response time	
	Product availability	
	Product/service range	
	Lean-agile	

Network configurations	Solution-oriented Business Model	
	Theory	Actual
Type of coordination	Business Ecosystem	

Dynamic Capabilities: Solution-oriented Business Model		
Theory		Actual and key insights
Sense	Identify new market opportunities	
	Explore technological possibilities	
	Other capabilities	
Seize	Service development capabilities	
	Mass service customisation capabilities	
	Digitalisation capabilities	
	Network management capabilities	
	Other capabilities	
Transform	Service methodologies and process for developing efficiency gains	
	Service culture	
	Risk management and mitigation	
	Other capabilities	

Appendix D: Chain of Evidence

D.1 Sample contact notes

PrintCo

Fieldwork - Contact Summary Sheet

1.0 Interview Background

Interviewee	XXX (Confidential)	**Contact sheet no.**	C3-01
Job title	Director of global sustainability operations	**Date**	20/11/19
Contact details	Withheld for reasons of confidentiality	**Location**	*Phone call*

- Has been working at PrintCo for approximately 24 years.
- Previously work as a head of environmental compliance across EMEA (Europe, Middle East and Africa and based in UK. Then, promoted as a director of global sustainability operations.
- Main responsibilities involve global operational management of hardware, packaging, and other IT consumables recycling and compliance. Direct customer engagement for sales support, values alignment according to customer expectations, market and business need as well as assure compliance for all products and services across global markets.
- Also as well as internal engagement (i.e. building a well-performing team culture to reduce risk, cost and liability across supply chain).

2.0 Main Issues or Themes Arising

- Focus on how PrintCo leverages their expertise in order to extend the similar service offering (MPS) which already offered to B2B to make this more affordable to B2C (instant ink).
- How PrintCo optimise their operational costs in order to compensate with the higher costs associated with the IoT-enabled servitized offering offerings.
- The adoption of closed-loop manufacturing model in their offerings.
- Understand four major global megatrends identified by PrintCo including rapid urbanization, changing demographics, hyper globalization and accelerated innovation.

3.0 Summary of Information Gathered

- Managed Printed Services and instant ink services start from addressing customer's pain points. MPS has been offered for B2B customers for 20 years (e.g. University, companies) which originated from the idea of leasing products.

- B2B customers pay approximately 30,000 pounds for printing services
- Developed software capabilities to control the up-time of products and access to the products as different departments of companies had budget control.
- Develop internetworking capabilities, using local network, local internet or IP address.
- MPS is very successful and applied to the same concepts to B2C in instant ink they found that, customer 90% purchase ink cartridge through their channel partners
- For consumer space (B2C) starts from wireless printing service where customers can print remotely from their personal laptop.
- PrintCo can monitor ink remotely for 2 main goals: Never run out of ink and to reduce the ink cost or require customers to pay for separate products form printing services.
- This tends to move towards subscription models and looking at the ***social megatrends (e.g. demographic and sustainability) published in the innovation journal.***
- Focusing on customer needs through conducting market research and focus groups
- PrintCo is highly networked, strong outdoor network (with 56,000 staffs -- do get silos) and recognition program for innovating products or service.
- Organisational cultures: enabled and empowered staff to have ideas look at failure (fail fast) as the way for learning.
- They developed consultancy internally, have fundings.
- Were launched in 20 countries and aims to scale this up to 10 billion subscribers
- In UK, PrintCo aims to build on instant ink business model for customers to purchase printing services which will be cheaper than owning the printers and ink cartridges from the third party
- ***Process optimization capabilities*** – modify the package design and design ink cartridge to be bigger in order to reduce frequently shipping.
- ***Internalised logistic costs*** – delivered by HP (send less is more) by applying different ways of thinking

4.0 Other Salient, Interesting, Illuminating or Important Aspects

- Social megatrends – market sensing where we think future would be (innovation journal).
- Clone cartridges – intellectual property
- Full range of consumer offerings

5.0 New/Outstanding Questions for Next Visit

- Data needs to be gathered from secondary sources (including the ones that the interviewee recommended in section 6.0 and other relevant documents and synthesized in the data analysing template before getting back to the interviewee for verification.

- Look at PrintCo's official website of social megatrends to see the relevance with the findings.

6.0 Secondary Data

- https://quocirca.com/content/exploiting-printernet-things/
- Quocirca is a print industry analyst organisation which should be researched further
- https://www.edie.net/news/12/HP-circular-economy-servitisation-business-model-sustainability-Kirstie-McIntyre/
- https://www.globenewswire.com/news-release/2019/10/24/1935270/0/en/HP-Tango-Terra-is-the-World-s-Most-Sustainable-Home-Printing-System-1.html
- https://sustainablebrands.com/read/product-service-design-innovation/the-circular-economy-in-action-hp-leading-the-way
- https://hpmegatrends.com/

D.2 Example of chain of evidence from contact note to data analysis

The data analysis of firm resources according to the contact note of contact IN2-01

PrintCo's Firm's Resources: Usage-based Business Model – Instant Ink				
		Theory	**Practice**	**Supporting information from contact note**
Assets and their locations	**Facilities**	• Bypassing intermediaries • Multiple field facilities close to market for supplying product	• Bypassing intermediaries (i.e. retailers) • Multiple facilities close to market for supplying product	*"Deliver ink directly to the customer from PrintCo's multiple channel partners close to the market"*
	IoT network	Closed network	Hybrid network	*"Develop internetworking capabilities, using local network, local internet or IP address before the wireless network is introduced and adopted"*
	People and skills	Highly skilled worker with technical knowledge on product and service	Highly skilled worker with technical knowledge of product and service	*"Require workers with strong technical knowledge to support customers"*
Ownership	**In-house**	Vertically integrated in product manufacture and delivering service provision to control quality, minimise the cost of both product and service	Vertically integrated in product manufacture and service provision to control quality, minimise the cost of both product and service	*"Introduce closed-loop manufacturing model to ensure the quality and reduce the cost of product and service"*
	Outsource/ partnerships	Non-core products or service operations	Non-core products or service operations such as logistic activities and partnerships with software vendors	**"***Rely on partners for non-core services e.g. logistic activates, channel partners and software vendors.*

D.3 Example of chain of evidence from transcripts to data analysis

The data analysis of dynamic capabilities according to the transcript of contact IN1-01

FuelRetailCo's dynamic capabilities: Add-on Business Model – Fill up and Go			
	Theory	**Practice**	**Quotations**
Sense	**Identify new market opportunities**	• Identification of customer pain points and business challenges • Identification of alternative purchasing options for customers	*"We knew 60% of our customers just wanted to buy their fill and go. They had no intention of going in the shop and buying anything from the shop and that was fab. But of course I want the other 40% now. So I need to integrate the shop good into the app and we need to look at how we can start offering the customers the ability to purchase things beyond fuel"*
	IoT technology exploration capabilities	• Exploration of the internal technological capabilities	*"The other way that we are widening the offer is through API. So we're utilising open APIs now where we have third party interested in consuming our digital payment"*
Seize	**Digital service development capabilities**	• The development of a small scale of full service version to assess and test the concept	*"With the onset of smartphone adoption which I'm sure you've seen a lot of figures on in the numbers of the smart phones and smartphones contracts are now. It was obvious we needed to move into a more digital mindset for payment. And subsequently this is where 'fill up and go' derived from was the real core of customer need and business challenges around cost and IT infrastructure that we decided to do an over-the-air payment service*
	Mass service customisation capabilities	• Leverage customer data for CRM or marketing purposes (i.e. personalised offers and promotions)	*"We knew 60% of our customers just wanted to buy their fill and go. They had no intention of going in the shop and buying anything from the shop and that was fab. But of course I want the other 40% now. So I need to integrate the shop good into the app and we need to look at how we can start offering the customers the ability to purchase things beyond fuel"*
	Digitalisation capabilities	• Interoperability of IT systems within the service network • Data management and descriptive analytics to extract useful information to support offerings • Connectivity and internet network coverage	*"A lot of integration with IT system, the way that we have a digital payments is we still master the transaction on the POS. Though the app is just mirroring what the till system is doing. That, for us, therefore is one of the biggest capabilities, is being able to have the site system integration"* *"so we break the data down into quite a number of different areas to sort of tell us around the customer experience, tell us the transactions, tell us the value, but then also tell us some of the technical issues as well and help pain point where we need to deep dive further, sort of remediation"*
	Network management capabilities	• Co-location with their partners • Strategically choose and assess the partners to be part of the service ecosystem	*"It's more collaborative working. When we choose vendors, that's part of the culture that we're looking for is when they're assessed how we think they could work with us. And I think there's also a natural connection between the themes and that really helps. Having co-located themes, bringing members of the vendors to work in our offices with us and vice versa when you're developing is really practical. "*
	Other Capabilities **- Staff's digital knowledge**	• Training the front-office staff on digital skills to remotely support customers in real-time • Training the back-office staff on working in a cross-functional team, agile methodologies and having hybrid skills (IT expert and business understandings)	*"The other biggest area for training is around our supportability team. So this is supportability in terms of our IT system but also supportability for our customers."* *"The first one with our IT system is our support desk being able to monitor the services. 2. "And the one for the customer, this is when the customers phone up and then of course they could have a variety of different questions".* *"And that the call centers also need to have a lot of information and access to the mobile payment platform. So it's not like they can take the call centre in the car and show them how it works in person. You have to send them videos and instructions and pictures so that they can actually visualise what the customer is saying."*
Transform	**Service methodologies and process for developing efficiency gains**	• Focus on customer feedback and iterate the change in sprint • Simplify the service delivery process	*"I think when it comes down to the reporting and the tagging that we have at the moment and this is really grown as product owner. So when the product, they're really looking after their product and looking at the report. Then the moment they can see an area that isn't working for them, justifying that they need to make a change, need to iterate."* *"So they work in sprint, they work in released cycles, they're encouraged to look at customer feedback, they're encouraged to use the products obviously themselves."*
	Service culture	• Embed digital and agile mindset • Develop customer-centric culture	*"But when it comes to digitalisation and working on agile methodology which is all about being quick and working in sprint and getting out a minimum variable product. The company, of all, has not quite caught up in terms of the mindset that we would like to adopt to be able to move quickly and keep up with the customer demand ultimately and I think as such the FuelRetailCo group needs to work out how we can manage our risks and manage all of the various procedures"*
	Risk management and mitigation	• GDPR and the privacy of customer data • Data security	*"And obviously GDPR and protects customers data so obviously it's obviously but privacy first in terms of customers data yes and there's a very strong (FuelRetailCo) process that's about information risk management and data privacy to make sure that those processes are robust"*

D.4 Example of chain of evidence from secondary data resources to data analysis

The data analysis of operational capabilities according to the secondary data resources

PrintCo's Operational Capabilities: Solution-oriented Business Model –Managed print services (MPS)			
	Theory	**Practice**	**Quotations from secondary data resources**
Process	Agile	Lean-agile	*"To operate a supply chain as described, it is also important to spend sufficient time and energy on innovation and improvements – this is what often is called 'Bi-modal'. (DC2-08)*
Governance and decision rights	Heterarchy	Hierarchy-Heterarchy	*"The fewer organisational layers to navigate, quick decision making between strategically aligned senior management has facilitated flexible, rapid development" (DC2-08)*
Organisation Design	Value co-creation	Value co-creation	*"Client Communications will help customers prepare employees for the transition, address concerns, and provide assistance around process changes. PrintCo will collaborate with customers to develop an internal communications plan to keep users informed of changes prior to implementation. PrintCo will also work together with customers to define the Service Request Process and communicate this information to end-users." (DC2-14)*
Performance Management	Service quality	Customer satisfaction	*"Different customers have different expectations. ...In some areas predictability is the key to customer satisfaction, in others it is about speed or special services. As well as using our own internal metrics, we communicate a lot with customers about their metrics of evaluating us to see whether we are performing the best we can" (DC2-08)*
	Service response time	Service response time	
	Service reliability	Service reliability	
	Service performance of individual customers	Service performance of individual customers - SLA	

Appendix E: Participation Information Leaflet

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Participant Information Leaflet for the key informants involving in the process of transitioning from traditional product-oriented business model to IoT-enabled servitized business models

Study Title:	Dynamic capabilities: An exploration of how firms transition from traditional product-oriented business model to IoT-enabled servitized business model
Investigator(s):	Chutikarn Suppatvech supervised by Prof. Janet Godsell

Introduction

You are invited to take part in a research study. Before you decide, you need to understand why the research is being done and what it would involve for you. Please take the time to read the following information carefully. Talk to others about the study if you wish.

Please ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Who is organising and funding the study?

This project is not funded by any organisations. It is part of the University course.

What is the study about?

This study aims to move a step further by taking the perspective of resource-based view and dynamic capabilities to explore how firms transition from traditional product-based business model to IoT-enabled servitized business model. This study will specifically investigate how firms can exploit their existing resources and capabilities to successfully implement an IoT-enabled servitized business model by conducting case study research. The context of this study can be referred to firms who currently adopt product-based business model and extend their value by utilising IoT technology to provide servitized offerings. The study will help to increase an understanding of traditional firms who adopt product-based business model on certain resources and capabilities which can help them to successfully utilise IoT technology in increasing value-added by enabling servitized business model.

What would taking part involve?

You will be informed about the date and time of the case study will be conducted within your company. A participant information leaflet and a consent form will be circulated to you a minimum of 24 hours. The forms need to be completed if you decide to take part. Then, the consent form will be returned to me before the case study begins.

The case study will include a workshop/ series of interviews that will take place in a private room within the company. The workshop/ interviews will run for 2-3 hour in which a variety of questions related to company structure, organisational/ business strategy, operating environments and business model. The main study questions will include the supply chain network design, supply chain operating model, ordinary capabilities and dynamic capabilities required to upgrade from traditional product-based business model and IoT-enabled servitized business model. You are free to answer and to refuse any questions that are asked. The interviews will be audio recorded by myself and a third party will be paid to do transcription.

Do I have to take part?

No. Participation in this study is completely voluntary and choosing not to take part will not affect you in any way. You can also choose to withdraw your participation at any time, without giving a reason by contacting one of the research team. Further details about withdrawing from the study are provided later on in this document.

What are the possible benefits of taking part in this study?

The study will help to increase an understanding of traditional firms who adopt product-based business model on certain resources and capabilities which can help them to successfully utilise IoT technology in increasing value-added by enabling servitized business model.

What are the possible disadvantages, side effects or risks, of taking part in this study?

No known side effects. You have the right to withdraw at any time if you feel uncomfortable.

Expenses and payments

You will not be required to make any payments to take part in this study**.**

Will my taking part be kept confidential?

Yes. The data will be collected in person through the interview and may be audio-recorded. All collected data will be stored on an encrypted the University of Warwick's internal cloud where the collected data will be shared with my supervisors (Janet Godsell and Joshua Ignatius). Participants will be given a study number to protect their identity and the code linking this will be stored separately to the research data. In the researcher's dissertation and any future publications, the direct quotes may be used to report the results. However, the reported data will be pseudonymised to protect the original identity of the participants. The pseudonymised data will only be available to the other researchers that will have joint-publication with me.

What will happen to the data collected about me?

As a publicly-funded organisation, the University of Warwick have to ensure that it is in the public interest when we use personally-identifiable information from people who have agreed to take part in research. This means that when you agree to take part in a research study, such as this, we will use your data in the ways needed to conduct and analyse the research study.

We will be using information from you in order to undertake this study and will act as the data controller for this study. We are committed to protecting the rights of individuals in line with data protection legislation. The University of Warwick will keep information about you for 2 years after the study has finished.

Research data will be **pseudonymised** as quickly as possible after data collection. This means all direct and indirect identifiers will be removed from the research data and will be replaced with a participant number. The key to identification will be stored separately and securely to the research data to safeguard your identity. You will be free to withdraw at any time, without giving a reason and this will not affect you or your circumstances in any way.

Data Sharing

The data will not be shared outside the University for this study.

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. The University of Warwick has in place policies and procedures to keep your data safe.

This data may also be used for future research, including impact activities following review and approval by an independent Research Ethics Committee and subject to your consent at the outset of this research project.

For further information, please refer to the University of Warwick Research Privacy Notice which is available here: https://warwick.ac.uk/services/idc/dataprotection/privacynotices/researchprivacynotice or by contacting the Information and Data Compliance Team at GDPR@warwick.ac.uk.

What will happen if I don't want to carry on being part of the study?

Participation in this study is entirely voluntary. Refusal to participate will not affect you in any way. If you decide to take part in the study, you will need to sign a consent form, which states that you have given your consent to participate.

If you agree to participate, you may nevertheless withdraw from the study at any time without affecting you in any way. You have the right to withdraw from the study completely and decline any further contact by study staff after you withdraw.

If you withdraw from the study, it will often not be possible to withdraw your data which has already been collected, after it has been anonymised. To safeguard your rights, we will use the minimum personally-identifiable information possible and keep the data secure in line with the University's Information and Data Compliance policies.

What will happen to the results of the study?

Prior to any distribution of the results (in any of the following methods) they will be discussed with the person in charge to establish whether the data is restricted or not. It is anticipated that none of the data will be restricted given the nature of the project and the type data that is involved.

The results will be used and discussed in the researcher's dissertation as part of the program. The results will also be used in any journals that the researcher plans to publish and it may be discussed at any conferences or seminars that the researcher will attend.

Who has reviewed the study?

This study has been reviewed and given favourable opinion by the University of Warwick's Biomedical & Scientific Research Ethics Committee (BSREC): REGO-2019-2356

Who should I contact if I want further information?

If you have any questions about any aspect of the study, or your participation in it, not answered by this participant information leaflet, please contact:

Chutikarn Suppatvech. Email: [redacted] Telephone number: [redacted].

Janet Godsell. Email: [redacted]. Telephone number: [redacted]

Who should I contact if I wish to make a complaint?

Any complaint about the way you have been dealt with during the study or any possible harm you might have suffered will be addressed. Please address your complaint to the person below, who is a senior University of Warwick official entirely independent of this study:

Head of Research Governance
Research & Impact Services
University House
University of Warwick
Coventry
CV4 8UW
Email: researchgovernance@warwick.ac.uk
Tel: 024 76 522746

If you wish to raise a complaint on how we have handled your personal data, you can contact our Data Protection Officer, Anjeli Bajaj, Information and Data Director who will investigate the matter: DPO@warwick.ac.uk.

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).

Thank you for taking the time to read this Participant Information Leaflet

Appendix F: Ethical Approval

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PRIVATE
Miss Chutikarn Suppatvech
WMG
University of Warwick
Coventry
CV4 7AL

26 February 2019

Dear Miss Suppatvech,

Study Title and BSREC Reference: *Dynamic capabilities: An exploration of how firms transition from traditional product-oriented business model to IoT- enabled servitized business model* REGO-2019-2356

Thank you for submitting the above-named project to the University of Warwick Biomedical and Scientific Research Ethics Committee for research ethical review.

I am pleased to advise that research ethical approval is granted.

In undertaking your study, you are required to comply with the University of Warwick's *Research Data Management Policy*, details of which may be found on the Research and Impact Services' webpages, under "Codes of Practice & Policies" » "Research Code of Practice" » "Data & Records" » "Research Data Management Policy", at:
http://www2.warwick.ac.uk/services/ris/research_integrity/code_of_practice_and_policies/research_code_of_practice/datacollection_retention/research_data_mgt_policy

You are also required to comply with the University of Warwick's *Information Classification and Handling Procedure*, details of which may be found on the University's Governance webpages, under "Governance" » "Information Security" » "Information Classification and Handling Procedure", at:
http://www2.warwick.ac.uk/services/gov/informationsecurity/handling.
Investigators should familiarise themselves with the classifications of information defined therein, and the requirements for the storage and transportation of information within the different classifications:

> *Information Classifications:*
> http://www2.warwick.ac.uk/services/gov/informationsecurity/handling/classifications
> *Handling Electronic Information:*
> http://www2.warwick.ac.uk/services/gov/informationsecurity/handling/electronic/
> *Handling Paper or other media*
> http://www2.warwick.ac.uk/services/gov/informationsecurity/handling/paper/.

Please also be aware that BSREC grants **ethical approval** for studies. **The seeking and obtaining of *all* other necessary approvals is the responsibility of the investigator**

www.warwick.ac.uk

These other approvals may include, but are not limited to:

1. Any necessary agreements, approvals, or permissions required in order to comply with the University of Warwick's Financial Regulations and Procedures.
2. Any necessary approval or permission required in order to comply with the University of Warwick's Quality Management System and Standard Operating Procedures for the governance, acquisition, storage, use, and disposal of human samples for research.
3. All relevant University, Faculty, and Divisional/Departmental approvals, if an employee or student of the University of Warwick.
4. Approval from the applicant's academic supervisor and course/module leader (as appropriate), if a student of the University of Warwick.
5. Health Research Authority (HRA) approval for research studies undertaken in NHS Trusts (previously NHS R+D approval).
6. NHS Trust Clinical Audit Approval, for clinical audit studies undertaken in NHS Trusts.
7. Approval from Departmental or Divisional Heads, as required under local procedures, within Health and Social Care organisations hosting the study.
8. Local ethical approval for studies undertaken overseas, or in other HE institutions in the UK.
9. Approval from Heads (or delegates thereof) of UK Medical Schools, for studies involving medical students as participants.
10. Permission from Warwick Medical School to access medical students or medical student data for research or evaluation purposes.
11. NHS Trust Caldicott Guardian Approval, for studies where identifiable data is being transferred outside of the direct clinical care team. Individual NHS Trust procedures vary in their implementation of Caldicott guidance, and local guidance must be sought.
12. Any other approval required by the institution hosting the study, or by the applicant's employer.

There is no requirement to supply documentary evidence of any of the above to BSREC, but applicants should hold such evidence in their Study Master File for University of Warwick auditing and monitoring purposes. You may be required to supply evidence of any necessary approvals to other University functions, e.g. The Finance Office, Research & Impact Services (RIS), or your Department/School.

May I take this opportunity to wish you success with your study, and to remind you that any Substantial Amendments to your study require approval from BSREC before they may be implemented.

Yours sincerely

pp. [redacted]

Dr David Ellard
Chair
Biomedical and Scientific
Research Ethics Sub-Committee

Biomedical and Scientific
Research Ethics Sub-Committee
Research & Impact Services
University of Warwick
Coventry, CV4 8UW.
E: BSREC@Warwick.ac.uk

http://www2.warwick.ac.uk/services/ris/research_integrity/researchethicscommittees/biomed

Appendix G: SLR Publication

Industrial Marketing Management 82 (2019) 70–86

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journal homepage: www.elsevier.com/locate/indmarman

The roles of internet of things technology in enabling servitized business models: A systematic literature review

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Warwick Manufacturing Group, University of Warwick, Coventry CV4 7AL, UK

ABSTRACT

The internet of things (IoT) is gaining attention from both scholars and practitioners regarding its potential as a key enabler of servitized business models; academic research on this emerging concept is increasing but overall underexplored, however. This paper comprehensively analyses and consolidates the relevant literature on the emerging concept of IoT and servitized business models through conducting a systematic literature review. Based on an analysis of 74 articles, four archetypes of business models are identified that are enabled by the IoT: add-on, sharing, usage-based and solution-oriented and supplemented with information on what role IoT adoption takes, benefits from the provider perspective, and the inhibiting factors per archetype. A framework draws the findings together and forms five propositions about these elements and their corresponding business models that may guide future empirical research and serve as a common typology. Therefore, this study contributes to the body of knowledge on innovative servitized business models by classifying emergent business models utilising IoT and what is currently known about them. For practice, this paper provides an overview for initial consideration by practitioners before adopting IoT in enabling servitized business models and the range of applications IoT may have in enabling servitized business models with examples.

[redacted]

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