Socio-technical transitions in the logistics sector: how companies manage their innovation in the era of digitalisation

By

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Abstract

There is a growing theoretical interest in the role of firms in socio-technical transitions studies. In doing so, transitions scholars start to explore business model innovation in the context of a transition towards a more sustainable production and consumption system. However, due to a lack of a firm-level perspective in transitions theory, it is still unclear how business model innovation unfolds in a socio-technical system context over time. This thesis adopts an S-D logic, service ecosystems view on the role of firms to extend the transitions theory. Besides, logistics innovations have not been widely explored in the transitions literature. As one of the first studies to explore logistics innovations from a socio-technical transitions perspective, this thesis also contributes to understanding the system reconfiguration of production and consumption systems from a logistics perspective.

This thesis employs a multiple-case studies design to investigate firms' innovation activities and their impact at the micro-, meso-, and macro-levels of service ecosystems. Qualitative research methods such as semi-structured interviews, direct observation, and secondary data have been used to investigate firms' innovation projects. The thesis then examines the interrelation between innovation activities, logistics strategies, and logistics trends to explain not only why firms have to balance their innovation efforts at the micro-level of the service ecosystem, but also how logistics innovations unfold at the meso- and meso-levels by the enactment of these value propositions.

In light of the investigation, this thesis adopts a balanced view of the relationship between firms and socio-technical systems, which helps overcome the 'niche-actor' and 'regime-actor' dichotomy in transitions studies. Also, this thesis provides a conceptual framework that bridges production and consumption by using logistics innovations as an empirical lens. Finally, due to the exploratory nature of this thesis, these findings may provide valuable insights for future research that integrate these two research streams for a better understanding of the firm-level innovation activities in socio-technical transitions.

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Publications

Journal publication

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Conference papers

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List of Acronyms & Abbreviations

AGV	Automated Guided Vehicles
AM	Additive Manufacturing
AWS	Amazon Web Services
AR	Augmented Reality
B2B	Business-to-Business
B2C	Business-to-Consumer
BMI	Business Model Innovation
CAT	Connected and Autonomous Truck
CLM	Council of Logistics Management
CSCMP	Council of Supply Chain Management Professionals
DfT	Department for Transport
DSC	Digital Supply Chain
EC	European Commission
ERP	Enterprise Resource Planning
EU	European Union
EVP	Ecosystem's Value Proposition
FBA	Fulfilment by Amazon
FTL	Full Truckload
G-D logic	Goods-dominant Logic
GDP	Gross Domestic Product
GNSS	Global Navigation Satellite Systems
GVA	Gross Value Added
HGV	Heavy-goods Vehicle
IoT	Internet of Things
JIT	Just-in-Time
LCV	Light Commercial Vehicle
LPI	Logistics Performance Index
LSP	Logistics Service Provider
MLP	Multi-level Perspective
NHTSA	National Highway Traffic Safety Administration

OCR	Optical Character Recognition
OEM	Original Equipment Manufacturer
OSR	Order Storage Retrieval
PPE	personal Protective Equipment
RFID	Radio Frequency Identification
S-D logic	Service-dominant Logic
SME	Small-Medium Enterprise
SNM	Strategic Niche Management
TEN-T	Trans-European Transport Network
TIS	Technological Innovation System
TM	Transition Management
TSP	Transport Service Procurement
WBCSD	World Business Council for Sustainable Development

Chapter 1. Introduction

1.1 Research background

This thesis focuses on how firms manage their innovation activities in the socio-technical transition of the European logistics industry. The multi-level perspective (MLP) has been adopted to study this complex and dynamic phenomenon. The MLP was developed to study technological transitions, but it has been refined as a heuristic device for understanding more complex socio-technical transitions (Svensson and Nikoleris, 2018). Although organisational actors (e.g., firms) are considered crucial for supporting or preventing transitions, their innovation strategy and the associated industry trends have received little attention in the transitions studies literature (Marletto, 2014; Marx et al., 2015). To address this issue, scholars have explained that there is a lack of a firm-level perspective in transition theory and called for further research to better understand the role of firms (Geels, 2018a).

More recently, the business model concept has received attention from transitions scholars because it can be used to describe the link between firm-level activities and business networks (Bolton and Hannon, 2016; Bidmon and Knab, 2018; Sarasini and Linder, 2018). However, there is still a lack of a consistent framework to connect “business models with the dynamics of markets, industries, or society and that helps understand the dynamic role of business model innovation for sustainability transformations of markets” (Schaltegger et al., 2016, pp. 271). To address this gap in transitions studies, we try to explore the interrelations between firms, business models, and market formation based on a service-dominant (S-D) logic, service ecosystems view for the following reasons: 1) S-D logic is based on the premise that firms do not create or deliver value, and value is always co-created by firms and customers, and other stakeholders; 2) there is no difference between producers and consumers, and all actors are resource integrators; 3) resource integration activities are coordinated through institutional arrangements (Vargo et al., 2015; Vargo and Lusch, 2016). Therefore, from an S-D logic perspective: 1) firms are resource integrators; 2) business models are formulised solutions for solving specific problems; 3) market formation requires the routinised adoption of these solutions (Wieland et al., 2017).

1.2 Empirical context

The application of the MLP has been illustrated with case studies of transitions in mobility (Truffer and Schippl, 2017), water supply (Fuenfschilling and Binz, 2018), commercial aviation

(Slayton and Spinardi, 2016), and electricity (Geels et al., 2016). Despite early attempts by Geels (2002) to address shipping services from the MLP framework, little attention has recently been given to logistics activities (Pettit et al., 2018; Damman and Steen, 2021). As argued by McMeekin et al. (2019), previous research has focused on part of the supply chain to explore a single and radical technology innovation. Thus, there is a need to understand more about 'multiple innovations and system reconfiguration' to address the importance of considering both production and consumption in transitions studies (Geels, 2018b).

Logistics services are defined as an extension of physical distribution, including the management of the materials and information flow related to production, warehousing, distribution, and the reuse of products (Chapman et al. 2003). In other words, the entire supply chain is impacted by logistics activities. With the introduction of Industry 4.0 – related technologies, the logistics function would be transformed into a new business model that proactively shapes production and consumption systems (Tang and Veelenturf, 2019). Hence, logistics services can be adopted as an empirical lens to understand the 'whole system reconfiguration' approach for socio-technical transitions (Geels et al., 2015). Although logistics innovations are often implemented with local partners worldwide, the empirical context of this thesis is the European logistics industry because all our case study companies are Europe-based. Furthermore, the European logistics industry is experiencing a digital transformation, and firms need to evolve their innovation strategies, cultures, and business models accordingly to keep up with the industry trend (Cichosz et al., 2020).

1.3 Research strategy

As one of the first studies to examine logistics innovations from a socio-technical transition perspective, an abductive research strategy has been adopted because of the exploratory nature of this thesis (Kovács and Spens, 2005). The multiple-case design of this thesis helps extend the transition theory by exploring how innovation activities and their associated socio-technical systems can be viewed from a firm-level perspective (Eisenhardt and Graebner, 2007; Geels, 2018a). The unit of analysis of this study is the innovation project, which helps us examine how value propositions are created and developed. Given the qualitative nature of the thesis, an interpretivist paradigm is used to guide the case study implementation (Bryman, 2016). Therefore, the core data collection is based on semi-structured interviews with executive managers who have extensive experience with the innovation strategy of the case study companies. Secondary data has also been collected to corroborate evidence obtained from other sources (Saunders and Lewis, 2012).

1.4 Research questions

Following the above ideas, this thesis adopts an abductive, multiple-case study approach to explore how firms manage their innovation activities in the transition of the logistics industry. To this end, four main research questions have guided this thesis:

1. What is the role of firms in socio-technical transitions in the logistics industry?

This research question aims at exploring the role of firms in socio-technical transitions. Transitions studies try to categorise actors based on the distinction between incumbents and new entrants. More recently, the third category: ‘mature entrants’ has been identified to describe the actors falling in between this ‘incumbent-new entrant’ dichotomy. However, it is suggested that system change may occur through interactions among multiple niches and multiple regimes. Thus, more empirical evidence is needed to develop and refine the dichotomous conceptualisations of firms’ strategies in transitions studies. As a middle-range theory, the MLP can benefit from other theoretical lenses in business and management literature (Geels, 2018a). Consequently, the first research question aims at extending our understanding of the role of firms in the transitions literature.

2. What is the role of logistics innovations in socio-technical transitions?

Following the first research question, acceleration in system change involves multiple niches and regimes in different socio-technical systems. However, transitions studies often focus on single and radical technology innovation embedded part of the entire chain of production, distribution, and consumption. Therefore, transitions scholars are encouraged to use new approaches to understand multiple innovations and system reconfiguration (Geels et al., 2015). Logistics activities are crucial in connecting production and consumption systems, but they are often overlooked in comparison to other studies such as mobility, energy, and agriculture in the transitions literature. As a result, the second research question aims at addressing this issue by using logistics innovations as an empirical lens to add value to the whole system reconfiguration approach.

3. How are value propositions developed and evolved?

Research question 3 is designed in line with our unit of analysis in the case study research. This thesis is mainly concerned with logistics innovations and their impacts on socio-technical systems. Thus, innovation projects are selected as the unit of analysis because firms' innovation strategy is often articulated and formulated through these innovation activities. According to S-D logic, logistics innovation is defined as creating new value propositions or developing existing ones. Therefore, the investigation of these innovation projects enables us to understand how value propositions are evolved rather than considering value propositions as a static concept that firms provide to customers.

4. How firms' innovation activities contribute to the transition of the logistics industry?

Having identified how value propositions are developed and evolved at firms' level, we try to explore how logistics innovation activities shape a broader socio-technical system. By adopting a service ecosystems perspective, research question 4 aims at exploring how logistics innovations shape resource integration activities within service ecosystems, including micro-level (niches), meso-level (industries), and macro-level (socio-technical systems).

1.5 Thesis structure

Chapter 2 presents a careful review of the various literatures related to the subject of this thesis. The chapter begins with an introduction of the Multi-level Perspective (MLP) and transition pathways, and especially focusing on how the concept of the socio-technical regime has been advanced and evolved from the technological regime. Then, we present the application of the MLP in different empirical domains such as mobility, energy, and agriculture. Also, other research strands such as strategic niche management (SNM), technological innovation systems (TIS), and transitions management (TM) have been briefly introduced. The review highlights some criticisms of the MLP, including 1) lack of a firm-level perspective; 2) lack of a spatial dimension; 3) landscape as a residual category; 4) bias towards bottom-up change models; 5) flat ontologies versus hierarchical levels. Consequently, we identify the first criticism (lack of a firm-level perspective) is most relevant to this thesis, then we turn to review the application of the business model concept in transitions studies. Consequently, we suggest using an S-D logic, service ecosystems view to examine the role of firms in socio-technical transitions. At last, we review the literatures that are related to innovation management in logistics services.

Chapter 3 explains why this thesis follows a qualitative case study methodology. We then introduce the use of an abductive approach for extending existing theories. Next, we explain the case study approach in detail, including the multiple case study strategy, unit of analysis, case selection criteria, data collection methods, and data analysis process. Moreover, we describe how to improve the quality of research design using four tests suggested by Yin (2018).

Chapter 4 introduces the empirical context in which the data collection takes place. The purpose of Chapter 4 is to briefly review the historical development of the European logistics industry and explore how socio-technical factors have shaped the current industry. Importantly, we provide the empirical context to illustrate the relationship between short-term logistics strategies and long-term logistics trends, which is crucial for examining how logistics innovations 'travel' between different levels of aggregation in service ecosystems.

Chapter 5 introduces the findings from our pilot case studies. The research themes developed from the literature review and methodology chapter are applied and addressed in this chapter. The pilot case studies provide an opportunity to refine our data collection plans, research questions, and conceptual framework. At last, both theoretical and methodological issues are reflected throughout the pilot study.

Chapter 6 introduces the findings from our main case studies. Two main case studies are examined in this chapter, including a revisiting of Company A (logistics service provider) and a new case study of Company D (digital freight forwarder). This chapter describes our finding based on a refined conceptual framework to outline how value propositions are developed and evolved within a given service ecosystem.

Chapter 7 applies our conceptual framework to discuss how logistics innovations shape or are shaped by service ecosystems. As shown in Chapter 6, the case study companies are embedded in their institutional arrangements that coordinate resource integration activities. In Chapter 7, our focus is on a broader service ecosystem to examine how logistics innovations contribute to changing the institutionalised rules of resource integration at the micro-level (e.g., changing the business logic), meso-level (e.g., changing the industry structure), and macro-level (e.g., changing production and consumption patterns).

Chapter 8 is the conclusion chapter, where we answer our research questions based on the empirical findings and discussion of the case study results. Next, we discuss the theoretical and empirical contributions of this thesis. Also, practical implications are pointed out as potential guidance for senior managers involved in logistics innovation activities. Finally, we reflect on the strengths and weaknesses of the research strategy, and several opportunities for further research are therefore suggested.

2. Literature Review

2.1 Chapter Introduction

This literature review chapter aims to critically review the various literatures related to the key concepts of socio-technical transitions. In particular, the chapter's focus is on identifying studies that provide insights into how to understand the role of firms and logistics in socio-technical transitions. Subsequently, we have reviewed the relevant literature in business models, business model innovation, and sustainable business model, as well as their applications in transitions studies.

The literature review is divided into four main sections. The first section reviews the literature on the major strands of socio-technical transitions studies, including the multi-level perspective (MLP), strategic niche management (SNM), technological innovation system (TIS), and transition management (TM). In particular, the MLP is adopted by this thesis because it helps understand complex system changes, which is directly linked to our research question on the role of logistics innovations in shaping broader production and consumption systems. Following this, we introduce the applications of the MLP in transitions studies and its strengths and weaknesses. The second section includes the review of the literature on business models, business model innovation, and sustainable business models because many transitions scholars have started exploring the role of firms in socio-technical transitions in order to have a firm-level perspective on system changes. In the third part, we present the related literature on innovation management in logistics research and try to link logistics innovations with broader issues such as logistics strategies and trends. At last, we introduce an integrated conceptual framework based on an S-D logic, service ecosystems view and the MLP to answer our research questions.

2.2 Review of the socio-technical transition theory

2.2.1 Multi-level Perspective (MLP) and transition pathways

As a heuristic device to elaborate the concept of technological transitions, the "multi-layer perspective" is firstly introduced by Rip and Kemp (1998). It includes three levels of interaction from both social and technological aspects, including the micro (artefacts), meso (technical regimes), and macro (socio-technical landscapes) levels. Next, to further develop and overcome technology-oriented rules, the core concept: the socio-technical regime is established by Geels and other scholars (Geels, 2002; Geels, 2005a; Markard and Truffer, 2008) as an extension of 'technological regimes' in recognition that technological trajectories are also influenced by societal factors such as users' attitudes, policymakers, and other social groups. The socio-technical landscape is considered exogenous and provides a set of deep structural trends, such as energy security, peak oil, social value, and climate change. The landscape cannot be directly influenced by the regime and niche actors. Instead, the landscape may create pressure on the regime and create a window of opportunity (Hermwille, 2016). Thus, a multi-level perspective (MLP) has been established for investigating large scales and long-term changes in socio-technical systems (Figure 2.1).

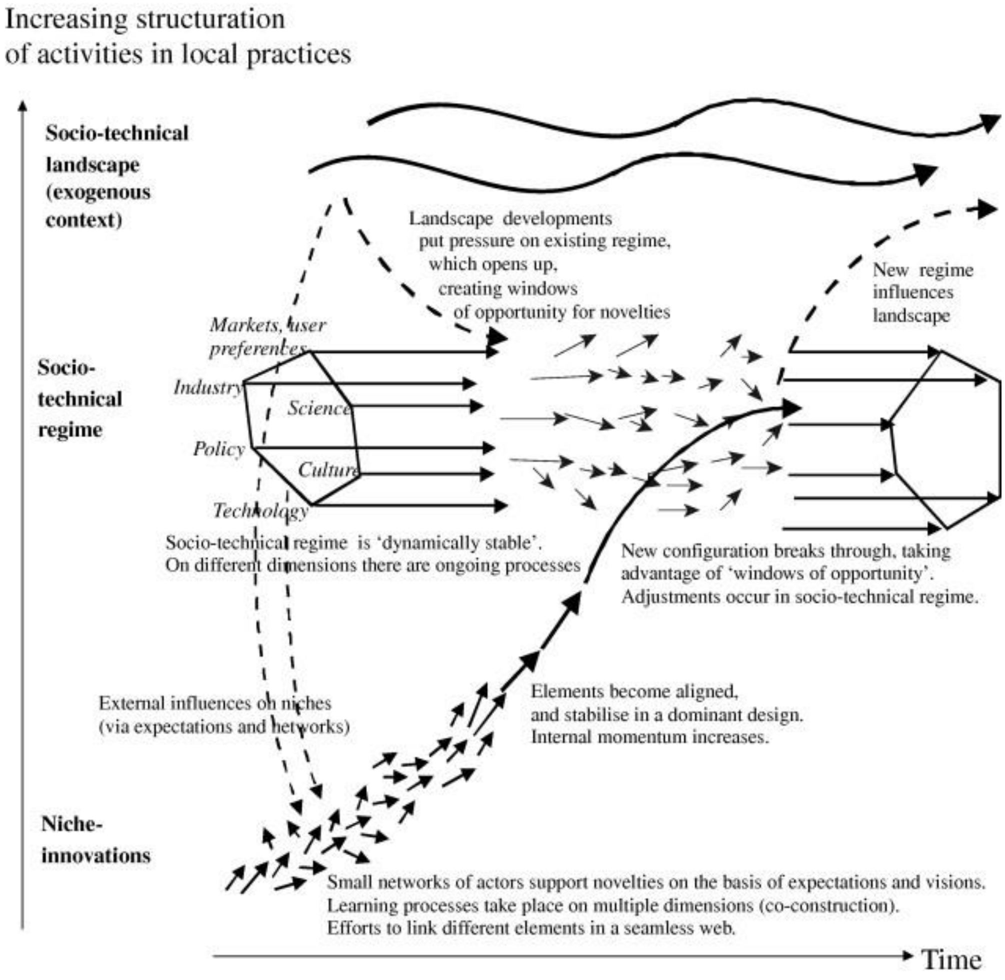

Figure 2. 1 The multi-level perspective on transitions (adapted from Geels, 2012).

2.2.1.1 Niche

In MLP dynamics, niches mentioned above are described as unstable ‘protected spaces’ for novelties and located at the bottom of the three analytical levels of the MLP (Geels, 2005a; Geels and Schot, 2007). The niche level is a crucial concept embedded in the socio-technical hierarchy. This concept is deeply rooted in insights from sociology of technology, which says the acceptance of new technologies is based on the socio-technical alignment. The niche level is the place where radical innovation takes action. More importantly, the niche is referred to as ‘protected space’ or ‘incubation room’ to protect these novelties from mainstream market selection (Markard and Truffer, 2008). Thus, Schot and Geels (2008) describe niche development as a process in which sustainable technologies emerge through a series of experiments and demonstration projects.

> “A niche can be defined as a discrete application domain (habitat) where actors are prepared to work with specific functionalities, accept such teething problems as higher costs, and are willing to invest in improvements of new technology and the development of new markets” (Hoogma et al., 2002, p. 4).”

2.2.1.2 Regime

Next, the socio-technical regime is the focal unit of transitions studies, which shares similar structures with technological niches. However, the main differences between niches and regimes are size and stability (Geels, 2002). Therefore, both niche and regime are coordinated by certain rules. However, the rules at the niche level are less stable and less articulated than they are in regime-level institutions (Geels, 2018b). Geels (2002) defines the focal unit of transitions studies as the ‘socio-technical regime’, which can be analysed via the heuristic device of the multi-level perspective (MLP) as a way of understanding a change from one socio-technical system configuration to another. A socio-technical system (Figure 2.2) is defined as (Geels, 2004):

> “ST-systems in a somewhat abstract, functional sense as the linkages between elements necessary to fulfil societal functions (e.g., transport, communication, nutrition). As technology is a crucial element in modern societies to fulfil those functions, it makes sense to distinguish the production, distribution and use of technologies as

sub-functions. To fulfil these sub-functions, the necessary elements can be characterised as resources. ST-systems thus consist of artefacts, knowledge, capital, labour, cultural meaning, etc.” (Geels, 2004, p. 900)

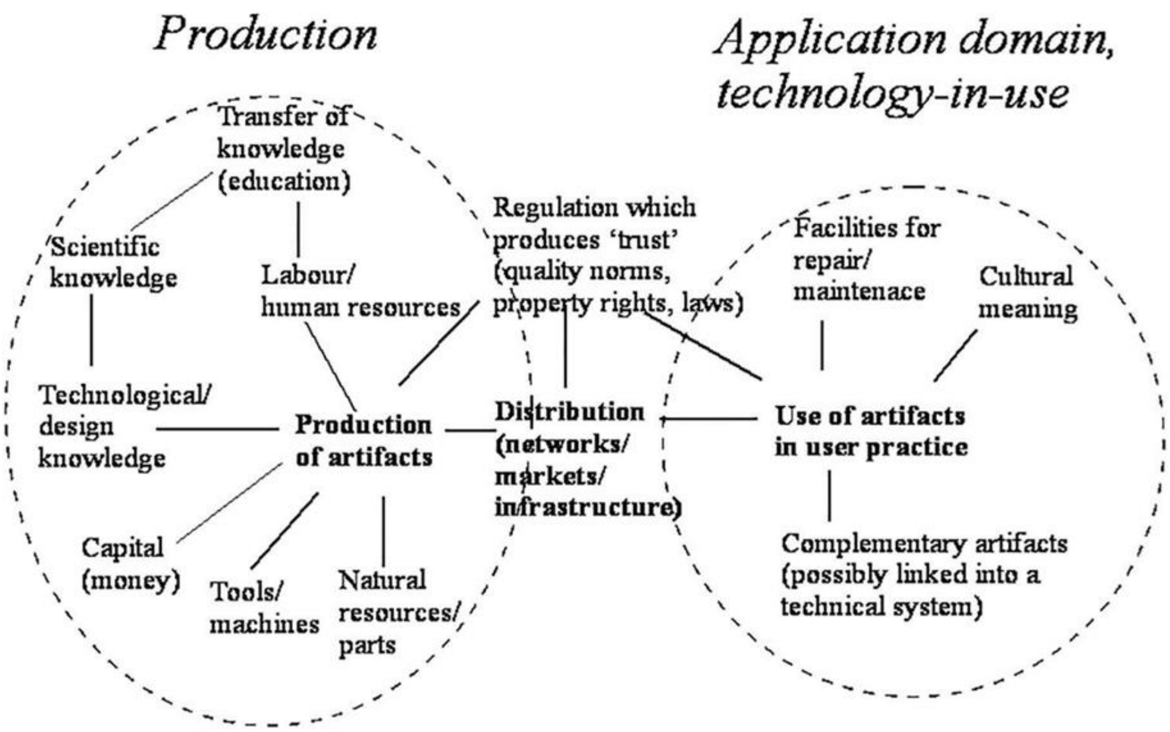

Figure 2. 2 The basic elements and resources of socio-technical systems (Adapted from Geels, 2004)

In MLP dynamics, the ‘socio-technical regime’ is an extension of Nelson and Winter’s (1982) technological regime. The technological regime emphasises that the shared cognitive routines between engineers and firms form a technological regime, resulting in technological trajectories. The concept of the socio-technical regime introduces broader social activities around the technological trajectories, including cognitive routines, regulations, cultures, sunk investments in infrastructures, and competencies (Geels and Schot, 2007), which can accommodate the innovations in social and institutional structures. More importantly, the concept of the ‘socio-technical regime’ focuses on why this stable structure may nonetheless change over time (Geels, 2005b). It means that the MLP is built upon the distinction between structure (regime) and the socio-technical system (Svensson and Nikoleris, 2018). Therefore, it is necessary to clarify the difference between the socio-technical system and regime, and Geels (2011)’s view has been adopted:

Socio-technical system: refers to tangible and measurable elements (such as artefacts, market shares, infrastructure, regulations, consumption patterns, public opinion).

Socio-technical regime: refer to intangible and underlying deep structures (such as engineering beliefs, heuristics, rules of thumb, routines, standardized ways of doing things, policy paradigms, visions, promises, social expectations and norms).

"'regime' is an interpretive analytical concept that invites the analyst to investigate what lies underneath the activities of actors who reproduce system elements." (p. 31)

According to Geels and Schot (2007), there are three types of rules that guide (non)changes in socio-technical systems: regulative rules (e.g., regulations, standards, and laws), normative rules (e.g., relationships, values, behavioural norms), and cognitive rules (e.g., belief, definitions, and principles). The evolution of socio-technical systems is a fundamental concern of the MLP because novelties have to compete with long-established technologies that benefit from current technological systems and governing institutions (Unruh, 2000). In other words, the elements in socio-technical systems have to be reproduced, maintained and changed by various social groups (Geels, 2010). Such actors are coordinated by deep-structural rules that prevent radical changes in socio-technical systems (Giddens, 1984). Consequently, changes occur incrementally in socio-technical systems in a predictable way, representing lock-in mechanisms and path dependence. Geels (2012) illustrates such lock-in mechanisms by using six examples, which are: (1) shared beliefs, (2) consumer lifestyles, (3) regulations and laws, (4) people and infrastructure, (5) vested interests and (6) economies of scale. Therefore, the socio-technical regime, a compilation of such system elements, overcomes the producer-centric perspective from traditional innovation studies, which sees manufacturers as the key actors in regimes and underlines the importance of different stakeholder groups.

2.2.1.3 Landscape

The socio-technical landscape has the most stable structure compared to niches and regimes, and it represents an exogenous environment that does not directly interact with niche and regime actors (Geels, 2005b). Thus, as discussed previously, the macro-level landscape represents the wider exogenous environment that may affect niche-regime interactions (Geels and Kemp, 2007). However, external circumstances at the landscape level are crucial to couple with sufficiently developed niches to compete with socio-technical regimes (Morone et al., 2016). Smith et al. (2010) explain socio-technical landscapes as:

> "… an influential backdrop with ramifications across a variety of regimes and niches: providing gradients and affordances for how to go about establishing socio-technical configurations that serve societal needs" (p. 441)

2.2.1.4 Transition pathways

As a result, the MLP helps sustainability transitions scholars to explain why socio-technical changes may happen simultaneously within these three analytical levels. Moreover, to avoid the bottom-up niche bias, Geels and Schot (2007, p.32) has proposed four transition pathways that result from the different timing and nature of multi-level interactions:

- *Transformation pathway*: landscape developments exert pressure to destabilise the regime, but niche-innovations are not well-developed. Incumbent actors may adjust their innovation activities and development paths.

- *Reconfiguration*: landscape developments exert pressure on regimes and niche innovation are more developed. It enables incumbent actors to adopt them as 'add-ons' for specific issues.

- *Substitution pathway*: landscape developments exert pressure on regimes when niche-innovation are mature. It leads to two possible patterns: 1) niche-innovation replace the regime with the help of window of opportunity; 2) niche-innovations replace the regime by their internal momentum without landscape pressures.

- De-alignment and re-alignment: landscape developments destabilise the regime when multiple niche-innovations are well developed. Niche-innovations will co-exist for a certain time until re-alignment eventually occurs around one innovation, leading to a new regime.

2.2.2 Applications of the MLP

The MLP has been applied to a range of sustainability transition topics such as mobility, energy supply, housing, food, waste, and other socio-technical systems, investigating how they can transform into more sustainable patterns (Smith et al., 2010). Recently, sustainability transitions scholars have adopted different theoretical lenses because the MLP has been introduced as a middle-range theory and can benefit from different theoretical frameworks (Geels, 2011). For example, Sovacool et al. (2017) have applied the MLP together with the Triple Embeddedness Framework (TEF) and the Design-Driven Innovation to investigate the failure of an entrepreneurial company called Better Place. Despite formal innovation studies emphasising Better Place's poor innovation strategy, management, and technological issues. The mismatch between how far can Better Place stretch in the current car regime and how well can Better Place fit into existing user practices plays the most influential role. Another example is Bolton and Hannon's (2016) interpretation of the coevolution relationship between innovative business models, infrastructures, and institutions. This research has introduced both the business model and socio-technical systems approaches and emphasised that system changes need to be triggered by greater institutional changes, such as political, regulatory and market, rather than business model innovation.

More recently, transitions scholars put more attention on multi-regime interactions. They have discovered that niche anchoring into socio-technical regime results from the different types of regime interactions (Sutherland et al., 2015). Regarding multi-regime interaction studies, the focus has moved further to the whole system reconfiguration because socio-technical transitions are likely to involve multiple niche-innovations and multiple regimes (Geels, 2018b). Furthermore, limited attention has been given to organisational actors (e.g., firms) in previous transitions research, and the dichotomy between market incumbents (at regime level) and new entrants (at niche level) is criticised as simplistic (Geels and Schot, 2007; Berggren et al., 2015). Further studies have found that co-operation and competition between individual firms can also lead to niche-regime interactions and result in alternative transition pathways (Geels et al., 2016). In addition to researching successful socio-technical transitions, Wells and Nieuwenhuis (2012) conduct a case study on transition failure in the automotive industry. The research reveals that the automotive industry regime is stable enough to maintain path dependency.

2.2.3 Critique of the MLP

Socio-technical transitions studies have started in early 2000 as a research strand of innovation studies. Several historical case studies such as mobility, water, energy, shipping, and the music industry (Geels, 2005a; Geels, 2005b; Geels, 2007; Bos and Brown, 2012) have helped test and refine one of the core research frameworks - the MLP. Recently, the MLP has gained more attention in various empirical context and been applied to the analysis of ongoing and future sustainability transitions such as car-sharing practices (Meelen et al., 2019), electric bicycle development (Lin et al., 2018), 3D printing innovations (Birtchnell et al., 2020), and biofuel industry development (Kim et al., 2019). Although the MLP has become a fruitful middle-range framework, it receives some criticisms that help refine the framework. Geels (2011) summaries these criticisms as follows: 1) lack of agency; 2) operationalisation of regimes; 3) bias towards bottom-up change models; 4) epistemology and explanatory style; 5) methodology; 6) socio-technical landscape as a residual category; 7) flat ontologies versus hierarchical levels. The following sections will focus on the most relevant limitations to this PhD research based on the academic debate and criticisms of the MLP.

2.2.3.1 The role of actors

The MLP has received criticism for the weak conceptualisation of agency fails in accommodating the critical roles of actors in socio-technical transitions (Smith et al., 2005; Smith, 2007; Genus and Coles, 2008). In response to the criticism, Geels (2011) explains the MLP is “shot through with agency, because the trajectories and multi-level alignments are always enacted by social groups” (p. 29), and agency has always been in MLP dynamics. Consequently, Geels and Schot (2007) introduce four transition pathways based on different regime-niche interaction patterns to pay more attention to the main actors involved in socio-technical transitions.

Furthermore, Geels (2011) suggests that the MLP could benefit from introducing insights from business studies and strategic management to address the important role of regime and niche actors. As suggested by Boons et al. (2013, p. 4), “While research of past transitions has shown that innovative firms have been crucial, the issue of how firms can contribute significantly to bringing about these transitions has received too little attention, especially in relation to business models.” Therefore, scholars start to explore the role of business models

(BM) and business model innovation (BMI) to address the lack of a firm-level perspective in socio-technical transitions studies (Bidmon and Knab, 2018; Sarasini and Linder, 2018).

2.2.3.2 Bias towards bottom-up change models

According to Berkhout et al. (2004, p. 62), MLP approaches "tend unduly to emphasise processes of regime change which begin within niches and workup, at the expense of those which directly address the various dimensions of the socio-technical regime or those which operate 'downwards' from general features of the socio-technical landscape". In response to this criticism, Geels (2011) argues that early transitions studies have primarily focused on bottom-up dynamics because 'green' niche innovations have to overcome regime barriers. As a result, four different transition pathways have been introduced to differentiate the timing and nature of multi-level interactions (Geels and Schot, 2007; Geels et al., 2016).

In addition, the bias towards bottom-up change models shows that most work seems to focus on a single regime or a single and radical technology innovation under landscape developments (McMeekin et al., 2019). This problem may lead to two possible research directions: 1) multi-regime interactions – as the growth of certain technologies depends on interactions between two or more regimes (Geels, 2007; Sutherland et al., 2015); 2) the whole system reconfiguration approach –moving from focusing on part of the supply chain to multiple innovations and system reconfiguration (Geels et al., 2015; Geels, 2018b, Pettit et al., 2018).

2.2.3.3 Lack of a spatial dimension

The transition process always happens across different geographic locations, requiring a clear definition of landscape, regime, and niche since they are ambiguous in empirical research (Wells and Lin, 2015). For example, Wells and Lin (2015, p. 373) argue: "can a city with millions of people be considered as a landscape or a niche?". Some related discussions about the lack of geographical sensitivity in the MLP reveal: 1) transitions studies tend to implement at the national level; 2) a lack of consideration of local variations and interpretations, regimes are described as homogenous structures; 3) niche development is not only shaped by actor networks, expectations, and learning, the geographical access to specific capabilities and resources is also important to nurture innovations (Coenen et al., 2012; Truffer and Coenen, 2012; Raven et al., 2012).

2.2.3.4 Landscape as residual category

The exogenous context or socio-technical landscape is a crucial factor to influence the interactions between niche-innovation and existing socio-technical systems. However, the landscape has been criticised for being residual category in the MLP analytical framework (Koirala et al., 2018). Geels (2011) gives some suggestions about developing and reformulating the landscape, such as 1) have a more dynamic view on the landscape because previous transitions studies see the socio-technical landscape as the most stable and slow-moving structure. The dynamic view can be categorised into factors that do not change (e.g., physical climate), rapid external shocks (e.g., wars, oil price), and long-term change (e.g., demographical changes) (Moallemi et al., 2017).

2.2.3.5 Flat ontologies versus hierarchical levels

The idea of the MLP can be criticised from a flat-ontology perspective because “you don’t need several layers, different layers... You only need places that are connected and the possibility of actors and information to circulate from one place to another one.” (Barry and Slater, 2002, p. 293). Geels (2011) suggests that flat approaches may help drop the notion of ‘nested hierarchy’ of the MLP because niches do not often emerge within regimes, and the socio-technical landscape and regimes are not necessarily hierarchical. For example, Actor-Network Theory (ANT) adopts a ‘flat ontology’ to understand how the network promotes innovations by growing and consolidating between local practices (Geels, 2011). Thus, ANT provides opportunities for investigating interactions between existing networks and emerging networks (Geels, 2010). As a result, Diaz et al. (2013) argue that the ANT-based approach is suitable for ‘zooming in’ on how a local niche struggles, negotiates, and builds links with the regime.

2.2.4 Other research strands: Strategic Niche Management (SNM)

To date, strategic niche management (SNM) has been proved as a useful tool to manage and incubate new technologies in the fields such as energy, agriculture, and transport systems. Previous SNM research views the dynamic of niche processes because these radical innovations usually face market incumbents' competition. Therefore, a mismatch in existing infrastructures, user preference, regulations, and the trade-off relationship makes these emerging technologies in a vulnerable position (Schot and Geels, 2007; Whitmarsh, 2012). The aims of strategic niche management are: articulate the changes; technical, economic, and environmental consequences of these technology options; stimulate further development; network formation between different stakeholders (Kemp, et al., 1998).

Therefore, a fundamental mechanism has been introduced to see how to constitute niche formation processes in the SNM approach, including three phases (Kemp, et al., 1998; Schot and Geels, 2008;):

1) The articulation of expectation and visions: promises are crucial in the early stage of technological development. Further learning processes are led by these expectations.

2) The building of social networks: there are many barriers preventing the introduction and adoption of new technology. Uncertainty and perceptions can be solved by the building of a social network between relevant stakeholders.

3) Learning processes: the formation of a new actor-network is crucial in niche formation. Learning processes at multiple dimensions could help create networks (e.g., technical aspects, design specification, market, and user preferences).

SNM has been using as a useful device to understand and manage radical innovations in different research fields, such as sustainable mobility, renewable energy, sustainable building, manufacturing industries, and grassroots social innovations. For instance, Sushandoyo and Magnusson (2014) take a business perspective and discuss how to develop and introduce hybrid-electric trucks by forming bridging markets. Also, SNM has been adopted to analyse non-technological innovations, such as the concept of social entrepreneurship (Witkamp et al., 2011) and grassroots innovations (Kirwan et al., 2013). More recently, SNM scholars start to include the business model concept in their research, such as PV business model experiments in the Netherlands (Huijben and Verbong, 2013) and car-sharing business models in promoting electric vehicles technology (Sarasini and Linder, 2018).

Early SNM literature has been criticised because it relies on the bottom-up processes of niche expansion and over-emphasises the role of niches in socio-technical transitions (Genus and Coles, 2008; Geels, 2011). Therefore, it is argued that the interaction between incumbent socio-technical configurations (regime), radical innovations (niche), and exogenous environment (landscape) may facilitate technological innovations diffusing widely (Sushandoyo and Magnusson, 2014; Wolfram, 2016). Moreover, theories of SNM try to highlight the importance of the interaction between firms and social/political actors, and less attention have been given to the competition between firms (Berggren et al., 2015). Hence, the multi-level perspective (MLP) can be helpful to further develop the SNM by linking different transition pathways to transitions studies. On the other hand, SNM research can also contribute to extending the MLP. According to Schot and Geels (2008),

> "Most of the MLP studies focus on one regime, but Raven found that niche developments may be influenced by multiple regimes, this influence can be beneficial when a niche innovation becomes linked as solution to multiple regimes, but it can also create new problems and uncertainties about regulations, definitions, technical linkages, and responsibilities." (p. 547)

2.2.5 Other research strands: Technological Innovation Systems (TIS) and Transition Management (TM)

Research on technological innovation systems (TIS) is another major strand in the field of transitions studies. The research strand describes the institutional and organisational changes that should be in line with technological innovations (Markard et al., 2012). There are three structural components of the TIS: actors, networks, and institutions (Bergek et al., 2008). Importantly, the TIS concept highlights a particular institutional infrastructure that drives the interplay of firms and other actors, which results in the generation, diffusion, and utilisation of technological innovation (Markard and Truffer, 2008; Bergek et al., 2015). Recently, the TIS has been applied to several sectors, such as district heating systems (Hawkey, 2012), nuclear decline and the energy transition (Markard et al., 2020), and the sectoral configuration of the TIS in lithium-ion battery technology (Stephan et al., 2017).

Transition management (TM), on the other hand, works with insights from complex systems theory and governance approaches to influence ongoing technological transitions into more sustainable directions (Markard et al., 2012). Therefore, the TM approach tends to use 'top-down' governance to purposefully create temporary protection of niche innovations (Smith et al., 2005). As a governance model, the TM has been applied to several areas such as marine resources (Kelly et al., 2018), innovation policy implementation (Veldhuizen, 2020), and renewable energy transitions (Goddard and Farrelly, 2018).

2.3 Business model theory

As discussed in previous sections, there is an increasing emphasis on actors' roles and innovation activities in sustainability transitions. Early attempts have been made to integrate the business model concept with strategic niche management (SNM) (Huijben and Verbong, 2013; Steinhilber et al., 2013). The SNM approach has been applied as a policy instrument in socio-technical transitions, and these studies emphasise the importance for firms to engage with social and political sectors. The core component in the SNM: niches, is a shelter for socio-technical experiments, which can protect these radical innovations from the competition with a dominant regime. According to Caniëls and Romijn (2008), several protections can protect the innovation process from market pressures, including government tax exemptions, R&D commitments by firms, or prospective adopters' willingness to participate in trials on an unpaid basis. However, co-operation and competition between firms have received less attention (Berggren et al., 2015).

In niche-regime interactions, the MLP could also benefit from integrating with the business model concept to have a co-evolutionary view on organisational actors (e.g., firms) because market incumbents could play an important role in accelerating sustainability transitions (Geels, 2012). Recent studies have shown that incumbent firms can play different roles in transition processes and called for a move beyond the niche-incumbent dichotomy (Ruggiero et al., 2021). However, the lack of a firm-level perspective in transitions studies requires further clarification by conceptualising business models (Sarasini and Linder, 2018).

2.3.1 Business model, business strategy, and business model innovation

Over the past 20 years, the business model concept has been applied and developed by research communities and practitioners. The rising of new global trading pattern, especially the establishment of new communication technologies and online platforms, have largely transformed the ways of doing business in many industries. In contrast with the supply-driven logic, customers have moved towards a centric position in the business. Therefore, companies are looking for a better business pattern to provide their products and services to fulfil customers' needs to convert payments to profits. According to Teece (2010), the business model:

> "Articulates the logic and provides data and other evidence that demonstrates how a business model creates and delivers value to customers." (Teece, 2010, p. 173)

However, business management scholars start to realise that there is a fragmented usage of the business model concept, and it is crucial to have a consensus regarding its meaning. DaSilva and Trkman (2014) thus describe the business model as an "incomplete approach" that focuses on short-term consequences in a more generic manner. However, a business strategy and emphasise that "without a clear strategy ready to modify the existing business model, the competitive advantage may soon be offset" (p. 386). Casadesus-Masanell and Ricart (2010) present a framework to distinguish business strategy and business model concepts: the business model describes how firms operate and create value among different stakeholders (Figure 2.3). The business strategy refers to how firms select their business models to gain competitive advantages. Osterwalder and Pigneur (2010) use a "nine-building blocks" canvas to characterise a business model, which includes value propositions, customer segments, customer relationships, channels, revenue streams, partnership, key activities, key resources, and cost structure. The business model canvas helps researchers understand how to create value for customers, deliver value to customers, and capture value from customers. Thus, the concept has become a popular concept and adopted in transitions studies, and we will discuss it further in the following sections.

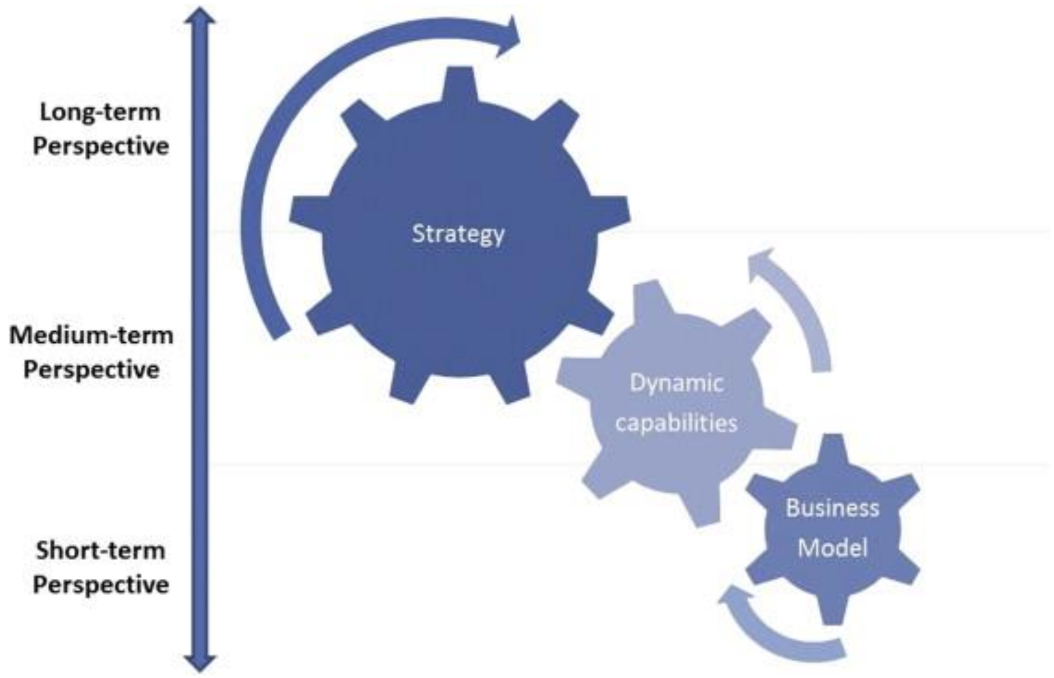

Figure 2. 3 The Relationship between business model and business strategy (Adapted from DaSilva and Trkman, 2014)

More recently, some reviews of business model literature have been published, trying to have a more comprehensive review of the business model management studies. These studies have gradually identified the components and common themes of business model studies (Zott et al., 2011; Foss and Saebi, 2017; Wirtz et al., 2016). Following Zott et al. (2011)'s classification, the business model can be considered a unit of analysis, a holistic view of how companies do businesses as a part of its ecosystem. The business model can also be seen as simplified descriptions of scale models to identify the similarities between firms (Baden-Fuller and Morgan, 2010). Furthermore, the business model of a firm can describe the firm's boundary-spanning transactions with different stakeholders, such as customers and suppliers (Brettel et al., 2012). From a more abstract view, the business model framework includes three basic categories: value propositions, value creation and delivery, and value capture (Richardson, 2008; Hamwi et al., 2021):

> *Value proposition*: describes what the firm will deliver to its customers, why they will be willing to pay for it, and the firm's basic approach to competitive advantage, the focus is on customer segments and needs.

Value creation and delivery system: describes how the firm will create and deliver value to its customers, the focus is on key stakeholder roles (e.g., suppliers, partners, key activities, and resources).

Value capture: describes how the firm generates revenue and profit, such as revenue sources and the economics of the business.

While a business model describes the “design or architecture of the value creation, delivery and capture mechanisms” (Teece, 2010, p. 172), business model innovation considers “designed, novel, non-trivial changes to the key elements of a firm’s business model and/or the architecture linking these elements” (Foss and Saebi, 2017, p. 201).Thus, business model innovation provides firms with opportunities to identify new sources of value creation based on the interactions between the different components of a business model, such as value proposition, value network (i.e. value creation and delivery system), and revenue/cost model (i.e. value capture) (Bohnsack et al., 2014).

It is crucial to have a strategic view of the business model implementation to achieve commercial success, because a firm can have various business models to create value regarding different market segments (Shomali and Pinkse, 2016). Also, business strategy and technological innovation races are equally important in fostering technological innovation diffusion. An example is a competition between Boeing and Douglas in the 1950s (Slayton and Spinardi, 2016). Technological innovations have received much more attention, especially in the ‘technologically progressive society’ (Teece, 2010). However, Teece suggests that if the company wants to capture value through technological innovations, a suitable business model needs to be coordinated to reach its goal. Other scholars present how an organisation innovates its business model through learning, which gives the business model a dynamic perspective. For example, the ‘trial-and-error learning’ process can explain how entrepreneurs’ psychological and emotional characters can influence business model innovation, rather than only taking the company’s externalities and environmental contingencies into consideration (Sosna et al., 2010).

Regarding the degrees of business model innovation (BMI), Mitchell and Coles (2003) propose four types of business models: improvement, catch-up, replacement, and actual innovation. Furthermore, established firms can receive positive feedback when they innovate their business models. Thus, Foss and Saebi (2017) categorise four main research themes in the past decade’s BMI studies: 1) conceptualising BMI; 2) BMI as an organisational change process (Roome and Louche, 2016); 3) BMI as an outcome; 4) consequences of BMI. They also highlight that the concept of BMI has been translated into different research disciplines, such as sustainable business models.

2.3.1.1 Sustainable business model

Boons and Lüdeke-Freund (2013) make a systematic review of the interrelationship between business models and sustainable innovations, trying to determine the factors that make sustainable innovations more successful. As a result, four key elements have been identified to constitute a generic business model, including value proposition, supply chain, customer interface, and financial model. Also, they highlight that both social and economic profits are crucial for large companies to participate in sustainable entrepreneurship. Moreover, the value proposition creates a strong-tie between companies and their customers. The tie should be built upon a ‘triple bottom line’: the balance between economic, social, and ecological value (Boons et al., 2013). Furthermore, several archetypes of sustainable business models have been identified based on categorising technological, social, and organisational orientated innovations (Bocken et al., 2014). Based on the previous literature on sustainable business models, (Schaltegger et al., 2016) define a sustainable business model:

> “A business model for sustainability helps describing, analysing, managing, and communicating (i) a company’s sustainable value proposition to its customers, and all other stakeholders, (ii) how it creates and delivers this value, (iii) and how it captures economic value while maintaining or regenerating natural, social, and economic capital beyond its organisational boundaries.” (p. 4)

Other research themes, for example, BMI and sustainability strategy (Schaltegger et al. 2012), the architecture of sustainable business model (Wells, 2013; Wells, 2016), and sustainable BMI tools (Bocken et al. 2013), also contribute to a comprehensive understanding of sustainable BMI in various research fields. Besides, a clear difference between market incumbents and market start-ups has been investigated in the sustainable entrepreneurship literature. A well-cited paper subscribes incumbents as “greening Goliaths” and new entrants as “emerging Davids”, and the coevolution relationship of these actors consequently leads to the sustainable transformation in the industry (Hockerts and Wüstenhagen, 2010). On the other hand, both market incumbents and new entrants can innovate and evolve their business model through different sustainability strategies to reach sustainable transformation (Schaltegger et al., 2012; Schaltegger et al., 2016).

2.3.2 Socio-technical transitions and business model theory

There have been some efforts to introduce a business perspective in earlier transitions studies. For example, despite a high priority of simulation modelling in supply chain studies, strategic niche management (SNM) has been applied in supply chain management. By introducing the concepts of learning processes, networking, and expectation, the whole supply chain will benefit from the alignment of knowledge flows (Caniëls and Romijn, 2008). Transition management (TM) has been introduced at the early stage of transition experiments and helps the government manage the direction of sustainable technology penetration. Also, transition management can be served in a business environment to help companies break through the current lock-in and create new business models (Loorbach et al., 2010; Loorbach and Wijsman, 2013). However, previous studies show that these approaches are not easily implemented, and it is better to adopt them as a 'shadow track' in parallel with the common practice.

Marletto (2014) has positioned automotive manufacturers in socio-technical systems based on their business models and propulsion technologies, showing innovation strategies have the power to influence related transition pathways. Also, Sushandoyo and Magnusson (2014) suggest new technologies have to be prepared for both niche and mass market because this could avoid the bias towards the specific technology development in demonstration projects. The research also challenges the perception of 'regime actors' as a transition resistance because incumbent actors may have various roles at both regime and niche levels. Therefore, further investigation of firms' innovation strategies is needed. For example, Berggren et al. (2015) have also found that established automotive manufacturers may rely on their different innovation strategies in socio-technical transitions.

Therefore, transitions scholars have started to explore the business model's role in socio-technical transitions, which shows that a firm-level perspective has attracted more attention in transitions studies (Huijben and Verbong, 2013; Marletto, 2014; Bidmon and Knab, 2018). As suggested by Markard et al. (2012), the strategies of firms should be considered to understand the interplay between different firms. That is to say, transitions studies have been successfully implemented in various research fields but left some space for discussion from a firm-level perspective.

Geels (2011) suggests that the business model concept can be introduced in niche learning processes or broader socio-technical systems (Köhler et al., 2019). Furthermore, the three roles of business models in transitions studies have been identified by Bidmon and Knab (2018):

1) A device to commercialise technological niche innovation (Wainstein and Bumpus, 2016; Wells, 2016).
2) A generic way of creating and capturing value. A barrier to transitions (Wells and Nieuwenhuis, 2012).
3) A non-technological niche innovation (Gorissen et al., 2016; Schaltegger et al., 2012; Bolton and Hannon, 2016).

Huijben and Berbong (2013) have explored three main business model experiments in the Netherlands and examined how PV business models are developed through inter- or intra-organisational learning. The research has also found that market incumbent players participate in this PV development through this business model learning. Moreover, political, economic, social, and technical factors need to be considered to make successful business model innovations in energy system transitions. Therefore, companies from both market incumbents and new entrants can commercialise new technologies with the application of new business models (Bolton and Hannon, 2016). Another example is the electric vehicle business model innovation in China. The new business model has introduced the intermediary players to their value chain and thus reduces the dependency on government incentives in EV promotion (Li et al., 2016).

As discussed above, transitions studies have shifted from making little attempt to explore the role of firms in socio-technical transitions to understand better how firms adapt their innovation strategies to fit socio-technical changes (Van Waes et al.,2018; Bidmon and Knab, 2018). However, Sarasini and Linder (2018) argue that it is problematic to examine the role of business models and the dynamics of BMI in broader socio-technical systems by using existing transition theories. There are two reasons: 1) the lack of a firm-level perspective in transition theories; 2) BMI is considered a complement to traditional classes of product/process innovations (Zott et al., 2011; Wirtz et al., 2016).

2.3.3 Innovation strategy: the choice between business model innovation and technological innovation

This section's focus is on how firms choose and develop their innovation strategies. For example, automotive companies will face a dilemma in commercialising their new technologies: creating new business models for the technological transformation or adopting new technologies without a fundamental change in their business models (Wells and Nieuwenhuis, 2012). Better Place's electric vehicles leasing solution represents an innovative business model with product-service systems. Its solution inevitably challenges the current electric vehicle ownership and the automotive industry, leading to a significant competitive advantage (Christensen et al., 2012). It is arguably easier for new entrants who are not constrained by established practices to implement. However, the strategy is more likely to provoke a defensive response from market incumbents and then increase the chance of failure (Sovacool et al., 2017).

Another crucial factor for companies to innovate their business model is disruptive technologies (Bower and Christensen, 1995; Chesbrough, 2010). Thus, companies would be required to respond to technological breakthroughs. Shomali and Pinkse (2016) have found that when the electricity industry faces the 'smart grid' opportunity, they both see opportunity and reluctance to deploy this new business model. Because once they start to combine their current business models with smart grid technology, they would run the risk of reducing electricity usage and competing with new entrants with market uncertainty. Another example is when truck manufacturers face the potential technology shift (e.g., new powertrain technology), they will run the risk of dealing with their outmoded business models in the future if they continue their technological innovation strategies. However, if they adopt business model innovation strategies, the value creation process will be ambiguous, which is considered a dilemma to stay competitive in the market (Tongur and Engwall 2014).

As market incumbents will confront the 'trade-offs' when disruptive technologies are introduced to the market, technologies alone cannot significantly change the industry logic if they are relatively immature. Thus, business model innovation would postpone the disruptive technologies until they reach significant scale diffusion and maturity (Hall and Roelich, 2016). When diversified entrants from other industries enter the market with their successful business model, the current business value chain will be challenged and reshaped to fit into the new business patterns. For instance, the IT and diagnostics industries represent a shift from the product-centric approach to servitisation in the emerging technology-centric drug industry (Sabatier et al., 2012). Another example is 3D printing technologies, and there are roughly four stages of these technologies: rapid prototyping, rapid tolling, direct manufacturing, and home fabrication. The first two stages are considered to have a relatively low impact on business model innovations. However, the latter two could represent a disruptive potential because the latter technological trend could enable companies to move flexibly (upstream or downstream) in their value chains (Rayna and Striukova, 2016).

Business models also contribute to the alignment between technological innovations and the pathway that leads to commercialisation by adjusting firms' technology design and their value proposition (Lehoux et al., 2014). Still, in these 'trade-offs', entrepreneurial firms bring the novel business model in the market because they are less dependent on the existing infrastructure and value networks when facing technology discontinuity. Therefore, they can only refer to the experience from adjacent industries. Sometimes the consequence of these business model innovations is "uneven". Bohnsasck et al. (2014) have found that during the adoption of sustainable technologies (such as electric vehicles), the market incumbents' business models are more resilient because the adjustment in their current business model may result in a marginal effect. For example, the EV ventures are even continuing after General Motors and Chrysler bankrupt.

2.3.4.1 Patterns of innovation strategies

The previous section has introduced the choice between technology development and business model innovation to develop different innovation strategies (Pisano, 2015). Early transitions studies emphasise product innovations, and the focus is on the functionality (use context) and design (technical form). Transitions usually start with a closer distance to the existing socio-technical regime. This development gradually leads to the new technical form and user experience, thereby creating a new socio-technical regime. It is called the "fit-stretch pattern" (Figure 2.4).

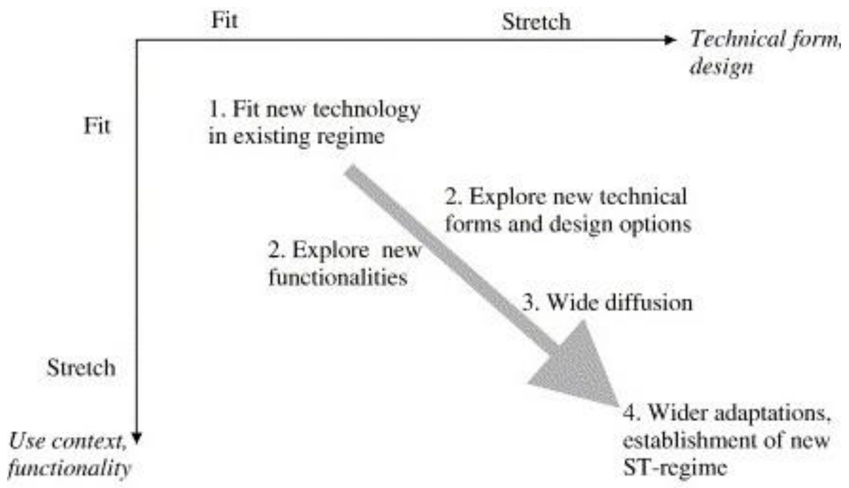

Figure 2. 4 Fit-stretch pattern in the co-evolution of form and function (adapted from Geels 2005)

Similarly, an investigation in design-driven innovation shows how firms manage their innovation proactively without considering users' insights. A meta-model of design-driven innovation is introduced to understand better innovation strategies (Figure 2.5) (Verganti 2008). Verganti highlights three actions of innovation: 1) "design-driven innovation" describes the value-adding process through enduing new meanings and languages to the products, which will lead to the changes in socio-cultural regimes; 2) "market pull innovation" represents a user-centric approach which analyses the user's demand and needs, it is embedded in the current socio-cultural regimes; 3) "technology-push innovation" means technological innovation is always associated with its socio-cultural regimes in the long terms, in other words, it is also a capacity-push process.

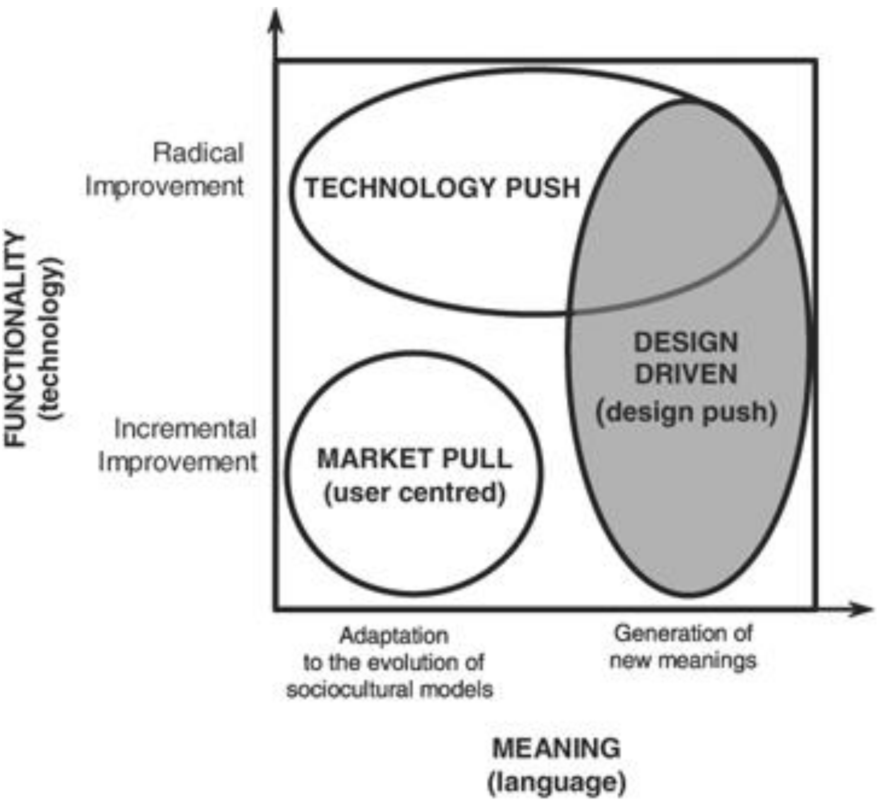

Figure 2. 5 Innovation strategies: from a design-driven perspective (Adapted from Verganti 2008)

As discussed earlier, there is a clear distinction between business model and business strategy. For instance, business models focus on value creation-value capture processes, and business strategy represents how to reach a competitive edge among firms' competitors. However, these two terms are often intertwined with each other (DaSilva and Trkman, 2014). In terms of the competitive advantage, business model innovation could help companies move towards a new business space where a traditional competitor cannot reach. Choosing suitable innovation strategies can help companies avoid mistakes and make a better decision when facing the trade-off. Furthermore, the established firms may have other options when facing socio-technical changes, such as implementing routine improvements or solely relying on technological innovations. Hence, innovation strategies can be categorised by the degree of change in companies' technological capacity and the degree of change in their business models. Moreover, just as companies may have several business strategies to gain competitive advantage, they can also employ various innovation strategies to align their innovation efforts with their business strategies (Bohnsack et al., 2014; Pisano, 2015).

Figure 2.6 positions possible innovation strategies with four quadrants and addresses the interrelationship between technology and business model innovation (Wells, 2013; Pisano, 2015). The “business as usual” or “routine innovation” quadrant represents companies’ innovation strategy is based on their existing technological competencies their current business models. It could help companies profit from incremental improvement in their business processes. The second quadrant is “disruptive innovation”, which could help companies compete differently in the market. Companies try to gain competitive advantages through business model innovation without the fundamental change in their existing technological capability. “Radical innovation” represents a purely technological change to make companies compete better in the market. This quadrant can be found in most of the knowledge-intensive industries, in which product or process innovations can help companies gain a competitive edge. The last quadrant combines technological and business model innovations called “architectural innovation”. It is the most difficult innovation strategy for incumbent companies to apply. However, companies will reach a position as “beyond competition” with the successful application, and no competitors could threaten them in the short term.

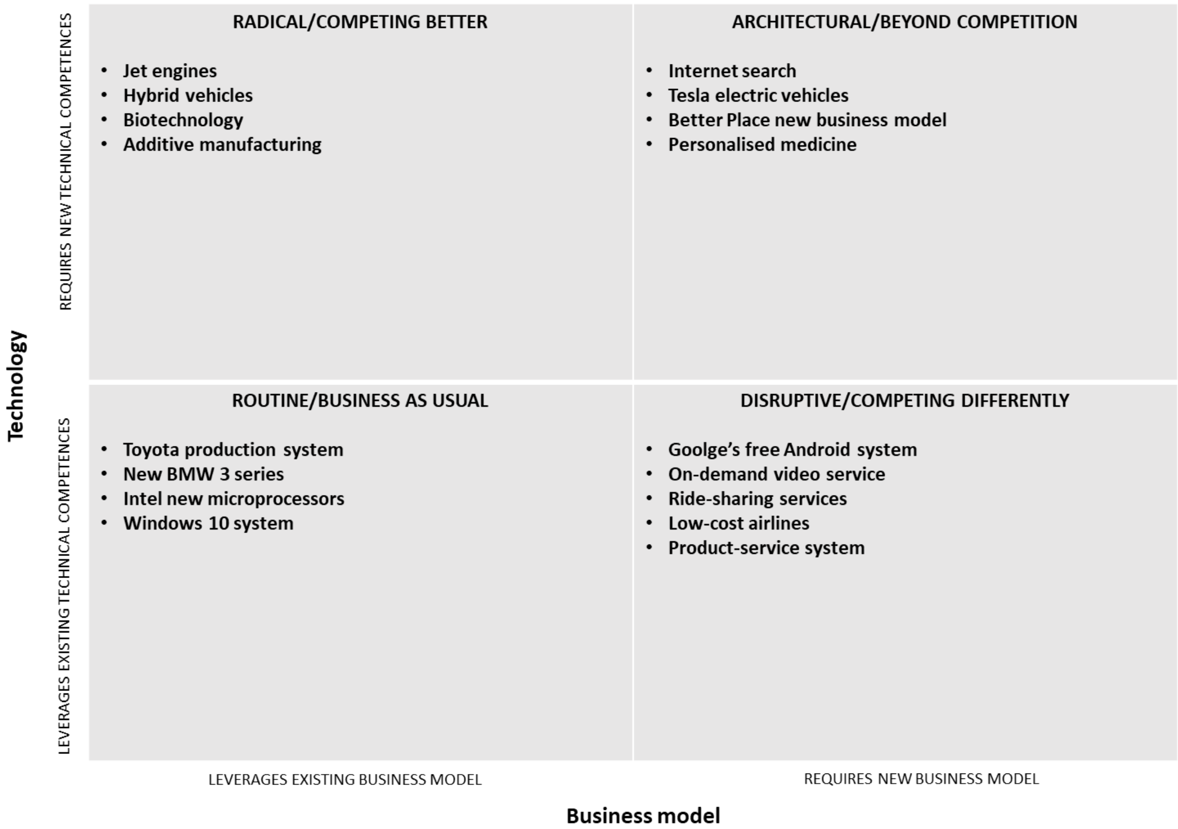

Figure 2. 6 Four innovation strategies (Adapted from Wells, 2013; Pisano, 2015)

The typologies mentioned above have been adopted to understand how companies try to pursue different innovation strategies. The view of business models helps researchers build an understanding of the relationship between business models and their technology choices (Wells, 2013; Pisano, 2015). However, these approaches are relatively static and less helpful to identify how business model evolution occurs (Demil and Lecocq, 2010). Accordingly, there is a growing literature attempts to understand how business models evolve to achieve long-term competitiveness (Bohnsack et al., 2014). According to Skålén et al. (2015), technologies can be considered potentially useful knowledge, which must be integrated into practices to develop value propositions. There are four types of service innovations:

1. Adaptation: integration of existing resources and existing practices.

2. Resource-based innovation: new resources are integrated into existing practices.

3. Practice-based innovation: new practices are integrated into existing resources.

4. Combinative innovation: integration of new resources and new practices.

Skålén et al. (2015)'s typology identifies innovation types 1-3 as incremental innovation, and type 4 can be considered radical. Importantly, this typology adds a precise definition of radical innovations, defining radical service innovation as "the extent to which a firm's new services differ drastically from current offerings and require major changes in the application of competences" (Ordanini and Parasuraman, 2011, p. 10). However, it should be noted that some non-radical and less tangible improvements such as continuous improvements (also called process improvements) can also be included in incremental innovations (Cole and Matsumiya, 2007; Audretsch et al., 2011). Therefore, according to Escrig-Tena et al. (2021, p. 2), incremental innovation can "refine the potential of products/services (e.g., adding some features to existing products/services) and draw upon leveraged existing knowledge and experience".

2.4 Logistics innovations and transitions studies

Over the past decade, limited attention has paid to investigate freight transport and logistics services in the sustainability transitions literature because there has been a tight connection between sustainable product innovations and transitions studies (Sarasini and Linder, 2018; Bidmon and Knab, 2018). Thus, these sustainable products can be easily linked to the production and consumption pattern of socio-technical systems, and transport in the transition literature has often focused on the private/public transport sector to promote sustainable transport modes, such as alternative fuel vehicles, car sharing practices, and road infrastructure (Geels, 2012; Whitmarsh, 2012). However, logistics services have received much less attention than it deserves because they act as an interface between production and consumption systems and play a crucial role in socio-technical transitions (Geels et al., 2015). To date, only a few transitions studies have looked specifically at the logistics industry, although the early research on the MLP is based on land transport and shipping (Geels, 2002; 2005a).

Consequently, only a handful transitions studies have investigated in the context of logistics. For example, shipping relies heavily on fossil fuels and needs to improve sustainability, Mander (2017) focuses on two technological innovations – slow steaming and wind propulsion – to seek opportunity for reducing the emissions from shipping. Pettit et al. (2018) apply the MLP to evaluate sustainability challenges regarding the technological and operational eco-efficiency of shipping. In a similar manner, Damman and Steen (2021) investigate the zero-emission transformation among small-medium sized ports by using the MLP. Other studies focus on last-mile delivery in urban areas. For instance, Guo et al. (2019) explore the application of crowdsourced delivery to mitigate the issue of the last-mile city logistics. Fraske and Bienzeisler (2020) try to understand the transition towards smart sustainable cities by using city-logistics as an empirical lens. Since there is limited empirical evidence exploring the role of logistics innovation in transitions studies, the following sections will examine the nature of logistics innovation and try to find a link between these two research streams to answer research question 2:

RQ2: What is the role of logistics innovations in socio-technical transitions?

2.4.1 Types of logistics innovation

As a service industry, the definition of innovation can be considered an output of the whole innovation process, which leads to the improvement in “management practices, streamline organisational structures, customise service, enhance networking, improve distribution, advance procurement, and facilitate financing” (Chapman et al., 2003, p. 633). Concerning this ‘soft innovation’ nature, new technology can be considered a vehicle to activate or enhance service processes, leading to incremental innovations rather than radical ones (Buss and Wallenburg, 2011). The adoption of new technologies may enable logistics service providers to offer new service then gain a competitive advantage in the market. Thus, logistics companies adopt new technologies rather than generate them (Wagner, 2008; Grawe, 2009; Rajahonka and Bask, 2016). Also, a survey of UK service companies suggested that they focus more on incremental innovations than radical innovations (Oke, 2007). Research also shows proactive cost and performance improvements in LSPs positively impact customers' loyalty (Wallenburg 2009). In this thesis, we adopt Flint et al. (2005, p.114)'s view on logistics innovations:

> "By logistics innovation, we mean any logistics related service from the basic to the complex that is seen as new and helpful to a particular focal audience."

In terms of the logistics innovation literature, Grawe (2009) recommends that it would be beneficial to consider theoretical frameworks outside the scope of logistics innovation. For example, the knowledge-based view can be adopted because a firm's knowledge is key to sustain competitive advantage (Grawe et al., 2011); the dynamic capabilities framework can help examine the innovativeness of a logistics company; the exploration-exploitation framework can be seen as an alternative to the incremental – radical classification (Rajahonka and Bask, 2016); other suggested frameworks include the Schumpeterian innovation framework, the theory of S-curves, and network theory (Su et al., 2011; Björklund and Forslund, 2018). In addition, Busse and Wallenburg (2011) suggest that logistics innovations can be classified into three basic groups: 1) product/service – process innovations; 2) organisational/administrative – technological innovations; 3) incremental – radical innovations. Other scholars define logistics innovation in a similar manner, such as process, product/service offering, and network/relationship innovation (Rossi et al., 2013).

2.4.1.1 Product/service innovation

Product/service innovation happens where a new or improved service has been created. Given the nature of logistics services, Barras (1986) argues that innovation adoption in the service industry should mirror the theory of the product cycle. There are three stages of technology adoption in the service sector: 1) organisations take advantage of the existing technology to improve service efficiency; 2) technological innovation helps organisations to improve the quality of their services; 3) technology contributes to the transformation of existing services or creates new ones. Therefore, in logistics, new services are equivalent to new products in the manufacturing sector (Su et al., 2010). For example, Amazon's order-tracking feature reduces the cost by sharing information with the logistics company, allowing more customers to check their packages in a real-time manner (Zott and Amit, 2007). Furthermore, the increasing demand for last-mile delivery requires innovative delivery solutions in urban areas. The crowd-based logistics solution is based on the concept of “sharing economy”. Information technology plays an important role in enabling a platform to track and trace all users in real-time (Sampaio et al., 2019). By sharing transport loads, warehouse capacity, and workforce, the crowd-based solution opens the door to both start-ups and large firms in the logistics sector (Frehe et al., 2017; DHL, 2020). Moreover, the “click and collect” solution is designed as an alternative to home delivery, which includes two major types: automated locker points and service points. The click and collect solution has several benefits, including reducing travel distance and delivery costs, increasing delivery efficiency, and a point for returning orders (Milioti et al., 2020).

Arguably, technological innovations play a crucial role in providing new logistics services. According to Lin (2008), in addition to traditional transport and warehouse services, other services like materials management, information management, and value-added activities can also be considered logistics competitive edges. Therefore, technological innovations can be classified into four categories: 1) data acquisition technologies; 2) information technologies; 3) warehousing technologies; 4) transport technologies. It argues that ICT remains the most important technological factor that gives LSPs competitive advantage (Sauvage, 2003; Russell and Hoag, 2004; Goldsby and Zinn, 2016; Koc and Bozdag, 2017).

Other technologies like 3D printing, autonomous vehicles, and unmanned aerial vehicles (drones) will substantially impact the logistics industry (Birtchnell and Urry, 2013). According to Ryan et al. (2017), several implications could be drawn by introducing 3D printing as manufacturing technology, such as its effects on transport costs, lead times, inventory, product quality and reliability, production flexibility, productivity and economies of scale, supply chain sustainability, new business models and opportunities for new suppliers. 3D printers could be installed in a van or container to move manufacturing processes closer to final consumers. So, the firm that adopts 3D printing technologies can provide a distributed manufacturing solution as an additional value-adding service (Birtchnell and Urry 2013). Due to safety, regulatory, and social acceptance concerns, new delivery options such as autonomous vehicles and drones will take some time before the application in all circumstances (Winkelhaus et al., 2020). However, the COVID-19 pandemic could accelerate adopting these technologies due to a high risk of face-to-face contracts during the pandemic (Kim et al., 2021).

2.4.1.2 Process innovation

Process innovation, on the other hand, focuses on a newly developed or improved service that can help to reduce the cost of providing a service or improve the quality of a service (Wagner, 2008). As discussed in the previous sections, logistics innovations usually focus on the market-pull dynamic: a customer-centric approach with incremental improvements to increase operational efficiency (Tokman and Beitelspacher, 2011). For example, LSPs are more willing to provide subcontracting solutions and add value through their logistical processes rather than increasing their technological capacities (Sauvage, 2003; Oke, 2008; Busse and Wallenburg, 2014). In other words, LSPs prefer to adopt technology, deepen their knowledge, and provide new solutions rather than develop new technologies with R&D activities (Busse and Wallenburg 2011).

There has been growing evidence that some leading logistics service providers have changed their innovation strategies from adopting innovations to implementing innovations with other stakeholders (Christopher and Ryals, 2014). Flint et al. (2005) developed a framework to better understand the logistics innovation process. Three environmental factors and five organisational factors have been identified by Grawe (2009) to investigate the process of logistics innovation diffusion. Although customers have been expecting innovative solutions, logistics innovations are mainly driven by LSP's customers. However, more recent studies have explored the opportunity that LSPs can stay competitive. For example, knowledge management can help logistics services improve operation efficiency and learning processes can be created to influence firm innovativeness (Busse and Wallenburg, 2011; Ramírez, 2012). Also, Cichosz et al. (2020) identified five barriers and eight success factors for LSPs to adapt to digital transformation. Also, LSPs can take knowledge co-producer roles as they constantly interact with customers during the innovation process (Pedrosa et al., 2015). The above studies outline that research attention has shifted from focusing on value-adding activities to proactively manage the innovation processes in supply chains (Lusch, 2011).

The Internet of Tings (IoT) is believed to change the logistics industry and the entire logistics value chain (Yu et al., 2015). Logistics services like warehouse management, freight transport, and last-mile delivery will benefit from applying IoT technologies (Hopkins and Hawking, 2018). The term IoT describes physical products being connected to the internet, and the term is closely linked with information technologies like RFID, sensors, and the cloud. For example, Sheffi (2004) sheds light on RFID technology and anticipate its potential to bring structural changes to warehousing systems, manufacturing processes, and the interaction between LSPs and customers. Therefore, the logistics industry will be one of the major sectors that benefit from the alignment of information and material flows to improve operation efficiency (Ben-Daya et al., 2019).

Robotics and automation have a profound impact on warehousing and delivery operations. Growth in e-commerce is changing customer expectations for on-time and efficient services, leading to a change in warehouse design and warehousing technologies (Bogue, 2016). Therefore, warehouse and distribution centres have been the pioneers of new technologies (Yavas and Ozkan-Ozen, 2020). According to McKinsey & Company (2019), Warehouse automation technologies can be categorised into two groups: 1) devices that can help the movement of goods, including automated guided vehicles (AGV), swarm robotics, and automated storage/retrieval systems; 2) devices that improve goods handling such as robotic arms with sensors.

2.4.1.3 Network/relationship innovation

According to Rossi et al. (2013), beside classical *product/service* and *process* innovations, *network/relationship innovation* offers new ways of collaboration across company boundaries, and it is becoming crucial for a company to be successful in the knowledge-based economy. Logistic services are an extension of physical distribution and works as a connection between business and customers regarding material and information flow (Chapman et al. 2003). Over the past decade, logistics service has evolved from a passive and cost-reduction role to a more sophisticated service by which companies gain a competitive advantage (Busse and Wallenburg, 2011; Pedrosa et al. 2015).

Followed by an innovation process management's view, Flint et al. (2005) have explored the nature of logistics innovations: a customer value-oriented social process, as shown in Figure 2.7. The innovation process starts with creating an interactive environment in a company because it is mainly driven by customer demand, followed by the process of reflexivity and finally accomplished by inter-organisational learning from other companies and customer organisations.

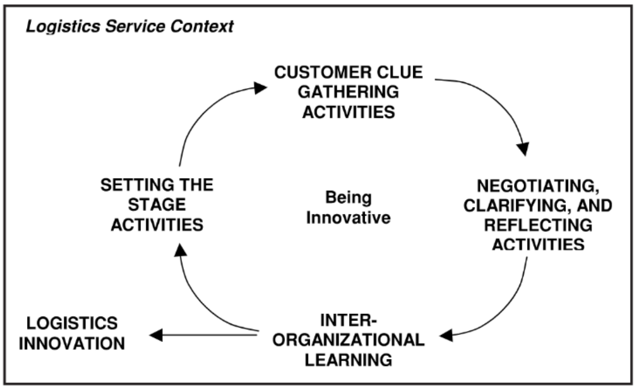

Figure 2. 7 A logistics innovation process (adapted from Flint et al., 2005)

Accordingly, several innovation activities have been identified by Wagner (2008) based on the investigation of the German transport industry. Innovation activities are categorised as the input of logistics innovation management, including internal/external research and development, investment in infrastructure and capital goods, acquisition of knowledge, and training and further education. This research has also pointed out the importance of factors like macroeconomy, technological advancements, and industry life cycle that could influence firms' innovation activities. Previous logistics innovation research has identified logistics innovations as a final output. Therefore, understanding more about innovation activities from the input side could help us know who brings innovation into logistics services, how they are selected, and gradually reach the main research question of how these innovations emerged in the logistics context (Busse and Wallenburg, 2011). Tanskanen et al. (2015) have found the same innovation activities in the construction supply chain, which have been conducted at the early stage and will repeat through the innovation project.

The learning process is an essential factor for logistics innovations, which enables high-quality logistics service delivery. Because "logistics is one of the only areas in the firm that interacts with both upstream and downstream supply chain exchange partners" (Esper et al. 2007, p. 66). The strategic edge enables logistics companies to maintain their competitive advantage by the service delivered to their clients. A highly integrative relationship between logistics companies and their customers is crucial for innovation processes, which could lead to new logistics innovations (Pedrosa et al., 2015). Besides technological innovations, business model innovation can be learnt through individual or organisational learning processes (Sosna, 2010). For example, DHL helps its clients adopt sustainable business models to improve their current business process by experience gained from DHL's practices (DHL, 2010).

According to the final suggestion of Flint et al. (2005, p. 139), there is a component of logistics innovations that needs to be investigated deeply: "if logistics innovation is seen as a social process, what aspects of social interaction and relationships impinge upon the innovation process?" The social interactions in logistics innovation processes have attracted less attention, and Su et al. (2011) recommend deliberate management to facilitate the interactions. The learning process has also been approved by Panayides (2007) because inter-organisational learning can improve service effectiveness and firm performance. It could also help create customers' value by responding to customers' needs. Also, logistics innovations have a highly integrative manner, which could extend the LSPs' own research capacities, leading to innovations that new to logistics firms and even new to the logistics industry (Wang et al., 2019b). Therefore, customers are considered the most important resource for joint innovation projects, which can help firms in the logistics industry become more innovative and obtain sustainable competitive advantages (Wagner and Sutter, 2012). From a micro view, Pedrosa et al. (2015) use boundary-spanning employees as a lens to investigate individual's behaviours in service innovation development, and BSEs can identify the current and future needs of the customer.

2.4.2 Innovation strategies, logistics strategies, and logistics trends

The previous section presents different types of logistics innovations and general innovation processes in the relevant literature. There is a need for companies to select between different ideas (i.e., innovation projects) during the innovation journey, which also means that challenges can be found in how to allocate decision to fulfil a company's strategy (Storey et al., 2015). However, as pointed by Björklund and Forslund (2018, p. 206): "this challenge is not found in logistics innovation literature" because logistics service companies can grow without innovating in the short-term (Busse and Wallenburg, 2011). As a result, a comprehensive investigation of logistics innovation strategies has received less attention. Compared to innovation studies in other industries, the differentiation between types of innovation strategies seems less critical for the logistics industry (Wagner, 2008; Grawe, 2009). Thus, the topic of innovation strategies remains a gap in the logistics innovation literature. It should be noted that innovation strategies are of crucial importance to reach long-term success. As concluded in Section 2.4, innovation strategy is "generally understood to describe an organisation's innovation posture with regard to its competitive environment in terms of its new product and market development plans" (Adams et al., 2006, p. 30). Innovation strategy has arguably been strategic in orientation, which means logistics service companies need to take a few specific factors into account (Busse and Wallenburg, 2011). As a result, one of the aims of the thesis is to fill this gap in the logistics innovation and transitions literature by adding empirical evidence. Thus, research question 4 asks:

> *RQ4: How firms' innovation activities contribute to the transitions of the logistics industry?*

As discussed above, the strategic orientation of innovation strategies needs to reflect a number of specifical factors in its competitive environment, leading to the formation of logistics strategies. According to the European Commission (2015)'s definition, logistics strategies are:

> "Companies react to the external factors with relevant logistics strategies. As external factors are continuously changing, logistics strategies also have to continuously develop. Logistics strategies can be considered as a procedure, activity field or change of intensity, which is a business reaction to the development of one or more external factors." (p. 45)

Logistics strategies are adopted by companies to solve some specific problems in the short-term, but some specific strategies would show their effectiveness and then will be widely adopted by the logistics sector. Therefore, these trends collaboratively determine the future of the sector. Here in this section, these trends are defined as logistics trends:

> "A logistic strategy that is used permanently and widely by the logistics sector is termed as a logistic trend." (p. 45)

Tang and Veelenturf (2019) introduced three logistics strategies that help companies to position themselves and to create economic, environmental, and social value in the Industry 4.0 era: 1) a competitive lever, companies adopt Industry 4.0 technologies to transform logistics activities from cost centres to competitive edges; 2) a social value creator, industry 4.0 technologies can serve as an intermediary for the creation social value; 3) an enabler for sustainability, companies and government can apply Industry 4.0 technologies to facilitate the transition towards sustainability. In the following subsection, logistics trends are summarised from both social and technological aspects (Table 2.1). These trends are identified by using various sources such as DHL Trend Research (DHL, 2012; DHL, 2020), PwC Future study (PwC, 2016), and academic research under the topic of Industry 4.0 and its application in the logistics sector (Paprocki, 2017; Tang and Veelenturf, 2019; Winkelhaus and Grosse, 2020). At last, these trends are examined according to the logistics strategies that have been identified above to provide an empirical context of the following chapters.

Logistics strategy	Logistics trend
Transform logistics as a competitive advantage	Platform-based business models
	Complex competition in logistics services
	IoT and data-driven logistics
Logistics as a social value enabler	New work patterns
	Co-creation of social value
An enabler for sustainability	Decarbonisation of the logistics sector
	Enabling a circular economy

Table 2. 1 Logistics strategies and logistics trends in the logistics sector (Developed by the author, based on Tang and Veelenturf, 2019 and DHL, 2020)

2.4.2.1 Transform logistics as a competitive advantage

(1) Platform-based business models: e-commerce is the main factor that drives this trend since companies can implement transactions digitally regarding the product, service, and information exchanges (Ordanini and Pol, 2001; Wang et al., 2011). As a result, a company can play an intermediary role between shipper demand and carrier supply by adopting digital platforms. This concept is not new to the logistics industry. However, the success of consumer-facing logistics platforms (e.g., Uber and Deliveroo) has accelerated the rise of platform-based business models in the logistics industry (Choudary et al., 2019).

This trend will leave space for start-up companies and other new entrants who can offer digital brokerage services and create a digital marketplace for managing shipment visibility, customs document, and other value-added activities (PwC, 2016). According to the DHL Trend Research, logistics e-marketplaces' focus is mainly on three market segments: freight forwarding, warehousing and last-mile delivery (DHL, 2020). In 2016, the European road freight market was about €314,350 million in size and expected to grow at a growth rate of

3.0% to €353,770 million (Transport Intelligence, 2017). According to Eurostat (2019), there was an increase in the demand for road transport activities carried out over distances between 50 km and 1,999 km. More specifically, the highest growth was recorded in the category “from 300 to 499 km”. Therefore, the rapid growth in demand for cross-border delivery provides opportunities for digitalising full truckload (FTL) or less-than-truckload (LTL) freight services as digital platforms provide transparent price, real-time quoting, and empty ride reduction.

Digitalisation and automation are also offering flexible and on-demand warehousing management solutions, such as warehousing marketplaces. This trend can be enhanced by adopting new technologies such as robots and automated storage systems that improve warehouse utilisation and inventory flow (Savills, 2017). On the other hand, the e-marketplace of last-mile delivery requires data accessed from different partners and real-time information sharing in concerned in terms of data security issues. However, blockchain-backed services may offer a transparent solution to facilitate the collaboration (Wang et al., 2019a). For example, TradeLens is a blockchain-backed platform under the joint development between IBM and Maersk. The platform aims to provide transparent trade by sharing trusted information in the supply chain (Jensen et al., 2019). This collaboration also enhances the traditional LSP’s ability to leverage platform-based business models.

Recent developments in e-marketplaces include a company called Flexport has created a user-friendly platform in-house, which helps customers to book with carriers and to contract with local forwarders at the same time. This digital business model provides great data transparency to customers, reducing cost because of less traditional email and phone communications (Premcak, 2019). Another example is a British start-up named Beacon – a company that provides a digital platform for customers to view shipping costs and prices to choose the most suitable routes for cargo (Campbell, 2020). The company also enters supply chain finance. For example, the company can make an up-front payment for customers because sea transport often takes a more extended period (more than one month), which leaves shippers with immediate cash demands.

(2) Complex competition in logistics services: on the one hand, this trend is partially led by online retailers because fast and punctual delivery services have become the key factor in differentiating themselves in homogeneous markets. Thus, online retailers can reduce their dependency on external logistics providers to cut costs; more importantly, they can significantly increase their logistics efficiency by analysing customer data (Mason, 2019). Furthermore, by using advanced warehousing solutions such as advanced robotics, automation technologies, and hardware-software integration, some high-tech companies have shifted their role from technology suppliers to new entrants in the European logistics sector. Ocado – the UK-based world's largest dedicated online grocery – has provided end-to-end e-commerce solution for their partners such as Morrisons, Marks & Spencer, and Aeon (Zissis et al., 2018). Moreover, 5G technology could reduce safety concerns about warehouse robots and significantly increase the coordination between robots, which would make the automation fulfilment solution more difficult for competitors to follow (Park et al., 2021).

On the other hand, technological innovations such as 3D printing technology and its related applications have pushed this competition. 3D printing or additive manufacturing (AM) is believed to be one of the most disruptive technologies in the mid-future because it has the potential to relocate manufacturing processes to the place near the end-user (Kapetaniou et al., 2018). In other words, the application of 3D printing by manufacturing companies will reduce transport demand (Sasson and Johnson, 2016). However, logistics service providers (LSPs) can reinvent their business models by developing 3D printing hubs, transforming traditional warehousing facilities, or coordinating 3D printing activities, potentially turning LSPs into competitors to some of their customers (PwC, 2016). Meanwhile, the COVID-19 pandemic has provided an opportunity to demonstrate how AM could be used by LSPs in the future, as traditional manufacturers could not cope with a spike in personal protective equipment (PPE) and ventilation machine demand (Kovács et al., 2021).

(3) IoT and data-driven logistics: this trend is primarily driven by the key factors that lie at the centre of logistics services: operation efficiency and service quality. As discussed in the previous sections, the application of ICT (Section 4.2.2.3) has been considered the most important technological factor that has shaped the current European logistics sector. In recent years, the costs and size of RFID sensors and other existing technologies are decreasing. Therefore, the internet of things (IoT) devices can contribute to the logistics sector in terms of their ability to increasing the visibility and real-time connectivity of logistics operations (Ben-Daya, 2017). Meanwhile, augmented reality (AR) can provide an interface to facilitate human integration in the IoT-based system, especially in 'smart factories', ports, and warehousing facilities (Harris et al., 2015; Egger and Masood, 2020).

Europe contributes to 23% of global IoT devices spending (about €663 billion in 2019), in which the single largest use is the transport and logistics sector (CBI, 2020). As logistics networks are becoming more complex, shipments may need to be completed via different transport modes. Inexpensive sensors help companies maintain the digital connection to transport goods and monitor transport location, temperature, light, and damage (DHL, 2020). In addition, IoT devices offer a new opportunity for manufacturing companies and physical stores to develop “smart shelves” by using devices with weight sensors or cameras. The smart shelves or workstations can implement timely replenishment because the notification will be sent by IoT devices before products run out of stock (Tang and Veelenturf, 2019). However, the logistics industry has high levels of fragmentation, which will require defined data exchange and communication standards to harmonise information across supply chains (Hofmann and Rüsch, 2017).

2.4.2.2 Logistics as a social value enabler

(1) Creating value from new work patterns: first, the future of work is influenced by the ageing society. As is discussed in the previous section (Section 4.2.2.4, social and cultural factors), the European transport and logistics sector will need a structural change to adapt to an ageing society. From a human resource perspective, elderly employees are becoming a prominent issue in the logistics sector. For example, a lack of skilled personnel can be detrimental to a company’s operation and administration. Several studies found that businesses have difficulty recruiting and retaining skilled staff in the European logistics sector (McKinnon et al., 2017). Robotic exoskeleton – together with its logistical application – has been tested in working condition such as assisting elderly workers with lifting and moving goods in Japan (Bogue, 2018). In addition, self-driving technologies (e.g., autonomous trucks and truck platooning) could help assist truck drivers by creating optimised routing and better working conditions and may also help solve the shortage of qualified truck drivers in the future (Anderhofstadt and Spinler, 2020). Moreover, the logistics industry will need to adapt to the rise of elderly consumers as the demand for wearable technology. Similarly, smart home solutions will be increasing in the upcoming years (DHL, 2020). Therefore, logistics companies need to incorporate these changes into new value-added logistics services by considering senior needs.

Second, there has been a significant increase in online retail services during the Covid-19 pandemic due to government restrictions and lockdowns. Therefore, last-mile delivery companies need to adapt to the pandemic and to provide contact-free services. This trend may also increase the social acceptance of autonomous delivery robot for home deliveries (Pani et al., 2020). Meanwhile, the pandemic has significantly increased the adoption of remote working technologies that have been existing for many years, accelerating the usage of online shopping and home delivery services (Brem et al., 2021).

(2) Co-creation of social value: a social trend that leads the shift from ownership to the usership of goods, assets, and services with the rise of digital platforms, under the broad theme of the 'sharing economy'. The sharing economy, such as Uber and Airbnb, has disrupted many traditional sectors. However, the application of the sharing economy concept has just begun in the logistics sector, and four types of shared logistics have been identified by Carbone et al. (2018):

- Peer-to-peer logistics: users exchange and operate logistics services by themselves.
- Business logistics: the platform organises and manages logistics exchanges between peers.
- Crowd logistics: a crowd of individuals execute logistics services that are assigned by the platform.
- Open logistics: users are free to design/organise/execute logistics services without using traditional supply chain networks.

Furthermore, customers are increasingly concerned about the quality of food/drug products after a series of European food industry scandals (Montecchi et al., 2019). Monitoring the operations across supply chains was considered time-consuming and costly, but blockchain technology can help improve provenance, especially in food/drug supply chains (Tang and Veelenturf, 2019). For example, by collaborating with IBM, Nestlé has applied blockchain technology for customers to track and check the quality of baby milk powder to build parent's trust in its brand (Aitken, 2017). In addition, blockchain and AI technologies can help track and trace every step of the supply chain, resulting in more ethical supply chain practices (Manski, 2017). For example, Volvo has jointed a responsible sourcing collaboration that aims to adopt blockchain technologies to audit battery mineral supply chains. The collaboration enables Volvo to establish a partnership with its suppliers whereby the company will increase the traceability and create an ethical supply chain across industries (Jaeger, 2019).

2.4.2.3 Logistics as a key sustainability enabler

(1) Moving towards a decarbonisation of the logistics sector: according to the European Green Deal, Europe aims to transform the Union into a competitive and sustainable economy, at which no net emissions of greenhouse gases will be generated by 2050 (EC, 2020a). The transport sector contributes a quarter of the EU's greenhouse gas emissions, and the European Green Deal seeks to cut 90% in transport-related emissions by 2050 (EC, 2019). Around 75% of the population lives in European urban areas, and more than 80% of freight movements are under 80 km (Melo and Baptista, 2017). In addition to electric vehicles, cargo cycles represent a zero-emission alternative in city centres (Schliwa et al., 2015; Strale, 2019). As for long-haul transport, battery-electric heavy-goods vehicles (HGVs) are not economically viable at the moment because the electrification of HGVs is a complex change and therefore needs to be part of the charging infrastructure development (Liimatainen et al., 2019). For example, Daimler Trucks is developing an ecosystem to support the adoption of battery-electric trucks, which is called the "eTruck Charing Initiative". The initiative brings different actors together to establish the charging infrastructure for battery-electric trucks, including customers, power grid operators, energy suppliers, changing hardware manufacturers and charging software providers (Daimler Trucks, 2020). Hydrogen is considered an alternative option to decarbonise the freight transport sector. However, according to Çabukoglu et al. (2019), there is still a need for significant investments to ensure sustainable hydrogen production and adequate refuelling availability.

(2) Enabling a circular economy: as part of the European Green Deal, the EC considered the circular economy as the way of enhancing the EU's industrial competitiveness as well as contributing to the dematerialisation of the European economy (EC, 2020b). Reverse logistics has been a major component of the circular economy because it enables a closed-loop between different actors across the supply chain (Guarnieri et al., 2020). Also, sustainable packaging has been considered an important aspect of the circular design strategy (Farooque et al., 2019). Furthermore, Industry 4.0 technologies will endow the logistics industry with more power which allows creating new business models by integrating all actors across the value chain. For instance, the use of additive manufacturing will lead to a decentralised production-distribution system, which will allow logistics companies to develop distributed manufacturing solutions with 3D printing and other advanced data analysis technologies (Liu et al., 2020). Thus, logistics activities will be able to transform conventional linear value chains to circular value chains by gradually closing the information gaps between manufacturers, distributors, consumers, and recyclers (Figure 2.8).

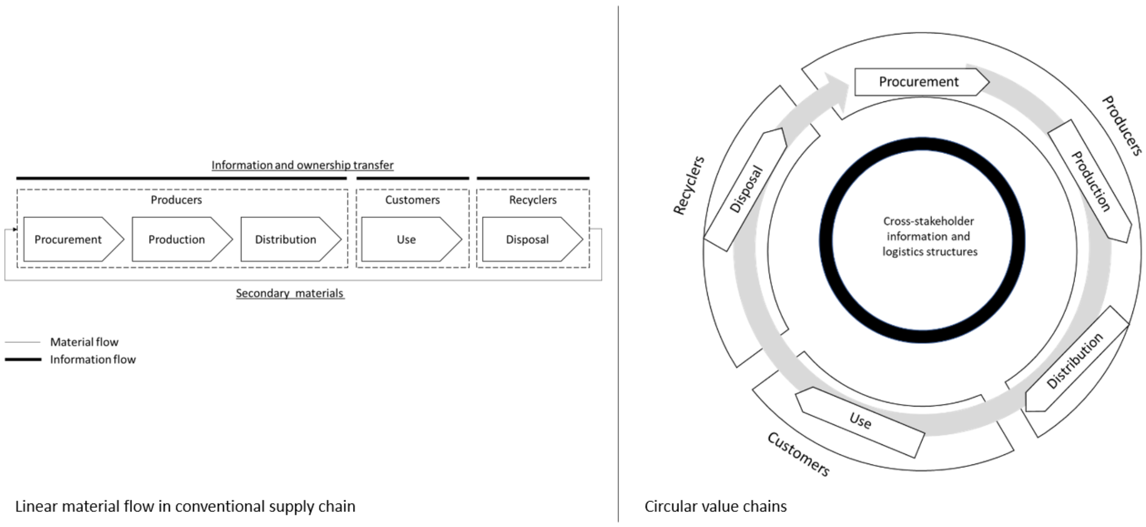

Figure 2. 8 Logistics transformation: towards a circular business model (adapted from Fraunhofer IML, 2018)

2.5 Socio-technical transitions from a firm-level perspective: a conceptual framework

Firms potentially contributes a critical role in such a transition from one socio-technical regime to another (Köhler et al., 2019), because firms may be highly involved in niche market (Smith and Raven, 2012) and bridging market development (Andersson and Jacobsson, 2000; Sushandoyo and Magnusson, 2014), as well as mass-market consolidation and destruction (Wells and Nieuwenhuis, 2012). Transition pathways thus can be (re)formed in terms of technologies, actors, and institutions. Institutional changes can thus emerge out of conflict and cooperation between incumbents and new entrants (Geels et al., 2016).

However, the dichotomy of incumbents and new entrants provides a limited understanding of the role of firms contributing to socio-technical changes by adopting different innovation strategies, as they can reorient themselves in terms of different organizational elements (e.g. routine operations, technical capabilities, beliefs and business models) (Geels et al., 2016). Thus, Berggren et al. (2015) have argued that incumbent firms could adopt technological innovation strategies to overcome 'creative destruction' (Abernathy and Clark, 1985): from incremental improvement, which contributes limited institutional changes to the existing regime; to more radical change, which contributes more substantial changes to the existing regime. With respect to the role of actors in transitions, firms may be rule followers or compliant actors at the regime level, and these shared rules and cognitive framings guide innovation activities towards some specific directions. Alternatively, shared rules and practices are less stable at the niche level, so firms do not necessarily follow the rules that lead to the reproductive pathways (Jørgensen, 2012). These arguments show that the regime actors may both operate in the regime and niche level as instruments of change, possibly in parallel to acting as a resistance factor to preserve stability and prevent changes. Therefore, such discussions lead us to investigate the main research question of this PhD thesis:

RQ1: What is the role of firms in socio-technical transitions in the logistics industry?

In previous transition studies, the conventional view on business models holds that firms create and deliver value to their customers (Osterwalder and Pigneur, 2010; Wirtz et al., 2016). Customers, including other stakeholders, are conceived as passive in the value creation process. Thus, the value creation process is assumed that value is created by firms and to be used in the market (Vargo and Lusch, 2004). The view is underpinned by a goods-dominant logic (G-D logic) which emphasises value is achieved through economic exchange (Vargo et al., 2015). However, Vargo and Lusch (2004; 2008) elaborate value creation activities on a service-dominant logic (S-D logic) to emphasise the importance of resource integration and value co-creation activities (Table 2.2). In particular, the five axioms of S-D logic have been developed by Vargo and Lusch (2016).

Axiom	Description
Axiom 1	Service is the fundamental basis of exchange
Axiom 2	Value is co-created by multiple actors, always including the beneficiary
Axiom 3	All social and economic actors are resource integrators
Axiom 4	Value is always uniquely and phenomenologically determined by the beneficiary
Axiom 5	Value co-creation is coordinated through actor-generated institutions and institutional arrangements

Table 2. 2 The axioms of S-D logic (Adapted from Vargo and Lusch, 2016)

Nudurupati et al. (2015) highlight the importance of viewing the S-D logic from two perspectives: resource integration and value co-creation. As far as resource integration activities are concerned, the main difference between S-D logic and G-D logic is viewing the basis for exchange as a service (Axiom 1), even when the exchange is underpinned by production of tangible goods. As for value co-creation, Axiom 2 argues that value is always co-created by multiple actors. This is following the S-D logic's perspective that there should be a balanced consideration of social and economic actors, which should be seen as resource integrators (Axiom 3). Importantly, S-D logic represents a departure from previous research that focus on value-adding and value-delivery activities to customers (Lusch and Nambisan, 2015). Furthermore, in S-D logic, value is only created when the service is accepted by its beneficiaries (e.g., customers) (Axiom 4). At last, Vargo et al. (2015) proposes an S-D logic, service ecosystems view on innovation, emphasising the importance of institutions in guiding resource integration and value creation activities across micro-, meso-, macro-levels of service ecosystems (Axiom 5).

Theorists who adopt the S-D logic perspective are not confined to the service industry alone but consider all economies are service economies. Here, service is defined as a process where one actor integrates resources to benefit another (Vargo and Lusch, 2008). These actors can integrate, apply, and exchange resources to provide a value proposition to other stakeholders. Value can only be created when a beneficiary accepts this value proposition in a certain social context. Thus, S-D logic proposes a perspective on innovation that is both applicable in the service and manufacturing sectors, and service innovation can be related to the creation and development of different value propositions (Skålén et al., 2015). Furthermore, Wieland et al. (2017) propose an S-D logic, service ecosystems view on business models, which emphasises that business models are dynamic processes among multiple actors' resource integration activities through to the market (Figure 2.9).

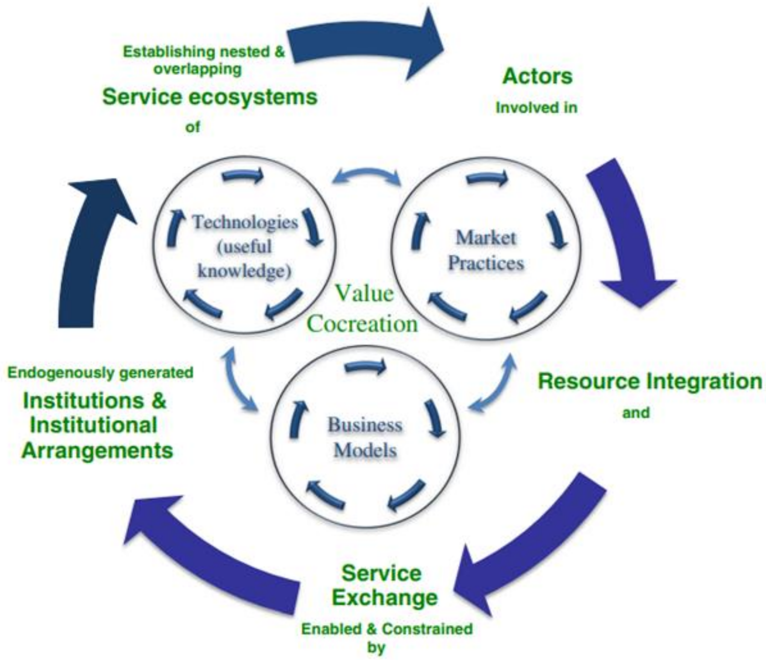

Figure 2. 9 The performative nature of markets, technologies, and business models (Adapted from Wieland et al., 2017).

Similarly, Tokman and Beitelspacher (2011) introduces the co-creation concept into logistics innovation studies, and logistics companies are encouraged to move from value-adding service providers to logistics service co-creators, reflecting a shift from the goods-dominant (G-D) logic to the S-D logic in supply chain management. From a service ecosystem perspective, processes such as that of innovation should be viewed as a set of collaborative efforts aiming to create and develop value propositions. This also requires a shift in focus to the nature of 'service' - that is, the integration of resources to benefit others in a service ecosystem (Frow et al., 2016). More specifically, the service innovation's focus is on the evolution of operant resources (e.g., useful knowledge and skills) that enhance value propositions (Skålén et al., 2015). S-D logic argues that there is no difference between service industry and manufacturing industry, and considers all economies are service economies (Vargo and Lusch, 2008). In addition, S-D logic views all economic actors are resource integrators (Vargo et al., 2014; Barrett et al., 2015). From this view, logistics innovation is defined by how firms can better create vaule propositions with customers rather than by what firms produce as output (Vargo and Lusch, 2008). Thus, this PhD thesis also seeks to answer research question 3:

RQ3: How are value propositions developed and evolved?

As a middle-range theory, the MLP could benefit from an integrated theoretical exploration (Geels, 2011). To this end, we elaborate on an S-D logic, service ecosystems view to examine the role of organisational actors (e.g., firms) in socio-technical systems. From this view, business models are:

> "… dynamic assemblages of institutions that not only shape the perceptions of useful knowledge (i.e., technologies) and other resources, but also the relationships with other actors through which these resources are integrated." (Wieland et al., 2017, p. 935)

Thus, technology can be conceptualised as potential useful knowledge (Vargo et al., 2015); a business model represents a formalised solution in response to a specific problem (Wieland et al., 2017); business model innovation is the process by which resources are transformed into established practices to offer an attractive value proposition to other actors in the service ecosystem (Maglio and Spohrer, 2013); service innovation can be defined as a formalised solution (practice) to integrate resources into value propositions (Skålén et al., 2015; Frow et al., 2016). Thus, market formation relies on the proposal and acceptance of value propositions by different actors. On the other hand, these ongoing and repeated interactions among multiple actors could contribute to the (re)formation of the market (Table 2.3).

	Value creation mechanism	View on business model	Role of firms
Conventional view from previous socio-technical transition studies	Firms as the producers of value and customers as the recipients of value	Business models as part of the socio-technical regime; intermediates between the technological niche and the socio-technical regimes; non-technological niche innovation	Incumbents vs. new entrants
An S-D logic, service ecosystem view on socio-technical transitions	Value is always co-created, and driven by the integration of resources among different stakeholders	Business models are not unique to "producers", but "the assemblages of institutions that shape an actor's perceptions of problems"	An actor-to-actor network, all actors are enterprises (from individuals to large firms)

Table 2. 3 Different views on value creation, business model, and firms in socio-technical transitions

Therefore, the S-D logic, service ecosystems view can help transitions scholars better understand the role of firms and the relationship between business models and socio-technical systems. More importantly, adding more explanatory power to market, which has been discussing recently in transitions studies (Boon et al., 2020; Ottosson et al., 2020). As a result, from an integrative manner, Vargo et al. (2020) see innovation diffusion as a value co-creation process (Figure 2.10):

> “From an aggregated, service-ecosystems perspective, innovative ideas can spread horizontally, as can be seen by looking across a level of analysis, including across a particular application (intra-niche) and across applications (inter-niche). Moreover, novel ideas can also ‘travel’ vertically, as can be seen from the perspective of different levels of analysis (aggregation), through the restructuring of the more general, conceptual meso- (e.g., ‘industry’) and macro-level (e.g., social) landscapes.” (p. 529).

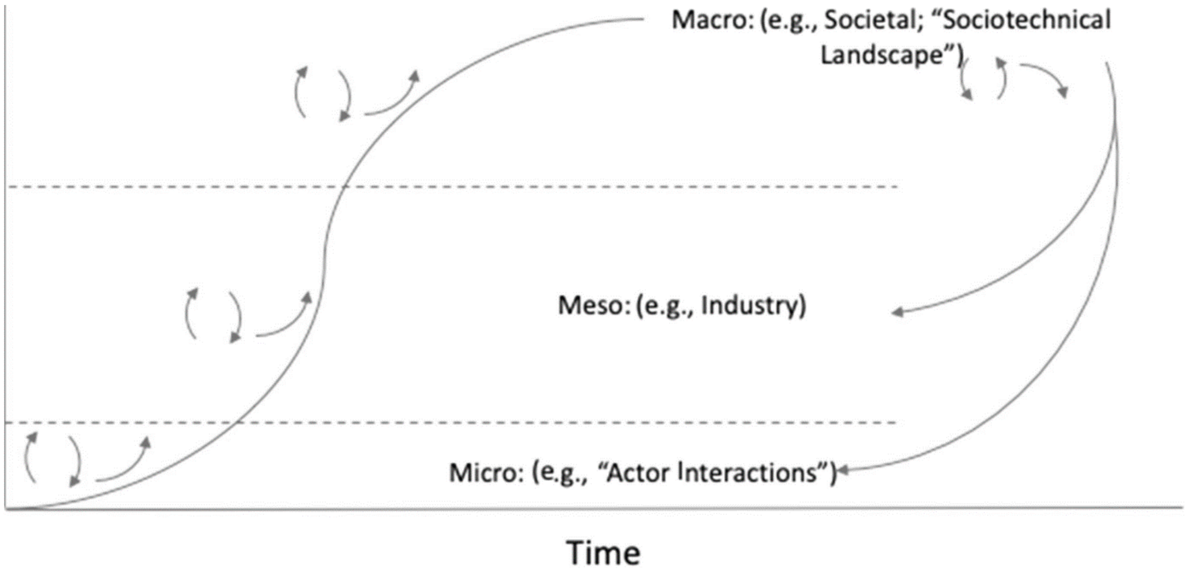

Figure 2. 10 Socio-technical transitions as a co-creative process (Adapted from Vargo et al. 2020)

In this chapter, we highlight the lack of attention both socio-technical transition and logistics innovation scholars have paid to the interrelationship between technologies, business models, and firms' innovation activities that contribute to the formation of socio-technical systems. As noted by Geels (2018), there is a need to shift from a single 'disruption' focus to a greater attention on the 'system reconfiguration', because previous transition studies have predominantly started from either the production or consumption side of socio-technical systems (Geels et al., 2015). As a result, we currently have a poor understanding of 1) how firms' innovation activities contribute to socio-technical transitions; 2) what is the role of logistics innovations in socio-technical transitions. Therefore, an integrative perspective can be helpful to understand logistics innovations as socio-technical and systemic processes and to provide a bridge to connect both production and consumption systems (Geels et al., 2015; Vargo et al., 2015). Here is a visual representation of our conceptual framework to show how we integrate the S-D logic and MLP together (Figure 2.11):

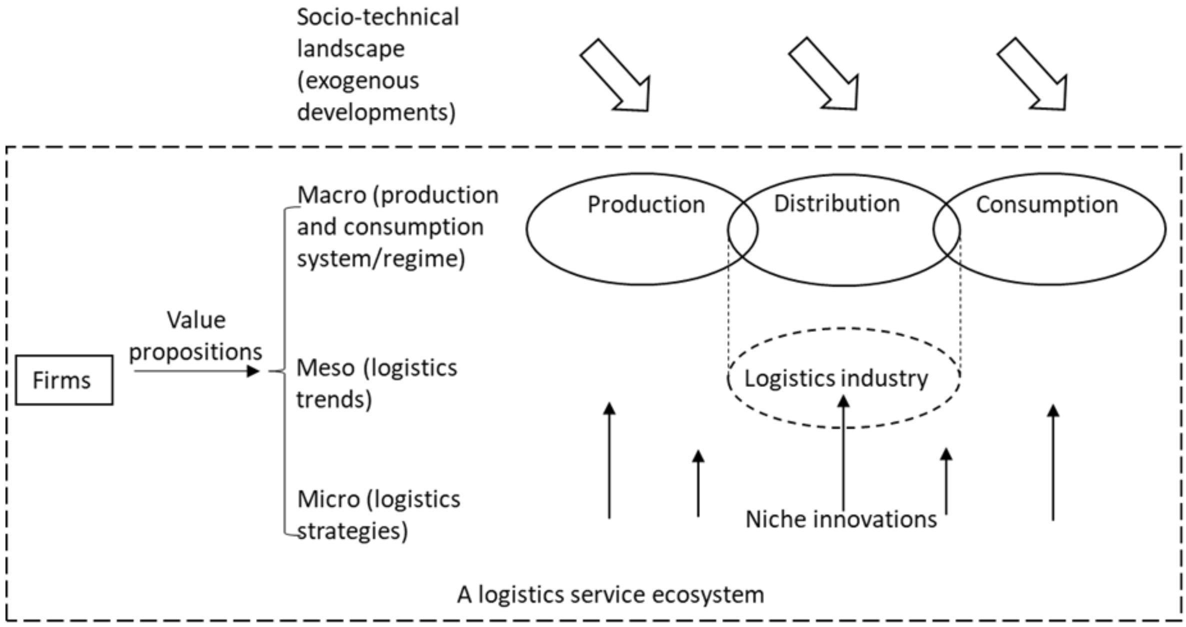

Figure 2. 11 An integrated conceptual framework illustrating logistics innovation diffusion

However, it should be noted that the integrative view of S-D logic and the MLP on firms in socio-technical transitions is at very early stage of development. For example, the socio-technical landscape is considered an exogenous environment that cannot be directly influenced by niche and regime actors (Geels and Schot, 2007). Also, the boundaries of service ecosystems have to be determined since there is no fixed boundary of a service ecosystem (Lusch et al., 2016). The framework is mainly based on the discussion from Vargo et al. (2020) on an S-D logic, service ecosystems view and McMeekin et al. (2019) on the whole system reconfiguration approach, although we have made some changes that have been discussed throughout this literature review chapter. As discussed in the previous section, firms' innovation strategies will be in line with specific logistic strategies to gain competitive advantage; logistics strategies then will show their effectiveness and then will be widely adopted by the logistics sector as logistics trends through inter/intra-niche learning; these trends will collaboratively determine the future of the sector and then shape the production and consumption system. However, in order to apply this integrative conceptual framework, we need to take the following concerns into consideration:

1) According to the MLP, niche and regime actors (e.g. firms) cannot directly interact with the socio-technical landscape, so the boundaries of service ecosystems should be carefully selected (Vargo et al., 2015). As the service ecosystem concept has

predominantly applied at the firm level in the marketing literature (Frow et al., 2014; Sklyar et al., 2014), it could be challenging to be integrated into a socio-technical system perspective. This concern is mainly related with RQ3 and RQ4 to seek how value propositions evolve at firm and socio-technical system level.

2) Also, firms' innovation activities only happen in a short period of time, and value propositions have often been developed and evolved. But transitions describe a long-term shift in socio-technical systems (Wells, 2013). As shown in Section 2.4.2, innovation activities, logistics strategies, and logistics trends may change at different rates and levels of service ecosystems, so it should be reflected in our conceptual framework. This concern is related with RQ1 and RQ3 to investigate how firms' innovation activities are shaping or being shaped by logistics strategies and trends.
3) Logistics services have received less attention in previous transition studies, but they help provide an empirical lens to investigate the 'whole-system reconfiguration' approach (Geels, et al., 2015; McMeekin et al., 2019). Therefore, the logistics socio-technical system is defined as the macro level of the logistics service ecosystem. The last concern is about the role of logistics innovations in socio-technical transitions, and it tries to provide empirical evidence to answer RQ2 and RQ4.

2.6 Chapter summary

The chapter presented that there has been a lack of a firm-level perspective in transitions studies, although some attempts have been made by connecting the business model concept with the transitions theory. Firms are considered important in driving or preventing the transitions towards a low-carbon economy. Thus, there is a need for a consistent framework to connect firms with business models, the dynamics of the market, industries, and society (Schaltegger et al., 2016). The MLP is adopted because it provides an analytic framework to understand complex socio-technical processes. More importantly, the MLP is a middle-range theory that can benefit from an integrated theoretical explanation. Therefore, we adopt an S-D logic, service ecosystems view, to examine the role of firms in socio-technical transitions. There are several reasons for the adoption of this perspective: 1) S-D logic considers all firms as resource integrators, which is helpful to move away from the 'incumbents-new entrants' dichotomy in previous transitions studies; 2) S-D logic has expanded our understanding of logistics innovations in socio-technical transitions because logistics activities are often linked with the distribution of product goods; 3) S-D logic helps understand how firms' innovation activities shape broader socio-technical systems by explaining the interrelation between short-term innovation activities and longer-term industry strategies or trends. In the next chapter, we try to explain how to mobilise this conceptual framework in our empirical investigation and what kind of research design will be the most relevant to address this new idea.

Chapter 3. Methodology

3.1 Introduction

The previous chapter has introduced an integrative view on firms' role in socio-technical transitions, consisting of an S-D logic, service ecosystems view and the MLP. The conceptual framework helps understand the interrelationship between business model, technology, and market formation, all of which contribute to transforming one socio-technical system into another. The exploratory nature of the PhD study is based on two main reasons: 1) The application of the business model concept in transitions studies is only at the starting point; 2) there is still a lack of empirical evidence regarding logistics innovations in the field of transitions studies. Therefore, a suitable research design is required to extend our knowledge about a firm-level perspective in socio-technical transitions.

Thus, this chapter is built upon Saunders and Lewis (2012)'s research onion model, which explains the different stages of the research process. Section 3.2 explains the rationale behind the selection of interpretivism as the philosophical stance of this PhD research. In section 3.3, the reason for choosing a case study research strategy is presented. Section 3.4 introduces the methods used for qualitative research and presents case study implementation. In section 3.5, we describe the data analysis methods used for this thesis and the criteria for evaluating research quality.

3.2 Research paradigm

According to Kuhn (1996), a research paradigm represents "the set of common beliefs and agreements shared between scientists about how problems should be understood and addressed" (p. 45). Thus, the research paradigm can be seen as a research system that consists of research philosophy, methodology, and various research methods (Denzin and Lincoln, 2005). The data collection methods are in the centre of the research onion as they are directly linked to the research questions (Figure 3.1). However, several important outer layers of the onion need the researcher to explain to ensure the quality of the research (Saunders and Lewis, 2012; Bryman, 2016; Hansmeier et al., 2021). In addition to the data collection methods, the research onion of the thesis has four outer layers: an interpretivism research philosophy, an abductive reasoning process, a case study research strategy, and a qualitative research choice.

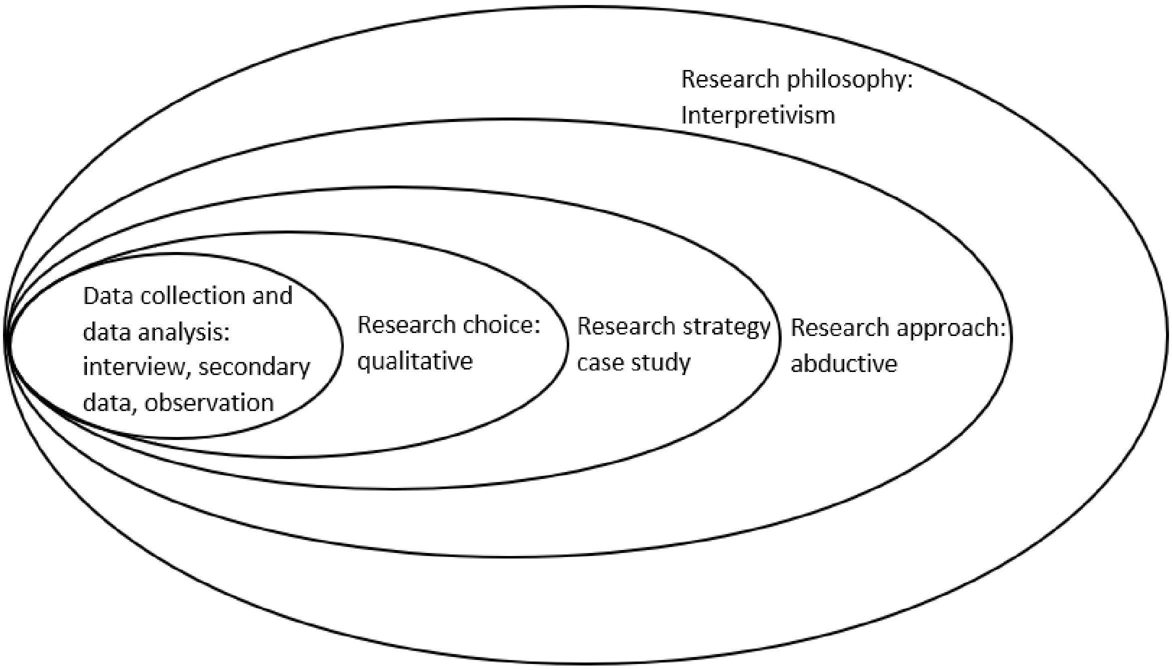

Figure 3. 1 The research onion model used in this study (Adapted from Saunders and Lewis, 2012)

3.2.1 Research philosophy

Ontology considers the nature of social entities or the nature of reality (Saunder et al., 2012; Bryman, 2016). Thus, questions of ontology are usually concerned for reasons: 1) “Whether social entities can and should be considered objective entities that have a reality external to social actors”; 2) “whether they can and should be considered social constructions built up from the perceptions and actions of social actors.” (Bryman, 2016, p. 28). These two positions can be referred as to objectivism and constructivism, respectively (Schwandt, 2003). First, objectivism indicates that we cannot reach or influence the “reality”. Social phenomena are independent of social actors and can only be measured objectively rather than through actors’ understanding and perceptions (Bryman, 2016). Alternatively, constructivism is an ontological position that implies that social phenomena are produced by the interaction between social actors, and knowledge and truth are continuously created during these societal activities. Therefore, in this position, social phenomena are revised through ongoing interactions and often associated with the term “subjectivism” (Saunders and Lewis, 2012).

Epistemology concerns the question of possible ways to gain knowledge (Crotty, 1998). The core issue of epistemology is "whether the social world can and should be studied according to the same principles, procedures, and ethos as the natural sciences" (Bryman, 2016, p.24). Therefore, researchers need to understand their philosophical position in business and management studies because the research process is driven and influenced by philosophical choices (Saunders and Lewis, 2012). According to Bryman (2016), three major epistemological stances in social science research are positivism, interpretivism, and realism.

Positivist researchers hold an objective view of society, which means that the "truth" is out there and can be observed and measured in certain conditions. So, positivists consider that reality is independent of the observer, which is called scientific objectivity (Guba and Lincoln, 1994). Also, positivists advocate the research can only be conducted by objective and value-free researchers (Wass and Wells, 1994). However, it is a mistake to consider the positivist stance as synonymous with science. Because from a positivist view, there is no difference between social science and natural science (Bryman, 2016). Therefore, from the positivist view, the world can and should be studied by following the same principle and research procedure. The research's role is to generate hypotheses that can be tested by those experimentations and observations (Bryman, 2016). As positivism is originated from natural science and adopted by social science and business studies, it has received several criticisms regarding its prime objection. For example, the positivist stance fails to examine the social world constructed from interactions between and among social actors. Therefore, the observation made from positivist research cannot lead to a full understanding of society (Buttle, 1998).

Alternatively, the interpretivist stance holds an opposite view of the positivist orthodoxy and has been applied in social science studies to understand social phenomena in their natural settings (Clarke, 2002). Interpretivists believe that reality is relative, and there are no fixed realities. Therefore, the aim of social scientists is to interpret the subjective meaning from the interaction between different social actors (Lincoln and Guba, 1985; Black, 2006). However, researchers should not only interpret based on others' interpretations. Importantly, social scientists should further elaborate on these interpretations by following conceptual frameworks, theories, and research disciplines (Bryman, 2016). As a result, a key factor for interpretivist researcher is to create or co-create knowledge from the interaction with research participants (Leitch et al., 2010). According to Saunders and Lewis (2012), the interpretivist stance can be beneficial for business and management studies because business situations “represent a particular set of circumstances and individuals coming together at a specific time to create a unique social phenomenon” (p. 107). However, an interpretivist researcher may face the challenge regarding the lack of definition between different methodologies (Farquhar, 2012).

According to Bryman (2016), realism shares similarities with positivism in two aspects. First, the collection and explanation of data should be applied to both the natural and the social sciences. Second, there is a reality beyond what people have observed. Moreover, realism has two major forms: empirical realism and critical realism. Empirical realism claims that reality can be understood through conducting appropriate research and experiments, and it is also referred to as naïve realism (Sayer, 1999). On the other hand, critical realism is developed as a critique of naïve empirical realism. Critical realists argue that what we experience are the sensations of the things (Saunders and Lewis, 2012; Bryman, 2016). There are two steps of critical realism. First, the reality is independent of our thinking. Second, our knowledge of reality is based on social interactions (Farquhar, 2012). Therefore, Sayer (1999) argues that:

> “Critical realism acknowledges that social phenomena are intrinsically meaningful, and hence that meaning is not only externally descriptive of them but constitutive of them (though of course there are usually material constituents too). Meaning has to be understood, it cannot be measured or counted, and hence there is always an interpretative or hermeneutic element in social science” (p. 17).

3.2.2 Socio-technical transitions and interpretivism

The Multi-level Perspective (MLP) has emerged as a fruitful middle-range framework for studying sustainability transitions (Geels, 2011). However, the framework has been criticised for lacking consideration of agency and the role of power. The MLP could be beneficial to incorporate some constructivist approaches, such as social construction of technology (SCOT), actor-network theory (ANT), and constructive technology assessment (Smith et al., 2005; Genus and Coles, 2008). In response to criticisms over the MLP, Geels (2010) elaborates on seven social science ontologies to discuss their assumptions on agency and causal mechanisms, including rational choice, evolution theory, structuralism, interpretivism, functionalism, conflict and power struggle, and relationism. Specifically, Geels (2010) explains the MLP is built upon a crossover between evolution theory and interpretivism/constructivism:

> "The MLP originates from the Twente school's quasi-evolutionary theory that aimed to make evolutionary variation-selection-retention mechanisms more sociological via crossovers with interpretivism/constructivism. Variation is seen as guided by expectations… Selection occurs in a multi-dimensional selection environment… Actors are not cultural dopes who passively follow rules. Instead, they are knowledgeable agents… Retention is not only a process of 'retaining what works', but also an interpretive, negotiated, and contested process of institutionalization" (p. 504).

The interpretivist stance combines long-term trajectories with various social interactions (e.g., behavioural and cognitive learning). These learning processes reproduce different actors' interpretations and cognitions. Also, on the vertical axis of the MLP, there is an 'evolutionary logic' within the interaction of niche-regime interactions (Hess, 2016). As a result, the crossover between evolution theory and interpretivism/constructivism allows transitions scholars to link the evolutionary process with long-term socio-technical transitions (Geels, 2002; Geels and Schot, 2007; Geels, 2010).

Therefore, interpretivism should be considered the most suitable research paradigm to explore these complex social interactions. As illustrated above, the aim of this chapter is to determine which research paradigm is best suited for used for this thesis. As shown in Chapter 2 (Literature Review), two main perspectives serve as the basis of this thesis: the MLP and an S-D logic, service ecosystems view (Bakker et al., 2014; Wells and Lin, 2015; Vargo and Lusch, 2016). The Interpretivist stance could help scholars obtain the subjective meaning of social interactions because socio-technical transitions describe a series of complex social interactions and coevolution in industry, technology, markets, policy, culture, and civil society (Geels, 2012). Similarly, the S-D logic, service ecosystems view emphasises that the meanings and practices embedded in artefacts are the most important in markets (Vargo and Lusch, 2008). The theoretical foundations of S-D logic are: 1) An actor-to-actor network, which describes all actors are resource integrators in co-creating value; 2) resource integration, which means that all social and economic actors resource integrators; 3) value co-creation is coordinated actor-generated institutional arrangements (Lusch and Nambisan, 2015). This view considers innovation diffusion as a social process that includes value co-creation and resource integration activities:

> “… a service ecosystems view suggests that innovation (i.e., evolution of useful knowledge) involves the institutionalization of new solutions. It offers an understanding of diffusion as a general, institutional change process, as well as the adoption of technology for a contextually-specific purpose” (Vargo et al., 2020, p. 527).

3.3 Research strategy: a qualitative case study research

Following the research onion model, this section’s focus is on why a qualitative case study design has been chosen and the potential risks of choosing this methodology.

3.3.1 Literature review strategy

The exploratory nature of this thesis suggested that a narrative literature review can be particularly useful to synthesise insights from various perspectives and disciplines, and the following reasons were taken into account: 1) logistics services remained an underexplored research field in transitions studies; 2) the lack of a firm-level perspective encouraged transitions scholars to explore the application of the business model concept; 3) innovation adoption in the logistics service industry often mirrored the theory of the product cycle, leading to a limited number of research efforts designed to use the business model concept in the logistics innovation literature. As a result, meta-analysis or systematic reviews were less suitable as they often required a large number of evidence on well-defined research questions (Table 3.1) (Sovacool et al., 2018). Therefore, narrative reviews were adopted because there was the need to “integrate advances in a certain research field by reinterpreting and interconnecting many publications on different topics and with diverse methodological approaches” (John and Lawton, 2018, p. 849).

Literature review types	**Data availability**	**Research questions**
Meta-analysis	A series of comparable quantitative studies	Specific, clear, and consistent research questions
Systematic reviews	Large bodies of quantitative or qualitative evidence	Well-defined research questions
Narrative reviews	Existing resources are limited	Exploratory research questions

Table 3. 1 The codes of practice for literature reviews (adapted from Sovacool et al., 2018)

The reviewed papers were mainly searched via two databases: Scopus and Google Scholar. First, after briefly introducing socio-technical transitions and business model theories, we started searching the application of the business model and its related concepts in transitions studies. In doing so, we referred to the most recent international rankings of English-speaking journals in “Innovation” and “Strategy” categories from the Academic Journal Guide (ABS list 2015&2018). Keyword searches were carried out by using terms such as “business model”, “business model innovation”, “innovation strategy”, “sustainability transitions”, and “socio-technical transitions”. Second, considering that there are very limited number of transitions studies have focused on logistics innovations and the topic of this PhD thesis is on how companies manage their innovation activities, we mainly focused on the logistics innovation management literature in “Operations and Technology Management” and “Sector Studies” from the ABS list (2015&2018) by following the three types of logistics innovations identified by Rossi et al. (2013). Keywords such as “logistics innovation”, “process innovation”, “product/service innovation”, “network/relationship innovation”, “incremental/radical innovation”, and “technological/business model innovation” were applied in this section. Besides academic journals, several industry reports, such as DHL Trend Research, PwC Future Research, and European Commission reports, were applied to identify the relationship between innovation strategies, logistics strategies, and logistics trends. At last, since this thesis was based on an abductive reasoning, another round of literature search in the marketing literature was carried out during the pilot study implementation because an S-D logic, and service ecosystems view was adopted to guide our main case studies.

3.3.2 An abductive reasoning

There are two major approaches to conduct research: deduction and induction (Figure 3.2) (Saunders and Lewis, 2012; Bryman, 2016). Deductive research involves testing a theoretical proposition by following a direction from a general theory to a more specific case (Danermark et al., 2019). There are four key characteristics of deductive research: first, researchers need to explain causal relationships between variables. Second, relevant concepts need to be operationalised by deductive researchers. Third, data collection and analysis are crucial to answer the research questions. Fourth, a rigorous methodology to facilitate the replication of research findings (Saunders and Lewis, 2012). Alternatively, inductive research provides a ‘bottom up’ view to developing theory. In other words, a theory is built upon research that consists of different observations (Eisenhardt and Graebner, 2007). Researchers who take inductive reasoning may follow steps: first, inductive research begins with specific observations and measures. Second, patterns and repeated occurrences of phenomena need to be recorded. Third, generating hypothetical propositions that can be tested (Ketokivi and Mantere, 2010; Saunders and Lewis, 2012).

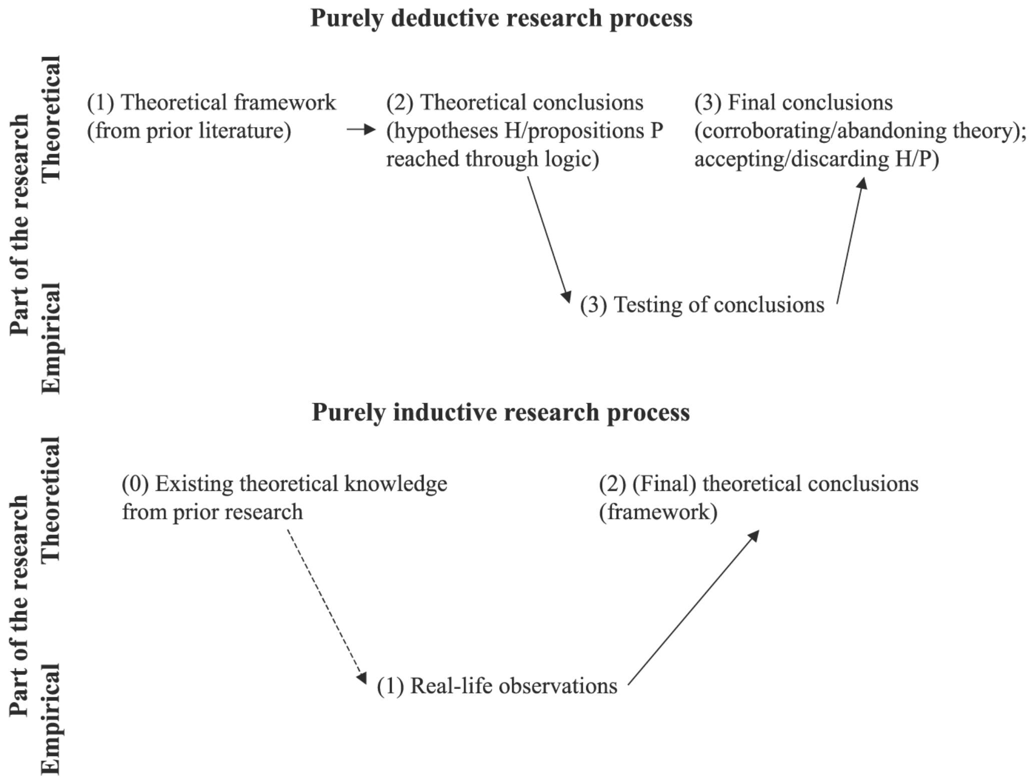

Figure 3. 2 Deductive and inductive research processes (Adapted from Kovács and Spens, 2005).

However, abductive reasoning has been applied to this thesis, which is also called 'theory matching' or systematic combining' by Spens and Kovács (2006). Dubois and Gadde (2002, p. 555) described that abductive reasoning is "an argument for a stronger reliance on theory than is suggested by true induction. On the other hand, systematic combining is even more distant from deduction." Abductive reasoning is also considered a subtype of informal induction (Bruscaglioni, 2015). While both the inductive and abductive approaches aim to develop theory, the abductive approach's focus is on understanding a new phenomenon (Kovács and Spens, 2005). According to Chamberlain (2006), an abductive research strategy consists of two parts. First, an interpretivist stance should be applied by the methodology, and participants' perception contributes to the understanding of social reality. Second, when the researcher becomes more engaged and immersed in the research project, the causation of the situation can be addressed insightfully. Therefore, abductive reasoning allows researchers to begin with real-life observation and go back and forth between theoretical knowledge and empirical findings (Gummerus and Pihlström, 2011) (Figure 3.3).

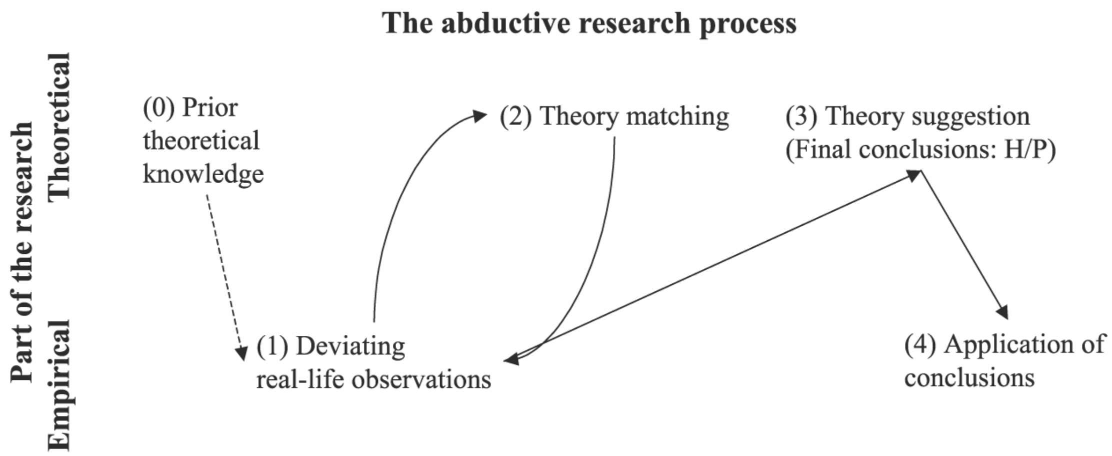

Figure 3. 3 The abductive research process (Adapted from Kovács and Spens, 2005).

As discussed in research philosophy, an interpretivist stance has been adopted to understand complex social interactions and socio-technical transitions. As a result, the abductive approach is more suitable for three reasons. First, there is limited research in transitions studies that starts from a firm-level perspective, although the business model concept has been introduced into transition theories (Bidmon and Knab, 2018; Sarasini and Linder, 2018). Second, an integrative view of socio-technical transitions and the service ecosystem perspective has recently started to emerge (Ottosson et al., 2020). Thus, more empirical and theoretical work is needed to provide a sufficient explanation of this theoretical combination (Vargo et al., 2020). Third, logistics services have received limited attention in the transitions literature because of the dominance of deductive research in logistics, which leads to a lack of qualitative and interpretive research (Kovács and Spens, 2005). The abductive approach could help transitions scholars explore this new research area (Pettit et al., 2018; Guo et al., 2019; Karslen et al., 2019).

3.3.3 Summary of research strategy

Therefore, the abductive strategy is implemented and presented as follows (Figure 3.4):

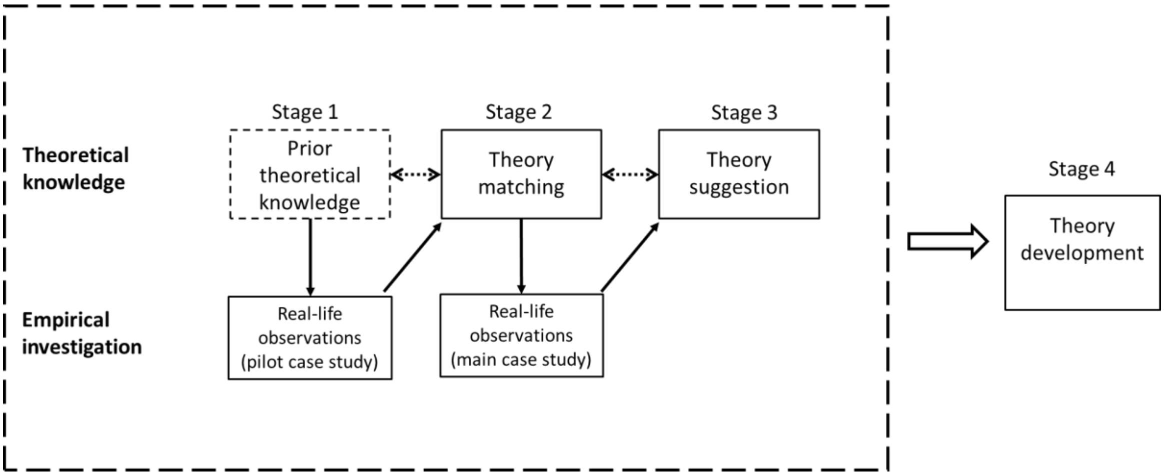

Figure 3. 4 Presentation of key stages of research strategy (Developed by the author)

Stage 1: A conceptual framework and research questions were identified based on the literature review from transition theories and business model theory. They were applied in pilot studies (Company A, B, and C).

Stage 2: The pilot studies' data were analysed and served as an indicator to refine research questions and the conceptual framework. The refined research questions and conceptual framework (an S-D logic, service ecosystems view) were introduced in main studies (Company A and D).

Stage 3: The findings from the pilot and main studies were analysed to decide whether or not to refine research questions or conceptual framework for further theory development (Dubois and Gadde, 2002).

Stage 4: The refinement of the MLP was accomplished to understand the role of firms in socio-technical transitions by using an S-D logic perspective.

3.3.4 A qualitative case study approach

Socio-technical transitions studies have tried to explore theoretically and empirically how sustainability can be achieved. It is worth noting that the case study design is the most commonly used in transitions studies, such as the steamship transition (Geels, 2002), mobility practices (Geels, 2005a), sustainable energy development (Geels and Raven, 2006), and low-carbon electricity transitions (Foxon et al., 2010). Yin (2018) explains when to use the case study as a research method based on three conditions: 1) The form of research questions, especially when "how" and "why" questions being asked; 2) the researcher has little control over behavioural events; 3) the focus is on contemporary events. Following the selection criteria, this thesis has fulfilled all three conditions: 1) It has two "how" research questions (Section 1.4); 2) the researcher has no control over behavioural events in case study companies; 3) the research aims at investigating how companies manage their innovation activities in the era of digitalisation, and interviewees have fully/partly involved in those events.

As discussed in the previous section, abductive reasoning has been adopted as a research strategy for this thesis. Case studies based on abduction help researchers generate new concept and develop theoretical models. In other words, theory development is key to abduction (Dubois and Gadde, 2002; Kovács and Spens, 2005). Therefore, the case study offers concrete and context-dependent knowledge rather than produces general and context-independent theory (Flyvbjerg, 2006; Blaikie and Priest, 2019). Although the case study tends to use a qualitative strategy, it is not appropriate to associate case studies with qualitative research because case studies can be quantitative and qualitative (Yin, 2018). So, considering there is a limited understanding of the role of firms in socio-technical transitions, it would be inappropriate to generate hypotheses that cannot be tested immediately (Blaikie, 2007). Also, the interpretivist nature of the research requires the researcher to develop an existing theory by conducting detailed descriptions of events. Consequently, qualitative methods are more appropriate than other quantitative methods to investigate each company's innovation activities. Therefore, the qualitative case study method is applied to the thesis:

> "A case study allows investigators to focus on a case and retain a holistic and real-world perspective such as in studying individual life cycles, small group behaviour,

> organisational and managerial processes, neighbourhood change, school performance, international relations, and the maturation of industries." (Yin, 2014, p. 4)

It is worth noting that there are some criticisms of the case study method. The most commonly criticised feature of the case study is that findings cannot be generalised. Yin (2018) argues that there are two types and generalisation, known as statistical generalisation and analytic generalisation. Statistical generalisation refers to the inference based on a sample and is applied to a population, and the sample has to be selected randomly to represent the population. However, case study research will be misguided using statistical generalisation because cases are not sampling units (Mills et al., 2009). Analytic generalisation, which is also called theoretical elaboration, tries to link findings from case studies to a theory (Yin, 2018). As a result, the use of theory can guide the case study design and be empirically enhanced through the investigation process. Hence, case study research should consider analytic generalisation, and statistical generalisation is not the aim of conducting case studies (Flyvbjerg, 2006; Bryman, 2016).

3.4 Case study design and implementation

Yin (2018) presents four types of case study designs to avoid the risk of conducting research without proper guidance and direction. The four types are: 1) Single-case (holistic) design; 2) sing-case (embedded) design; 3) multiple-case (holistic) design; 4) multiple-case (embedded) design. Thus, researchers need to decide which design should be adopted to make case studies stronger and easier to follow (Yin, 2018). For instance, the case study protocol would be different regarding different research designs. Also, the quality of case study research should be tested regarding validity and reliability, requiring different tactics for different case study designs (Mills et al., 2009).

While single-case design can provide a deep description of a phenomenon (Stake, 1995), multiple-case studies are often considered more compelling and robust (Yin, 2018). However, it worth noting that a single-case design can also contribute to theoretical development by examining the unusual or critical case, which is considered the advantage of the sing-case design (Flyvbjerg, 2006; Yin, 2018). In terms of theory development, multiple-case studies provide a wider exploration of research questions and theoretical elaboration, which is essential to create a more robust theory (Eisenhardt, 1989; Eisenhardt and Graebner, 2007). Consequently, the multiple-case design is selected for this thesis since the aim of the research is to extend the transition theory by exploring how different firms implement their innovation projects.

Furthermore, selecting the multiple-case design could also bring new challenges that need to be overcome. First, as noted by Eisenhardt and Graebner (2007), the trade-off between the emergent theory and the rich empirical evidence should be considered. Thus, theory development is important to solve this trade-off because each part of the theory is discovered by the empirical evidence generated from the cases (Stake, 1995). Second, adopting the multiple-case design could raise new questions, and "a major insight is to consider multiple-case studies as one would consider multiple experiments – that is, to follow a replication design." (Yin, 2018, p. 55). Thus, it can be solved by following a replication logic for case selection, which will be discussed in the following sections.

3.4.1 Unit of analysis

Within the multiple-case design, an embedded unit of analysis is defined as:

> "A unit lesser than and within the main case in a case study, from which data also are collected (e.g., household data within a neighbourhood case study, individual employee data within an organization case study, or project data within a program case study)" (Yin, 2018, p. 287).

The unit of analysis is the major entity for analysing in the case study, which helps define the boundaries of a case (Mills et al., 2006). Also, the definition of the unit of analysis should be in line with how research questions have been developed (Yin, 2003). This thesis is primarily concerned with firms' innovation activities in the European logistics industry. Therefore, four firms have been selected since they have clear innovation strategies to adapt to the digitalisation of the logistics industry. Furthermore, these innovation strategies have a long-term orientation and need to be achieved through different innovation projects. In order to determine the factors associated with successful or failed innovations, many empirical studies have only looked into successful (or failed) innovations at the organisational level; others have taken the individual innovation project as the unit of analysis (Rothwell, 1992; Bahemmia et al., 2018). As noted by Bellantuono et al. (2021), the level of analysis should follow the meanings attached to innovations (in this thesis, logistics innovations).

Logistics service companies are familiar with operational projects, such as warehouse implementation. However, innovation projects are often more challenging because the goals are more ambiguous at the beginning and tend to be clear during the project implementation (Wagner and Sutter, 2012). For instance, Company A has followed a proactive manufacturing strategy, and three innovation projects were selected accordingly during the company's innovation journey. The distributed manufacturing service and on-demand forecasting service were proved successful. But when the company wanted to add the additive manufacturing service into its distributed manufacturing services, it was proved less successful because of legal copyright issues (see Section 5.3.1.3). Also, when Company B wanted to introduce the optical ordering system into its innovative Kanban bin solutions, the result showed the system was not very attractive to its customers (see Section 5.4.2). Similar examples were found in Company C's new delivery methods as they were not economically feasible and restricted by government regulations (see Section 5.4.3). Moreover, Company D's original idea was to provide fleet management system to carriers, logistics solution for shippers, and mobile applications for drivers. But the company decided to shift its focus to small and medium carriers at last (see Section 6.3.2.1).

Therefore, Wagner and Sutter (2012, p. 946) define innovation projects as firms' activities to "execute the innovation process and to bring a product or service idea to a commercial application." Thus, further investigation in these innovation projects helps better understand how firms' value propositions have evolved because the selected projects may prove to be commercially successful (or unsuccessful). Also, focusing on a specific innovation project helps us design context-specific questions to improve the quality of interviews (Maria et al., 2016). This thesis is particularly concerned with the innovation projects developed to fit companies' long-term innovation strategies because these projects are about adding new functionality to the overall value proposition of service ecosystems (Koskela-Huotari, et al., 2016).

3.4.2 Case selection criteria

The previous sections have focused on the reason for choosing a multiple-case design for this PhD thesis. To develop existing theory, Yin (2018) suggests that the design should follow a theoretical replication logic rather than a statistical sampling logic. As discussed in Section 3.3.3, the statistical sampling logic would mislead case study research for three reasons: 1) Case studies are not aiming at inferring about the prevalence of phenomena; 2) a large number of relevant variables could be generated by statistical sampling, which leads to a superficial examination of the case; 3) many important empirical investigations would not be applied. Hence, after selecting each case, the individual case can either predict similar results (a literal replication) or "predict contrasting results but for anticipatable reasons (a theoretical replication)" (Yin, 2018, p. 55).

Moreover, theoretical interest should guide the case selection logic rather than a simple prediction of similar/contrasting results. (Eisenhardt and Graebner, 2007; Yin, 2014). In other words, the analytic generalisation may be reached either through modifying and extending theoretical concepts or by the new concepts from the completed case studies (Yin, 2018). Thus, theoretical considerations have guided the case selection strategy. The research interest of this thesis is in exploring the role of firms and their innovation activities in socio-technical transitions. By following the conceptual framework, firms can be understood as resource integrators to co-create value, and logistics innovations can be seen as different value propositions that aim at reshaping service-ecosystems and wider socio-technical systems. Thus, the thesis tries to understand the co-evolutionary relationship between firms' innovation activities and the digital transformation of the logistics industry in Europe.

An initial set of case selection criteria are identified by reviewing the existing literature in socio-technical transitions and logistics innovations. Then, these criteria are developed using further insights from reviewing the innovation strategies and logistics strategies (see Chapter 2, Section 2.4.2) in the era of digitalisation. Moreover, the pilot study also contributes to the development of the case selection criteria because the conceptual framework has been refined through the pilot cases. Importantly, the refined criteria have guided the selection of interviewees in the main case studies. Flyvbjerg (2006) introduces the information-oriented selection strategy to enhance analytic generalisation, which is based on the idea of clarifying the deeper meaning of given issues (Table 3.2). Hence, the information-oriented selection strategy is chosen based on “expectations about their information content” (Flyvbjerg, 2006, p. 230).

Information – oriented selection	**Purpose**
Extreme/deviant cases	To obtain information on unusual cases, which can be especially problematic or especially good in a more closely defined sense.
Maximum variation cases	To obtain information about the significance of various circumstances for case process and outcome (e.g., three to four cases that are very different on one dimension: size, form of organization, location, budget).
Critical cases	To achieve information that permits logical deductions of the type, “If this is (not) valid for this case, then it applies to all (no) cases.”
Paradigmatic cases	To develop a metaphor or establish a school for the domain that the case concerns.

Table 3. 2 Strategies for case selection (Adapted from Flyvbjerg, 2006)

The case selection criteria are as follows:

- Case studies should be implemented in Europe-based companies because the empirical context (see Chapter 4) is the logistics industry in Europe. It is worth noting that companies might be multinational, especially for logistics companies who tend to develop innovation activities with local partners worldwide. However, the decentralised structure of the company can be used to explain how these local innovation practices contribute to the formation of the global network (global niche), which has been discussed in SNM literature (Geels and Raven, 2006).
- Logistics – related Innovation projects should present a certain level of “disruptiveness” to the logistics industry. Thus, we can draw a broader picture of these innovation activities as an “ongoing process of institutionalisation” that aims at maintaining and disrupting existing institutions (Vargo et al., 2015). It is crucial for us to link companies’ innovation activities to the digital transformation of the logistics industry.
- A clear logistics strategy should be presented. Thus, the company’s innovation activities are guided by an innovation strategy closely linked to the core value proposition (Pisano, 2015). It will allow us to investigate how logistics innovations evolve over time (Skålén, 2015).

- The cases selected should not be solely within the logistics industry boundary. The reason is that socio-technical transitions may result from the strategic reorientations of incumbent firms (Berggren et al., 2015), niche-regime interactions (Schot and Geels, 2008), and the involvement of "mature entrants" in niches (Manders et al., 2018). The entire supply is impacted by logistics activities as logistics are defined as an extension of physical distribution. So, several activities, including raw material and information flow related to production, warehousing, distribution, and the reuse of products, are all included in logistics services (Grawe, 2009). In recent years, "mature entrants" such as online retailers have shifted their role from customers into participants or even competitors to logistics companies by developing their in-house technologies (Qin et al., 2020). Meanwhile, technology development in the logistics sector has attracted companies like IBM to collaborate with traditional logistics service providers to enter into the logistics industry. Last, the rise of platform-based business models has impacted ofreight forwarding, last mile delivery, and warehouse management businesses, and these new entrants make the competition more complex in the logistics industry. Therefore, *extreme* or *paradigmatic* cases may be more suitable for this thesis (Flyvbjerg, 2006).
- Because of the exploratory nature of the research, the cases should be selected regarding the availability of empirical data (e.g., interview opportunities, secondary sources). Logistics innovations have not been widely researched in the transitions literature. Accordingly, the companies that engaged in logistics innovations are arguably less investigated as research topics compared with automotive and energy companies (Bolton and Hannon, 2016; Dijk et al., 2016). Therefore, the selection depends on whether we have been given access to the members of executive management because they have extensive knowledge about the specific innovation projects, the innovation strategy, and the broader logistics trend of digitalisation. Details will be discussed in our interviewee sampling strategy.

Following the case selection criteria, three companies (Company A, B, and C) were selected for the pilot study because of their: 1) accessibility – it was easier to know companies' senior managers as they came to the university to participate in workshops, research seminars, and guest lectures; 2) company size – making more secondary data available (e.g. annual reports, online articles, and interview records) to determine the core innovation strategies that we needed to investigate; 3) opportunities for further investigation – as the selected companies were representative (or *extreme cases*) in terms of their "disruptiveness" in the logistics industry, further investigation was particularly helpful to see how their innovation strategies (core value proposition) developed and evolved as some of the selected innovation projects might be ambiguous in the beginning and eventually proved to be commercially successful (or unsuccessful) (see Section 3.4.1 Unit of analysis).

Two main case studies (Company A and D) were selected after the pilot study by following the refined conceptual framework. Initially, we were targeting at seven more companies who were representative of “niche actors” with their innovative business models in the logistics industry because the three companies in the pilot study can be seen as “regime actors” or “mature entrants”. The seven companies included grassroots innovations (Company I and J), sustainable urban logistics (Company E, F, G), sharing logistics (Company H), and digital freight forwarder (Company D). In the meantime, the three companies in the pilot study were contacted to request follow-up studies to learning how their innovation strategies were developed. At last, grassroots innovations (Company I and J) were not selected mainly because they were highly dependent on the collaboration between local communities and government, resulting in difficulties in defining the boundary of each case study. Also, sustainable urban logistics companies (E, F, G) were excluded because their business models were based on single ‘green’ technology, such as (electric) cargo-bikes and electric vans, which made it difficult to link with the whole system reconfiguration approach and digital transformation of the logistics industry. Platform-based business models (Company H and D) have been proven promising trends (see Section 2.4.2.1) in the logistics industry. Company H and D were both selected as they had clear innovation strategies to be disruptive in the logistics industry. However, Company H denied our request for case study access, so Company D was chosen as one of the main studies in this thesis. Meanwhile, Company A agreed us to initiate a collaborative research project to understand their distributed manufacturing strategy (Table 3.3).

Company name	Innovation types	Selected for main case studies
Company E, F, G	Sustainable urban logistics	Not selected: single disruption in certain ‘green’ technologies; less representative in the digitalisation concept
Company I and J	Grassroots innovations	Not selected: case study boundaries; access issues with local communities and government
Company H	Sharing logistics platform	Not selected: access denied
Company D	Digital freight forwarder	Selected: platform-based business model; access to executive managers; representative in digital freight business;
Company A	Distributed manufacturing services	Selected: access to revisit the company by participating a collaborative research project

Table 3. 3 The selected case studies for the main study based on the selection criteria

3.4.3 Overview of cases

The section’s focus is on providing an overall picture of the selected cases and explaining how these cases meet the selection criteria. The empirical context (see more detailed information in Chapter 4) of this thesis is the European logistics industry. This industry is chosen for three reasons. First, the logistics industry plays an important role in connecting production and consumption systems, which needs to be further explored in the transitions literature (Geels et al., 2015). Second, the logistics industry is facing increasing competition from big retail players and technology firms, which can be used as an empirical lens to understand multi-regime interactions and the role of firms in transitions (Sutherland et al., 2015; Sarasini and Linder, 2018). Third, this empirical context is selected because of prior research experience and contacts that make it more possible to gain access to the case studies. All cases are presented in detail as follows and summarised in Table 3.4.

Company A’s expertise is built on international freight forwarding services, specifically air and ocean freight services. The company employs around 16,000 people and operates 500 offices in more than 80 countries around the world. In 2011, the company decided to add logistics services as value-adding activities to enhance its value proposition. However, the company recognised that it would not gain success by simply introducing a new logistics service into a competitive industry as the logistics industry has been suffering from commoditisation that results in slow growth, lower margins, and increasing competition. As a result, several innovative approaches were considered by the company to differentiate it from existing logistics players. Therefore, Company A decided to follow a proactive manufacturing strategy to avoid an increased level of price pressure in the logistics industry. The manufacturing innovation strategy has to be in line with the company's logistics strategy as the company has tradition of success in air freight and ocean freight – that is, giving its customers an end-to-end logistics solution. Thus, following the innovation strategy, several innovation projects have been implemented, including 1) A distributed manufacturing solution; 2) an on-demand forecasting solution; 3) an additive manufacturing solution. Other innovation projects such as E-commerce platform, inventory management, and procurement were excluded because they are not directly linked with the distributed manufacturing innovation strategy.

Company B's history is built on expertise in its logistics solutions for manufacturing component. The company has one of the most advanced logistics centres in Europe and employed more than 1,640 people in the headquarter. More importantly, Industry 4.0 technologies and their applications in Kanban systems have become a competitive advantage to the company. The company has developed IoT-based solutions for manufacturing companies by using sensors or cameras in "smart shelves" and "smart bins" to ensure timely replenishment. Therefore, the innovation strategy of Company B is focusing on the application the Industry 4.0 concept in modern manufacturing component management. With the adoption of IoT-based solutions, the company can directly supply its customers with a modern logistics centre and move from supplier-customer relationship to collaboration among each other, which is seen as the company's logistics strategy. As a result, customers can achieve greater supplier consolidation and reduce costs in transport services. The modern Kanban systems offered by Company B has been selected to investigate how the company engaged in the automation of its supply systems by using the RFID technology. Other innovation projects such as lean factory, warehouse automation, and value-added logistics services excluded as they were less relevant to the selected innovation strategy – innovation in manufacturing component management.

Started as an online retail company, **Company C** has now been considered a high-tech company with more than 15,000 employees. The company's core competency lies in its automated fulfilment centres, which allows improving its own operational efficiency, and more importantly, with the integrated e-commerce solution, Company C is able to provide an end-to-end online retail solution for its customers. Meanwhile, the company has tested several innovative delivery methods to see its potential applications in its smart e-commerce platform. Consequently, the company has created an additional business model as a technology provider in the logistics industry. Therefore, with the newly developed business model, Company C transforms its logistics function to a competitive advantage in the online grocery business, which can be seen as the company's main logistics strategy. In order to achieve this competitive advantage, the innovation strategy of Company C is to develop an end-to-end ecommerce solution for operating online grocery businesses. As an important part of the e-commerce solution, innovation in smart fulfilment centre and innovative delivery methods were selected as innovation projects. Other innovation projects, such as robotic arms for pick and place applications, food waste reduction, and other operational improvement projects were not selected as they were relatively peripheral to the core innovation strategy.

Company D is a start-up company aiming to enter the European road freight market by its digital platform-based business model. The company has become one of the largest digital platforms for road freight in Europe. The company has two main value propositions: increasing data transparency and the elimination of intermediaries in the road freight in the market. Therefore, the core innovation strategy of Company D is to accelerate digitalisation and automation in the truckload ecosystem. To stay competitive in full truckload market as a start-up company, this innovation strategy should follow the company's logistics strategy, that is, growing in the market by connecting large shippers with smaller freight carriers. In doing so, Company D has implemented several projects and tried to directly link big shippers to small carriers in Europe, such as collaborating with a fuel card provider and developing a truckload-shipping ecosystem. Other innovation projects like artificial intelligence, alternative fuels were not selected because they were at the very beginning of the project development in Company D.

Company	Business sector	Company size (No. of employees)	Geographic scope	Logistics strategy	Innovation strategy
Company A	Logistics and freight forwarding	16,000 employees	Worldwide	An end-to-end logistics service to differentiate in the logistics market	Distributed manufacturing services
Company B	Industrial supply	1,700 employees	Worldwide	Enabling a new collaborative relationship between supplier and customer	IoT-based manufacturing component management
Company C	Online retail	15,000 employees	Europe	transforming the logistics function to a competitive advantage	End-to-end online retail platform services
Company D	Freight forwarding	600 employees	Europe	Growing by connecting large shippers with smaller freight carriers	Digital platform-based services

Table 3. 4 Summary of the selected cases (Developed by the author)

3.4.4 Data collection methods

3.4.4.1 Qualitative interviews

Qualitative interviews are widely used and one of the most important sources for conducting case studies (Kvale and Brinkmann, 2009). In scholarly research, qualitative interviews are "research vehicles, the purpose of which is to produce empirical materials for the study in question" (Eriksson and Kovalainen, 2011, p. 78). There are three major types of qualitative interviews:

- **Structured and standardised interviews** are often made from positivist 'what' questions in mind. However, they can be helpful to reduce variety if several interviewers (such as volunteer or inexperienced interviewers) participate in the research.
- **Unstructured (open) interviews** are more informal and often applied by researchers who want to explore in-depth a general topic (Saunders and Lewis, 2012). Contrary to

structured interviews, researchers do not need to have a list of questions to ask in unstructured interviews. Therefore, researchers can conduct data collection without the guidance of the interview protocol, which means the conversation can be led to any indirection of interest that may occur during the interview (Bryman, 2016).

- **Semi-structured (guided) interviews** are often used in business studies since their advantages of answering "what" and "how" questions (Eriksson and Kovalainen, 2011). The researcher often prepares an outline of topics, interview questions, or research themes before the interview. However, for some semi-structured interview, the researcher has sufficient control to vary the wording and order of questions for an individual interview. For example, the interviewer may decide not to cover specific topics because the interviewee is not relevant. Also, the interviewer may decide to ask follow-up questions to get more depth information about a topic (Saunders and Lewis, 2012).

Therefore, semi-structured interviews are selected to conduct formal interviews as they balance the advantages of unstructured and structured interviews (Bryman, 2016). Specifically, the unit of analysis of this thesis is each innovation project that may involve participants with different responsibilities. For example, an executive manager and an innovation analyst may have a different understanding to project implementation. Thus, the semi-structured interview method can help us adjust interview topics to guide each interview. Moreover, unstructured interviews are adopted in informal interviews with research partners, NGOs, and academics who are directly or indirectly involved in the innovation projects to understand broader trends of the logistics industry.

Although interviews provide depth and breadth through combining field notes and other sources, several limitations need to be considered. For example, the interviewees may only give what interviewers want to hear and omit crucial information if trust has not been established (Weiss, 1995). Also, the interviewers' interpretation of the research topic may be insufficient to identify the causal factors during investigations, leading to biased and poorly articulated questions (Mills et al., 2006). Therefore, the interviewer needs to focus on the research topic and questions that are meaningful and important to design relevant research questions. It is worth noting that researchers may confuse their research questions and interview questions, which means they only have opinion, but not proper research questions (Eriksson and Kovalainen, 2011; Bryman, 2016). As a result, it is important for researchers to conduct case study interviews by 1) Using a case study protocol that guides the line of inquiry; 2) following an unbiased manner to verbalise actual questions (Yin, 2018).

The interviewee sampling strategy is designed by following the theoretical replication basis as explained in Section 3.4.2, and a core criterion depends on the access to the executive managers of the case study companies. Therefore, we have attended several industry conferences, workshops, and seminars to gain access to the targeted companies by introducing our research project (Yin, 2018). It has two main benefits. First, interviewer and interviewee must meet before the interview to discuss the research scope and process, which means that the potential interviewees either have extensive experience of the innovation projects or/and participated in the projects (Hutcheson, 2013). Second, it helps us conduct snowball sampling in the case studies. This sampling strategy allows the executive managers to give names of further appropriate interviewees regarding the specific innovation projects of the case study companies. Furthermore, an interview topic guide is given to interviewees before each interview takes place to help them get familiar with academic research interviews (Turner III, 2010). Importantly, the guide is part of the case study protocol that has been developed throughout the research (Yin, 2018).

3.4.4.2 Secondary data

Using secondary data is considered a crucial alternative to collecting new data in case study research (Bryman, 2016). Yin (2018) explains the use of secondary data is highly relevant to every case study topic and needs to be added in data collection plans. Secondary data can be both qualitative (non-numerical) and quantitative (numerical). There are three major forms of secondary data: survey, documentary, and multiple sources (Table 3.5).

	Type	Example
Survey	Censuses	Governments' censuses
	Continuous and regular surveys	Labour market trends Employee attitude surveys
	Ad hoc surveys	Governments' surveys Organisations' surveys
Documentary	Text materials	Organisations' databases Reports and minutes of committees Newspapers Magazines
	Non-text materials	Television and radio Voice recordings Video recordings Images
Multiple source	Snapshot	Government publications *Financial Times* country reports
	Longitudinal	Industry statistics and reports Government publications EU publications

Table 3. 5 Different forms of secondary data (Adapted from Saunders and Lewis, 2012)

For case study research, secondary data has its advantages in providing stable sources and can be reviewed repeatedly. Also, secondary data is not intentionally created for the case study and contains names, references, and details of specific events (Lauria and Wagner, 2006). Furthermore, secondary data can provide broad information and cover a long time, often applied in socio-technical transitions studies (Bryman, 2016). Thus, multiple secondary sources have been adopted to this thesis to corroborate primary data, such as documentary information, snapshot data, and longitudinal data sources.

There are limitations of secondary data. For example, secondary data can be difficult to find. In particular, researchers may not gain the internal documents that relate to specific projects. Also, the reporting bias due to the bias of the document's author, which makes the data less reliable (Bryman, 2016). However, as noted by Yin (2018), the most important use of secondary data is to corroborate evidence from other sources. Hence, detailed interview records (text and video recordings) can be found in the public media because some of our interviewees come from executive committee members and appear in many events. It is beneficial to enhance construct validity by reviewing interview questions before the fieldwork and analysing case studies after data collection (Saunders and Lewis, 2012).

3.4.4.3 Direct observation

Using multiple methods of data collection can contribute to the development of a well-built case study (Mills et al., 2012). According to Yin (2018, p. 122), "observational evidence is often useful in providing additional information about the topic being studied." Thus, the real-world setting of the case provides the opportunity for direct observations to serve as another source of evidence. As a result, direct observation has been adopted, as communication plays a crucial role in developing innovation projects to facilitate customer value creation (Gustafsson et al., 2012). In one of the pilot case studies, two direct observations have been made, one in a customer open day and another in a research seminar. However, the direct observation method has been removed after the pilot case study because the method is time-consuming and requires multiple observers to increase the reliability of observational evidence (Yin, 2018), which is considered difficult for a single researcher to implement during the fieldwork.

3.4.4.4 Ethical considerations

"Since virtually all research using primary data, that is data which we collect specifically for the purposes of our research, involves our relationships with others, this is clearly something we shouldn't ignore. Or can we?" (Saunders and Lewis, 2012, p.75). Research ethics should be understood as an ongoing reflection for research practices that involve human participants (Mills et al., 2012). Bryman (2016, p. 125) explains the ethical principles can be broken down into four questions:

1. Whether there is harm to participants
2. Whether there is a lack of informed consent
3. Whether there is an invasion of privacy
4. Whether deception is involved

Harm can be defined in several ways, including physical harm, harm to participants' development, and other indirect harm (Bryman, 2016). Moreover, confidentiality is key to getting access to the company as it often requires that researchers not disclose the company's identity. As semi-structured interviews have been applied in this thesis, it should be noted that qualitative interviews are valuable but sometimes can be very sensitive. For example, Wesseling et al. (2014, p. 200) explain that some car manufacturer representatives are not willing to discuss the specific topics in-depth, so “to facilitate candid responses, all interviewees were granted anonymity for this paper.” Consequently, this thesis chooses to use pseudonyms to keep the anonymity of the participants and the companies involved in the research. Importantly. Ethical approval has been obtained from the Research Ethics Committee prior to commencing data collection (see Appendix xx). For all research participants, a case study brief was prepared as part of the data collection process to help interviewees understand the topic and purpose of the search. Furthermore, a consent form was provided before the interview, and interviewees are required to read and sign the form (see Appendix xx). Also, interviewees must be informed that the interview would be recorded for transcription, and they had the right to withdraw at any stage of the research process (Bryman, 2016). At last, interviewees would be given a copy of transcripts to have the opportunity to correct any factual errors.

3.4.5 Pilot case studies

Yin (2018) notices that it is important to treat a pilot case study as a ‘pilot test’ rather than a ‘pre-test’. Because a pilot case study is considered more formal and helps researchers refine research questions, data collection plans, and conceptual frameworks. Importantly, the pilot case study provides insights into the case study protocol (Ellinger and Watkins, 2005). The multiple-case design requires a clear case study protocol to guide the data collection throughout the investigation process (Yin, 2018). Moreover, a pilot study plays a pivotal role in conducting qualitative case studies, especially where semi-structured interviews are applied (Malmqvist et al., 2019). Due to the interpretivist nature of this thesis, the pilot case study is essential to develop an understanding of our conceptual frameworks and data collection procedures (Ellram, 1996).

A case study protocol was developed before data collection began as suggested by Yin (2018), including four sections: 1) An overview of the case study; 2) data collection procedures; 3) interview question pool; 4) tentative outline for the case study report. A preliminary case study protocol was developed based on previous research and literature in the fields of socio-technical transitions, business models, and logistics innovations (Ellram, 1996). Then, the supervisory team reviewed the preliminary research protocol before the pilot case studies were conducted. Moreover, the pilot case studies contributed to the development of the case selection criteria (see Section 3.4.2), research questions, the conceptual framework, and interview questions (see Section 3.5).

The pilot case studies continued for 6 months (started from 06/2017 to 12/2017). By following the case selection criteria, we attended several research seminars and conferences to introduce the research topic of this PhD study. As a result, three companies agreed to participate in the pilot case studies, including Company A (logistics service), Company B (industrial supply), and Company C (online retail). More importantly, we had the chance to interview the case companies' executive managers responsible for the innovation projects that we were interested in. In addition, we were invited to attend the customer open day of Company B to explore how the company presented its innovative solutions to customers. Table 3.6 provides a summary of the pilot case studies.

	Innovation projects	Interviews	Other data collected
Company A 06/2017 – 12/2017	Distributed manufacturing solution	Global Head of Strategy and Innovation (1A) Logistics Service Analyst (A) (3A)	Annual report: 2015-2018 Investor presentation: 2015-2018 Press articles: distributed manufacturing service introduction (2017); new logistics manufacturing hub (2018); lunch new services in South America Company presentation in distributed manufacturing services (2017) Interview records: supply chain future (2017); warehouse locations (2020)
	On-demand forecasting solution	Research Leader of University Research Centre (2A)	Press articles: new research centre (2016); on-demand forecasting product introduction (2016); innovation awards (2016) Company workshop in forecasting (2017)
	Additive manufacturing solution	Global Head of Strategy and Innovation Logistics Service Analyst (B) (4A)	Annual report: 2018 Press articles: 3D printing partnership with technology provider (2016); partnership with university (2016); 3D printing and revolution in supply chains (2019) Company workshop in additive manufacturing (2018)
Company B 08/2017 – 12/2017	Innovative Kanban bin system	Regional Managing Director (1B) Head of Marketing (2B)	Annual reports 2018-2019 Company presentations: lean production concept (2017); future Kanban systems (2017); components management solutions (2017) Press articles: Kanban system and principle (2017) Brochure: RFID Kanban system (2018); lean management, Bins (2018) Observation: customer open day (2017) Fieldwork to the UK branch (2017)
Company C 11/2017	Smart fulfilment centre	Head of the Innovation Centre (1C)	Annual reports:2017-2020 Press articles: warehouse automation (2015); 4G technology in warehouse (2016); first international customer for e-commerce solution (2017); software development centre (2018); vertical farming (2019); new smart fulfilment centre in North America (2020) Company presentations: smart online grocery platform (2017); robotic warehouse technologies (2019) Interview records: warehouse automation (2017); disruptive innovation (2019)
	Autonomous vehicle delivery		Press articles: driverless van delivery trail (2017); the autonomous vehicle project (2018); partnership in autonomous vehicle delivery (2021) Interview records: new partnership to develop autonomous vehicles (2021)

Table 3. 6 Pilot case studies summary (Developed by the author)

As explained in Section 3.3.2, by following an abductive approach, pilot studies are crucial to go back and forth between theoretical knowledge and empirical findings (Kovács and Spens, 2005). In this thesis, the pilot case studies are crucial to refining the conceptual framework and research questions because it was initially designed to relate socio-technical transitions and business model theory. Therefore, an S-D logic, service ecosystems view has been adopted in the main case studies to explore the role of firms in socio-technical systems (details of theoretical and methodological reflection see Section 5.5). Another main purpose of the pilot case studies is to develop and refine the case study protocol. As noted by Yin (2018, p. 99), "the heart of the protocol is a set of substantive questions appearing in [protocol questions]." Consequently, the refined conceptual framework has guided the following empirical investigation. The link between interview questions and the likely sources of evidence (e.g., academic literature, other published data) helps collect data from the main studies (Ellram, 1996; Yin, 2018).

3.4.6 Main case studies

The pilot case studies enabled us to further refine the conceptual framework, research questions, and data collection procedures (see detailed reflections in Section 5.5). Thus, we conducted the main case studies based on an integrative view of S-D logic and the MLP. Data collection was mainly based on semi-structured interviews, which started from 09/2019 until 02/2020. As part of the pilot case studies' methodological reflections, secondary data formed the basis for the preparation of the interview questions. They provided additional information for the case study analysis, especially the recorded interviews found in the public media. As a result, data triangulation was reached by developing convergent evidence from multiple sources (Yin, 2018).

Two case studies were conducted in stage 2 by following the revised case study protocol. First, we decided to revisit Company A for the following reasons: 1) Company A's innovation projects were guided by a clear innovation strategy – distributed manufacturing. So, the value proposition of the company had been evolving accordingly with the innovation strategy; 2) the company was representative of a trend in the logistics industry that had been adapting to digitalisation; 3) the company's innovation activities represented S-D logic and implied a shift from creating value for customers to creating with customers, which was in accordance with our theoretical replication logic of the case selection criteria. However, due to access problems to the target interviewees, we decided to conduct a research project with Company A's research partners to investigate how the company's value propositions were developed and evolved. As a result, the project started from 01/2018 until 09/2019 and was collaborated with Company A's research partners by adopting an S-D logic, service ecosystems view on logistics innovations.

Methodologically, the second-round research of Company A was in line with the concept of "longitudinal immersion", which is defined as "the situation in which the accumulative insights generated through knowledge acquisition in multiple diverse research settings, criticality and reflexivity are repeatedly tested against multiple aspects of practice through sequential and overlapping engagements" (Wells and Nieuwenhuis, 2017, p. 48). This process included discussions with research partners, academics, and practitioners, which allowed us to understand the research object over a protracted time frame. The project gave us opportunities to share knowledge related to the development of Company A's innovation projects. Furthermore, the research project allowed us to achieve reflexive triangulation by adopting S-D logic in a single case study of Company A (Farquhar et al., 2020). In addition, the project helped re-access interviewees. It provided the opportunity to attend several conferences that were organised by Company A. One final formal interview was conducted in 2020 with the executive manager of the company. A general picture portrayed by the interviewee helped us identify the new development of the distributed manufacturing service, making this case study more comprehensive. The research project is summarised in Table 3.7.

Activity	Description	Dates
Research project	Investigating how logistics innovations have evolved by adopting an S-D logic, service ecosystems view	01/2018 to 09/2019
Conferences and research seminars	Attending and engaging with the company's research events	03/2018 and 11/2018
Academic conference paper	Preparation for the research paper, receiving feedback from academics	01/2018 to 08/2018
Academic journal paper	Looking for academic journals to submit and publish the paper	10/2018 to 03/2020

Table 3. 7 Summary of the research project (Developed by the author)

Company D was selected following the theoretical replication logic. As a start-up company, Company D's platform-based business model represented a disruption to the road freight sector in Europe. Specifically, the company's focus was on the digitalisation and automation of the sector. Thus, Company D was selected as the representative of a disruptive business model that aimed to accelerate the logistics industry's digital transformation. Following the case selection criteria, we gained permission to conduct a case study by introducing the research topic to a senior director of the company. At last, two-day fieldwork was conducted abroad after the discussion with the senior director. In total, seven face-to-face semi-structured were conducted in the company's meeting room, and secondary data such as brochures, press releases, and recorded interviews were also collected before and after the fieldwork.

During the data collection process, the interview questions of two main case studies were refined by adopting an S-D logic, service ecosystems view on the role of firms. Although the interview structure was similar to that in the pilot case studies, the emphasis was given to the innovation project development process. Therefore, these interview questions were served for both within-case and cross-case analysis to explore how value propositions contributed to the institutionalisation of novel resource integration (Lusch et al., 2016). For example, instead of asking, "how would you anticipate your business model development process", interviewees were asked, "were there any factors that modified your decision during the innovation project?" Table 3.8 provides a summary of the main case studies.

	Innovation projects	Interviews	Other data collected
Company A (revisit) 09/2019-02/2020	Lean logistics improvement	Global Head of Strategy and Innovation (1A) Research Partner A Research Partner B	Press articles: waste-reducing circular economy (2017); a new lean management tool (2019)
	Distributed manufacturing solution		Annual reports: 2019-2020 Press articles: launch new services in South America (2018); new distributed centre (2018) partnership with high-tech company (2019);
	On-demand forecasting solution		(N/A)
	Additive manufacturing solution		Press articles: creating end-to-end solution (2017); 3D printing for medical use in COVID-19 (2020) Interview records: global supply chain future (2020)
Company D 09/2019-11/2019	Truckload-shipping ecosystem	Executive Manager A (1D) Executive Manager C (3D) Software Engineer Manager (4D) Senior Director (7D) Operation Manager (4D)	Brochures: fleet management software (2019) Press articles: live tracking for trucks (2018); digitisation in the transport industry (2018); the German logistics market (2018); GPS tracking and impacts (2018); optimising the route of transport (2019); truck platooning and autonomous trucks (2019); digitalisation in the logistics industry (2021) Interview records: company's business model (2017); future of freight (2019); technology-driven industry (2020); the European logistics industry (2021); company strategy (2021);
	Fuel card collaboration	Executive Manager B (2D) Business Development Manager (6D)	Brochures: fuel card service (2019) Press articles: cooperation with the fuel card provider (2019) Interview records: accelerate growth in the logistics industry (2021)

Table 3. 8 Main case studies summary (Developed by the author)

3.5 Data Analysis

3.5.1 Coding

Data analysis is considered the most difficult and most important aspect of qualitative research. Basit (2003, p. 143) explains: “coding is one of the significant steps taken during analysis to organise and make sense of textual data.” The multiple-case study design has generated a large database such as field notes, interview transcripts, and secondary data, and it is crucial to give the data meaning (Bryman, 2016). In addition, a large amount of data has been obtained from the case studies, the qualitative data analysis software – NVivo 12 is used to facilitate our transcribing and coding process.

In this thesis, qualitative data analysis of the case studies is based on open, axial, and selective coding by using grounded theory (Ketokivi and Choi, 2014; Bruscaglioni, 2016). Strauss and Corbin (1998, p. 22) explain the notion of theory as “a set of well-developed categories… that are systematically related through statements of relationship to form a theoretical framework that explains some relevant … phenomenon.” Thus, these coding techniques aim at extending existing theory in the transitions literature. The three coding phases are as follows (Strauss and Corbin, 1998; Bryman 2016):

> Open coding: the process of breaking down, examining, comparing, conceptualising, and categorising data.
>
> Axial coding: a set of procedures whereby data are put back together in new ways after open coding, by making connections between categories.
>
> Selective coding: the procedure of selecting the core category, systematically relating it to other categories, validating those relationships, and filling in categories that need further refinement and development.

However, the three coding phases have received some criticisms. For example, Bulmer (1979) asks whether researchers can suspend their prior knowledge of relevant theories until the data analysis takes place. Also, Coffey and Atkinson (1996) argue that the fragmented data produced by the coding process will lead to “a loss of a sense of context”. As the case study design is based on an abductive reasoning and interpretivist stance, the coding procedure is following the evidence generated from the case studies. Importantly, our prior understanding of the transitions field, business models, and S-D logic helps refine the procedure during the research process (Hahn and Ince, 2016).

First, open coding of the interview transcripts and the secondary data was conducted. The aim was to create tentative labels for keywords, sentences, or paragraphs that helped identify general attributes from the interviews. The primary goal of this phase was to identify as many attributes as possible (Strauss and Corbin, 1998). Hence, a word or short phrase that came from the interview and the secondary data was often taken as a code. As a result, some initial concepts were recognised during the open coding process.

Open coding was followed by axial coding that aimed at identifying relationships among the open codes to generate more abstract categories and subcategories. It should be noted that the categories were the result of constantly going back and forth between the categories and the data (Strauss and Corbin, 1998). Thus, the data analysis process was considered an ongoing process that shaped the interpretation of our open and axial coding (Bryman, 2016). In line with the aim of theory extension, we tried to link open codes with the structure of the conceptual framework. Furthermore, the business model framework (Osterwalder and Pigneur, 2010) and the notion of value co-creation (Vargo et al., 2015) contributed to developing several categories and subcategories, including customer relationships, key activities, resource integration, and value co-creation.

At last, selective coding was applied to address the research questions by enhancing and verifying the categories. Thus, the selective coding concentrated on core categories that contributed to theoretical development (Haraldsson et al., 2011). Furthermore, an S-D logic, service ecosystems view offered a certain level of analytical flexibility to understand the role of firms in socio-technical transitions. For instance, the service ecosystems concept was adopted at the micro level to explore how innovation activities shaped the firm’s service ecosystems. The concept was also developed at a higher level to explain how firms had co-evolved with broader socio-technical systems by following different logistics strategies.

3.5.2 Within-case and Cross-case analysis

Section 3.5.1 introduces the coding techniques that have been applied in this thesis. Next, within-case analysis has been adopted to allow us to immerse in the data within a single case (Mills et al., 2012). It should be noted that each case represents a stand-alone entity in a multiple case study. Therefore, we conducted the within-case analysis with a similar structure to gain "a rich familiarity with each case" to let the unique patterns of the case emerge (Eisenhardt, 1989). The transcripts were read again once the patterns were identified, which helped understand what had happened in the case study companies. Furthermore, the explanation building technique was applied. The within-case analysis revealed how and why companies involved in the innovation projects enhanced our understanding of the causal mechanisms between firms' innovation activities and their operational environment.

Then, cross-case analysis was adopted to "force investigators to look beyond initial impressions and see evidence through multiple lenses" (Eisenhardt, 1989, p. 533). The cross-case synthesis was guided by a "case-based approach" as suggested by Yin (2018), which aimed at comparing or synthesising important with-case patterns while retaining the integrity of the case. This approach helped identify similar and contrasting themes across the cases studies. The research questions were also considered by focusing on institutional changes initiated by companies' innovation activities (Vargo and Lusch, 2016). Considering the degree of institutional changes that the innovation projects have achieved through the value proposition development, the innovation projects were cluster into three groups to identify different patterns:

1. Maintaining institutionalised rules of resource integration
2. Disrupting institutionalised rules of resource integration
3. Changing institutionalised rules of resource integration

It should be noted that the three forms (maintaining, disrupting, and changing) of institutional works should be seen as happening simultaneously. This means that the innovation projects will break the existing rules of resource integration and some of the existing rules will be maintained at the same time (Koskela-Huotari et al., 2016). In this thesis, logistics innovations aim at reconfiguring the institutional structure in service ecosystems are occurring with conflicts and tensions. As a result, from the cross-case analysis, we can determine whether the findings from the within-case analysis were robust across the cases, such as different network configuration, redefining roles of actors, and reframing resources. Thus, similarities and difference were compared between groups to build an explanation about how these innovation activities contributed to the formation of logistics strategies, logistics trends, and production and consumption systems.

Finally, both within-case and cross-case analysis were implemented interactively to develop and identify theoretical propositions (Mills et al., 2012). The purpose of using within and cross-case analysis was to help our understanding: 1) how value propositions are created and developed; 2) how service-ecosystems are shaped and evolved; 3) what is the role of firms in socio-technical transitions; 4) what is the role of logistics innovations in socio-technical transitions. By conducting a multiple-case study of logistics innovations from four companies, we provided an additional and valuable view on logistics activities to understand the whole-system reconfiguration approach. Furthermore, an S-D logic, service ecosystems view provided a balanced view of firms and moved beyond the niche-actor and regime-actor dichotomy in transitions studies (McMeekin et al., 2019).

3.6 The quality of research design

Reliability and validity are important criteria to establish and assess the quality of quantitative research. However, qualitative researchers have started to adopt these criteria for qualitative research (Bryman, 2016). Yin (2018) recommends four tests to judge the quality of case study research, including:

- Construct validity: identifying correct operational measure for the concepts being studied.
- Internal validity: seeking to establish a causal relationship, whereby certain conditions. are believed to lead to other conditions, as distinguished from spurious relationships.
- External validity: showing whether and how a case study's finding can be generalised.
- Reliability: demonstrating that the operations of a study – such as its data collection procedures – can be repeated, with the same results.

Construct validity is also called measurement validity (Mills, 2012). Three tactics have been recommended to enhance construct validity: 1) The major strength of case stud research is the opportunity to collect multiple sources of data. This procedure provides a basis for data triangulation, which helps researchers develop convergent evidence to enhance the case study's construct validity (Yin, 2018). As introduced in Section 3.4.4, multiple sources were collected during data collection, such as interviews, secondary data, and direct observation. 2) Maintaining a chain of evidence, which means the reviewer can trace the research process from research questions to findings or the other way around. The chain of evidence was established by developing the case study protocol to link interview questions with the database and case study report procedures. 3) The interviewees were asked to provide feedback on case study reports to enhance construct validity.

Internal validity is typically used in quantitative studies. However, it can be enhanced by using pattern matching and explanation building strategies in qualitative case studies (Mills, 2012). Several data analysis techniques were adopted in this multiple case study, including three-phase coding (open, axial, and selective), within- and cross-case analysis. Thus, the explanation – building strategy was adopted to analyse case study data by building an explanation (Yin, 2018). Therefore, comparing the emergent theory with existing literature was crucial to internal validity, and explanations were established by the evidence collected throughout the case studies.

External validity relates to generalisation, which has been discussed in detail in Section 3.3.3. Here, only analytic generalisation was undertaken by using replication logic for case selection. Furthermore, case selection criteria (see more details in Section 3.4.2) were carefully developed based on the information-oriented selection strategy to enhance analytic generalisation (Flyvbjerg, 2006). As a result, paradigmatic and extreme cases were selected to avoid using sampling logic to guide multiple-case studies (Yin, 2018).

Finally, a case study protocol was carefully designed with the supervisory team to enhance case study reliability. The protocol included four major sections and was developed significantly during the pilot case studies (see details in Section 3.4.5).

- An overview of the case study (e.g., topics, research questions, data selection criteria)
- Data collection procedures (e.g., gaining access, methods, ethics, secondary data)
- Interview question pool (e.g., interview guide)
- Tentative outline for the case study report (e.g., coding, transcribing, report format)

3.7 Chapter summary

This chapter has introduced the methodology used for this thesis. First, after discussing the ontological and epistemological assumptions of the study, we decided to use an interpretivist stance to explore complex social interactions between logistics innovations and socio-technical transitions. Given the exploratory nature of this study, an abductive and qualitative approach was followed, which allowed us to go back and forth between theoretical knowledge and empirical findings to extend our understanding of the role of firms in socio-technical transitions. Considering logistics innovations have not fully explored in the transitions literature, the multiple case study design was used to provide an in-depth investigation of this new research topic. Case selection criteria were developed by reviewing existing related literature and guided by the information-oriented selection strategy, and extreme/paradigmatic cases were selected to facilitate the theory development process. We further explained the ethical consideration in the study because human participants were involved in the data collection process. Finally, we examined the quality of the research design by using four different tests. In the following chapter, we will introduce the empirical context in which this research was implemented, providing background information about how the European logistics industry has been shaped.

Chapter 4. Empirical context: industry trends in the European logistics sector

4.1 Chapter Introduction

As discussed in the literature review, we bring socio-technical transition theory and S-D logic to explore how companies manage their innovation activities in socio-technical transitions. However, the purpose of this chapter is not to see how companies' innovation activities shape the logistics service ecosystem. Instead, this chapter briefly reviews the macro level (landscape) development to explore how socio-technical factors shape the current industry. As shown in our conceptual framework (see Section 2.5), landscape factors cannot directly influence or be influenced by system actors in the short run, but actors at the niche and regime levels can respond to these factors. Thus, the chapter's focus is on providing an empirical context that helps understand why companies choose to become more innovative in the era of digitalisation of the European logistics industry, which is considered the topic of this thesis. For this purpose, we develop a narrative around the rise of the European logistics sector from the 1950s.

This chapter is structured as follows. In Section 4.2, a brief history of the European logistics sector will be presented. Then we try to elaborate on how the European logistics market is shaped by these macro-level developments rather than a comprehensive review of the logistics sector in Europe. As a result, several landscape factors have been found that may contribute to the formation of the current European logistics sector.

4.2 The rise of the European transport and logistics market

The logistics industry is one of the biggest sectors in Europe. The European logistics industry generates more than €900 billion market value and €300 billion added value annually, contributing 7% of the total GDP (Savills, 2017; Huang et al., 2019). The growth of logistics and freight transport is not only the consequence of economic growth at different levels such as global, regional, or logical scales, and it is also in accordance with the structural changes in the geography of production and consumption (Hesse and Rodrigue, 2004). Thus, the logistics industry plays a dual role in shaping (and being shaped) by the separation of production and consumption locations (Pettit et al., 2018).

Moreover, the logistics sector has moved towards more complex service provision, which fits into modern production and consumption systems. Consequently, a restructuring of distribution activities has made logistics activities more strategic and important to business over the decade (Holl and Mariotti, 2018). Thanks to the rise of worldwide supply chains and the development of retail-led business, eight of the ten best-performing countries are in Europe in terms of logistics activities according to the LPI (Logistics Performance Index) 2018 report published by the World Bank (World Bank, 2018). In this section, the definition of logistics is based on the European Commission (EC)'s report on the logistics industry:

> "Logistics is considered as a set of services including the planning, organisation, management, execution and monitoring of a company's entire material, goods and information flows (from purchasing, production and warehousing, to added value services, distribution and reverse logistics)" (EC, 2015, p. 27)

4.2.1 The formation of the European logistics sector: from the 1950s to the 2000s

As discussed above, the rise of logistics in the EU results from the alignment of various developments which started from the 1950s (Vahrenkamp, 2010). Five waves have been identified which are interrelated to the so-called "logistics revolution" in Europe (Hesse and Rodrigue, 2004; Vahrenkamp, 2010; Holl and Mariotti, 2018):

(1) Mass motorisation and the motorway network: mass motorisation started in the 1950s after the end of the Second World War - a period of unprecedented economic growth in Western Europe (Schipper, 2007). Widespread car use led to a series of transformations in road infrastructure because of cheap fossil fuels. Thus, European counties needed to extend the motorway network in response to the increasing need for car users and the increasing pressure from the auto lobby (Borowy, 2013). The expansion of the motorway network has also contributed to the growth of truck traffic, which has been considered decisive for the truck-based logistics systems because it has significantly improved the economics of trucking (Frémont and Franc, 2010). Meanwhile, rail transport failed in the competition with the truck-based freight on quantity and time-based services during the 1950s and 1960s.

(2) The rise of the consumer-oriented economy: such developments contributed to the evolution of model logistics systems in two main fields of the consumer-oriented economy. According to Vahrenkamp (2010), there are: 1) the concept of JIT (just-in-time) delivery for the automotive industry; 2) the modern distribution systems for the consumer goods industry. As a result, essential logistics infrastructure, including transport networks and warehouses, have been developed to enable the growth of the mass consumption society in Europe.

(3) The deregulation of transport modes and the integration of European Single Market: the logistics and transport sector has been strongly affected by the policy development such as cabotage rules, railway packages, Single European Sky initiative, and European maritime transport space without barriers (EC, 2015). The deregulation of the transport industry has contributed to the private supply of logistics services and increased the performance of logistics services in terms of fleet utilisation, lead-times, freight rates, and service quality.

Starting from January 1, 1993, the European Single Market contributed to the emergence of global logistics activities and restructured the European domestic distribution systems. The single market has also been considered as the main factor that pushes business to restructure their manufacturing and distribution operations in the following decades (O'Sullivan, 1997). However, there was uneven development across different transport modes. For example, no single market has been created for maritime transport, different standards (e.g., track gauges, signalling systems) existing in the rail sector, and other legal and administrative barriers (Monti, 2010). Thus, the European logistics and transport system needs to operate more efficiently and flexibly to facilitate other sectors getting full benefits from the single market. Moreover, the concept of a Digital Single Market for Europe has been introduced to "…tackle a wide range of issues related to the digitisation of European society, but an over-arching theme is the facilitation of cross-border electronic commerce within the EU" (Marcus et al., 2019, p. 11). As a result, the Digital Single Market will also accelerate the logistics sector's digitalisation, enabling cooperation across different transport modes and sectors.

(4) Globalisation increases the flow of goods: international trade has significantly shaped the nature of the physical distribution. Globalisation has accelerated the relocation of world economic activities, which results in more complex global economic integration and the subsequent necessity of new transport networks. From the 1980s to the 1990s, the consumer goods industry started moving to low-wage countries, such as Eastern European countries, Turkey, and Asian countries (Zhu et al., 2002). Meanwhile, containerisation has contributed to a significant reduction in transport costs since it offers great economies of scale while retains a wide variety of supply chains (Guerrero and Rodrigue, 2014; Levinson, 2016). Globalisation and containerisation have also required significant investments in port infrastructure to improve container handling facilities because of the growth of transhipment traffic. For example, from 1980 to 1990, global container throughput had grown from 40 million TEU to 75 million TEU (Notteboom and Rodrigue, 2008).

(5) Internet-based systems and the rise of supply chain management: computer technology has advanced since the 1980s and contributed to the emergence of Enterprise Resource Planning (ERP) systems from the 1990s. The ERP systems have gradually been installed in most large companies since the 2000s since they helped integrate diverse information into a single database which simplified the exchange of information across the global supply chain (Akkermans et al., 2003). In 2004, the Council of Logistics Management (CLM) changed its name to the Council of Supply Chain Management Professionals (CSCMP), reflecting the trend that the concept of supply chain management has encompassed logistics management and become a global phenomenon rather than local and regional activities. As such, CSCMP has created official definitions for supply chain management and logistics management (CSCMP, 2013):

- *Definition of Supply Chain Management*: “Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities.” (pp, 187)
- *Definition of Logistics Management*: “Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements.” (p. 117)

4.2.2 Key factors that shape the current European logistics industry

The previous section has briefly introduced the formation of the European logistics sector from the 1950s to the 2000s. In this section, the aim is to identify the key factors that shape the current logistics sector. These factors have been categorised using the PESTLE framework (i.e., political, economic, socio-cultural, technological, legal, and environmental factors) by the EC (EC, 2015). Therefore, this section's focus is on the application of the PESTLE framework to the current European logistics industry. The findings can serve as a basis for exploring future trends in the next section. According to EC (2015), the PESTLE framework includes several dimensions, which are explained as follows:

4.2.2.1 Political factors

As is discussed in Section 4.2.1, the deregulation of the European logistics and transport market started in the mid-1980s, but it was accelerated by introducing a new White Paper on transport policy in 2001 (Giorgi and Schmidt, 2002). Such deregulation of the logistics and transport market has impacted across all sectors, including road freight transport, rail freight transport and air transport, which reshaped the modal split and increased the volume of freight transport services (Lafontaine and Valeri, 2009). For instance, in the EU road freight market, the cabotage market was first opened to some Member States in 2006, which allowed certain Member States to enter cabotage transports in the EU. However, the country-specific interpretations have been replaced by the introduction of Regulation 1072/2009 in May 2010 (EC, 2015). The new regulation is called "three-in-seven" to coordinate all national cabotage transport. This regulation limits cabotage transport to a duration of seven days and up to three cabotage operations (Sternberg et al., 2020). The deregulation in the road freight market fosters foster competition and reduce transport costs within a single European transport market in which operators can perform logistics activities (McKinnon, 2007).

Furthermore, transport infrastructure plays an essential role in shaping a resilient European logistics network. The Trans-European Transport Network (TEN-T) aims to develop a comprehensive Europe-wide transport network that comprises railway lines, intermodal terminals, airports, roads, inland waterways (EC, 2018a). The TEN-T policy consists of two steps. The first step is to connect the most important nodes (the core network) by 2030. The second steps targets covering all European regions (the comprehensive network) by 2050. Such developments in the European transport infrastructure also enhance the function of the EU Single Market by fostering cross-border transport and multimodality. More importantly, most of the TEN-T projects have engaged with the promotion of sustainable transport modes. For example, the TEN-T has contributed to a shift from carbon-intensive modes toward railways, inland waterway, and maritime transport in long-distance transport. As a result, the

TEN-T policy's implementation will lead to a low emission transition in the European logistics sector (EC, 2011; EC, 2018a).

On 23 June 2016, the EU referendum was held, and the British citizens decided to leave the EU. The outcomes of Brexit will be expected to reshape the European logistics industry across all modes of transport. In 2019, UK exports to the EU were £294bn (43% of all UK exports), and UK imports from the EU were £374bn (52% of all UK imports) (UK Parliament, 2020). According to Deloitte (2019), some of the key impacts are: 1) road haulage, because international hauliers contributed to the majority of products imported and exported from the UK; 2) specific air freight routes could be impacts; 3) maritime transport could face challenges in terms of cabotage, seafarer certificates, and maritime security notifications. Moreover, Brexit will affect logistics operations in various ways, such as logistics efficiency, the customs and documentation process, and additional administrative works (Tielmann and Schiereck, 2017).

4.2.2.2 Economic factors

In the EU, the logistics sector contributes about 7% of the total GDP and employs more than 7 million people (Savills, 2017). Although the coupling between GDP growth and freight demand weakening at both European and global scales (Wang et al., 2020). As argued by the EC (2001, p.11)'s White Paper: "…we have to consider the option of gradually breaking the link between economic growth and transport growth." The logistics sector still holds a strong connection to manufacturing industries and other industries related to distribution systems. The enlargement of the EU in 2004 resulted in the shift of industrial capacity towards the lower labour cost countries in Central and Eastern Europe. This trend has led to faster growth in freight transport than in GDP (McKinnon, 2007). More importantly, the containerised transport system has further supported the development of intermodal transport in the EU (EC, 2017). Furthermore, the logistics sector largely depends on globalisation, which has significantly changed logistics activities since new logistics and manufacturing systems have emerged globally (Akyelken and Keller, 2014). As is described by Benvegnù et al., (2019):

> "Now, in the second decade of the twenty-first century, logistics is acting as a leading vector for the decomposition and restructuring of transnational value chains, allowing an undefined expansion of global production networks and configuring a giant wall-

less global factory articulated on different scales, from transnational supply chains to urban platforms." (p. 10)

In 2020, the COVID-19 pandemic significantly impacted businesses and the global economy. GPD has fallen by 12.1% in the euro area and 11.9% in the EU (Eurostat, 2020a). According to PwC research, the forecast decrease in gross value added (GVA) in the European freight transport and logistics sector is about -8.6%, which shows the sector's dependence on other final demand sectors such as automotive, retailing, and food industries (PwC, 2020). As a result, uncertainties that are faced by the logistics sector are largely dependent on the recovery of other industries since logistics is a downstream industry. However, the COVID-19 pandemic has created opportunities for the logistics sectors in the transition towards a digital and sustainable sector (Sarkis et al., 2020).

4.2.2.3 Technological factors

Technology plays an important role in shaping today's European logistics sector. However, the logistics sector has been described as "not very innovative" because of its high dependency on customers' requirements, which results in the low incentives for proactive technological innovations (Oke, 2008; Busse and Wallenburg, 2014). Information and communication technologies (ICT) have been a fundamental part of globalisation and impacted different industries across the supply chain. Pervasive ICT technologies and their application in logistics activities can be concluded in the following aspects (Harris et al., 2015; EC, 2015):

- Supply chain planning tools: ICT technologies improve the quality of information shared by different stakeholder groups by reducing interaction and transaction costs (Colin et al., 2015).
- Data-sharing: logistics activities have been transformed from transporting goods to exchange information, and the use of ICT helps to process data more efficient and accurate than conventional methods (Aiello et al., 2016).
- Track-and-track visibility: end-to-end visibility of supply chains can be achieved, and it is important that the growing complexity of supply chains and actors involved (Evangelista et al., 2013).

- Supporting technologies: such applications include Radio Frequency Identification (RFID), barcode, Optical Character Recognition (OCR) barcode, Global Navigation Satellite Systems (GNSS), and other technologies that have been applied warehouse systems to enhance safety, information provision and monitoring. These technologies have become more important with the introduction of the concept of “Industry 4.0” to the logistics sector (Winkelhaus, et al., 2020)

In terms of sustainable development, vehicle and transport technologies are crucial for the EU CO_2 reduction targets. Cleaner and efficient technologies thus become the key to meet the increasing emission standards. For example, Euro VI standards for heavy-duty vehicles have become mandatory since 2013, and CO_2 emissions and fuel consumption must be declared by newly produced trucks since 2019 (EC, 2018b). In 2016, the EC rolled out a low-emission mobility strategy to respond to the increasing demand for mobility and consumer goods. There are three main phases of the strategy (EC, 2016), which include:

- Increasing the efficiency of the transport system
- Speeding up the deployment of low-emission alternative energy for transport
- Moving towards zero-emission vehicles

Therefore, e-mobility has become an ideal option for low-carbon transport because it generates zero-emission and low-level noise during the operational period. At the current stage, electric vehicles are suitable for short-distance urban deliveries such as last-mile logistics completed by electric vans. However, issues such as driving range, charging time, and the availability of recharging infrastructure have become the barrier to further adoption of electric vehicles (Morganti and Browne, 2018). Heavy-duty vehicles are responsible for around 25% of CO_2 emissions from European road transport. However, the barriers and main challenges in sustainable long-haul transports are battery performance and charging infrastructure, such as on-road charging stations, conductive/inductive charging facilities (Liu and Song, 2018; DHL, 2020). Fuel cell trucks can be another option to reach decarbonisation in the road freight sector, although substantial infrastructure investment is expected to develop hydrogen production and refuelling (Çabukoglu et al., 2019).

Industry 4.0 is a collective term that originated in Germany to describe the fourth industrial revolution, which leverages new technologies such as additive manufacturing, robotics, artificial intelligence, and blockchain (Tang and Veelenturl, 2019). As part of the EU's Digital Single Market Strategy (see Section 4.2.1, No.4), the EC aims to help all industrial sectors accelerate the transitions towards a smart industrial system (Industry 4.0) with the integration of new technologies. As is described by German Chancellor Angela Merkel (Davies, 2015), Industry 4.0 is:

> "…a comprehensive transformation of the whole sphere of industrial production through the merging of digital technology and the Internet with conventional industry."

Therefore, it is clear that the concept of industry 4.0 is rooted in the digitalisation of manufacturing economies. As shown in the research by Deloitte Insights (2018), only 6% of all respondents reported that their organisations are developing Industry 4.0-related technologies in logistics, but 73% of the respondents' focus is on operations. However, when compared with other supply chain members, logistics and transport services may play a strategic role in examining and enabling these emerging technologies in practice (Abdirad and Krishnan, 2020; Kucukaltan et al., 2020).

Industry 4.0-related technologies bring a number of potential disruptions to the logistics industry (Kucukaltan et al., 2020). For instance, although in the experimental stage, autonomous trucks represent a disruptor, not only for a transformation in the trucking and logistics industry but also potentially impacts business models in the automotive industry (Fritschy and Spinler, 2019). Semi-autonomous platooning has become a more viable option at the current stage since fully autonomous driving is not yet ready and likely to realise gradually in the future (Xue et al., 2021). Additive manufacturing is another disruptive technology that will substantially impact the logistics industry because it will lead to localised manufacturing activities, reduced warehousing cost, and less waste (Jiang et al., 2017; Goehrke, 2018).

4.2.2.4 Other external factors

In addition, social and cultural factors have been highlighted by various studies and been often identified as both drivers and barriers for the European logistics sector. The following factors are addressed by previous research works (EC, 2015; PwC, 2016; DHL, 2020):

(1) Ageing society: currently, Europe's median age is 42 and a quarter of the population is aged 60 or over. According to the EC's forecast for ageing societies, the EU's old-age dependency ratio (the ratio between the age group 65+ and the age group 15-65) was 30.5% in 2018 and is projected to be 57.3% by 2100 (EC, 2019). Therefore, a structural change of the European logistics and transport sector is likely to adapt to the ongoing ageing issues. For example, elderly consumers will change the consumer landscape because of their shopping habits such as shopping time, shopping frequency, home delivery needs, and different product types (EC, 2015).

On the other hand, an ageing population may lead to a shortage of employees in the transport and logistics sector. According to Paradowska et al. (2016), one in three workers in the transport and logistics sector is over 50 years old and will be pensioned in 10-15 years. The lower payment for entry-level roles also discourages young workers from entering the logistics industry (McKinnon et al., 2017).

(2) E-commerce business: e-commerce accounts for 10% of total retail sales in the EU (Savills, 2017). Online shopping is growing substantially across all age groups over the last decade. According to Eurostat (2020b), 32% of people in the EU aged 16 to 74 shopped online in 2009, and the percentage had nearly doubled to 60% in 2019. Also, 15% of European consumers shop online from other European countries (EC, 2015). The increasing volume of e-commerce businesses will require the logistics sector to increase speed, reliability, and punctuality (Tang and Veelenturf, 2019). Furthermore, the COVID-19 pandemic has specifically accelerated this trend and expanded e-commerce towards new customers, firms, and types of services (Brem et al., 2021).

(3) Environmental awareness: with customers' increasing demand for green supply chain, the logistics sector needs to create value propositions that meet this environmental challenge (PwC, 2016). Therefore, new investments will be made into three venues according to the research conducted by DHL (2020): (a) transport optimisation, which helps to cut overall emissions; (b) zero-emission logistics fleets like battery or fuel cell electric vehicle technologies; (c) logistics facility design and placement, such as sustainable building materials, smart warehousing technologies, other IoT devices. Moreover, not only logistics companies, other economic actors (manufacturers, government, and consumers) have to participate in green logistics activities to achieve an environment-friendly culture (Baah et al., 2020).

(4) Social and safety regulations: in order to ensure road safety, minimise the distortion of competition and improve drivers' working condition in the EU, Regulation (EC) No 561/2006 set up to provide EU rules on maximum daily and fortnightly driving times, as well as rest periods for all road freight and passenger transport drivers (EC, 2009). According to the regulation, drivers must not drive more than 4 ½ hours without a 45-minute break, and daily rest should be at least 11 hours (Goel, 2018). However, this regulation could potentially reduce the driver's flexibility because of uncertain waiting periods at the loading ramps (EC, 2015).

Furthermore, Directive (EU) 2015/719 has been implemented in Europe to improve road safety and avoid damaging transport infrastructures. The directive sets up dimensions and weights for international transport, ensuring the free movement of goods in the EU (Palmer et al., 2018). The directive also grants derogations on vehicle length if the vehicle uses greener/safer technologies such as improved aerodynamic performance, new safety features, and alternative fuels. Consequently, the legislation helps to create a fair logistics market for competition between European logistics service providers, but it also hinders the competitive position of some LSPs' operation outside the EU (EC, 2015). In terms of carbon emissions, maintaining current regulations on weights and dimension may increase transport activities, leading to increased transport pollution and accidents (Palmer et al., 2018).

4.3 Chapter Summary

In this chapter, we introduced how the European logistics industry has developed over the past decades and what are key factors that shape the current logistics industry. Using the PESTLE framework, we examined several factors (e.g., political, economic, technological, and other factors) that contributed to the formation of the current logistics industry. These key factors are crucial for us to address how logistics innovations will contribute to the long-term socio-technical transformations in the discussion chapter. In the following chapter, we will draw upon these insights to address the findings from the pilot case studies. Furthermore, a reflection on both methodological and theoretical issues will be presented.

Chapter 5. Pilot Case Studies

5.1 Chapter Introduction

This chapter presents the findings of three pilot studies regarding logistics innovations in different company settings. As illustrated in the Methodology chapter (Chapter 3), the pilot case studies are crucial because both transitions theory and the business model concept are relatively new to logistics innovation research. In this manner, the pilot case studies contribute to developing research questions, research design, and the conceptual framework rather than merely a 'pre-test'.

This chapter comprises five sections. Section 5.2 provides an overview of the pilot case studies, comprising research methods, selection criteria, and the time period for the studies. The current transitions studies that have addressed a firm-level perspective often use the business model concept. Thus, the pilot case studies in this chapter also start from the business model perspective (see Section 5.3), trying to frame companies' innovation activities as a way of identifying new sources of value creation based on the interactions between different components of a business model – for example, value proposition, value network, and value capture. Also, such innovation activities contribute to the learning process of new technologies and their applications in different logistics services (see Section 5.4). However, we found that the current understanding of business models was not sufficient to interpret logistics innovations from a socio-technical transition perspective (see Section 5.6.2 theoretical reflections). Therefore, we defined logistics innovations from the S-D logic – how companies develop existing value propositions or create new ones. Section 5.5 presents how to use the S-D logic perspective to illustrate logistics innovations, including value proposition development and the changing roles of actors. Finally, Section 5.7 summarises the benefits of these pilot studies and their potential contribution to the PhD thesis.

5.2 Overview of the pilot case studies

A pilot study can be helpful to refine the data collection plan in both theoretical and methodological aspects. Thus, these three pilot case studies aimed to examine the theoretical framework in the real-life setting and the research procedures were adjusted according to the pilot case studies' results. Moreover, these pilot studies allowed to refine and develop the main and sub-research questions of this thesis. As suggested by Yin (2018), the criteria for selecting the three cases included: convenience, access, and relevance to the 'Logistics 4.0' concept. These factors helped the researcher build less structured and more prolonged relationships with case study participants. In turn, the pilot cases served as a ‘laboratory’ to improve the case study protocol.

Therefore, three companies were chosen since they were the most geographically approachable firms, and each company had been leading in developing industry 4.0-related innovation projects. Importantly, they agreed to provide access at the beginning of the pilot case study period. Another important issue was that the unit of analysis of the case study is each innovation project. Such innovation projects were being implemented during the data collection period, which helped us obtain first-hand insight into each stage of the projects’ implementation since they might spread across the organisation at different geographical locations. Besides, other data collection methods such as documentation and observations were made during the pilot case studies.

As shown in Table 5.1, three data collection methods have been applied in the pilot case studies, including interviews, documentation, and direct observations. For instance: 1) interviews have been conducted with key individuals such as executive managers, innovation managers, research partners, and research analysts; 2) secondary data was collected from multiple sources, including press articles, annual reports, company presentations, and company leaflets; 3) two direct observations were made in one pilot case study: one through a fieldwork and one through a customer open day. The data generated from these three pilot studies were analysed through the conceptual framework identified in Chapter 2 (Literature Review). The socio-technical transition theory and the business model framework (Osterwalder and Pigneur, 2010) have guided the data collection procedure. Also, the pilot case studies helped frame the individual firm’s efforts in a co-evolutionary manner to address Research Questions 1 and 2. Detailed information can be found in the Methodology Chapter.

Company	**Industry**	**Dates**	**Nos. of Interviews**	**Other data collected**
Company A	Logistics service	08/2017-12/2017	4	Secondary data
Company B	Industrial supply	08/2017-12/2017	2	Secondary data; Observation
Company C	Online retailer	02/2018-03/2018	1	Secondary data

Table 5. 1 Overview of three pilot studies (Developed by the author)

5.3 Results of the pilot case studies

This section provides an account of the findings from the pilot case studies in three sections. Each section is devoted to an individual firm. All cases are anonymised to protect the identity of the companies concerned.

5.3.1 Case study: Company A

This section provides an empirical investigation of Company A's innovation projects, including (1) the distributed manufacturing solution; (2) the on-demand forecasting solution; and (3) the additive manufacturing solution (Table 5.2). Company A has a long history in international air and ocean freight services. Company A has around 16,000 employees in 500 offices worldwide and operates with different partners globally. Company A decided to add logistics services to its existing business in 2011. However, the company realised that introducing logistics services into an already competitive market would not be successful. Also, the logistics industry was suffering from commoditisation, which resulted in lower margins for most organisations, especially for those who relied on traditional logistics warehousing services such as store, pick, and pack. As a result, Company A decided to develop innovative approaches to differentiate itself from its competitors in the logistics market.

5.3.1.1 The Distributed manufacturing solution

The most important aspect of Company A's distributed manufacturing solution was to combine a part of customers' manufacturing process with order fulfilment activities. Several questions were asked by company managers before initiating this innovative solution, such as: Is it possible to integrate with the customers' manufacturing process? How to improve asset velocity[1]? How to move the production process closer to final customers? At the start, Company A recruited a senior executive to lead the new logistics business. Several manufacturing specialists were also recruited to bring a new mindset into the company.

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[1] Increase asset velocity: improve inventory management by moving products quickly to reduce warehouse stock

“The company recruit […] had manufacturing background; he entered the company in order to improve the logistics operations… so what he tried to do is improve the assets velocity… in our case, the warehouse. What we are going to do is instead of having our warehouse full of products for a long period of time, we need to increase the turnover… this could help us to improve the profitability” (Logistics Service Analyst A, Company A, 3A).

This innovative solution was first applied with one of its customers in the telecoms industry in Brazil, which allowed the customer to relocate part of its manufacturing process from China to other places to make the fulfilment process timely and local. As a result, the solution led to a significant reduction in lead time, allowing last-minute software customisation to be implemented prior to delivery. More importantly, the distributed manufacturing solution helped Company A establish an overall manufacturing strategy that served as a base for the following innovation projects.

The distributed manufacturing solution could be considered a manufacturing strategy that Company A pursued to be differentiated from traditional logistics services. In this case, the warehouse was the core focus of the company because the ultimate goal of this innovative solution was to increase asset velocity by participating in the manufacturing process. Traditionally, logistics service providers’ focus was on value-adding activities in the supply chain, such as offering standard pick and pack services. However, since this innovative solution started, Company A was capable of adding value through whole logistics activities. For example, receiving orders could be broken into smaller quantities. In the meantime, Company A could reconsolidate these orders when received from different customers, which meant that more products could be stored for a shorter period of time instead of having warehouses full of product for a longer period. Also, the distributed manufacturing solution resulted in better cash flow performance from the customer’s perspective.

“… Now the lead time is reduced to 8 weeks or so (it used to be 24 weeks previously), so it is a massive reduction in lead time… That reduction in lead time is the major factor in the success of this new service” (Logistics Service Analyst B, Company A, 4A).

More importantly, with the application of Company A's manufacturing knowledge, customers' manufacturing resources were integrated with Company A's service provision since the company took over assembling and installation activities. Thus, the distributed manufacturing service reflected a shift in focus from value-adding activities to proactively managing customer's value creation activities by integrating manufacturing resources (Table 5.2). In this manner, value is co-created by both customers and Company A, leading to a closer relationship between both parties.

Value proposition	A customised manufacturing process closer to the final customer
Value creation and capture	Participating in customer's manufacturing process

Table 5. 2 Overview of the distributed manufacturing solution (Developed by the author)

5.3.1.2 The On-Demand Forecasting solution

The core idea behind this innovation project was similar to the distributed manufacturing solution, which was associated with asset velocity in the supply chain. More specifically, this innovative solution's focus was on the optimisation of customers' supply chains, rather than the traditional logistics service in filling warehouse space. Therefore, the new solution could proactively help Company A's customers balance their inventory level throughout the supply chain and understand customers' needs from a 'customer-centric view'. It is worth noting that the innovation project was initiated by an external academic partner and accepted by Company A as a collaborative research project. As a result, the value proposition was developed by the reciprocal relationship between the company and its research partner. This relationship provided opportunities for the further development of logistics service offerings.

> *"…the way it works is that the collaboration is supposed to be beneficial in both ways… we started a knowledge exchange [programme] from the university to Company A… [Company A] helped us to identify the relevant research questions that we tried to address" (Research Leader of University Research Centre, 2A)*

The on-demand forecasting solution was introduced as a customer-centric approach since it acquired the customer's supply chain information to be tailored to each customer's demand. In line with the distributed manufacturing solution, this solution also reflected a shift from "creating value for customers" or "adding value activities" to enhancing customers' value creation capability. However, according to the approach itself, its effectiveness largely depended on data availability, quality, and scope. Therefore, Company A played a role of coordinator in customers' supply chain to balance and control the inventory between supply and demand (Table 5.3).

Value proposition	A customer-centric view on the inventory management
Value creation and capture	Help customer to create value through their supply chains

Table 5. 3 Overview of the on-demand forecasting solution (Developed by the author)

5.3.1.3 The additive manufacturing solution

The reason for Company A to explore the potential of 3D printing technology was because the company and its research partner identified the technology could provide an important complement to its manufacturing strategy. As noted by one Analyst:

> *"… Company A had a [research project] previously, and it was a forecasting and inventory management solution, which was developed by [Research Analyst's name]. There was a question raised by [Researcher's name, University Partner]: have you considered additive manufacturing? Also, a customer was pushing Company A for customised glasses, and Company A couldn't do that at that moment [and] that was how the project started" (Logistics Service Analyst B, Company A, 4A).*

In the beginning, the initial idea was to install 3D printers in Company A's warehouses, which could be helpful to integrate its customers' supply chains. However, it was found difficult to change the internal mindset of Company A since the logistics industry has a reputation for being conservative, so Company A decided to establish a strategic relationship with a world-leading additive manufacturing provider. This collaboration allowed Company A to learn which products could be substituted by additive manufacturing techniques. More importantly, Company A had learnt how to implement, operate, and maintain the 3D printer, this enabled the company to become a certified additive manufacturing service provider. The company was able to control the inventory of raw materials through additive manufacturing process, which made the final stage customisation possible. Consequently, the newly developed service would allow customers to finalise their products at the latest possible stage of the supply chain.

> *"…Company A collaborates with [Research University] to acquire some experience with additive manufacturing and to develop analytical tools which we need, in order to start to sell additive manufacturing services to customers" (Logistics Service Analyst A, Company A, 3A).*

As illustrated above, the initial idea was to install 3D printers inside the warehouses of Company A. However, several factors had been identified as both barriers and opportunities during the project implementation. For example, legal copyright issues were identified after participating in the innovation project because Company A's legal department was not able to deal with such issues. Also, the investment cost of 3D printers became very high since 3D printing technologies were changing rapidly. Therefore, Company A decided to outsource the additive manufacturing service to other well-established companies to manage such legal copyright issues. As a result, Company A maintained its asset-light nature with the newly created value stream (Table 5.4).

Value proposition	On-demand production process at the latest stage
Value creation and capture	Outsource additive manufacturing service to create value

Table 5. 4 Overview of the additive manufacturing solution (Developed by the author)

5.3.2 Case study: Company B

The focus of this section is on the empirical study of Company B's innovation project in the Kanban bins as part of their RFID (radio frequency identification) system solution. Company B was established in 1999 as the subsidiary of a global group that focused on assembly and fastening materials (Table 5.5). As a subsidiary company, Company B began to provide logistics services to its parent company's customers in the early 2000s. Company B has become a leading company in the component supply solution and employed more than 1,640 people in the headquarter. The automation of traditional Kanban systems was not new to the market, but the innovation project provided the potential for the revolution of the conventional two-bin Kanban system.

Innovation project	Interviews	Focus
Innovative Kanban bin system	1B. Head of Marketing 2B. Regional Managing Director	Innovation activities; organisation strategy and goals; learning from the project; logistics trends

Table 5. 5 Overview of Company B's innovation projects (Developed by the author).

5.3.2.1 The innovative Kanban bin system

The traditional two-bin Kanban system was derived from lean manufacturing supply chain management and was helpful to optimise processes to reduce inventory levels. As is mentioned above, the automatic Kanban system was introduced in 2011 by adding RFID data transmission technology. Moreover, Company B decided to introduce an optical ordering system that allowed to record the quantity, number and ordering information for each bin's items. To do so, Company B worked with its sister company, whose focus was on the electronic components, and other partners were included since Company B realised that they lacked the best application technology. As a result, this innovation project resulted in a small parts bin with the installation of the camera. The camera can directly take a picture once the bin was delivered. The innovative bin solution also measured the percentage of remnants when employees started to remove the parts.

> *"The whole process was not only in our company alone but also in cooperation with our sister company. The first idea was doing at all in-house with our sister company. However, at a certain point, we said it okay, it is not a right way, because we do not have the best technology for doing so" (Head of Market & IT, Company B, 1B).*

As noted above, the innovative Kanban bins can automatically obtain information and transmit it to the ERP system. The benefit of this innovation project was that it allowed just-in-time small parts delivery on a demand-driven pattern. Importantly, these small parts could be delivered in real-time based on an image format. As the first-generation optical ordering system, it had the potential to work with other Industry 4.0-related solutions to provide a fully functioning cyber-physical system in an improved value chain (Table 5.6).

> *"I think the centralised thing, for me as a manufacturing company, I like to walk less and less, because if you plan the operate from this part of the factory to that part of the factory, to collect the product and walk all the way back again, that could be 15 or 20 mins when they are not working, that means it is less productive." (Regional Managing Director, Company B, 2B)*

Value proposition	Components supply in a real-time and transparent manner
Value creation and capture	Streamline warehouse processes and inventory reduction

Table 5. 6 An overview of the innovative Kanban bin system (Developed by the author).

5.3.3 Case study: Company C

The focus of this section is on the innovation projects of Company C, including (1) warehouse automation project; and (2) electric vehicle delivery project. Company C is an online retail retailer which was established in 2000. Compared with its competitors, Company C's core competency of its online retail solutions enabled the company to differentiate itself in the market. In 2013, Company C launched the first fulfilment centre as an integral part of their fulfilment solution. Combined with the latest automation and operation technologies, the solution helped the company secure important business partners. More importantly, Company C has been expanding its customer base in online retail services and exploring opportunities with other supermarkets that may be interested in their end-to-end e-commerce solution. In 2015, a smart e-commerce platform was launched with its physical fulfilment asset solution as an integrated platform that enabled its partners to run the whole online shopping process. In the meantime, Company C had run several trials in low-carbon last-mile delivery, including electric vans, electric scooters, and driverless delivery vans. Such activities had been implemented because electric vehicles could cut the company's carbon footprint, reduce traffic congestion, improve urban air quality, and reduce noise in residential areas.

5.3.3.1 Innovation in the smart fulfilment centre

With the integration of the digital e-commerce platform, Company C's smart fulfilment centre had been considered a core competitive advantage. Because it allowed the partners to open their own online retail business using Company C's distribution and fulfilment facilities, this solution started with the establishment of a strategic partnership with one of the leading groceries in 2014:

> *"[Partner's name] just chose what products to store in our distribution centre, so their customers can log in [Company C]'s system, to place their orders, so that way [Company C] can fulfil the orders, and make it looked like [Partner]'s service, and it makes very easy for [Partner] to manage because they have to choose which products to stock, and what prices to sell on the portal, and the rest of them can be managed by [Company C]" (Head of Innovation Centre, Company C, 1C)*

More specifically, Company C was improving its smart e-commerce platform by adding more features. For example, the latest robotic technology was integrated into the fulfilment centre to make the whole system more efficient. In addition, one of Company C's research partners helped Company C develop a wireless telecommunication system, enabling the robots inside Company C's warehouse to share a base station based on 4.5G technology. As a result, a faster communication channel was built to give orders to each robot in the system. Therefore, both existing and potential customers benefitted from the latest robotic warehousing technologies, which was seen as a competitive edge of Company C.

Company C created an additional business model in collaboration with its strategic partners since it could replicate its fulfilment solution for other businesses. For instance, the sales team engaged with some of the world-leading retailers since then, discussing how this smart e-commerce platform could be used to develop an online retail business for them. As a result, an alternative business model was created that allowed Company C to explore the opportunity for being a logistics technology provider while maintaining its core business model. Thus, this innovative method reflected the company's shift from "creating for customers" to "helping customers create their own value" (Table 5.7).

“We would like to be doing something similar to what we were doing with [Partner’s name] in Europe, America and far-east. Currently, we are focusing on how to make online retail very efficient, but once we have done that, we will be able to expand it into other fields, where we can reuse the same robotic warehousing system.” (Head of Innovation Centre, Company C, 1C)

Value proposition	Shortening lead-times, improving picking quality and accuracy in warehousing processes
Value creation and capture	An additional business model to provide the end-to-end solution

Table 5. 7 An overview of the Innovation in smart fulfilment centre (Developed by the author).

5.3.3.2 Electric/autonomous vehicle delivery demonstration projects

Company C added two electric vans as a part of their fleet in 2010. This trial aimed to determine whether electric vehicles were suitable under the company’s digital e-commerce platform. As an alternative delivery method, electric vehicles received attention since they provided more sustainable home delivery. Company C had also tried to purchase more electric vans and apply them to their fleet. However, several factors constrained Company C from adopting electric vans. The first factor was that electric vans were still not supported by mainstream manufacturers. Therefore, Company C had to rely on other companies responsible for converting conventional vans into electric-powered vans at the time. The second factor was related to the 3.5-tonne limit on commercial vans because electric vans were usually heavier than conventional ones due to the weight of batteries. Moreover, electric vehicles needed to power the fridge when delivering cold products, which reduced the driving range of electric vans. Furthermore, Company C participated in a trial to test autonomous van delivery in urban areas to test social, technical, and regulatory barriers that hindered the further adoption of autonomous vehicles. Although the acceptance of autonomous delivery vans was at an early stage, the major benefit was that Company C could remove the drivers’ cost and make last-mile delivery operations more efficient.

With the development of the digital e-commerce platform, Company C had the chance to provide an end-to-end solution for its customers. Therefore, these new delivery methods were important for the company to tackle environmental concerns and improve operations. These innovation projects were developed under an overall business strategy that allowed customers to access the delivery infrastructure. Hence, new technologies could be evolved under the company's service provision, which led Company C to provide such solutions at the earliest stage (Table 5.8). In addition, by making customers more dependent on e-commerce, Company C could benefit from collaboration with its customers (or competitors sometimes). In other words, Company C could manage its coopetition strategy with its customers (Tou et al., 2019).

Value proposition	Cutting greenhouse gas emissions and make urban deliveries cheaper and faster in urban areas
Value creation and capture	An integral part of the smart e-commerce platform

Table 5. 8 Overview of the new delivery models (Developed by the author).

5.4 Logistics innovations from a business model perspective: learning process

The three case studies presented above have covered several innovation projects that could impact firms' innovation strategies and future growth as firms often have to choose between increasing technological competence or innovating their business models to adapt to socio-technical changes. The second part of interview focused on the learning experience from each innovation projects because these learning processes contribute to intra- and inter-niche diffusion of local ideas. Therefore, this section focuses on how firms managed this dilemma in response to innovations in the logistic industry. The collection of secondary data was paired with interview data sources to enhance the triangulation and validity of the pilot case studies.

As a service industry, the logistics service often focuses on subcontracting solutions to add value through customers' logistical processes. Although technological advantages are crucial to service providers, the asset-light nature of such companies cannot be neglected since the speed of obsolescence could result in risking previous investments in certain technologies (Busse and Wallenburg, 2011). However, digitalisation has reshaped the logistics sector as well as other industries. Disruption occurs when start-ups and other new entrants bring new technologies and new business models into the market, which has happened within and outside the boundary of the logistics industry (DHL, 2019). Furthermore, digitalisation has affected traditional logistics companies and blurred the boundary of the current logistics industry. As discussed in the previous chapter, although the logistics service industry was described as "not very innovative" in the past, companies need to re-examine the role of logistics as supply chains are becoming more complex due to digital transformation. As illustrated by Tang and Veelenturf (2019), companies can create economic, environmental, and social value by transforming the logistics function with Industry 4.0 technologies.

> "*Technology is changing every aspect of how logistics companies operate. 'Digital fitness' will be a prerequisite for success: the winners will be those who understand how to exploit a whole range of new technologies, from data analytics to automation and platform solutions. Those who don't, risk obsolescence. But with so many technologies competing for management attention and investment, defining a clear digital strategy that's integrated into business strategy will be critical*." (PwC, 2016, p.7)

In this section, several key technologies and their applications have been identified from the pilot case studies, including additive manufacturing (Company A), Internet of Things (Company B), electric/autonomous vehicles (Company C), and robotics and automation (Company C). However, such innovations only represent the case companies' perspective on potential technologies that could disrupt the logistics industry. Therefore, secondary data has been used to examine the influence of technological innovations to enhance triangulation.

5.4.1 Internet of things (IoT)

The term "Internet of things" (IoT) covers a diverse set of technologies. According to Miorandi et al. (2012), IoT is:

> *"An umbrella keyword for covering various aspects related to the extension of the Internet and the Web into the physical realm, by means of the widespread deployment of spatially distributed devices with embedded identification, sensing and/or actuation capabilities."* (p. 1497)

With the decreasing cost of sensors and the development of IoT networks, the logistics industry could develop new IoT-based solutions like connected warehouses, intelligent transport solutions, and the connected consumer (DHL, 2019). In Company B, the RFID

Kanban system represented one of the major applications of IoT. It had the potential to contribute to data transparency of operational processes and improve asset utilisation. Therefore, using the IoT-based service, the customer's manufacturing process would be more productive and efficient. As noted by the regional managing director from the learning experience:

> *"What industry 4.0 is about, is to have more automated systems close to where operators are, because it makes more leaner, they don't need to walk to anywhere for that product, so for me I think it is the way we are going in the future"* (Regional Managing Director, 2B)

Moreover, IoT-based warehouses had the potential to transform the traditional warehouse management system since they could reduce overall costs, provide real-time tracking, and improve forecasting accuracy. For example, the smart fulfilment centres of Company C had shown the successful application of IoT. One of the major applications was to use robots for collecting groceries in an on-demand manner, so paperwork would not be used during the warehouse management process.

> *"… [Partner's name] helped us to develop a wireless telecom system, it is a bit like a 4G system that you use on your phone, more stable, when we have thousands of robots inside one warehouse, it is impossible to talk with them all. So, we developed something like 4.5G system which enabled robots to share one base station, and we can talk to each robot ten times each second, to give them instructions to find out where it is" (Head of the Innovation Centre, Company C, 1C)*

The learning experience from this innovation project enabled Company C to implement the IoT-based solution into its fulfilment centres, which would allow the company to replicate the solution for its customers. As an integral part of the smart e-commerce platform, delivery fleets applied with IoT sensors can improve operational efficiency because real-time information - such as the vehicle's location, speed, and fuel consumption - could be obtained and optimised. As a result, all possible routing and delivery options could be improved and resulted in a highly efficient delivery system.

5.4.2 Additive manufacturing (AM)

In the past 20 years, additive manufacturing technologies (or 3D printing) were established in several sectors, from medical equipment to aviation components. Flexibility has been frequently identified from the AM technology as compared to conventional manufacturing. For instance, 1) flexibility to manufacture 'on-demand'; 2) flexibility in design practice; 3) flexibility to produce a wide range of parts; 4) flexibility to fabricate a wide range of complex geometries; 5) flexibility to use many different materials; 6) flexibility to fabricate products without tooling; 7) flexibility to exploit process variables for efficient production (Eyers, et al., 2018). AM technology will influence the logistics industry since it has the potential to re-structure logistics networks, according to Brennan et al. (2015):

> *"Additive production… Aside from material savings, since manufacturing can be undertaken closer to the point of demand, transportation and logistics costs can diminish. Similarly, manufacturing just-in-time and on-demand rather than for stock will reduce overproduction and the need for warehousing and storage will lessen."* (p.1265).

Although the 'dematerialisation' of physical flows of manufactured products would not be happened in the near future, the impact of AM technology on the logistics industry will unfold in the following areas (Sasson and Johnson, 2016; DHL, 2019):

> *Logistics networks*: through AM, it would be possible to have shorter supply chains because a more regional supply chain network will replace traditional offshoring practices. Hence, a near-shoring supply chain requires companies to re-evaluate their supply chain strategy because global supply chains will transfer from final-product focused to raw-materials focused (Ratnayake, 2019).

> *B2B 3D printing services*: due to the distance, time, and complexity of manufactured products, previous research has been largely focussed on the application of AM technology to spare parts because 3D printing is seen as an alternative for low volume and customised products. For example, parts can be manufactured at the nearest facilities, which results in reduced lead times and inventory costs.

Warehouse transformation: the customisation of final products can be postponed to the last stage where the local distribution centres of logistics providers are located. With the installation of 3D printers in the warehouse, logistics providers can provide on-demand 3D printing service in the nearest location, enabling shorter lead times and low inventory. This would transform the current warehouse service from simple pick, pack, and store to the 'state-of-the art lab' (Ben-Ner and Siemsen, 2017).

In Company A, additive manufacturing technology was adopted to investigate the potential application in the logistics service industry. Although AM was a relatively new application in logistics services and considered a niche market, it fitted the company's overall manufacturing strategy well in terms of its focus on returns and repairs in the warehouse. For example, as a logistics service provider, Company A's warehouses were located around the world, some of which were dedicated to spare parts for automotive customers. However, many spare parts would be not used for many years but stored in their warehouses. AM technology could help transform this inventory into digital inventory, leading to on-demand 3D printing and a reduction in inventory level.

As aforementioned in this section, the speed of obsolescence of certain technologies may result in a 'lock-in' situation since AM technology is developing rapidly at the current stage. Because 3D printers are expensive and there are uncertainties regarding customers' demand, investment in such technology could be risky for a service company that considered itself as 'asset-light'. Moreover, the logistics industry's image is another problem when companies want to explore AM technologies. Adopting such technologies requires logistics companies to pursue a manufacturing strategy that is outside logistics services. However, As noted by DHL (2020), AM technologies could still provide opportunities for new service offering in the logistics industry: 1) they could coordinate more fragmented supply chains for raw materials and end products; 2) new business models such as on-demand printing and delivery could be created by using AM technologies; 3) new opportunities for regional logistics hubs and last-mile delivery.

5.4.3 Electric/autonomous vehicles

Governmental regulations and customer requirements have driven the shift towards a sustainable logistics sector. This trend pushes companies to develop environmentally friendly solutions to reduce carbon emission, improve air quality, reduce noise pollution, and reduce production waste. Therefore, electric vehicles are especially suitable for local and regional delivery in urban areas. According to Morganti and Browne (2018), two major factors have transformed urban freight across Europe: size-related vehicle restrictions; and the dieselisation of light commercial vehicles (LCVs). However, several low-emissions policies have been implemented during the past few years to encourage the use of low-emission vehicles in populated urban areas. In managing city logistics, low emission zones and diesel-vehicle bans will push logistics service providers to promote sustainable urban delivery. Furthermore, the online retail sector has expanded the volume of home delivery. Consequently, electric LCVs have been considered a greener solution and promoted by logistics providers and local governments. However, two major concerns have been raised from the operation of electric vehicles in last-mile delivery (Morganti and Browne, 2018).

> The first one is commonly cited in all types of electric vehicles: driving range. Both in personal transport and freight transport, range anxiety is the most concerning issue when it comes to electric vehicle adoption.

> The second one is payload restrictions because an electric van is normally one to two hundred kilogrammes heavier than a diesel one. Heavy batteries may result in the total vehicle weight exceeding the weight limit of 3.5 tonnes (E-mobility NSR, 2013), which will require a higher-grade driving licence (license C). Also, the number of parcels delivered by electric vans per journey may be lower, resulting in higher unit cost per delivery in some situations.

In this situation, the government is expected to help in two ways: developing charging networks and changing driving licences for light trucks. For example, in 2017, the Department for Transport (DfT) raised the weight threshold for electric LCVs from 3.5 tonnes to 4.25 tonnes. It allowed electric van drivers to drive on a Category B (car) licence to support the adoption of alternative fuel commercial vehicles (DfT, 2018). As noted by the interviewee:

> *"… we want to use more electric vehicles, but the electric vehicles are heavier than diesel ones. For example, the government is changing the law- if you are using the*

electric vehicles, and you are allowed to use a heavier one and to drive it with a normal driving licence for a diesel one" (Head of the Innovation Centre, Company C, 1C)

With technological advancements in Artificial Intelligence (AI) and sensors, autonomous vehicles will have the opportunity to transform the logistics industry, from trucks to last-mile deliveries. According to the US Department of Transportation's (NHTSA, 2020) definition, there are five levels of automation (Table 5.9).

Level 0	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**
No Automation	**Driver Assistance**	**Partial Automation**	**Conditional Automation**	**Hight Automation**	**Full Automation**
Level 0: Zero autonomy, the driver performs all driving tasks. Level 1: Vehicles is controlled by the driver, but some driving assist features may be included in the vehicle design. Level 2: Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving tasks and monitor the environment at all times. Level 3: Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice. Level 4: The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle. Level 5: The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.					

Table 5. 9 Automation levels (Adapted from NHTSA, 2020).

However, the adoption of autonomous vehicles is mainly dependent on social acceptance, regulatory environment, and economic concerns. Autonomous vehicles could contribute to the logistics industry in two major domains (Talebpour and Mahmassani, 2016; Hofmann and Rüsch, 2017):

1) long-haul transport: The salary of truck drivers and fuel cost significantly contribute to the total cost of road freight transport, but autonomous vehicles could help reduce operators' total cost of ownership (TCO) under different levels of autonomy. McKinsey Centre for Future Mobility has taken research into four waves of truck automation in

the future (Figure 5.1), and each wave will reduce the TCO- from very little to a lot (Chottani et al., 2018). In total, autonomous trucks will have the chance to reduce the current TCO by 45 per cent.

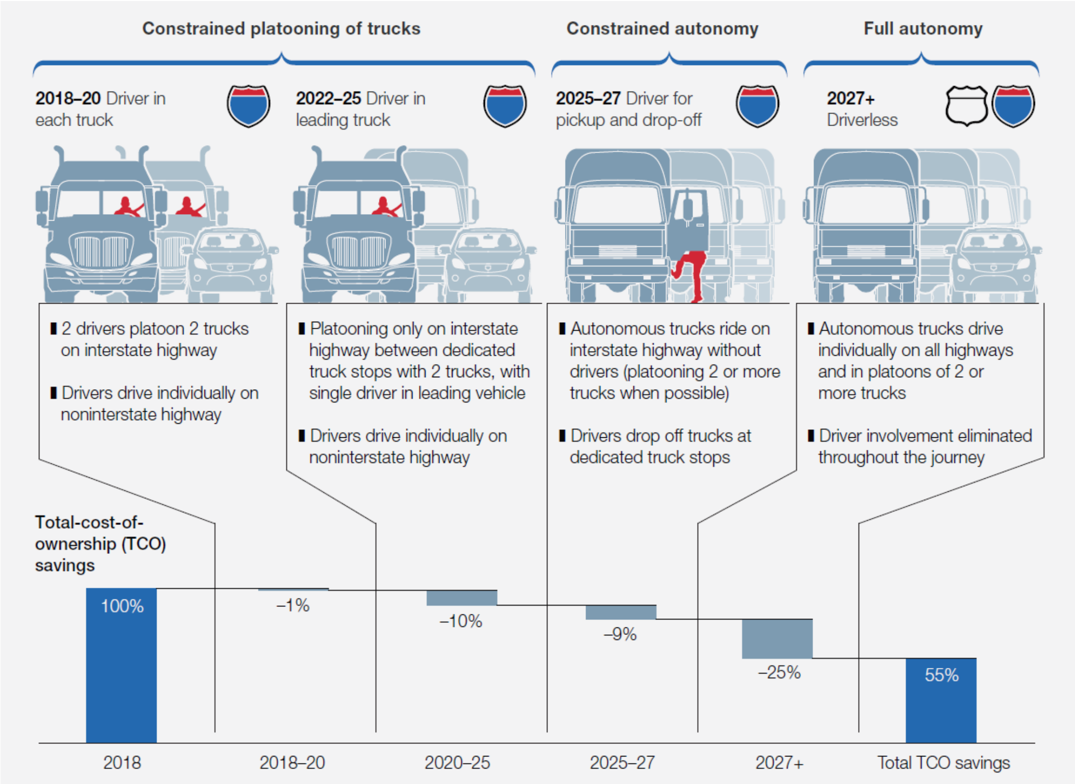

Figure 5. 1 Four waves of autonomous trucks (Adapted from McKinsey & Company, 2018).

2) Last-mile deliveries: Autonomous vehicles are still under the trial phase to improve software and hardware support (Ranieri et al., 2018). As shown in the case study of Company C, the test is based on a prototype driverless van that aims at short distances. The trial shows that driverless technology is ready to deliver in the condition of a low speed and controlled environment.

“ … *(the trial) gives us some understandings of the limitation of the technology. It is very good driving the car along the road, but if there is an obstacle in its way, then the car needs more machine and intelligence to work out how to safely drive around the obstacle, so such technologies are still under development*” *(Head of the Innovation Centre, Company C, 1C).*

As a result, the current application of autonomous vehicles could be in the warehouse, where vehicles are moving around the warehouse under monitoring. Furthermore, although unmanned autonomous vehicles (UAVs) are tightly constrained by government regulations, companies such as online retailers have been testing the role of autonomous vehicles and drones in urban deliveries. However, according to McKinnon (2016), three sets of constraints would limit the potential of UAVs in the foreseeable future, which are government regulations, lack of scale economics, and limited added value. Thus, the third limitation can be considered the key issue that needs to be addressed by Company C, because conventional models of urban delivery have already provided same-day delivery to satisfy their customers who have subscribed to membership schemes.

5.5 Business model innovations from a S-D logic perspective

The learning experience from certain technological innovations has been addressed in the previous section. However, as a service industry, the realisation of such technological innovations in the logistics sector has to be in line with certain practices, leading to business model innovations (Skålén et al., 2015). Therefore, this section's focus is on new practices that could potentially transform the conventional value propositions of logistics services that have been serving an important value-adding role in customers' logistics processes (Busse and Wallenburg, 2011). In other words, the role of companies has changed in accordance with their value proposition development, and the implications will be discussed in the following sections.

5.5.1 Evolving value propositions

In the case study of Company A, a proactive manufacturing strategy guided the three innovation projects. Different actors were introduced at each stage of the innovation activities as service-to-service exchanges. Firstly, a distributed manufacturing service was introduced to differentiate Company A in the logistics market, which meant that the company could move production processes closer to customers by using current facilities. Secondly, the on-demand forecasting solution was initiated by the collaborative research project, which helped customers balance their supply chains and eventually reduce the inventory cost. Thirdly, the additive manufacturing solution's focus is on a radical innovation (3D printing technology) and its potential application in the logistics sector. Table 5.10 presents each stage of value proposition development, and they contribute to add new functionality to the overall value proposition of the innovation strategy – a proactive manufacturing strategy that provides an end-to-end solution for customers.

Service offering	Innovation type	Value proposition	Resource integration
Distributed manufacturing service	Combinative innovation	Manufacturing processes close to end-customer marketplace	-Warehouse and transport networks -New staff with manufacturing background
On-demand forecasting service	Practice-based innovation	A customer-centric view on inventory	- Collaboration with a research institute -Customers' supply chain data
Additive manufacturing service	Combinative innovation	On-demand and distributed manufacturing processes	- Partnership with a 3d printing technology provider -Collaboration with a research institute -3D printers

Table 5. 10 Value proposition development (Company A, developed by the author).

As a result, we have identified two key phases of value proposition development (2011-2014) and one transition phase (2015-2017). As shown in Section 5.3.1, the original idea of the manufacturing strategy was to integrate with customers' manufacturing processes because it helped increase the inventory turnover. So, the distributed manufacturing service moved production closer to customers and made a better integration with customers. Later, the company decided to add more building blocks to the distributed manufacturing service, and the proactive inventory management service was selected. More importantly, this innovation project provided an opportunity for the additive manufacturing service as the research partner proposed another collaborative project to explore the application of 3D printers in their distributed manufacturing service. Figure 5.2 presents the key innovation projects related to the overall value proposition development.

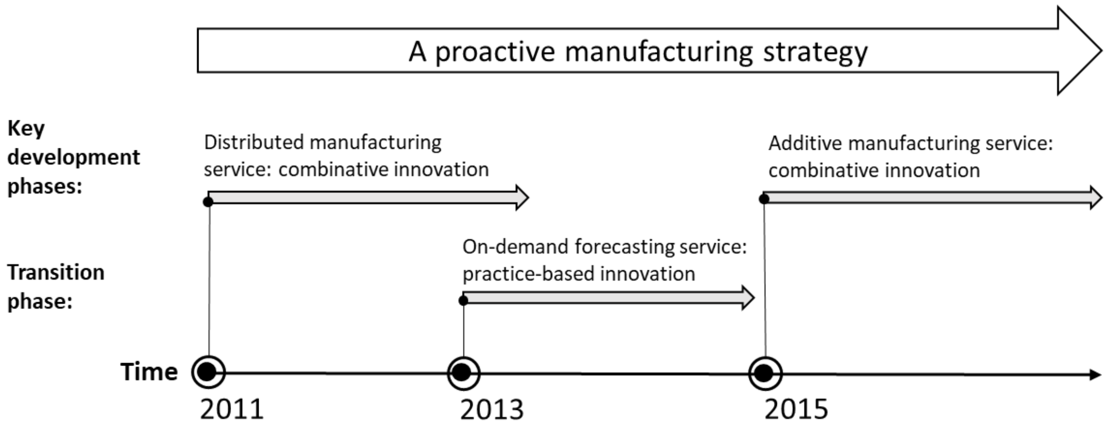

Figure 5. 2 Value proposition and key innovation projects (Company A)

In the case study of Company B, the RFID-based Kanban system enabled the replenishment of manufacturing material directly from the company's warehouse to the customer's production line. Therefore, the system helped in three ways: 1) demand fluctuations can be identified in the early stage; 2) repeated orders can be finished without scanning; 3) data can transfer between the company and the customer. In terms of the Kanban bin innovation, however, the cost of each bin had increased significantly with the integration of the optical ordering system, which seemed less successful than other innovative solutions. As a pioneering system, the innovative Kanban bin system had explored the potential of the industry 4.0 concept in warehouse management processes (Table 5.11).

Service offering	Innovation type	Value proposition	Resource integration
Innovative Kanban bin system	Resource-based innovation	Real-time and transparent components supply	- Joint development with its sister company in electronic components manufacturing –The camera fits into the bin module

Table 5. 11 Value proposition development (Company B, developed by the author).

As Company B's major customers were from the manufacturing industry, and the customers were increasingly demanding for fast response. As a result, Company B's RFID Kanban systems have showcased one of the IoT applications in warehouse management to increase production efficiency and data transparency. By adding the optical ordering system, the intelligent bins helped measure and calculate the existing quantity of manufacturing components for timely replenishment. To do so, the company worked with its sister company because the lack of technology capacity in Company B. As discussed above, although the intelligent Kanban bins were proved less commercially successful, Company B could still explore the application of IoT-based devices with its in-house innovation projects (Figure 5.3).

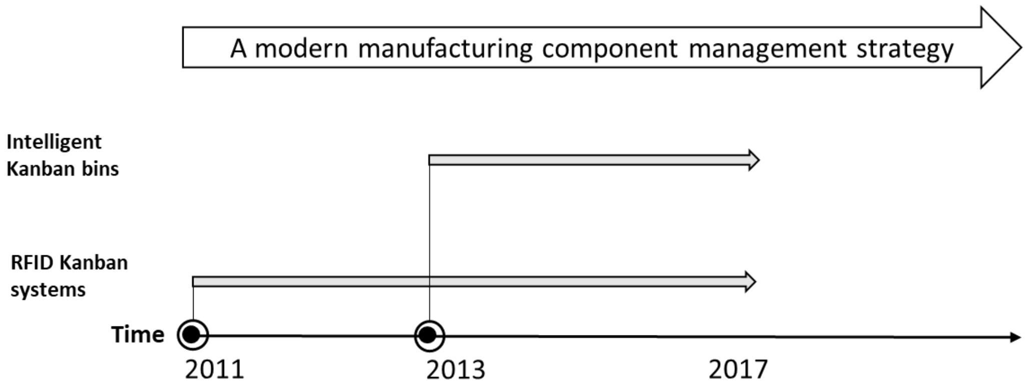

Figure 5. 3 Value proposition and key innovation projects (Company B)

In the case study of Company C, innovation projects were guided by the overall development of the smart e-commerce platform, which is now considered the company's core competitive advantage. As mentioned in Section 5.3.3, the smart e-commerce platform combined software modules with physical fulfilment assets. The first innovation project was the smart fulfilment centre. It allowed Company C to provide an automated and dense storage grid, resulting in more efficient use of warehouse space and improved product range. The second innovation project was related to last-mile deliveries. Company C tested new delivery methods that could serve as an integral part of the smart ecommerce platform (Table 5.12).

Service offering	Innovation type	Value proposition	Resource integration
Smart fulfilment centre	Combinative innovation	Automated fulfilment enables customers to manage warehouses more	- Joint development with its research partner in 4.5G technologies - The company's own warehousing facilities, software, and vans
Electric/autonomous vehicle delivery	Resource-based innovation	Cheaper, faster, and more sustainable urban delivery method	- Electric vans from car manufacturers - Research partner's expertise in autonomous technologies

Table 5. 12 Value proposition development (Company C, developed by the author).

As a result, the solution improved the company's operations and created a dedicated solution for other retail businesses. This e-commerce outsourced strategy can be traced back to 2006 when Amazon launched its Fulfilment by Amazon (FBA) to help third-party sellers manage storage, weight handling, and pick-and-pack operations (Zhu and Liu, 2018). One of the consequences of this strategy may lead to the new demarcations of third-party logistics and blurring the logistics sector's boundaries. Therefore, the core value proposition of Company C was to develop an end-to-end e-commerce platform service in order to transform its logistics functions to a competitive advantage in the online grocery industry. Smart fulfilment centre, and the Company's delivery fleets were integral parts of the e-commerce platform outsourcing strategy (Figure 5.4).

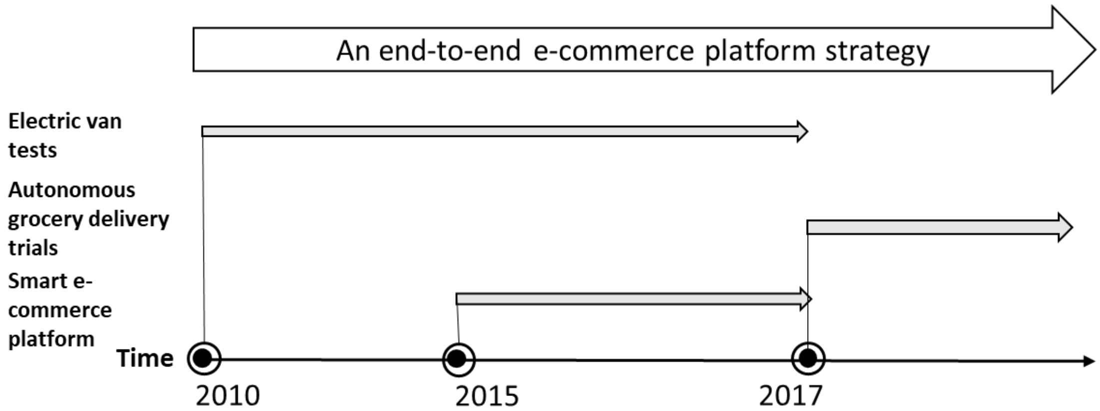

Figure 5. 4 Value proposition and key innovation projects (Company C)

5.5.2 The role of firms in logistics innovations

This section aims to discuss the role of organisational actors (firms) and their innovation strategies that emerged from these three pilot studies. In current research on sustainability transitions, firms have been identified as key causal agents in innovation system approaches. However, a lack of a theory of the firm will lead to a problematic understanding of business model dynamics in the socio-technical transitions discourse (Sarasini and Linder, 2018). As discussed in previous sections, the main conclusion from the three case studies is that companies have multiple roles rather than 'market incumbents' or 'new entrants' in the logistics sector (Geels et al., 2016).

As discussed in this chapter, Company A's innovation projects had been developed under the overall strategy of a distributed manufacturing service, which allowed the company to move parts of customers' manufacturing processes closer to final consumers by using its own logistics facilities. The distributed manufacturing solution (1A) could be seen as the reconfiguration of its physical assets (e.g., warehousing facilities and transport networks). Therefore, the application of this service meant that Company A could mobilise its resources to offer viable services. The on-demand forecasting solution (1B) showed Company A could proactively help customers analyse supply chain data. The additive manufacturing solution (1C) represented the concept of digital inventory that allowed production in an on-demand manner (Dwivedi et al., 2017).

In Company B, the smart bin solution was a part of the innovative Kanban system. This solution could implement automatic replenishment processes, making warehouse and production management more efficient and transparent. In particular, the flow of components in Kanban systems could be monitored and stored by Kanban label, RFID tag or the smart bin. As a result, the system's information, such as location, item, and quantity, could help place orders in an on-demand manner. Therefore, the innovative Kanban system was an application of industry 4.0 in warehouse and production management. It allowed Company B to extract data from the material flow of spare parts.

As noted in the previous section, the innovation projects of Company C were guided by an overall strategy of the smart e-commerce platform. The platform consisted of three parts: the online shop, the fulfilment centre, and the last-mile solution, which was seen as an end-to-end solution for customers to transform their online retail business. Therefore, Company C could digitalise traditional retail businesses and customise solutions for the unique requirements of different customers. Furthermore, the digital ecommerce platform had modified Company C's image since it made several agreements with its international partners. As a result, the Company's image could shift from an online retail to a logistics technology provider.

5.6 Reflections on the pilot case studies

To the researcher's knowledge, both business model theory and transitions theory are relatively new to the field of logistics innovation. This section will thus reflect on the methodological and theoretical issues that occurred through the pilot case studies to ensure the rigour and robustness of the study. Qualitative interviews were used as the primary data collection method of this PhD study. According to Willand et al. (2019), the confirmability of the research can be sought by pre-testing the interview questions from pilot studies because it helps to identify relevant questions for certain interviewees. Moreover, the pilot case studies can serve as a part of research question development, research design, and theoretical framework (Yin, 2018). Finally, the three pilot studies presented in this chapter have covered the major innovations in the logistics industry. For example, 1) warehousing equipment (pilot study A, B and C); 2) IoT-based information management (pilot study B); 3) last-mile delivery (pilot study C). This section is structured as follows: Section 5.6.1 presents the methodological reflections of the pilot case studies based on three major methods being used: semi-structured interview, documentation, and observation; Section 5.6.2 illustrates the contribution of the pilot case studies to the theoretical framework development.

5.6.1 Methodological reflections

This section will reflect on the methodological issues that arose from the pilot case studies, and the reflection is crucial to ensure the robustness of the studies conducted. More importantly, the methodological issues identified during the case study implementation can be used to inform the main studies (Yin, 2018). The qualitative research interview can provide direct and insightful explanations from the subjects' points of view (Brinkmann and Kvale, 2015). The pilot case studies were undertaken under a formal protocol, but some key information that we might find useful was not predictable during the data collection process. As a result, we lost the opportunity to ask further questions for additional evidence. However, this issue can be fixed by reviewing and updating the case study protocol, which is considered the pilot case study's main purpose. Moreover, some innovation projects were not at the core value proposition of the case companies. For example, Company C's electric van project aimed at exploring the potential and limits of sustainable urban delivery, and it was only a minor component in the overall business strategy – smart e-commerce platform. Therefore, the main case studies' selection criteria for innovation projects should be in line with the company's core innovation strategy. The data collection methods in the pilot case studies were semi-structured interviews, documentation, and direct observations. Due to the research scope of the thesis (each company's innovation activities), direct observations were removed in the main case studies because the method was time-consuming and required a team of observers. The issues and reflections are summarised in Table 5.13.

Research method	Issues identified	Causes	Reflections
Semi-structured interview	Some interviewees found it was difficult to answer the question in terms of business model innovations	The business model concept could be vague and general	Replace business model with practice in some instances; or core business model versus additional business model
	Interview questions: logistics industry trend was difficult to answer	Interviewees came from different industries or had no previous experience in the industry trend	Use social or technological trends to replace industry innovations; Answers can be found in other interview questions
	Some similar interview questions can be merged into one	The original case study protocol was not practical enough	Case study protocol needs to be refined according to the reflections on both methodological and theoretical sides
	Some interviewees did not follow the interview questions	Mainly occurring during telephone interviews	Design a list of potential interview questions, especially for the telephone interview
Documentation	Selectivity: many documents have been collected, but some of them were not relevant	Data management issues	Create separate folders for the background information of the case study and the related information of the innovation project
Direct observation	Time-consuming since the only direct observation took place in Germany (customer open day)	A geographical issue	Arranging observation and interview at the same time

Table 5. 13 Methodological reflections (Developed by the author).

5.6.2 Theoretical reflections

As discussed in the methodology chapter, this thesis is based on abductive reasoning, which attempts to develop and extend the current socio-technical theory. Prior to empirical investigations, the researcher has already had pre-perceptions and theoretical knowledge in business model innovations and socio-technical transitions (Kovács and Spens, 2005). However, the researcher has noticed that the current knowledge is not sufficient to clarify how these aforementioned innovation activities have been evolving and the relationship between organisational actors and socio-technical transitions (Köhler, et al., 2019). Hence, a service-dominant (S-D) logic has been adopted to address these issues. According to S-D logic, there are four meta-theoretical foundations relevant to service innovation (Lusch and Nambisan, 2015, p. 160):

> ***Actor-to-actor networks****: S-D logic views all actors are resource integrators in a network of other actors, and thus all actors are potential innovators or creators of value.*
>
> ***Resource integration****: S-D logic all social and economic actors as resource integrators.*
>
> ***Resource liquefaction****: refers to the decoupling of information from its related physical form or device.*
>
> ***Resource density****: S-D logic is the application of resources for the benefit of others or oneself, a central issue is whether resources can be quickly mobilised for a time/space/actor that will offer the desired service.*

Lusch and Nambisan (2015) further develope the understanding of service innovation into a conceptual framework that consists of three parts: (1) service ecosystems, (2) service platforms; and (3) value co-creation. The term ‘service platform’ is defined as:

> *“… a modular structure that comprises tangible and intangible components (resources) and facilitates the interaction of actors and resources (or resource bundles)*.” Lusch and Nambisan (2015, p. 166).

Having an ecosystem view on businesses is not new to business studies. It can be traced back to the research by Moore (1993), who built the linkage between natural and business activities that allow companies to position themselves in a more complex business environment. The first two foundations explain the role of companies and provide a balanced view (A-to-A networks) on firms, rather than considering their roles as ‘producers’ or ‘consumers’. Firms are thus participating in the same activities- integrating resources to benefit others. The combination of ‘resource liquefaction’ and ‘resource density’ provides a lens for measuring firms' different capabilities because firms seek to enhance resource density and liquefaction to improve viability in service ecosystems. So, the last two foundations help us identify the effectiveness of the innovation projects and explore how these innovation activities shaped service ecosystems. Consequently, adopting an S-D logic, service ecosystems view on socio-technical transitions opens additional research opportunities due to a limited number of transitions research in the logistics domain (Table 5.14) (Pettit et al., 2018; Stalmokaitė and Hassler, 2020).

Theory	Issues identified	Causes	Reflections
Socio-technical transitions theory	(Logistics) service innovations have not been particularly mentioned in the field of transitions studies. The logistics socio-technical system has been considered as a 'distribution channel' to link sustainable production and consumption activities.	STT's focus is primarily on 'greener technologies' and the production side of socio-technical systems	Demolish the gap between product and service innovations
	Difficult to integrate the business model concept into transitions studies	The business model concept is relatively new to transitions studies	Have a clear definition of the business model and business model innovation from a socio-technical perspective
	Role of organisational actors in socio-technical transitions	The dichotomy of market incumbents and new entrants	Actor-to-actor network could provide a balanced view of firms
Business model theory	The business model concept is vague and general, which was identified during pilot studies	Business model research is another major research stream	The unit of analysis is the innovation project, the focus should be on how to create an attractive value proposition
	The pattern of value creation-value delivery-value capture cannot fully understand the dynamic role of business model innovation. Also, the business model theory needs to include social and cultural value into consideration.	Traditional business model research started from a product-centric view; Innovation project as a trial-and-error process	Business model innovation can be seen as creating value propositions

Table 5. 14 Theoretical reflections (Developed by the author).

5.7 Chapter Summary

In this chapter, we presented the findings from the three pilot case studies. As discussed in the methodology chapter, pilot case studies are important to develop and refine research questions, data collection plans, and conceptual frameworks. We conducted the pilot case studies based on three data collection methods, including semi-structured interviews, direction observation, and secondary data. The main focus of these pilot case studies was on how firms' value propositions were developed and evolved, which helped answer research question 3. This investigation will continue in the next stage: main case studies (Chapter 6). More importantly, as transitions theory and the business model concept are new to logistics innovations, we focused on how firms understood the interplay of technological innovation and business model innovation.

Some methodological and theoretical reflections were presented in Section 5.6 to refine data collection methods and the conceptual framework that helped us guide the main case studies. As shown in the methodology chapter, an abductive approach guided this thesis, which allowed us to go back and forth between theoretical knowledge (e.g., business model theory) and empirical findings (e.g., logistics innovation projects). Hence, we refined our conceptual framework and adopted an S-D logic, service ecosystems view to guide our main case studies. Consequently, the next chapter will present the findings by using the service ecosystem lens to extend our understanding of the role of firms in socio-technical transitions.

Chapter 6. Innovation in service ecosystems- results from two main studies

6.1 Chapter Introduction

This chapter consists of the findings from two main case studies based on theoretical development from the pilot case studies (Chapter 5). We use service-dominant (S-D) logic as a theoretical lens to explore the role of firms in socio-technical systems. The S-D logic view is also helpful to understand the role of business models in a dynamic way since the focus is on the co-creation of value rather than a static view of business models (Vargo et al., 2015). Meanwhile, as discussed in the previous chapter (Section 5.6.2 Theoretical reflections), the theoretical foundation helps us understand how these innovation activities have shaped service ecosystems. Therefore, the two case studies presented in this chapter are based on an S-D logic, service ecosystems view on logistics innovations. The chapter has two main sections: section one represents a revisit to Company A, which provides rich data about how its value propositions have developed during the past few years. In section two, one of the leading digital freight forwarders in Europe has been investigated to explore how this disruptive business model impacts the current European road freight market.

As a result, all the case studies reported in Chapter 5 and Chapter 6 represent different characteristics in response to digital transformation. For example, Company A is a logistics service provider; Company B is a logistics service provider focusing on manufacturing components; Company C represents an online retailer; Company D comes from the emerging digital economy that may disrupt the logistics industry. All empirical data collected in this study are used in the next chapter (Chapter 7 Discussion) to discuss the role of logistics innovations in socio-technical transitions.

6.2 Company A revisited: service innovation in distributed manufacturing supply chains

6.2.1 Research background

As noted in Chapter 5, the first-round investigation of Company A was conducted in 2017, which enabled our understanding of three innovation projects conducted along its innovation journey. During our revisit to Company A, an S-D logic, service ecosystems view was adopted to examine how the company developed and evolved its value propositions. Therefore, the view considered Company A as one of the resource integrators that aimed to participate: (1) co-production of service offerings; (2) service exchange; (3) value co-creation (Flint et al., 2014). The service ecosystem is arguably multi-layered, which consists of micro- (e.g., customers), meso - (e.g., research partners, technology providers), and macro - (e.g., societal) levels.

6.2.2 Value proposition development: a proactive manufacturing innovation strategy

As mentioned in Chapter 5, Company A's innovation projects were under a proactive manufacturing innovation strategy identified as an 'umbrella' to guide its innovation activities. The findings showed that Company A's value propositions were evolving. Those innovation projects made Company A capable of helping its customers configure and customise products as close to the end-user as possible. The key stages of innovation strategy development is presented in Figure 6.1. As a result, part of the customers' manufacturing activities was integrated with Company A's distributed manufacturing service, making it difficult for other competitors to follow or compete in the market:

> *"… the customer became more dependent on [Company A] … they cannot easily change the service provider, because we have people in their operations and know the way their supply chain works" (Logistics Service Analyst A, Company A, 3A).*

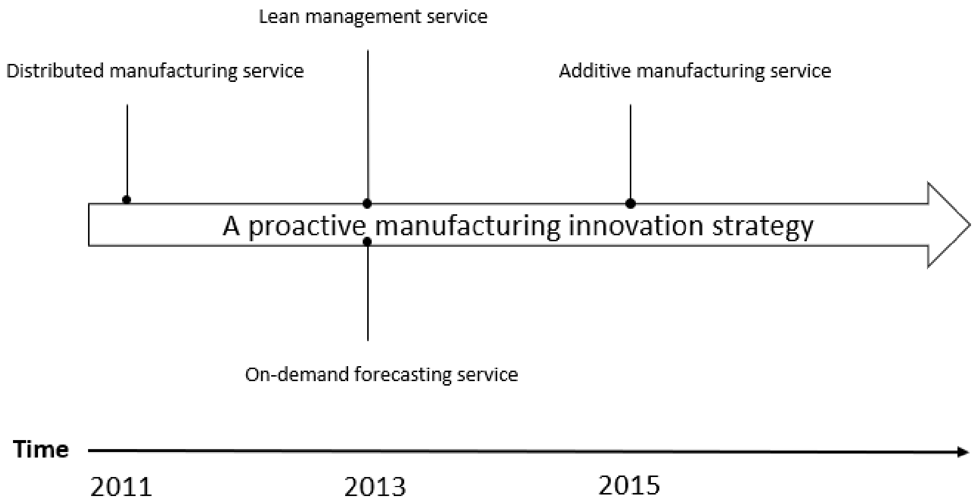

Figure 6. 1 Company A's manufacturing innovation strategy development

On the other hand, Company A's service provision was enhanced by accumulated knowledge because different organisations participated in the value proposition development. For example, in the on-demand forecasting solution, Company A co-created this solution with their research partner and customers. Also, the company's additive manufacturing solution was based on collaboration with its research partner and a 3D printing technology provider. In this manner, Company A worked as a network coordinator who participated in the co-creation of value propositions. With embedded new techniques, Company A was able to move from a traditional logistics service provider whose focus was on competing on a cost reduction strategy to a more proactive role that interacted with the customers' manufacturing activities.

> *"… so now [distributed manufacturing] is not just the case do activities inside our facilities like a factory, but also go out into the field and doing some of those installation and technical work in the field, build in their stations" (Global Head of Strategy and Innovation, Company A, 1A).*

The findings also showed that it was important for Company A to identify the right partner to launch the distributed manufacturing solution. Three types of contributions were of importance in developing joint innovation projects, including capital, knowledge, and testing opportunities:

> First, the collaborating firms both financed the innovation project. In our case study, the innovation projects were primarily funded by Company A. The investment also depended on the capability gap identified between Company A and its partner because there was more willingness for the partner to share the associated risk if the gap is small.
>
> Second, the learning experience between Company A and the partners' employees was crucial for the collaboration project. Throughout Company A's innovation journey, the ability to provide know-how, information, and management experience was considered key for success because these innovation activities entailed knowledge exchange across different actors.
>
> Third, the potential partners should be able to provide testing opportunities for the new services. During the development period of the distributed manufacturing solution, the customer provided a team of engineers, thereby ensuring a quality testing opportunity.

Therefore, Company A was better positioned to help their customer manage decentralised supply chains by providing the distributed manufacturing service. For example, the company could provide assembly, repair, and return services in the end-consumer markets rather than the OEM (original equipment manufacturer) itself. By 2020, the distributed manufacturing service was implemented in several different locations, and Company A had the biggest expansion of the service. As shown above, Company A was able to provide in-house installation and technical work inside the company's facilities, as well as in its customers' base stations. Furthermore, the distributed manufacturing service expanded in different sectors because more and more companies increased the demand for electronic devices.

> *"…we speak to quite a few companies from the automotive industry because they are becoming more electronic now. So, it started from the telecoms industry and extended into automotive as cars are becoming more intelligent, just like a computer on the wheel now" (Global Head of Strategy and Innovation, Company A, 1A).*

A new type of service innovation – routine innovation – was identified from the follow-up interview. The innovation project was implemented as a lean approach which helped customers improve supply chain efficiency and reduce wastes. In addition to more radical innovations such as the distributed manufacturing service and additive manufacturing solution, the focus was shifted towards working with their customers from the supply chain design stage. This approach allowed the company to create a holistic solution that helped optimise the supply chain. Consequently, the lean innovation offered four main benefits: 1) better collaboration and engagement within Company A; 2) cost reduction and efficiency in operation; 3) better management of the customer's supply chain because Company A had more information about the supply chain than its customers; 4) sustainable operations, which were not realised in the last few years:

> *"… the sustainability impacts of this approach are something that we have not realised. With the implementation of the project, we found that people (employees, project teams, customers) started thinking about what they can do to make things more sustainable…" (Global Head of Strategy and Innovation, Company A, 1A).*

6.2.3 Network reconfiguration: innovation in service ecosystems

The case study covered the four innovation projects implemented since 2011, including 1) the lean improvement tools, 2) the distributed manufacturing solution, 3) the on-demand forecasting solution, and 4) the additive manufacturing solution. Through these innovation projects, we examined how Company A developed value propositions with its customer and other partners (e.g., research institute, technology providers). These innovation activities showed that Company A played different roles in co-creating logistics value. For example, Company A received value propositions because its partners' expertise was crucial for innovation projects (see the on-demand forecasting and additive manufacturing solutions). Other times, Company A initiated the innovation projects because its own resources were more important for the innovation process and success than other factors, such as lean improvement and distributed manufacturing solutions. More importantly, customers were bonded closely since Company A could integrate with its customers' value creation activities, which allowed the company to maintain its long-term competitive edge. In this section, we adopted an S-D logic, service ecosystems view on logistics innovations at the firm-level to understand how these innovation projects would potentially influence the micro-level (service encounters), the meso-level (organisations), and the macro-level (societal issues) institutions.

6.2.3.1 Innovation at the micro-level

The findings showed that value proposition development was not only the result of resource integration activities but could also emerge from the service ecosystem in which the company operated. In other words, the development of value propositions was also conducted through collaboration within different actors in service ecosystems. For example, the distributed manufacturing solution was developed at the micro-level (e.g., service encounters) as a new service provided to customers. As explained in Chapter 5, Company A started the distributed manufacturing solution by recruiting a senior executive with extensive manufacturing industry experience. At this point, tangible resources were crucial in supporting the innovation project development, especially in the negotiation period with customers. Existing resources such as warehouse infrastructure became the foundation for service development.

> *"… he had an idea that logistics can be seen as manufacturing cooperation. So, what we do to distributed manufacturing is trying to process as many items as possible, and*

we try to add value to these items … increase the turnover, and more products are staying in the warehouse with less time" (Logistics Service Analyst A, Company A, 3A).

On the other hand, the newly embedded manufacturing knowledge changed the use of warehouse infrastructure, which led to the further development of the manufacturing strategy. For instance, the distributed manufacturing solution allowed customers to integrate their own manufacturing activities and resulted in the following innovation activities, such as the additive manufacturing solution.

"… we assembled components into the final product and sent to customers, but also in some cases. We wanted to do installations as well, gradually moving value-adding activities to the services portfolio … this evolved the distributed manufacturing solution from logistics services to value-adding [activities] in manufacturing process" (Logistics Service Analyst A, Company A, 3A).

6.2.3.2 Innovation at the meso-level

At the meso-level, Company A relied on the collaboration between different partners, leading to a change in the company's role in the service ecosystem. For instance, the on-demand forecasting solution and the additive manufacturing solution were developed at the meso-level (organisations), requiring the collaboration between research institutes and technology providers. Therefore, the further development of the manufacturing strategy required Company A to collaborate with other organisations to obtain new knowledge. This collaboration occurred at the meso-level of service ecosystems. Company A worked with its research partner and a technology provider to create the on-demand forecasting and additive manufacturing solutions.

Furthermore, some negative impacts of the innovation development could be mitigated if Company A realised the innovation activity was too disruptive to maintain the institutional status quo, shown in the copyright issues associated with its additive manufacturing solution. Another risk was to increase the volume of 3D printing while maintaining a high demand from the customer, which was out of the company's control. It also had some practical implications for Company A in conducting its innovation activities, especially when the company wanted to develop and deploy value propositions in new segments.

> *"… if the volume grows, we can move the technology into our warehouses, but often we find 3D printing- the volume is not big enough to install in one of our facilities…" (Global Head of Strategy and Innovation, Company A, 1A).*

Consequently, Company A learned how to invest in new resources (e.g., 3D printers) when the market demand was uncertain through those collaborations. The additive manufacturing solution development specifically pointed out that managers evaluated the risk of legal copyright issues and the rapid obsolescence of 3D printers due to heavy investments in 3D printing technology. As a result, the outsourced 3D printing solution helped the company maintain its position in the additive manufacturing market and keep its asset-light nature as a logistics service provider.

6.2.3.3 Innovation at the macro-level

At the macro-level (societal issues), the manufacturing strategy of Company A reflected several societal issues such as circular economy and decentralisation in production. Company A's distributed manufacturing service allowed re-distribute, repair, and recycle products to close the supply chain loop and reduce waste. Therefore, the service had the potential to transform traditional 'take-make-dispose' to distributed and circular supply chains. As discussed above, Company A's global transport network, logistics and manufacturing facilities were crucial to developing new logistics services. For example, the additive manufacturing solution of Company A would potentially increase material utilisation and lead to dematerialisation and reduce waste.

Moreover, Company A's distributed manufacturing experience in the telecoms industry enabled the company to move into other business areas, such as reverse logistics service and closed-loop supply chains. As a result, a collaboration was launched to provide an end-to-end solution for returned consumer electronic goods, allowing Company A to determine whether the returned products were easily repaired or refurbished by the company. If not, these products were forwarded to its partner for checking at the component level. However, this method was only one part of the product life cycle, and another part was associated with remanufacturing, repairs, and returns. As a result, the reverse logistics solution allowed Company A to recover high-value parts of products such as mobile phones or laptops and return defective products to the original suppliers. Importantly, Company A was able to identify whether it was the manufacturing, the design, or end-user problems and give feedback to manufacturers, which impacted the life cycle of the products. As discussed above, Company A proactively helped its customers reduce waste by adopting its on-demand forecasting solution. This forecasting solution enabled Company A to analyse its customers' inventories from a product life-cycle perspective. Furthermore, this solution created an additional business model for the company by selling the on-demand forecasting tool and resulted in helping customers move towards circular supply chains.

> *"… what we are trying to do is really help customers move towards more a circular supply chain, what that means is making fewer products by using forecasting and inventory demand planning to reduce the number of products is made. That is probably the single biggest waste [during the manufacturing process]" (Global Head of Strategy and Innovation, Company A, 1A).*

Besides, Company A's innovation projects represented the acceleration in the transition from a centralised to decentralised supply chain network because there was an increased demand for more customised manufactured products. For example, the distributed manufacturing solution showed that Company A could proactively manage more distributed supply chains and avoid competition in long and linear supply chains. This solution was in accordance with the long-term shift away from centralised production to distributed manufacturing processes. Furthermore, the 3D printing technology was considered by Company A to be an integral part of its manufacturing strategy because it provided a range of applications from mass customisation to distributed manufacturing. consequently, Company A potentially transformed its warehousing facilities to a more decentralised 'micro-factory' concept. Moreover, the 3D printing technology enabled a more localised manufacturing model, which allowed the consumer, or 'prosumer' to play a more important and direct role. Thus, the combination of ICT, CAD software, and 3D printers helped to change consumption patterns, and users needed to become more actively involved in manufacturing processes within a global manufacturing community.

"… moving production closer to customers, so we developed it in the telecommunications industry… but now we see all sorts of industries use the same idea. Adidas is a perfect example. It moves the production from Vietnam to Germany…" (Global Head of Strategy and Innovation, Company A, 1A).

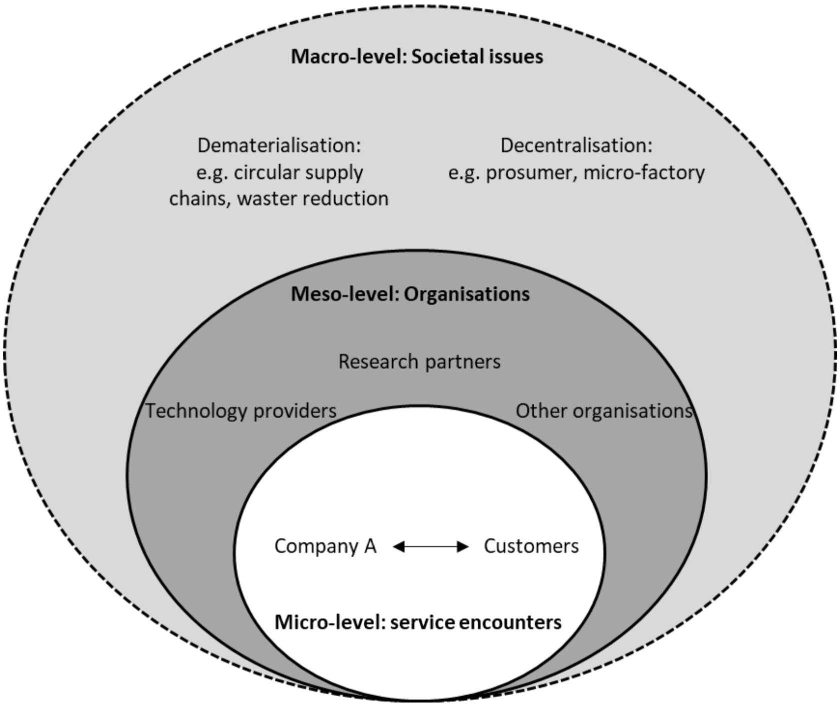

Figure 6. 2 Value proposition development from a service ecosystems view (Developed by the author).

6.2.4 Resource integration: co-creation of logistics value

The findings suggested that Company A's proactive manufacturing strategy can be considered a distributed manufacturing service platform that leveraged resource liquefaction [2] and enhanced research density[3]. As a result, the service platform served as a venue for several logistics innovations because many actors interacted in this platform to create new solutions (Figure 6.3). In the distributed manufacturing service platform, resource liquefaction was mainly driven by digitalisation in the following three examples.

[2] Resource liquefaction: refers to the decoupling of information from its related physical form.

[3] Research density: the ability to apply resources for a particular situation.

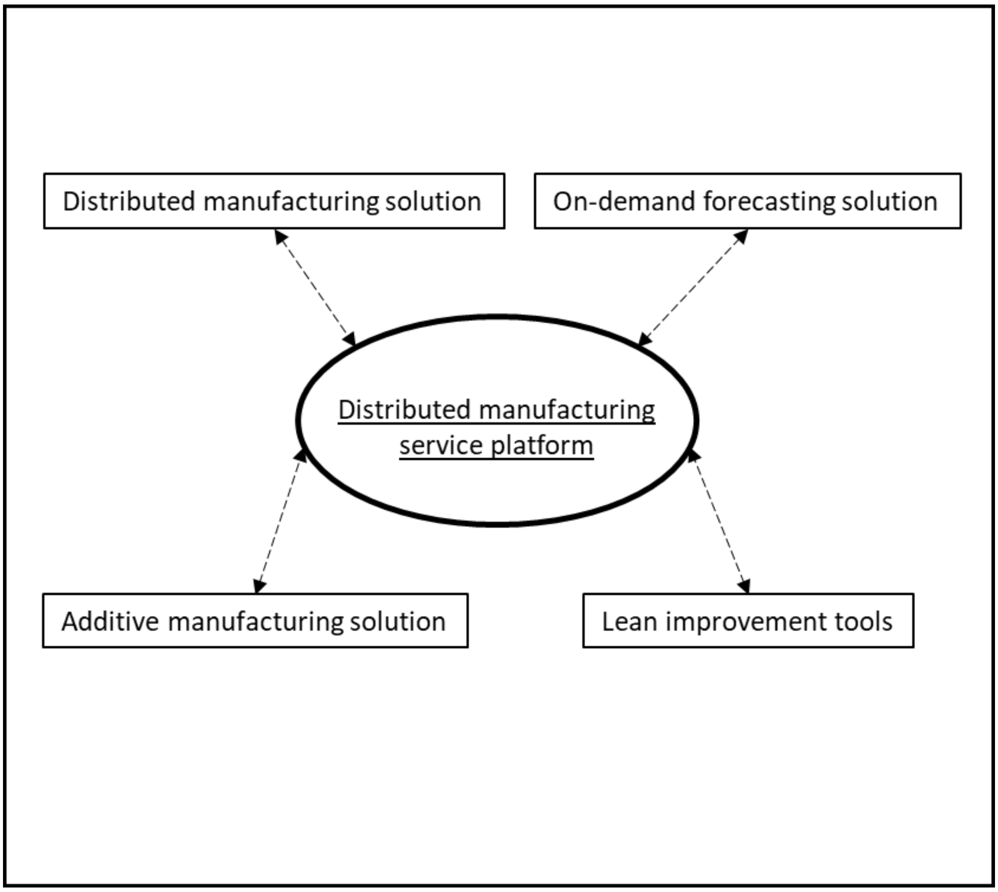

Figure 6. 3 The distributed manufacturing service platform (Developed by the author).

1) As shown in Company A's on-demand forecasting solution, the company obtained data from customers' supply chains to proactively manage their inventory level to avoid overstock and out-of-stock problems. As a result, this solution accelerated the digitalisation of the customers' supply chains by analysing the product life cycle and forecasting the future demand of the customers' products.

2) The additive manufacturing solution helped Company A generate revenue from digital inventory rather than having 3D printers in its warehouses. Moreover, the manufacturing process was brought closer to end-users in an on-demand manner, leading to a reduction in the need for warehousing.

"… 3D printing fits in very well with [distributed manufacturing], for returns and repairs, we would not have to store it for a long time, it can be printed, depends on what these

spare parts are, it easily fits with [distributed manufacturing]" (Logistics Service Analyst B, Company A, 4A).

3) The lean improvement tools allowed Company A to have a higher-level view by obtaining data from physical goods and information to reduce waste. As a logistics service provider, Company A had a holistic view of the entire supply chain, which was important to understand the impact of lean management on global supply chains.

"… as a logistics company, we know more about our customers' supply chains than they do, so our team make a spot area that our customer may not see by themselves" (Global Head of Strategy and Innovation, Company A, 1A).

Furthermore, Company A had to customise its distributed manufacturing services to meet customers' needs as a logistics service provider, resulting in enhanced resource density. As mentioned early in this chapter, Company A's value propositions were evolving by adding new services. For example, Company A launched its distributed manufacturing service in the telecoms industry, which allowed the company's engineers to manage the whole manufacturing process from planning to quality control in the region of end-customers. Later, Company A extended its distributed manufacturing service to provide customers with installation services because of its previous experience in manufacturing and configuring networking devices. Moreover, Company A added a new service for high-tech companies by managing their inventory from product procurement to shipment, which helped reduce lead time and save costs for customers. Consequently, these new services were developed in the distributed manufacturing service platform, which enabled the company to provide more complex and customised services to its customers. Furthermore, by adding returns, repairs and remanufacturing services, Company A aimed at managing the product life cycle to maximise resource density.

"… we do not manufacture these goods, but we assemble them, we do the software loading on the systems. We do repair if any requirement is needed to be done from our customers in the warehouses" (Logistics Service Analyst B, Company A, 4A).

6.3 Company D: a disruptive business model in the logistics sector

6.3.1 Research background

As is described in Chapter 2 (Section 2.4.2.1), e-marketplaces for logistics services have become one of the major logistics trends in the European logistics sector. In general, e-marketplaces such as Airbnb or Uber represent new ways of organising economic activities (Kollmann et al., 2020). E-Marketplaces also serve as an intermediary that enables transactions between supply- and demand-side users (Täuscher and Laudien, 2018; Leoni, 2020). According to their industry focus, there are two types of e-marketplaces: vertical e-marketplaces and horizontal e-marketplaces (Naujoks, 2020): Airbnb represents one example of vertical e-marketplace as its focus is on the lodging industry; on the other hand, Amazon provides products across different categories, which is called horizontal e-marketplaces. In the context of the logistics sector, e-marketplaces consist of three major parts: shippers, carriers, and a third-party exchange service provider, and the service exchange activities can be called transport service procurement (TSP) (Huang and Xu, 2013).

The logistics e-marketplace has three major parts: 1) shippers are usually large manufacturers or retailers who place transport orders to move their products between different business partners; 2) carriers (e.g., trucking companies) are on another side of the service exchange, and their services can be bought from the market or via a procurement contract; 3) the third-party exchange service is executed through a digital platform, and service providers work as a market broker between shippers and carriers (Lafkihi et al., 2019; Collignon and Sternberg, 2020).

This section focuses on the analysis of Company D's entrepreneurial innovation, which aims to disrupt the full truckload (FTL) market in Europe. As is discussed in Chapter 2 (Section 2.4.2.1), the European road freight sector was estimated at around €314 billion market value in 2016 (Transport Intelligence, 2017). However, the industry has been described as conservative and fragmented, relying on multiple layers of subcontracting. Besides, the deregulation of the European logistics and transport market has resulted in a fragmented industry, allowing big logistics companies to merge and provide more integrated and specialised services. On the other hand, it allows small or medium-sized companies to differentiate themselves to avoid being commoditised (König et al., 2018). Also, it leaves space for start-ups which can contribute to the improvement in pricing, data transparency, and service. In recent years, automation and digitalisation in logistics processes have offered benefits for customers, attracting venture capital investment in the European logistics sector.

Company D is a fast-growing freight forwarder in Europe, and the company's focus is on the automation and digitalisation of road freight logistics services. As Eurostat (2019) noted above, the transport distance between 300 to 499 km was recorded as the fastest-growing category amongst all the road freight activities, leaving space for start-ups to compete or attract investment. Company D has been trying to establish a digitalised truckload-shipping ecosystem, allowing truck drivers to use the company's mobile apps, carrier companies to apply fleet management tools, and shippers to integrate with Company D's freight management services. The research focus here is to consider the whole company as an entrepreneurial innovation consisting of several innovation activities to disrupt the logistics sector status quo. Besides, several questions were asked about how to achieve the company's strategic goal under current technological and social changes, and those questions helped to position the company in a higher level of service ecosystems (Table 6.1).

Innovation project	Interviews	Focus
Digital freight forwarding business model	1D. Executive Manager A 2D. Executive Manager B 3D. Executive Manager C 4D. Operation Manager 5D. Software Engineer Manager 6D. Business Development Manager 7D. Senior Director	Organisation strategy and goals; collaboration activities; learning from the entrepreneurial innovation; logistics trends

Table 6. 1 Overview of Company D's entrepreneurial innovation (Developed by the author).

6.3.2 Value propositions: elimination of intermediaries by increasing data transparency

Company D started its business from a crowdsourcing business model which aimed at the parcel delivery business. The company's original idea was to utilise empty fleets for delivering goods for e-commerce companies. However, due to the scalability of the business model, the company decided to move to the freight forwarding business. Thus, the company's business model targeted the long-haul and full truckload (FTL) market. There were several reasons for the company to choose this market. First, full truckloads were more economically feasible than other transport methods such as last-mile delivery or less than truckloads. Second, low asset utilisation of road freight transport because of empty (or partly full) return journeys (McKinnon and Edwards, 2010; Jentzsch et al., 2018). Third, it was easier to be automated by digital processes because the company could use regular carriers on regular lines. Fourth, the road freight market was highly fragmented in Europe, and around 80% of the companies were owned by small operators with less than ten trucks (Eurostat, 2016). In addition, there were often several subcontracting layers between shippers and carriers to deal with the increased cost (European Parliament, 2017).

> *"…we focused on cross-regional, longer distance, full truckloads, this is the simplest piece, if we can get the simplest piece electronically, then we can try some more complicated piece in the future …" (Senior Director, Company D, 7D).*

Company D aimed at growing its platform-based business in the FTL market by linking big manufacturing (or retailing) customers to eliminate intermediaries (Figure 6.4). With increasing digitalisation, several factors allowed Company D to integrate with the logistics value chain: 1) new infrastructure and technology; 2) more visible logistics data; 3) pressure to reduce costs (Choudary et al., 2019). Therefore, the core value proposition was a combination of were Company D's strategic resource (data) and the innovative practice (the elimination of intermediaries).

> *"… Shippers, like DHL, Schenker, K&N, sub-contracted onto middle-sized players ... there are often 3 to 4, sometimes 7 to 8 layers taking money from the value chain. Basically, we want to be one of them who connects small players. So, we could sell the capacity to big shippers…" (Senior Director, Company D, 7D).*

> *"… Right now, the industry is not ready for [digitalisation]. Still, lots of things have been done by paper, by phone, by email in a non-digital way. So, that is what I think exciting, what I like about [Company D] is the push to do these things and make things electronic as much as possible, not just to grow it, but to grow it cleverly…" (Senior Director, Company D, 7D).*

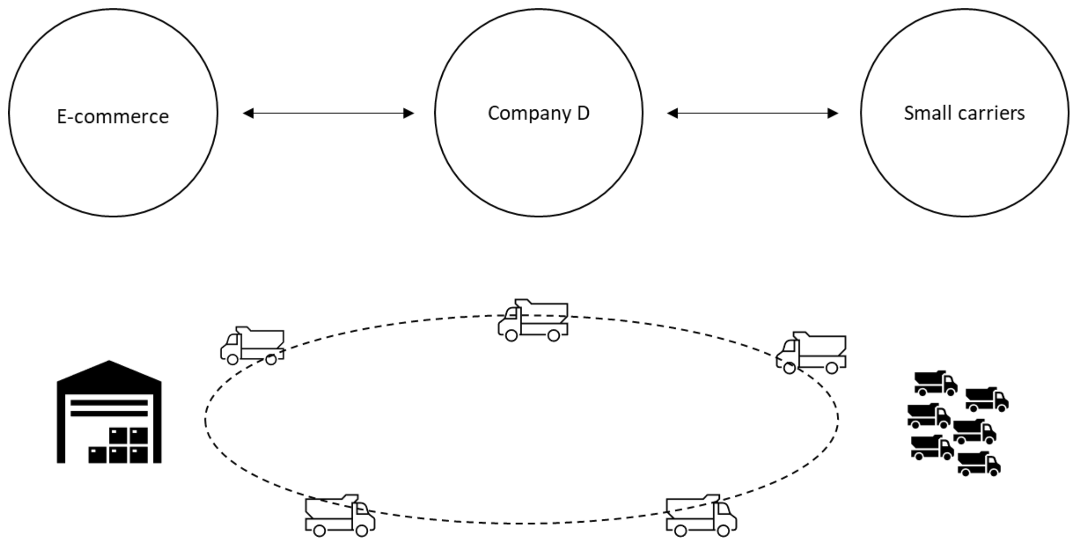

Figure 6. 4 Company D's business model: linking big shippers with small carriers (developed by the author).

6.3.2.1 Value proposition development: moving from shippers to carriers

Transparent and accurate data would help logistics companies manage the logistics flow proactively. Due to the multi-layer structure, the logistics market was not very transparent, especially in terms of pricing and capacity. The adoption of GPS tracking systems increased data transparency, so Company D could save money from the value chain by connecting big shipper directly to small carriers.

> *"… [the logistics industry is] so fragmented, there is no data flow happening. So, the customer doesn't know where the truck is, and the carrier doesn't know where the truck is. Also, the sub-contractor doesn't know where the truck is, and the sub-contractor of the sub-contractor maybe also doesn't know how to call the guy … because of the fragmentation, people use email, call [in this industry] …" (Software Engineer Manager, Company D, 5D).*

Company D was planning to develop a fleet management system for carriers, a logistics management solution for shippers, and a driver's app for truck drivers to collect data from different supply chain actors. First, the original idea was to provide the free fleet management system to carriers, so carriers would be able to see the orders when they were planning to handle for Company D, and carriers could bid on transport and see the pricing for each transport. As a result, Company D could push information to carriers when orders were available and accessible. Second, the solution for shippers, the most significant barrier to implementation was found that big shippers often had more than one supplier, and Company D was just one of them. Alternatively, the company could still integrate its platform with its customers' systems, which was considered standard practice when it worked with big shippers. Third, the driver's app had a relatively simple function that helped to track GPS data. As mentioned before, the fragmentation of the FTL market led to two major issues: 1) there were more than 100 apps in the market, and they were with similar interface with the potential to track the GPS data, 2) truck drivers were often driving for different companies, and they were not very keen on installing digital solutions.

Company D's focus had thus been shifted from shippers to carriers since big enterprise customers were able to provide stable volume flows with the long-term assignment. As a result, Company D had secured one side of the marketplace with big shippers. The next step was to establish the supply side of its business model:

> *"… in the spot market, you will find it is super difficult to find the right man between demand, transport, and suppliers' trucks. On the contract side, you always have demand, you will just have to find supply…" (Senior director, Company D, 7D).*

Therefore, two main collaborations were established to support Company D's move into carriers: 1) a fuel card service provider, 2) a truck manufacturer. The similarity laid in both collaborators was that these two companies had extensive knowledge about trucking companies. For instance, the fuel card service provider offered several services, including fuel cards, toll payment service, and other value-adding services, which made the company closer than other types of companies in the FTL market. The collaboration helped carriers to have lower fuel cost and discounts since the volume ensured the best price from the fuel card service provider:

> *"… if you are a small trucking company, you approach this kind of fuel card suppliers and tell them I have 20 trucks. Then you get a discount based on the total cost. What we did is that we have thousands of subcontractors, around 20 trucks each, please*

give us a discount rate. So, we have a fairly good discount rate for our carriers …" (Operation Manager, Company D, 4D).

Besides the wage of truck drivers, "fuel and toll" – amongst all costs of providing logistics services- had been a significant part of logistics costs (Anderhofstadt and Spinler, 2020). The fuel cost contributed to 20-40% (depending on the country) of the operation costs of a trucking company in Europe (Transport Intelligence, 2017). Thus, Company D could benefit in several ways from working together with a fuel card service provider: (1) helped to leverage bargaining power under the competition with other companies; (2) had closer cooperation with carriers; (3) offered more value-added services based on the partnership in the future. The collaboration showed that the company had been gradually moving from shippers to carriers. The fuel card project was considered a test on how Company D could sell additional services to existing carriers.

"… The goal behind the idea is how can we be valuable at carriers, again, ultimately is having the best relations to carriers, know what carrier wants, so [fuel card provider] just offers us with value-added services strategy …" (Business Development Manager, Company D, 6D).

Similarly, by collaborating with the truck manufacturer, Company D was getting closer to customers because both companies had the same customer base. The collaboration was an important factor since Company D could contact the carriers with 5-15 trucks in the market. Several benefits could be obtained by working with the truck manufacturer:

1) Access to expertise. The relationship between logistics service providers and carriers was crucial because the trucking market was supply-driven due to a lack of truck drivers. The collaboration allowed Company D to be introduced to the customers by the truck manufacturer's brand reputation.

"…So, [manufacturer's name]'s customers are our carriers, partners, the brand is very important, they give us a lot of credibilities… " (Executive Manager, Company D, 1D).

2) Enhancing know-how on truck operations. As an entrepreneurial company, knowledge exchange was important for collaboration activities. Therefore, Company D obtained expertise from the truck manufacturer, enabling it to gain external knowledge such as how technology (e.g., GPS) was applied to the truck and how to profit from such technology.

"… [Truck manufacturer's name] has thousands of trucks driving around Europe, every single company in the market has the problem with GPS tracking and the need to increase data transparency… when carriers signed the agreement, then we are able to gather tons of data to improve our operation efficiency…" (Business Development Manager, Company D, 6D).

3) Collaboration on specific projects. It was important when the company expanded its partnership with the truck manufacturer. Several initiatives underway to this collaboration regarding trucking, marketing, and truck leasing would help make the service more attractive and comprehensive to carriers.

6.3.2.2 Value proposition development: keeping the asset-light structure

As noted at the beginning of this section, Company D's innovation strategy was in accordance with the two major value propositions: improve data transparency and the elimination of intermediaries. Therefore, any investment in value proposition development should be mutually beneficial by examining Company D's (and its partners') competitive advantage. It was crucial because while the new resources brought on by innovation activities, Company D needed to select the most suitable projects to integrate those resources into its core competency. The market structure of road freight transport had some drawbacks due to data transparency and multi-layer subcontracting issues, so there was a clear strategy for the company to remain asset-light structure.

"… it is how the industry works: I have ten trucks, for instance, but if I receive 20 more transport offers, I just don't have the trucks to fill it. I need to push it onto my regional networks, which have 20 more trucks, and maybe they are not utilised yet … It is very interesting and non-transparent, and almost no digital process. But for us, it is a very

clear strategy running as asset-light [to enter the sector] …" (Business Development Manager, Company D, 6D).

Regarding other types of innovations, the asset-light structure allowed Company D to integrate the core competency – data technology – with its partners. For example, some companies were investigating autonomous vehicles or connectivity technologies, which helped them have a 'first-mover' advantage in applying such technologies in the logistics sector. Therefore, these innovation activities provided opportunities for Company D to find new potential solutions that combined its data technology with partners' resources without heavily investing in tangible resources such as trucks and other infrastructure. Hence, Company D tended to guide itself by considering the efficient use of the data in the collaboration. For example, in terms of autonomous truck development, the company might have a complementary role to provide the optimal network to autonomous trucks, thereby acting as a network coordinator rather than investing in its self-driving technologies.

"… what we see is that connectivity is so important. Because for autonomous trucks, you have to have precise data points, and the more we grow this digital platform, the better the place we are, to give that data to autonomous trucks in the right place, right time, and optimise the use of trucks …" (Senior Director, Company D, 7D).

As noted above, the priority for the company was to aggregate and monetise data, which was consistent with its core value propositions (Figure 6.5). Therefore, investing in digital technology remained key to keeping an asset-light model, and maintaining customer loyalty was another key in this regard. The company had improved warehouse operation and network optimisation by aggregating data at the current stage. It showed that Company D had to work with customers closely in order to offer transparency for operations. For instance, the fuel card project was mostly driven by customers because the product would help carriers get paid earlier with a lower fuel price. It enabled the company to attract carriers and to secure capacity. Thus, the company could provide more value-added services to carriers based on the tracking data collected by GPS, such as storage, insurance, and personal service. In the longer term, the company could try something more complicated such as less than truckload (LTL), which helped different customers get to the same truckload. However, this idea remained uncertain because Company D needed warehouses to consolidate, which meant that the company had to invest heavily in tangible resources and compete with big players such as DHL and K&N.

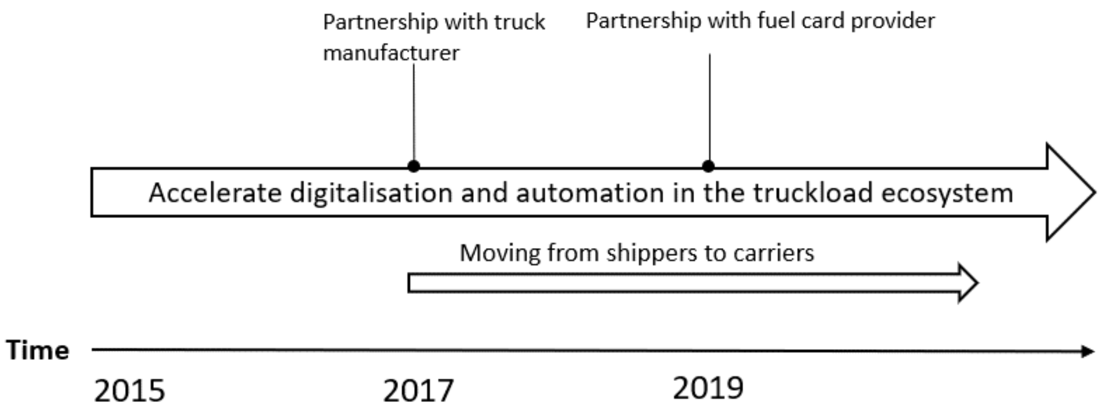

Figure 6. 5 Company D’s truckload ecosystem innovation strategy development

6.3.3 Network reconfiguration: innovation in service ecosystems

As evident from the above findings, Company D could not become a single entity that holds all the resources for innovation activities because of the digital freight forwarder's asset-light business model. However, it could become a network coordinator that participated in collaborative innovations and shared knowledge with its partners. It resulted in enhanced resource density and increased resource liquefaction within Company D’s service ecosystem. These considerations made it clear that the company did not intend to involve heavy investment in tangible resources far from its core expertise. Instead, the company could leverage its innovative know-how by re-allocating the position in the service ecosystem. Therefore, any new resources added to the service ecosystem should be in line with the company’s major value propositions.

As discussed in the case study of Company A, service innovations can be seen as the result of co-creating value propositions in a given service ecosystem. As an entrepreneurial company, Company D’s focus was on the growth of its innovative business model in the road freight market. As a result, the role of the innovation projects in Company D should be consistent with the major value propositions: data transparency and the elimination of intermediaries. Therefore, a service ecosystems perspective has been adopted, which consists of three analytical levels- micro (service encounters), meso (organisations) and macro (societal actors). According to Lusch et al. (2016), it is important to identify the boundaries of the relevant service ecosystem, so the three levels of service ecosystems are :

micro level (shippers, carriers, and Company D), meso level (truck manufacturers, fuel card providers, competitors, and incumbent LSPs, and macro level (shortage for truck drivers, digitalisation, sustainability and autonomation).

6.3.3.1 Innovation at the micro-level

As discussed above, Company D's focus was on empty trucks around Europe, which could be utilised by its innovative business model that linked large commercial shippers with small carriers. The company initially built the truckload-shipping ecosystem by providing software solutions to carriers, shippers, and truck drivers but began moving to more of a carrier-focused strategy. It was mainly driven by the market structure, which was depicted as 'extremely fragmented', 'multi-layers of subcontracting', and 'less digitalised'. Once the company secured the demand side (shippers), it was easier to grow in the road freight market. The outcomes of this interaction showed that the three actors – shippers, the focal company, and carriers – co-created the service offering at the micro-level of service ecosystems. Thus, the value proposition at the micro-level was connecting large shippers with small carriers.

6.3.3.2 Innovation at the meso-level

Company D collaborated with a truck manufacturer and a fuel card provider, which targeted a closer relationship with small carriers. As discussed in Company A's innovation journey, such value-added services increased customer loyalty and would make competitors difficult to follow. So, they were the companies that directly interact with Company D and co-created the service offerings. However, actors such as traditional LSPs and other digital freight forwarders had indirectly participated in the co-creation of the value proposition in terms of brand community and industry identity.

One factor was the increasing number of digital freight forwarders that had entered the European road freight market, even major actor from other sectors such as Uber Freight. Principally, the road freight market would become increasingly competitive since new entrants were coming into the industry. Thus, traditional logistics service providers had to compete directly with these digital freight forwarders. However, as discussed in the previous sections, the fragmentation of the FTL market made market consolidation less possible. Hence, digital freight forwarders would accelerate digitalisation rather than replacing the traditional logistics service providers in the market.

> *"… for example, Uber Freight will not hold 100% of the market share. So, there will be enough business for us. I am not too much afraid of that. On the other hand, it might be really helpful for them to join in Europe because they will bring some branding issues to the market, and the industry is quite conservative. Some big names on the digital freight forwarder might help us [in the market] …" (Operation Manager, Company D, 4D).*

Another factor was the branding issue that had resulted from the indirect service exchange between different digital freight forwarders. It would also exert pressure on incumbent actors since they had different business units that were difficult to change due to their complexity, making the whole company less agile. As a result, the second value proposition identified at the meso-level was a digital business model that reshaped the logistics market.

> *"… I think our biggest strength is size: smaller. You are getting bigger, but you are still small. It is easy for us to innovate because there is less momentum. In general, if you have big companies and people who have been working for 20 years on the same jobs, it is hard to tell them to complete a different job the next day…" (Software Engineer Manager, Company D, 5D).*

6.3.3.3 Innovation at the macro-level

In principle, societal issues are the drivers that lead to changes within different actors at the macro-level of service ecosystems. For example, as discussed above, a shortage of truck drivers tended to increase competition for capacity because truck drivers were not sufficient to cover the demand for trucks. On the other hand, these drivers were co-creating the service offering in the service ecosystem, contributing to the institutionalisation of the new rules, norms, and practices. The response to these societal issues had changed the way of integrating resources to position actors in newly formed value networks.

For instance, there was a shortage of truck drivers in the European logistics sector. As discussed in Chapter 2 (see Section 2.4.2.2. New work patterns), the European transport and logistics sector would need to adapt to the ageing population and the shortage of skilled personnel. According to IRU (2019), Germany's driver workforce's average age was about 47 years old, and 40% of the truck drivers were going to retire by 2027, which would leave a shortfall of about 185,000 drivers. It had two implications: first, logistics service providers needed to strive to reach the high utilisation of their assets (reduce empty running) and increase efficiency by optimising their network (increase data transparency and digitalisation). Second, actors like logistics service providers and truck manufacturers would need to develop autonomous trucks to cut truck drivers' cost. As a digital freight forwarder, Company D would generate more data to optimise the use of autonomous trucks. However, with the development of autonomous technologies, the business model of truck manufacturers and other OEMs would need to be reinvented to adapt to these changes.

> *"… my personal opinion is that the platooning technology is about money-saving around 2%-6%, but take the driver out means 30%, and this is where we are saving costs. So, we need to get straight from some autonomous trucks quicker in key markets where drivers are short in sophisticated markets, the pressure is high, and the driver is becoming more expensive…" (Software Engineer Manager, Company D, 5D).*

Moreover, small and medium-sized carriers had no incentives to follow a sustainable development as Company D shifted the focus to the carrier's side. To this end, Company D had to make an incremental improvement in fuel consumption and truck utilisation since customers' buying behaviour was against sustainable development. Meanwhile, the company would choose to work directly with energy companies rather than third parties (e.g., fuel card providers), so, Company D would offer more alternative fuel options for carriers to choose in the future. To achieve this goal, shippers also needed to accelerate digitalisation by sending electronic orders that could be used in the transport process. So, Company D's platform-based business model was not only a disruption to the logistics industry but also helped accelerate digitalisation and automation among its service ecosystems' actors such as shippers, carriers, and truck drivers.

> *"…we also need the shippers to catch up a little bit to be able to send electronic orders. But it is still a minority in the industry … Because the industry does not make a lot of*

money, the different layers are all taking small margin … not allow them to invest in technology … but the big players, Amazon, Uber have a lot of cash, stepping in the front of these existing guys. …" (Senior Director, Company D, 7D).

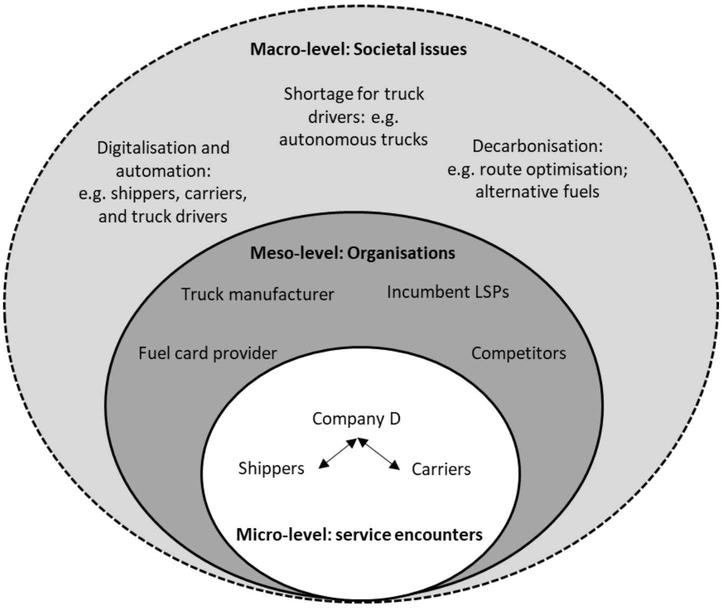

Figure 6. 6 Company D's service ecosystem, a S-D logic view (Developed by the author).

6.3.4 Resource integration: co-creation of logistics value

After discussing how Company D positioned itself to align with the institutional environment in service ecosystems, this section's focus is on another core concept of the S-D logic: value co-creation. Company D laid in the centre of the digital freight service platform, which aimed at developing a "shared world view" to coordinate the service exchanges between different actors. Consequently, the service platform helped increase resource liquefaction and enhance resource density within the service ecosystem. As a result, the service platform helped the actors co-create value through logistics innovations, in short, the co-creation of logistics value (Figure 6.7).

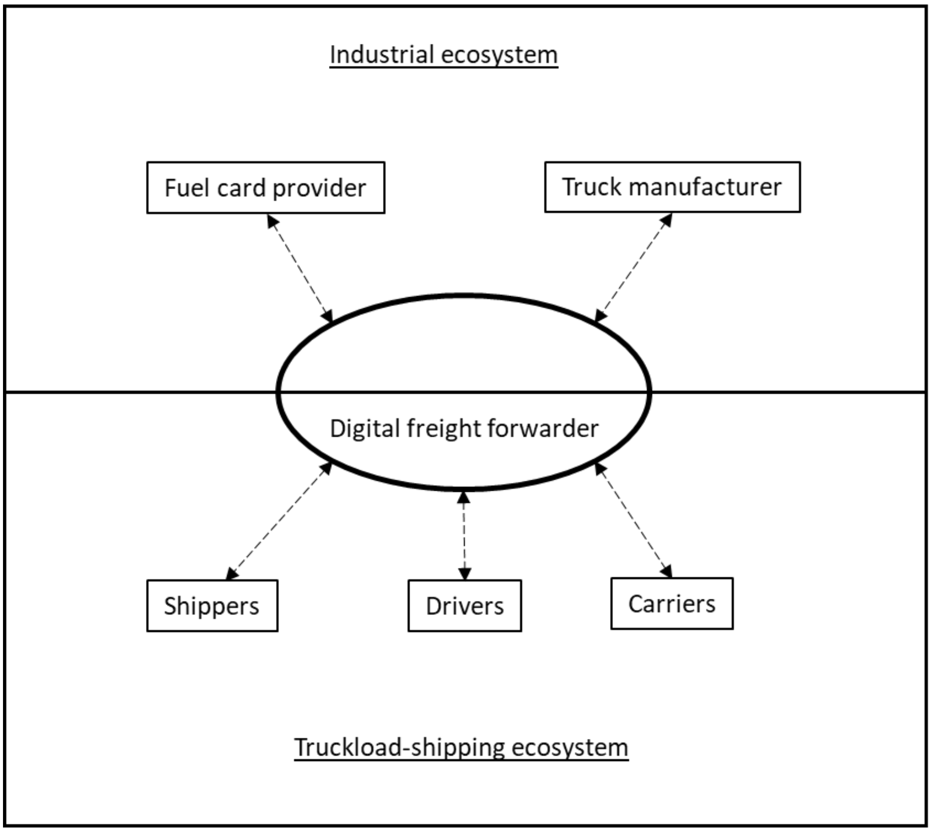

Figure 6. 7 The digital freight service platform: a modular architecture (Developed by the author).

Company D's core business - digital freight forwarding - arguably played an important role in this digital freight service platform as it extracted data from different services:

1) For truck drivers: Drivers always worked for more than one companies due to the fragmentation of the industry, and "many of them are not very digital in mind" (Software Engineer Manager, 5D, Company D). Therefore, Company D needed to persuade drivers to turn on the app when they were driving in order to get tracking data. With the insight of these data, Company D could generate more capacity, allowing drivers to know suitable loads and work consistently and efficiently.

2) For carriers: Company D provided fleet management software for carriers to schedule transport and make timetables at a starting point. As more carriers agreed to use the fleet management system, Company D could add more complex modules to accelerate the digital process.

3) For shippers. As discussed in this chapter, the big shippers preferred to use a single platform than multiple platforms provided by different freight forwarders. Therefore, Company D's aim was to integrate with shippers' platforms, which was considered an advantage because of its business agility.

4) For fuel card provider: the collaboration between Company D and the fuel card provider was mutually beneficial. On the one hand, Company D helped add more services by extracting data from daily operations, such as insurance and factoring services. On the other hand, Company D was also a distribution channel for the fuel card provider since they shared the same customer base.

5) For truck manufacturer: the partnership with the OEM allowed Company D to access GPS data of carriers based on the agreement, which would further improve Company D's operation efficiency.

As discussed above, resource liquefaction was achieved by Company D's core business that extracted data through its digital solutions and collaborative projects. Resource density was also enhanced through the service platform, as shown in Figure 6.5. Company D's digital freight service platform was found as a two-layered structure, including:1) a truckload-shipping ecosystem that aimed at its core value proposition, 2) an industrial ecosystem, which helped develop new value propositions derived from its core value proposition. This two-layer modular architecture helped Company D to increase the potential for service innovations as well as the ability to mobilise resources in an innovative way.

In the truckload-shipping ecosystem, Company D had shifted the focus from shippers to carriers, which meant that the company tried to maximise the ability to integrate its digital platform with carriers' trucks and truck drivers. It became difficult to integrate on the shippers' side because shippers always had options for choosing different logistics service providers, as discussed previously. It created another difficulty when Company D wanted to develop the logistics management solution for shippers because it required competitors' data to be shared in the system.

"… the tough part is you need to get your competitors' data into your platform, so saying a huge e-commerce giant uses your platform to trade all of their trucks, then if they give trucks to competitors, we also need to have them in our platform…" (Software Engineer Manager, Company D, 5D).

In the industrial ecosystem, two main collaborators were found (a truck manufacturer and a fuel card provider) to support access to Company D's main target - the carrier group. Therefore, more value-adding services would be added to the FTL market. As a result, Company D could access and mobilise resources for creating more innovative services. For example, Company D was not able to implement the factoring service by itself, but the company could develop such financing solutions with the tracking data from the daily operation. To this end, the collaborative projects represented a way of modifying resources in response to the carriers' demand. More importantly, Company D worked as a network coordinator that proactively shaped the norms and rules that platform actors used to co-create value. As mentioned in an interview, Company D would choose to work directly with energy companies rather than work with third parties in the future:

"… but in the long term, we probably want to cut the third party, just work directly with insurance companies and energy companies …" (Operation Manager, Company D, 6D).

6.4 Chapter Summary

This chapter presented the empirical results from the main case studies. We began by introducing the development of each firm's innovation projects, thus addressing Research Question 3: how value propositions are developed and evolved. We also described the contribution of these logistics innovations in shaping actors' resource integration activities at the micro – (service encounters), meso – (organisations and industries), and macro (societal) levels, which helped address Research Question 4: how firms' innovation activities contributed to the transition of the logistics industry.

We also identified what factors affected the decision-making process and what issues and dilemmas did they confront during the value proposition development. For example, Company

A finally decided to outsource its additive manufacturing solution to avoid legal copyright issues. Also, Company D shifted towards carriers because it was difficult to integrate the company's digital platform with big shippers. The findings showed that firms needed to balance their innovation efforts of maintaining and disrupting resource integration rules in service ecosystems. Finally, by adopting the concept of the service platform, we further examined how firms' innovation activities accelerated the digital transformation and enhanced the innovation capability. The findings showed that both firms adapted their innovation strategies to the digitalisation of the logistics industry, and digital technologies helped them to integrate with customers and resulted in customer loyalty. Therefore, firms needed to increase resource density by adding new actors and knowledge to the service ecosystem. This activity was often done at the meso-level (e.g., organisations, industries) of the service ecosystem. We will draw upon these findings to discuss the role of firms and the role of logistics innovations in socio-technical transitions in the next chapter (Chapter 7 Discussion).

Chapter 7. Socio-technical transitions as a value co-creation process

7.1 Chapter Introduction

In the previous chapter, the research focus was on the service-ecosystems of the two selected companies. Company A represented an established firm that adopted a proactive manufacturing strategy to enter the manufacturing domain. Company D is an entrepreneurial company that aimed at growing in the European road freight market. Data collected from these two case studies (and pilot studies) explored how firms confronted digital challenges and evolved their business models. Once the unique patterns of each case emerged from the within-case analysis in the previous chapter, cross-case analysis thus needed to be applied to synthesise evidence from different case studies. More importantly, the purpose of adopting both within-case analysis and cross-case analysis was not only to focus on focal firms but to have a co-evolutionary view on firms and their embedded socio-technical systems.

This chapter is built upon two perspectives: an S-D logic, service ecosystems view and the Multi-level Perspective (MLP). As discussed by Ottosson et al. (2020), transitions studies' focus is on meso-level (socio-technical regimes) to get policy implications. However, market formation studies have taken the view from focal firms to provide managerial implications. As a result, this chapter starts from an integrative explanation that tries to link the service-ecosystems view and socio-technical transitions (Section 7.2). The following sections will be presented based on the empirical evidence collected from the case studies: (1) A service ecosystems view on the transition in the European logistics industry, this is to answer Research Question 2; (2) the interdependencies between actors, technologies, and institutions, this is to answer Research Question 1 and 4.

7.2 An integrative view on innovations in the European logistics industry: drawing on S-D logic and the MLP

The prevailing understanding of innovation is shaped by the conventional view on the 'production-distribution-consumption' of goods or services (Geels, 2004; Vargo et al., 2015). From this view, there are two distinct aspects of innovation: one represents the technological part, and another one is the market part. Innovation in this understanding is the preserve of specific actors (e.g., firms). That is, innovations flow out from the firms and be consumed by customers through the market (Vargo et al., 2020). However, more recent concepts such as 'prosumers', 'product-service systems', and 'co-creation' have emerged to reflect a more dynamic and interactive view of innovation, reflecting the growth of the service sector in the past decades (Vargo and Lusch, 2016). Hence, we see the emergence of 'as-a-service' offerings in mobility, communications, and software alongside mechanisms that allow users or consumers to contribute to the innovation process. Accordingly, the research focus is shifting towards a systemic perspective on innovation, emphasising the role of social influences in technology adoption (Geels, 2011).

The case studies presented in the previous chapters have shown how companies develop their unique value propositions and how these value propositions help shape the service ecosystem in which the companies are embedded. However, it is insufficient to elaborate on the relationship between companies and the broader socio-technical system context. The reason is that the case study companies may come from different sectors and may not directly interact with each other, at least at the micro-level service exchange. Therefore, the concept of socio-technical regimes from the MLP enables an institutional view of companies' innovation activities at the meso-level (e.g., socio-technical regimes). As a middle-range theory, the MLP can also benefit from an integrated theoretical exploration (Geels, 2011). To this end, an integrative view on logistics innovations can help understand how companies' innovation activities contribute to the transition in the European logistics industry.

Geels (2002) defines the focal unit of transitions studies as the 'socio-technical regime', which can be analysed via the multi-level perspective (MLP) to understand institutional change from one socio-technical system to another. A niche is defined as an 'incubation space' for radical technologies. The overarching 'landscape' level represents the most stable exogenous context that shapes regime and niche interactions, and the landscape is not directly interacting with niches and regimes (Geels, 2012). Similarly, by adopting a service-ecosystems view, Vargo et al. (2020) argue:

> "… innovative ideas can spread horizontally, as can be seen by looking across a level of analysis, including across a particular application (intra-niche) and across applications (inter-niche). Moreover, novel ideas can also 'travel' vertically, as can be seen from the perspective of different levels of analysis (aggregation), through the restructuring of the more general, conceptual meso- (e.g., industry) and macro-level (e.g., social) landscapes. (p. 529)"

Thus, taking Uber as an example, its unique value proposition encourages customers to use traditional mobility services from independent drivers. So, Uber's business model can spread horizontally with other forms of sharing (e.g., car-sharing or ride-sharing services), contributing to the change of traditional mobility services (Wieland et al., 2017; Wells et al., 2020). Uber's value proposition 'better, faster, cheaper' can also 'travel' vertically across meso-level ecosystems as a more general concept of the sharing economy. This value proposition will challenge the product-based business model of the automotive industry. Finally, Uber's value proposition also impacts macro-level institutions, including a shift from ownership to usership (Polydoropoulou et al., 2020).

The case studies investigated in this PhD research provide several examples of value proposition development. These value propositions can be aggregated into specific sets of factors that aim at shaping new institutional arrangements. Following the conceptual framework presented in Section 2.5, we argue that firms can only provide value propositions to the niche and regime levels of a socio-technical system. In addition, firms always need to simultaneously maintain, disrupt, and change the institutionalised rules on different levels of institutional context (Koskela-Huotari et al., 2016). That is because radical innovation at niche level will eventually interact with selection environments at the regime level (Petzer et al., 2020). In other words, from an S-D logic, service ecosystems view, innovation diffusion requires the further enactment of value propositions at a relatively high level of aggregation (e.g., regime) (Smith et al., 2005). Therefore, from an integrative view based on the S-D logic concept and the MLP, selection environment can be seen as the process that how ecosystem actors from higher levels of aggregation accept/ or reject these value propositions (Andersen and Markard, 2020; Vargo et al., 2020). Further discussion on selection environment is shown in Section 7.4.

Figure 7.1 provides an integrative view of logistics innovations in the European logistics sector, in which value co-creation and resource integration activities help to maintain, disrupt, and change institutions at the different levels of aggregation in the logistics service ecosystem. As shown in Figure 7.1, logistics innovations can be seen as different value propositions that aim at shaping resource integration activities within the entire service ecosystem. Market selection relies on the routinised acceptance of these value propositions among multiple actors over time, which is also called 'institutionalisation' (Wieland et al., 2017). As discussed in Section 2.4.2, firms' innovation strategies need to reflect several specific factors in its competitive environment, leading to the formation of logistics strategies at the niche level; and these logistics strategies will show their effectiveness, then will be adopted by the logistics industry as logistics trends at the meso level (industry level); at last, these logistics trends will face selection environment from a higher level aggregation (i.e, regime) and then shape the new production and consumption systems (Vargo et al., 2020).

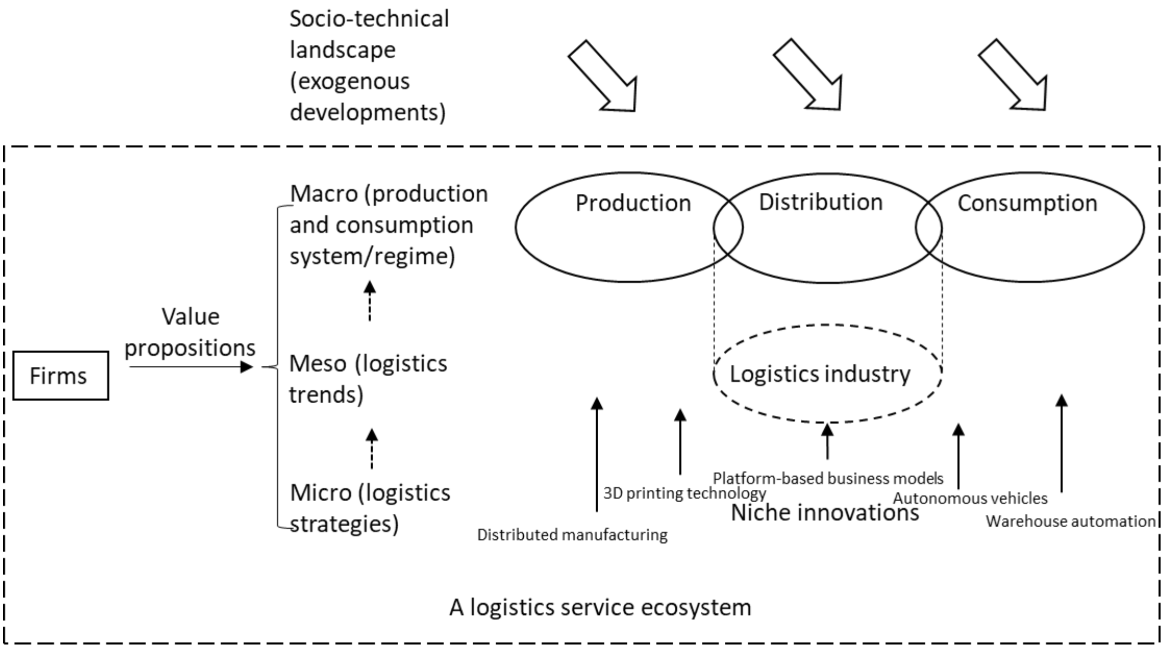

Figure 7. 1 A firm-level perspective on socio-technical transitions in the logistics industry (Developed by the author).

7.3 A service-ecosystems view on transitions in the European logistics sector

As discussed in the previous section, an S-D logic, service-ecosystems view on socio-technical transitions helps understand the interrelationship between technologies, business models, and market practices (Wieland et al., 2017). Similarly, Vargo et al. (2015) draw on the concept of institutional work (Lawrence et al., 2009) to examine how innovation unfolds through processes of institutional maintenance, disruption, and change in service ecosystems. This view of institutional development moves beyond a change in institutions by emphasising the importance of institutional stability (i.e., institutional maintenance) and the creative destruction of existing institutions (i.e., institutional disruption) are essential parts of institutional creation (i.e., institutional change) processes (Wieland et al., 2017). In other words, firms' value propositions not only aim at institutional change but also reflect the overlap between institutional maintenance and disruption to fit the current institutions (Vargo, 2015).

Accordingly, drawing on the insight from Chapters 4, 5, and 6, the following sections address different firms' efforts to change the institutionalised rules of resource integration (Koskela-Huotari et al., 2016), including 1) changing logistics strategies, 2) changing logistics trends, 3) changing production and consumption patterns. Table 7.1 provides an overview of these institutional changes, and further details will be discussed in the following sections.

Attributes of innovation	**Innovation patterns**	**Levels of service-ecosystems**	**Patterns of institutional change**		
			Maintenance	**Disruption**	**Change**
Making logistics services a competitive advantage Moving towards the co-creation of logistics value	Changing logistics strategies	Micro	Adhering to a cost-reduction role: operational efficiency; optimisation; customer satisfaction	Making the logistics function into a competitive advantage: redesign supply chain structure; implement data sharing policy; new patterns of communication, coordination, and collaboration	Changing value creation pattern: redefining the role of customers; enhancing actors' ability for value co-creation
Competing in the logistics industry without boundaries Moving towards a sustainable logistics industry	Changing logistics trends	Meso	Retaining the importance of logistics infrastructures such as warehousing facilities and transport networks; adhering to the logistics industry's image: service providers but not manufacturers or other roles	Transforming logistics as a sustainability enabler: increasing asset utilisation; reverse logistics; closed-loop supply chains; disruptions from platform-based business models: cutting the multi-layer subcontracting structure	Blurring boundaries between industries: new forms of collaboration; new entrants from online retail and high-tech industries
Digitalisation and automation of logistics services A service transition of production and consumption systems	Changing production and consumption patterns	Macro	Adhering to the contemporary pattern of production and consumption systems: the geographical separation of supply and demand; increasing demand for fast-moving consumer goods and electronics	Transitioning towards a service-based economy: new forms of competition and business models; customers become value co-creators	Shifting towards decentralisation and dematerialisation: micro-factory concept; circular economy

Table 7. 1 Patterns of institutional change: maintenance, disruption, and change (Developed by the author).

7.3.1 Changing logistics strategies at the micro-level

At the micro-level, firms have adopted different innovation strategies to stay competitive in the logistics industry. Thus, logistics innovations represent different value propositions aiming at shaping inter- (and intra) niche interactions. The focus here is on both direct interactions between the case study companies and their partners as well as on indirect interactions between the case companies. As a result, these value propositions will potentially lead to a change in logistics strategies, including two aspects, namely 1) making logistics services a competitive advantage, 2) shifting to the co-creation of logistics value.

7.3.1.1 Making logistics services a competitive advantage

Logistics is conventionally considered a cost that needs to be better managed in most businesses and industries. Accordingly, logistics innovations play a cost reduction role, which requires companies to operate more efficiently to stay competitive (Wagner and Sutter, 2012). Recently, big online retailers such as Amazon and Alibaba have heavily invested in logistics to differentiate themselves from competitors (PwC, 2016). This strategy also helps them avoid competition that might occur directly in the product price. Together with other technology firms, those online retailers will move from being customers to logistics companies' competitors, making the competition in the logistics industry more acute. Therefore, logistics companies also need to invest in automation technologies in picking, packing, and sorting to follow this trend. However, e-commerce companies often have more buying power in the logistics market. For example, e-commerce customers can make a comparison between different logistics companies' offers, which means they can easily switch their business from one logistics company to another. Consequently, it may discourage logistics companies' investment in automation technologies because they would face competition in price and receive less return than the invested amount (Dekhne et al., 2019).

However, as shown in Chapter 5, Company C's innovations in the digital e-commerce platform and smart fulfilment centres allow the company to provide an end-to-end e-commerce solution to its customers. These innovations improve the company's operations and enable its further development in core competencies, such as AI and machine learning and their applications in logistics services. Moreover, logistics performance will further be enhanced with the help of robotics and automation technologies. As a result, online retailers with their in-house technologies would further reduce their dependency on logistics service providers and even start offering their own logistics services (Yavas and Ozkan-Ozen, 2020). Thus, this trend of innovation with the company's counterparts can be concluded as a coopetition-based business model, which would be beneficial for Company C in 1) increasing the size of the current markets, 2) creating a new market, 3) increasing resource utilisation, and 4) improving the firms' competitive position (Ritala et al., 2014).

Another example is when Company B's operation efficiency is improved by the applications of smart sensors in component supply chains. Tang and Veelenturf (2019) note that real-time information about inventory level is often difficult to monitor in physical stores. However, the reduction in the cost of various sensors provides an opportunity for companies to develop inventory monitoring and replenishment systems. Therefore, Company B could enter other markets which the company has not previously fully explored. The regional director (Regional Managing Director, 2B) described the situation: "… most of our customers are the industrial customers, but you could use industrial vending solutions for public services which we have never looked at before … we come to other companies they do not manufacture and bulk anything together, but they might manufacture food, so these solutions do open other doors for us." However, it should be noted that Company B's innovation activities have always followed how to make the supply of components lean and efficient, maintaining the focus of logistics service on optimisation and operational efficiency.

7.3.1.2 Moving towards the co-creation of logistics value

From a value creation perspective, logistics services have traditionally focused on value-adding activities which attach to the transactional value of products being sold. This view is in line with the goods-dominant (G-D) logic, which considers the supply network as a system moving products downstream to create value (Tokman and Beitelspacher, 2011). However, from an alternative perspective, Vargo and Lusch (2008) defined service "as the application of competences (knowledge and skills) for the benefit for another party" (p. 256). The S-D logic represents a shift in the understanding of value creation processes. It suggests that logistics value does not belong to particular firms or distribution activities. Instead, the value is co-created by multiple actors in service ecosystems (Yazdanparast et al., 2010).

As shown in Chapters 5 and 6, Company A's distributed manufacturing strategy helps differentiate from the traditional logistics operations such as pick, pack, and deliver products in line with customer requirements. As a result, Company A becomes one of the 'producers' of logistics services because it can enhance its customers' value creation activities rather than fulfil customers' needs (Chakkol et al., 2014). For example, Company A can customise products at the latest possible stage by integrating 3D printing in the distributed manufacturing service. The additive manufacturing (AM) service requires Company A to examine existing resources such as warehouses and transport networks to meet the demand for customisation of unique parts. AM service also represents a shift from manufacturer-centric to customer-centric business models since AM enables co-creation with customers. As a result, the AM service helps Company A to participate in decentralised production networks that move manufacturing activities close to the place of consumption (Bogers et al., 2016).

Besides, Company A's distributed manufacturing solution results in better integration with its customers' manufacturing activities. This solution requires Company A's engineers and technicians to have specific knowledge for configuring and assembling products based on customers' needs. For example, the company has become a certified additive manufacturing provider in developing its additive manufacturing service. It can also be found in Company A's installation services for telecom equipment as the company's installers have passed several training courses to get the certification to implement distributed manufacturing services for its customers. Consequently, Company A can take over the whole process of postponed manufacturing, ranging from planning to quality control. In short, Company A is deeply integrated with its customers' value-creating processes and thus becomes a logistics value co-creator (Carbone et al., 2017).

Moreover, Company D's business model aims at aggregating shipper demand and carrier supply by using a centralised e-marketplace to provide not only attractive rates but also other logistics services such as fuel card, storage, insurance, and software services. As discussed in Chapter 6, Company D has become a network coordinator that facilities other companies' value creation activities in the service ecosystem. Thus, the value proposition (data transparency and eliminating intermediaries) should be developed in line with other participating companies' requirements to co-create logistics value (Wang et al., 2011). On the other hand, the data generated from users can be used by digital freight forwarders to enhance service quality and produce more customised services (DHL, 2020). From a service-ecosystems view, the ability to decouple digital information from its physical form is called ‘resource liquefaction’. Thus, Company D facilitates and contributes to the automation and digitalisation of its truckload-shipping ecosystem. As a result, logistics value co-creation enhances the actors’ ability throughout the service exchange in service ecosystems. Company D’s digital platform results in the reconfiguration of these operant resources, such as data and specific knowledge in the service ecosystem (Vural et al., 2019).

7.3.2 Changing logistics trends at the meso-level

The focus of the previous section is on logistics innovations and their impacts on the micro-level institution. As discussed in Section 7,2, each company’s innovation activities are guided by different innovation strategies to solve short-term problems. However, some of the logistics strategies would show their effectiveness and be adopted by the logistics industry. The resultant generic strategies will further contribute to the change of the industry structure, which is also defined as logistics strategies (EC, 2015; Tang and Veelenturf, 2019). There are two major aspects of the transition: 1) competing in the logistics industry without boundaries; 2) moving towards a sustainable logistics industry.

7.3.2.1 Competing in the logistics industry without boundaries

The first challenge comes from platform-based business models, which is brief discussed in the previous section. Consumer-facing transport and logistics platforms have gained a certain level of market shares in Europe, such as Uber and Deliveroo. These business models often need to coordinate two major parties: shippers and consumers. However, contrary to these consumer-facing platforms, electronic logistics marketplaces are more complex and facing multiple stakeholders with different expectations such as containers, transport infrastructure, regulations, and fuel prices (Wang et al., 2011). According to Choudary et al. (2019), three major factors are pushing the logistics industry towards platform-based business models: new infrastructure and technology, more visible logistics data, and cost-reduction pressure. Also, consistent data regulation helps to create a stable operational environment for platform-based companies. As discussed in Chapter 4, the EU’s Digital Single Market has accelerated the logistics industry’s digitalisation (World Economic Forum, 2017). Company D represents one of the platforms that has entered the European road freight market. More specifically, the full truckload (FTL) market. As shown in Chapter 6, several reasons make the company target this market, such as 1) FTL is relatively simple in terms of operation and suitable for large-scale entry; 2) low asset utilisation due to empty return journeys; 3) the FTL process is easier to be automated and digitalised; 4) around 80% of carriers are small operators with fewer than ten trucks in the European road freight market (Eurostat, 2016).

Furthermore, as discussed in Chapter 2, blockchain technology can improve supply chains' accuracy, visibility, and traceability. Thus, blockchain-backed platforms may increase trustfulness, and many supply chain activities will be executed in a secure business environment between various organisations (Wang et al., 2019a). For instance, Maersk and IBM have launched TradeLens, a blockchain-backed platform aiming at connecting the whole supply chain ecosystem in the container shipping industry. The platform is designed in an on-demand manner, which means that information is provided only when required by authorised participants in a supply chain ecosystem. Different actors in the ecosystem, such as ocean carriers, customs authorities, and inland transport providers, can access transparent data, leading to reduced administrative costs, lead times, and operational risks (Jensen et al., 2019). IBM has traditionally been a technology supplier to the logistics industry. However, with the application of blockchain-based technology, IBM can provide logistics services based on its expertise through digital platforms.

The second challenge comes from the online retailing industry. Big online retailers - with their in-house technology - will shift their role from customers into active participants or even competitors to logistics companies. For example, Amazon has been expanding its logistics capabilities in distribution facilities and fulfilment centres to reduce its dependency on logistics service providers. Amazon has also launched a service called Fulfilment by Amazon (FBA), allowing customers to use Amazon's facilities such as warehousing and Prime delivery service across Europe (Qin et al., 2020). As a result, it may become more difficult for traditional logistics companies to follow if big tech companies adopt advanced robotics and machine learning in warehousing solutions. As shown in Company C's smart e-commerce platform solution, the company can replicate its fulfilment solution for other businesses. Consequently, Company C has entered non-grocery and logistics business areas, which shows the company would potentially be both an online-retail and a logistics technology provider.

However, some challenges are also found in the development of these end-to-end logistics solutions by online retailers. First, such an innovation strategy requires a large amount of investment in R&D activities. For example, Amazon has passed Volkswagen AG to become the biggest corporate R&D spender in the world since 2016, and several radical innovations have been implemented, such as Kindle, AWS (Amazon Web Services), and Alexa (Fox, 2018). Second, 'routine alterations' are crucial to absorbing external innovation resources into the company's business model, which is also called "technology and content" by Amazon (Watanabe and Tou, 2019). Therefore, successful innovation not only requires adding new resources, but also looking for established practices to integrate these into attractive value propositions (Skålén et al., 2015).

7.3.2.2 Moving towards a sustainable logistics industry

Tang and Veelenturf (2019) argue that logistics can enable a more sustainable society regarding renewable energy usage, carbon footprint reduction, and social value creation. For example, companies can reduce emission by increasing asset utilisation through logistics data obtained from operations. The high percentage of low load vehicles and empty running contributes to the unsustainable part of the European road freight sector. According to Palmer et al. (2018):

> "EU statistics show a range of between 24% and 28% empty vehicle running, and a capacity utilisation by weight ranging from 54% to 57%, over a 10-year period." (p. 94)

As discussed in Chapter 6, Company D's digital freight platform aims at automating, optimising, and digitalising the road freight sector in Europe. The company's efforts may have a positive impact on the decarbonisation of the logistics industry. Therefore, Company D's expertise in route optimisation reduces empty running and downtimes and maximise carriers' transport loads, which may eventually cut costs and emissions. Moreover, Company D's focus has shifted from shippers to carriers, which means that the company will enable more carriers to maximise their transport loads when expanding its business in European markets.

However, it should be noted that in Company D's truckload ecosystem, shippers are often online retailers and manufacturers who place orders to move their goods between different business partners. Thus, the growth of e-commerce has the potential to increase the volumes of freight transport and result in higher fuel consumption and air pollution (Bonilla, 2016). Company D will have two potential options to mitigate the environmental impact of the growth of the e-commerce sector. First, as noted in the case study of Company D, small and medium-sized normally have no incentives to following a sustainable development goal. However, big shippers often need to follow a sustainability strategy as many large enterprises, for example, have become members of the World Business Council for Sustainable Development (WBCSD). Thus, Company D can provide shippers with more sustainable fuel options such as biofuels and natural gas for low-carbon freight transport in Europe (Navas-Anguita et al., 2019). Second, the data obtained from carriers' operations would contribute to developing connected and autonomous trucks (CATs) in the longer-term. For example, truck platooning would potentially contribute to reducing congestion, improving drivers' working condition, and increasing fuel efficiency (Gungor and Al-Qadi, 2020).

Routine innovations such as lean, resilient, and green have been proven effective in helping companies to become more sustainable in supply chain management literature (Sanchez Rodrigues and Kumar, 2019). As discussed in Chapter 6, Company A has implemented a lean approach that helps customers improve their supply chain performance and reduce waste. The lean project's outcome suggests that sustainability impacts are not expected at the beginning, and people have started to think about making things more sustainable at both individual and organisational levels during the project implementation. Moreover, Company A often has a holistic view of supply chains as a logistics service provider (LSP). Thus, data obtained from physical products and information may help Company A understand the impact of lean management on global supply chains. Besides, the adoption of lean practices needs further collaboration with the LSP and its customers, as well as other LSPs (Kumar and Sanchez Rodrigues, 2020). In particular, cloud computing is considered the key technology for Industry 4.0 and its application in lean supply chain management, which improves synchronisation and collaboration across all supply chain members by providing real-time monitoring and quick access to information (Núñez-Merino et al., 2020).

In terms of more radical innovations, such as Company A's additive manufacturing (AM) service and its application in the distributed manufacturing solution could potentially contribute to the transformation from linear to the circular supply chain. A circular supply chain has many elements, such as repair, reuse, remanufacturing, and recycling. It can be achieved by adopting the distributed manufacturing solution that moves manufacturing and repair processes closer to customers. However, to achieve these potential sustainable benefits, Company A needs to acquire new resources (e.g., 3D printers, manufacturing expertise) to integrate with its current resources such as warehouse facilities and transport networks. The company thus needs to be aware of the expectations of its customers. For example, the company's image is linked with the logistics industry, and customers need to be given more information about the circular business model. As noted by Logistics Service Analyst A:

> *"The problem is that our company is considered by customers as a logistics company, actually more of a freight forwarding company. So, they were very surprised by our distributed manufacturing solutions. That is the reason why we started the collaboration with [a technology provider] to change customers' perception of the company's brand" (Logistics Manufacturing Services Analyst A, Company A, 3A).*

The adoption of a circular economy concept requires firms to adapt their business model to this new industrial paradigm, leading a transformation from the linear flow of "resources-products-waste" to circular supply chain "resources -products-waste-renewable resources" (Urbinati et al., 2017). Therefore, supply chain collaboration is an important capability to connect a network of organisations by managing data and material flows, responsibilities, and sharing benefits (Leising et al., 2018). In this collaboration, logistics companies can be seen as a connection between these organisations as they work closely with a range of industries and have a better understanding of all levels of the circular economy. As shown in Company A's distributed manufacturing service, the company has entered the manufacturing process by purchasing components for assembly and proactively managing inventory, but this is only one part of the product life cycle. Another part is associated with remanufacturing, repairs, and returns, in which the company wants to manage and create value through the entire product life cycle with its partners.

7.3.3 Changing production and consumption patterns at the macro-level

The section's focus is on the change of the macro-level service ecosystem, which can be referred to as a reconfiguration of the production and consumption systems (McMeekin et al., 2019). Much previous work on socio-technical transitions has been on nurturing sustainable technologies or practices since several economic and social factors will lead to uncertainties regarding market selection (Geels and Raven, 2006; Schot and Geels, 2008). The focal unit of transitions studies is 'socio-technical systems', including cognitive routines, regulations, cultures, sunk investments in infrastructures and competencies (Geels and Schot, 2007). Although different systems may have various configurations, Figure 7.2 briefly describes how logistics innovations contribute to shaping production and consumption patterns (Sovacool et al., 2020). Here, firms' value propositions aim at shaping production and consumptions systems at the macro-level of the service ecosystem, and the further enactment of these value propositions contributes to the establishment of logistics industry trends.

In sustainability transitions studies, logistics is often considered a 'link' connecting production and consumption activities. However, as noted by Geels (2018), there is a need to shift from a single 'disruption' focus to greater attention on the 'system reconfiguration' because previous transitions studies have predominantly started from either the production or the consumption side of socio-technical systems (Geels et al., 2015). Thus, as shown in Figure 7.1, the logistics system can be considered a subsystem within the production and consumption subsystems, and logistics innovations become an additional entry point to understand the whole system reconfiguration (Pettit et al., 2018). This section has two major parts to show how these logistics strategies and trends will contribute to the reconfiguration of production and consumption systems: 1) digitalisation and automation of logistics services; 2) a service transition of production and consumption systems.

7.3.3.1 Digitalisation and automation of logistics services

ICT such as the internet, mobile and cloud computing, as well as IoT (referred to as a system of devices that can interact with each other), would transform the communication, coordination, and collaboration of supply chain partners (Colicchia et al., 2019; Tang and Veelenturf, 2019). The digitalisation and automation of supply chain and logistics services have led to the 'digital supply chain' (DSC) to a customer-driven economy because of the growing need for flexibility and speed. Thus, the DSC is described as "a customer-centric platform that captures and maximises the utilisation of real-time information emerging from a variety of sources" (Büyüközkan and Göçer, 2018, p. 165).

Additive manufacturing (AM) represents a disruption in conventional manufacturing activities and an enabler that creates new business models and supply chain design. On the production side, AM is likely to be used in creating highly customised products, which will lead to waste reduction, localised manufacturing, and shorter delivery cycles (Jiang et al., 2017). First, AM gives certain degrees of freedom in the design stage since it allows to manufacture of products from digital data. More importantly, AM could enable manufacturing processes at a digital factory in an on-demand manner, reducing lead-time and associated transport time and costs (Attaran, 2017). Second, digital inventory may replace physical inventory since manufacturers may not need to use a warehouse with high quantities of spare parts to integrate AM into existing manufacturing environments (Goehrke, 2018; Verboeket and Krikke, 2019). On the consumption side, AM allows B2B and B2C customers to design and produce their own products. As a result, there will be more localised and regional manufacturing facilities, and the rise of the resultant concept of 'prosumer' will increase the competition between AM and traditional manufacturers. As shown in Company A's distributed manufacturing solution, logistics providers could take advantage of AM's impacts on supply chains to create new logistics services, such as being a network coordinator to manage more fragmented supply chains for raw materials and products (DHL, 2020).

Digital logistics marketplaces, on the other hand, accelerate the digitalisation and automation of logistics services since they match shipper demand and carrier supply across supply chains. As noted by the Senior Director of Company D (7D), the European logistics industry has not been fully ready for digitalisation. Many works are still executed in a non-digital way, such as paperwork, mobile, and email exchange. However, digital logistics marketplaces can offer a centralised platform to provide delivery rates and schedules to customers. Other services such as customs document management, fuel cards and tolls, and supply chain visibility will improve customers' digital experience and accelerate the digitalisation and automation of logistics services. In addition to digital freight forwarders, on-demand warehousing services have entered the logistics industry using cloud-based platforms. For example, Stockspots is a start-up company aiming at connecting unused space in warehouses throughout Europe to provide on-demand warehousing service. The benefits are twofold: first, companies can use Stockspots' platform to rent available pallet spaces in an on-demand manner from a network of warehouses in regions. Second, companies can also push their excess warehouse space to the platform to generate extra revenue (Van der Heide et al., 2018). However, it is difficult for digital-only platforms to ensure service quality because lack of logistics infrastructure for the physical movement of goods, which leaves space for traditional logistics companies to implement their digital logistics services (Mikl et al., 2020). Consequently, the digitalisation and automation of the logistics industry would be accelerated by competition between start-ups and incumbent firms.

"… they do not have the infrastructure and networks, but a lot of big logistics companies did. So, in the end, the digital freight forwarders will rely on big companies to provide the service ... It is very difficult for those digital companies to build the infrastructure that we have got, but it's easier for us to build digital part instead of building the infrastructure…" (Global Head of Strategy and Innovation, Company A, 1A).

Furthermore, the growth in e-commerce demand is considered the primary factor that pushes companies to seek more effective logistics services such as digital freight and on-demand warehousing marketplaces. The COVID-19 pandemic has accelerated this trend because online shopping for fast-moving consumer goods has increased fast during the lockdown in Europe. According to the PwC survey, more than 28% of consumers who live in European urban areas have been using online shopping as the primary option for purchasing groceries. The number was 18% higher than a year ago before the pandemic arrived (PwC, 2020). The trend would continue in the future once consumers have positive experiences with online shopping (Brem et al., 2021).

7.3.3.2 A service transition of production and consumption systems

In an S-D logic view, the word 'service' here represents the application of resources for the benefit of others (Maglio and Spohrer, 2013). This view is based on the basic understanding of economic activity in terms of value creation, which considers all economic activity as service-for-service exchange (Vargo and Lusch, 2017). In this thesis, a service transition can be concluded from the four cases presented, which means that all the firms investigated are a certain level of a logistics provider along with the digitalisation of the logistics sector. This finding is in line with the S-D logic view on actors (Axiom3/FP9): "all social and economic actors are resource integrators" (Vargo and Lusch, 2016, p. 18).

The first example is the development of autonomous trucks and the impacts on OEMs and logistics service providers. Road freight transport's current business model is based on manufacturers - who sell vehicles to transport providers and various transport providers (ranging from small carriers to LSPs) - who provide transport services for shippers (Monios and Bergqvist, 2020). Autonomous trucks represent a potential disruption of truck manufacturers' business model and the trucking and logistics industry structure. Thus, new business models will be created with the introduction of autonomous trucks, and new types of cooperation and partnership will be built according to each partner's knowledge and expertise. For example, a new partnership has been formed between software providers, logistics providers, and OEMs (Skeete, 2018). Some tests have been done under this cooperation, such as DB Schenker and MAN's experiment on semi-automated truck convoys and Daimler Trucks and Waymo's partnership to develop automated trucks (Fritschy and Spinler, 2019).

As shown in the case of Company D, as a digital freight forwarder, the growth of its digital platform business will generate more data to optimise the use of autonomous trucks for future autonomous technologies. Consequently, the company's expertise in advanced data technologies could help to maintain its position through the further development of autonomous trucks. However, the OEMs' role will be changed in the future since they are embedded in incumbent socio-technical regimes and thus need to adapt to the new business environment, such as the shortage of truck drivers in Europe (see Section 4.2.2.4 Ageing society). As described by the Business Development Manager of Company D:

> *"…first, I think they will shift towards more leasing models because they have to keep cash flow, obviously. The second one is that they will probably make a partnership with big freight forwarders to make their trucks on leasing bases…" (Business Development Manager, Company D, 6D).*

Accordingly, Fritschy and Spinler (2019) present three possible scenarios that OEMs may face in the future: 1) cooperation and partnerships, OEMs will work as a boundary spanner in this scenario to provide both hardware and software into the trucks; 2) OEM's business model under attack, OEMs will own their trucks and offer 'capacity-as-a-service'; 3) OEM's position degraded, which means OEMs only provide the hardware to autonomous trucks.

The second example is the transition from service providers to manufacturers. This trend is also called 'productisation' as a reverse strategy to 'servitisation' in product-service literature (Roy et al., 2009; Harkonen et al., 2015). However, from an S-D logic view, the transition can be seen as companies adopting manufacturing knowledge to increase customers' value creation capabilities while retaining their core values (Liu et al., 2020). As discussed in Company A' case, a proactive manufacturing strategy helps transform its tangible resources such as warehousing infrastructure and transport networks. Meanwhile, the company brings manufacturing activities (e.g., assembly, repair, test, and return) closer to final consumers. As a result, distributed manufacturing will impact the consumption pattern and individual and industrial consumers' perception of electronic products. In the long term, the on-demand, decentralised and customised manufacturing process could transform traditional manufacturing into several local micro-factories (Wells, 2018; Weking et al., 2020), as noted in Chapter 6:

> *"… moving production closer to customers, Adidas is a perfect example since it moves part of the production from Vietnam to Germany… as switch more of their production into 3D printing" (Global Head of Strategy and Innovation, Company A, 1A).*

Similarly, Company C's core competencies lie in the interface between its hardware (e.g., smart fulfilment centres) and software (e.g., digital e-commerce solutions). Thus, the company plays a dual role as an online-retail and a technology provider, as discussed in Chapter 6. Furthermore, as the business grows, Company C will have more chances to add more blocks to its digital e-commerce solutions – and even enter production systems by using the aforementioned micro-factory concept. For example, the company has started experimenting with vertical farming and its application together with distribution centres. The experiment is mainly led by consumer concerns about food freshness and sustainability, which COVID-19 and subsequent lockdown have specifically accelerated this trend. Vertical farming technologies play a crucial role in urban sustainability in terms of organic waste and wastewater recycling (Maye, 2019). However, several new challenges will be created as the company integrates food production into its fulfilment services, such as pick, pack, and transport with a temperature-controlled environment (DHL, 2020).

7.4 The interdependencies between actors, technologies, and institutions

By adopting an integrative view of S-D logic and the MLP, the chapter conceptualises logistics innovations as different value propositions that aim at reconfiguring the institutional rules of resource integration. Three patterns of institutional change have been identified: maintenance, disruption, and change of institutions (Vargo et al., 2015). Besides, logistics innovations and their impact on all three levels of service ecosystems have been examined respectively, including 1) changing logistics strategies at the micro-level; 2) changing logistics trends at the meso-level; 3) change production and consumption systems at the macro-level. As a result, the chapter demonstrates how the institutional reconfiguration of actors, service ecosystems, and resource integration patterns impacts the role of actors, the structure of service ecosystems, and the nature of resources (Vargo et al., 2020).

7.4.1 The interdependence of institutional changes (maintenance, disruption, and change)

The interdependence of institutional changes has been explored as the notion of 'fit-stretch' in transitions studies, which describes how innovations can move from existing user preferences (a 'fit') to new-added functionalities (a 'stretch') (Sovacool et al., 2017). The 'fit-stretch' pattern can be found in earlier transitions in mobility, for example, from horse-drawn carriages to automobiles in the late 19^{th} century (Geels, 2006). Also, in technological shifts studies, the 'fit-stretch' is described as a dilemma of companies facing technology shifts: either radically increase technological competence or attempt to transform the firm's value proposition to stay competitive (Tongur and Engwall, 2014). Furthermore, Petzer et al. (2020) elaborate the fit-stretch pattern, emphasising strategy as a link between use environment and technology choices, resulting in a 2 x 2 matrix of introduction strategy (Table 7.2). In other words, as discussed in this chapter, ensuring successful logistics innovations requires certain levels of disruption to institutional rules. However, on the other hand, some old rules need to be retained, and, therefore, some new rules become easier for other actors in the service ecosystems to accept (Vargo et al., 2015).

Use Environment	**Technology choice and design**	
	Fit & Conform	**Stretch & Transform**
Fit & Conform	Selective Substitution	Leapfrog design for substitution
Stretch & Transform	Market differentiation	Exploration of a new regime

Table 7. 2 Typology of introduction strategies (adapted from Petzer et al., 2020).

Company A's distributed manufacturing solution shows the importance of institutional maintenance during project development. As discussed in Chapters 5 and 6, the company's distributed manufacturing strategy has been approved successfully. However, when adding additive manufacturing solution to the strategy, the company has been facing several issues like legal copyrights, heavy investment in 3D printers, and unstable demands. Therefore, the additive manufacturing solution has tried to disrupt the current socio-technical regime and resulted in a less successful implementation. As a result, the company has switched to the outsourcing approach to manage the additive manufacturing ecosystem by following an existing use environment (outsourcing 3D printing solution) as a market differentiation strategy. The finding supports previous research on the interdependence of institutional changes (see. Koskela-Huotari et al., 2016 and Sovacool et al., 2017), emphasising the importance of institutional maintenance in ensuring successful innovation. Similarly, Company D's platform-based business model aims at connecting shippers directly with carriers to eliminate intermediaries from the multi-layered industry structure. Thus, Company D has followed a market differentiation strategy to compete in the road freight sector without a significant technology change, contributing to the acceleration of digitalisation and automation. Because of the difficulties in providing the logistics management solution for large shippers, Company D has shifted its focus from shippers to carriers to maintain parts of the institutional structure as a 'cost-reduction tool' for carriers.

Company C's end-to-end e-commerce solution represents an exploration of a new regime because it has heavily invested in the hardware (e.g., automated fulfilment centre) and software (e.g., smart e-commerce platform) of the solution. Hence, Company C has developed a coopetition-based business model to provide the end-to-end solution to its competitors in the retail industry (Ritala et al., 2014). This strategy is also called 'beyond competition' that combines technological innovation with business model innovation (Wells, 2013). Meanwhile, Company C may face a high risk of failure since they aim to change too many parts of the institutional structure in service ecosystems (Koskela-Huotari et al., 2016). However, the successful implementation of the end-to-end solution helps Company C become a logistics technology provider while retaining its competitive positioning in the online retail industry. As a result, other competitors may find it difficult to follow or replicate this strategy. As discussed previously, Amazon adopts the concept of "technology and content" to guide its R&D activities, aiming at assimilating external resources of innovation into its core business model. Similarly, as noted in Chapter 5, Company C has implemented several trials of electric vans and autonomous vans in order to identify the potential application in its end-to-end e-commerce solution. However, several factors have been identified as risk factors for the development of new delivery models, such as less support from mainstream manufacturers, weight limit for electric vans from related regulations, and substantial infrastructure investment is required from the government. Consequently, Company C's focus has remained on route optimisation for efficient last-mile delivery.

7.4.2 The reconfiguration of resources and actors in service ecosystems

By adopting an S-D logic, service-ecosystems view, logistics innovations have contributed to blurring not only the distinction between 'producers' and 'consumers' but also the divide between 'innovators' and 'adopters' (Vargo et al., 2015). Thus, innovation is considered as an ongoing institutionalisation process that redefines actors and reframes resources in service ecosystems (Koskela-Huotari et al., 2016). This view can improve our understanding of socio-technical transitions in several ways by 1) including the role 'mature entrants'; 2) redefining the role of actors; 3) reframing the nature of resource integration processes.

First, this implication is important for understanding the role of organisational actors in socio-technical transitions because the common 'incumbent-new entrant' dichotomy overlooks the third category: 'mature entrants' (Manders et al., 2018). As shown in Section 7.3.2.1 (Competing in the logistics industry without boundaries), Company C has provided the end-to-end logistics solution to its customers and added another business model to the company's portfolio. As a result, Company C represents one of the 'mature entrants' in the logistics industry. Also, platform business models have grown significantly in size and scale as a result of new services coupled with digitalisation (Pelzer et al., 2019; Wells et al., 2020). In the case of Company D, the role of these platform businesses has been discussed regarding their 'disruptiveness' to the road freight sector. In transitions studies, market incumbents are often defined as large actors active in the mainstream socio-technical system for a longer time. In recent years, however, established high-tech companies have entered new domains such as Uber in logistics and transport (Uber Freight), Apple and Google in autonomous vehicle development. As discussed in Chapter 6, this trend may be due to ICT companies can provide a higher level of digitalisation (i.e., resource liquefaction) and result in high resource density, enabling them to explore relevant resources for specific applications in other industries (Lusch and Nambisan, 2015). Thus, further research is needed to explore why and how ICT companies are entering other industries, but not the other way around (Chester Goduscheit and Faullant, 2018; Manders et al., 2018).

Second, institutional reconfigurations in service ecosystems often entail that the role of actors is redefined accordingly. For example, in Company A's case, the manufacturing strategy needs to be implemented by integrating new manufacturing knowledge with its warehousing facilities. Since they have acquired additive manufacturing knowledge and become a certified provider of additive manufacturing services, Company A has further blurred the distinction between manufacturers and logistics service providers. Also, in the case study of Company D case, truck manufacturers' role has been discussed regarding how they will transform their business model to cope with the introduction of autonomous vehicles. 'as-a-service' transition

Furthermore, customers have become more active in developing logistics innovations. As shown in Company A's distributed manufacturing solution, customers contribute to successfully implementing the solution in three aspects, including knowledge, capital, and testing opportunities. Therefore, customers move from a passive role to receive logistics services to a proactive role in co-creating logistics value (Chakkol et al., 2014). Moreover, with the introduction of additive manufacturing technologies, the role of consumers – as well as small-medium enterprises (SMEs) – in the production process could be shifted from passive to become more active like producers (i.e., 'prosumers'). As suggested by Geels et al. (2015), the MLP's focus is often on technical innovation to understand the social shaping of technology from a supply-side perspective; sustainable consumption research focuses mainly on daily life activities and pays less attention to the supply side. Consequently, logistics innovations can be helpful to understand these crossovers by exploring how innovation diffusion occurs across production and consumption systems.

Third, S-D logic considers all social and economic actors as resource integrators, and no single entity can provide all these resources in service ecosystems. Actors thus need to combine various resources from either learning new knowledge or recombing existing resources to facilitate innovation (Lusch and Nambisan, 2015). This view echoes what strategic niche management (SNM) literature has been advocating for some time: new (sustainable) technologies can be nurtured within a selective environment through managing expectations, building networks, and learning (Turnheim and Geels, 2019). Therefore, innovations can spread horizontally, including intra-niche learning for a particular application and inter-niche learning for more complex applications. For example, as shown in the case study of Company D, the platform-based business model is not only adopted by start-ups to enter the logistics industry but also by traditional logistics companies to keep up with digitalisation by integrating with their existing infrastructure and transport networks. According to our conceptual framework, certain logistics strategies, such as the platform-based business model, will be eventually be adopted by the actors from higher level of aggregation, leading to the formation of logistics trends.

Furthermore, innovations can move vertically by including new actors and resources in service ecosystems (Vargo et al., 2020). The case studies show that innovation as collaborative recombination of practices also results in reframed resources. For example, by acquiring new know-how and building new partnerships, Company A and C have transformed their warehousing facilities' functionality, potentially leading to a more decentralised 'micro-factory' system. However, it should be noted that the logistics innovations have been observed in this thesis only represent a short-term phenomenon. However, transitions often unfold in complex ways over the decades. In this thesis, logistics innovations are conceptualised as different value propositions aiming at changing the institutionalised rules of resource integration in the service ecosystem. At the micro-level, resource integration activities may be shaped by firms' innovation strategies and result in a short-term change in logistics strategies. At the meso-level, the routinised acceptance of these value propositions may result in logistics strategies to shape the logistics industry structure. At the macro-level, aggregated interactions may lead to the gradual establishment of logistics trends that aims at shaping production and consumption patterns. As these three levels may change at different rates, the consideration of future enactments of value propositions is crucial for further studies to understand how value co-creation activities may influence transition pathways (Vargo et al., 2015; Vargo et al., 2020).

7.5 Chapter Summary

This chapter addressed the key findings from the previous chapters (Chapter 4, 5, and 6) in the context of the wider theoretical and empirical literature. The analysis and discussion of the results were based on ongoing debates about socio-technical transitions, business model innovation, and the S-D logic perspective. First, based on S-D logic and the MLP, we drew on an integrative conceptualisation of logistics innovations. Second, we presented how logistics innovations would shape the rules of resource integration on micro-, meso, and macro-level of the service ecosystem. Last, we discussed the interdependence of institutional changes (e.g., maintenance, disruption, and change) to address the role of firms in socio-technical transitions. In addition, the role of logistics innovations was discussed in terms of how these innovations shaped short-term business logic, as well as longer-term logistics strategies and trends.

In the next chapter, we will briefly summarise the findings of this thesis to address our research questions. Finally, we will suggest a number of future research directions based on our reflections on the research strategy and theoretical/empirical contributions.

Chapter 8. Conclusion

8.1 Introduction

The final chapter aims at drawing insights from the previous chapters to answer our research questions. Then, the theoretical and practical contributions of this thesis will be addressed based on our findings. Finally, the limitations of this thesis and future research directions are presented.

8.2 Addressing the research questions

The primary aim of this thesis is to investigate how firms manage their innovation activities in the digital transformation of the European logistics industry. By adopting a multiple-case study design, we have examined different types of logistics innovations to understand how these efforts contribute to shape companies' logistics strategies, wider logistics trends, and socio-technical systems. The research questions are addressed as follows:

1. What is the role of firms in socio-technical transitions in the logistics industry?

From a socio-technical transition perspective, firms are considered critical for driving or preventing transitions, such as incumbent and niche actors in the MLP dynamic and multi-actor network learning processes in SNM. Thus, socio-technical transitions may result from the strategic reorientations of incumbent firms, niche-regimes interactions, and "mature entrants" enter niche innovations. Following the previous classification in transitions studies, Company A and Company B represent market incumbents that adopt Industry 4.0-related innovations and result in strategic reorientations. Company D can be considered a new entrant that aims to disrupt the European logistics industry by using its digital platform-based business model. Moreover, a third category, 'mature entrants', has been added based on the investigation of Company C, as the company's end-to-end e-commerce solution provides an additional business model to enter the logistics industry as a logistics technology provider.

However, the above classification will neglect that firms often have multiple roles in socio-technical transitions. For instance, firms may be rule followers at the regime level, and firms do not necessarily follow the rules at the niche level since the shared rules are less stable. This view implies firms often need to seek opportunities between niche and regime levels.

Some transitions scholars have adopted the business mode concept to help understand the multiple roles of firms in sustainability transitions because business models can be considered a device to commercialise niche innovation, a barrier to transitions adopted by market incumbents, and a non-technological niche innovation. But we argue that these different roles should be existing at the same time. For example, Uber's business model can spread with other forms of mobility sharing businesses (e.g., car sharing or ride sharing) to disrupt the current product-based automotive industry, but the business model helps to retain a population of qualified drivers for the future.

Similarly, the role of firms can be further elaborated by adopting an S-D logic, service ecosystems view, which helps us understand how firms' innovation activities shape and are shaped by socio-technical transitions. S-D logic views all actors as resource integrators, and firms can be seen as resource integrators that interact through service exchange for value co-creation (Vargo and Lusch, 2016). Therefore, the interrelation between driving and preventing transitions can be understood through how firms balance their innovation efforts of disrupting and changing resource integration rules while maintaining some part of the rules. For example, in the case study of Company A, the company decided to outsource the additive manufacturing solution to avoid heavy investment and copyright issues in 3D printing technologies while maintaining its position in the additive manufacturing market. Also, Company D shifted the focus from shippers to carriers because it was difficult to integrate large shippers' platform into a comprehensive truckload-shipping ecosystem. In other words, although Company D's business model had the potential to disrupt the traditional road freight business in Europe and accelerate digital transformation, the company still needs to follow a cost reduction strategy to be easily adopted by carriers.

2. What is the role of logistics innovations in socio-technical transitions?

The findings from the multiple case studies show that logistics innovations have contributed to the formation of companies' logistics strategies, leading to a change in logistics trends, and result in new production and consumption patterns in socio-technical transitions. Transitions scholars call for a shift in focus from a single and radical technology innovation to the multiple innovations and system reconfiguration perspective. Logistics activities play a crucial role in connecting production and consumption systems. However, they are often neglected compared to other studies such as mobility, energy, and agriculture in the transitions literature because there has been a tight connection between sustainable product innovations. So, previous transitions studies have only focused on part of the supply chain (McMeekin et al., 2019). Our research starts from a firm-level perspective compared with previous studies that applied the whole system reconfiguration approach (Geels et al., 2015; Geels, 2018; Sunio et al., 2019). As a result, we can understand how logistics innovations have contributed to the blurring of boundaries between traditional industries, which allows firms to participate in both sides of production and consumption systems. The findings also confirm the S-D logic perspective's view on all actors are resource integrators.

First, moving from manufacturers to retailers: Manufacturers are becoming more like retailers to give fast customer response by enhancing information flows. Company B's RFID Kanban systems showed one of the IoT applications in warehouse management to increase production efficiency and data transparency. Therefore, the real-time information gained from sensors helped manufacturers monitor the existing quantity of manufacturing components for timely replenishment, which represented both lean and agile characteristics.

Second, moving from logistics service providers to manufacturers: Company A represents a traditional logistics and freight forwarding provider entering the manufacturing domain. As discussed in the previous chapter (see Section 5.3.1), Company A decided to follow a distributed manufacturing strategy to differentiate itself from its competitors in the logistics market. Thus, new staff members with manufacturing background were recruited at the beginning of the innovation project. Furthermore, company A became a certified 3D printing service provider during the development of the additive manufacturing solution, which allowed the company to develop a distributed and on-demand manufacturing network.

Third, online retailers move into logistics services: As discussed in the first research question, Company C can be considered a 'mature entrant' from the online retail industry that aims to develop its logistics capability to reduce dependency on logistics service providers. By integrating its digital e-commerce platform and automated fulfilment centres, Company C added an additional business model to provide the end-to-end online retail solution for its customers. As a result, the new business model has the potential to transform Company C from an online retailer to a logistics technology provider.

Fourth, shifting from products to services: Company D’s major value proposition is the elimination of intermediaries by increasing data transparency. As a digital freight forwarder, Company D will contribute to the European road freight sector's automation and digitalisation. Therefore, Company D will have more opportunity to adapt to the development of autonomous trucks because its digital platform can generate more data for autonomous driving. However, Company D’s partner – a truck manufacturer – may need to develop new forms of collaboration with software providers and logistics providers to transform towards an ‘as-a-service’ business model.

3. How are value propositions developed and evolved?

In this thesis, we define service innovations as an ongoing process in which a firm creates new value propositions or develops based on existing ones. Therefore, value propositions are not static and can be co-created and evolved over time. Also, we highlight the application of the ‘fit-stretch’ pattern from earlier transitions studies in investigating how value propositions have been developed and evolved. For example, the Better Place’s business model has a mismatch between how far the company can stretch in the current regime and how well the company can fit into existing user practices, which leads to a failure in its business model innovation. To ensure successful logistics innovations, companies need to disrupt certain institutional rules and practices. However, other old rules are also important for other actors in the service ecosystem to accept. For example, Company A’s additive manufacturing service was proved too disruptive to the current logistics industry. Therefore, the company decided to outsource the service and worked as a network coordinator. By examining the logistics innovation projects with which the case companies were involved, we also found that the development of value propositions resulted from recombining or/and integrating resources among different actors. For example, value propositions were often developed between customers, the focal firm, and other partners. As shown in Company A’s distributed manufacturing solution, there were several collaborations with research partners, technology providers, and customers. In particular, customers played an important role in the successful implementation of the distributed manufacturing solution as they provided know-how, capital, and testing opportunities. Similarly, Company C’s smart e-commerce platform was developed by a collaborative project with its research partners. Therefore, the dynamics of value propositions can be considered the exchange of knowledge between resource integrators.

Furthermore, value propositions need to be constantly revised in accordance with market dynamics. For example, Company D had built a partnership with a fuel card provider to attract its main target: carriers. Thus, the value proposition of Company D served to link different actors in the company's truckload-shipping ecosystem, which helped determine the most suitable network configuration. As part of Company D's longer-term innovation strategy, the company might work directly with energy companies, which meant that value propositions would constantly evolve to shape the composition of a network. Therefore, companies' innovation strategies often guided value proposition development, and it was also found in Company A's distributed manufacturing and Company C's smart e-commerce platform strategies.

4. How do firms' innovation activities contribute to the transition of the logistics industry?

As discussed in Chapter 7, logistics innovations can be considered value propositions that aim at shaping logistics strategies (micro-level), logistics trends (meso-level), and production and consumption patterns (macro-level). Therefore, these value propositions can be aggregated into specific sets of factors that aim at shaping new institutional arrangements. This view is especially helpful to bridge short-term innovation activities and longer-term industry trends by focusing on value proposition development, because the application of the business model concept in transitions studies often only focus one single technology or practice. Moreover, a shift in focus from one singe technology to value proposition development will help transitions scholars to understand the relationship firm-level innovation strategies and the whole system reconfiguration approach.

At the micro-level, the findings showed that the role of logistics was moving from a cost reduction function to a competitive lever, which led to a change in the logistics strategies of the logistics industry. As discussed in the case studies of Company B and C, these two companies gained a competitive advantage by investing in their logistics capabilities. For example, both companies invested in warehouse automation technologies such as Order Storage Retrieval (OSR) systems and robots to increase operational reliability and efficiency. As discussed above, Company C also created an additional business model to provide its end-to-end e-commerce solution, which made it difficult for competitors to follow. Furthermore, there was a shift from considering logistics innovations as value-added activities to viewing logistics innovations as the dynamic process of value co-creation. For instance, Company A’s distributed manufacturing solution allowed the company to take over some of the customer’s manufacturing activities and co-create logistics value.

At the meso-level, our findings showed that logistics innovations helped dissolve the boundaries between the logistics industry and the relevant industries. As discussed in response to RQ1 and 2, digital technologies enabled firms to play various roles in socio-technical transitions. For example, Company D’s platform-based business model allowed the company to enter the European logistics industry by offering agile pricing and real-time tracking to carriers. Meanwhile, Company D’s business model helped it adapt to the new business environment, such as the shortage of truck drivers. By expanding its own logistics offerings, Company C entered the logistics industry while retaining its competitive advantage in the online retail sector. Furthermore, the case studies' findings indicated that logistics innovations would enable a transition towards a more sustainable logistics industry. For instance, Company D’s route optimisation and asset utilisation helped reduce the environmental impact of road freight transport. Also, Company A’s distributed manufacturing had the potential to transform linear to circular economy by integrating 3D printing technologies and reverse logistics.

At the macro-level, the findings showed that the firms had an opportunity to reshape their logistics operations in the digital transformation era and resulted in a change in production and consumption patterns. For example, Company A’s additive manufacturing solution would allow B2B and B2C customers to be involved in the product design process, which shows its participation in both production and consumption sides. As discussed earlier, one of Company D’s partners (a truck manufacturer) would need to adapt to the introduction of autonomous vehicles in the logistics industry, such as forming new business partnerships and business models. Finally, the micro-factory concept was experimented by Company A and C. For example, Company A could provide on-demand part manufacturing by installing 3D printers in its warehouses. Company C was testing the potential application of vertical farming for its fulfilment centres. As a result, the micro-factory concept and its applications would lead to a more decentralised production and consumption pattern in the future.

8.3 Research contributions

8.3.1 Theoretical contributions

Transitions scholars have started exploring the role of business models due to the lack of a firm-level consideration in existing transitions theories (Sarasini and Linder, 2018). For example, Bidmon and Knab (2018) identify three roles of business models in transitions studies. Bolton and Hannon (2016) consider business models as activity systems to explore the application of the energy service business model in the UK. In this thesis, we adopted an S-D logic, service ecosystems view on the role of firms. This view helped us connect business models with technological and market innovation in socio-technical transitions (Wieland et al., 2017). Furthermore, S-D logic provided a balanced view on firms based on an actor-to-actor (A2A) orientation, which enabled us to overcome the niche-actor and regime-actor dichotomy in transitions studies (Ruggiero et al., 2021). This contribution helps to address the critique of the MLP in the role of actors. Also, as Geels (2011) suggests that flat approaches may be helpful because niche innovations do not often emerge with regimes, so the notion of 'nested hierarchy' of the MLP may need to be dropped. In our study, we argue that firms' value propositions can contribute to niche-level innovations by forming logistics strategies and to regime shift by forming logistics trends. However, the socio-technical landscape is considered an exogenous environment that cannot be influenced by niche and regime actors. So, landscape factors have been excluded from our conceptual framework since this thesis starts from a firm-level perspective, which is worth further exploration because the COVID-19 pandemic provides a good landscape pressure that can be directly received by different firms.

Socio-technical transitions studies are required to understand more about systemic changes across the production, distribution, and consumption systems (McMeekin et al., 2019). Geels et al. (2015) suggest exploring new approaches for understanding 'multiple innovations and system reconfiguration', as transitions studies often focus on single and radical technology innovation. As a middle-range theory, the MLP could benefit from other theoretical frameworks. Thus, this thesis explored the application of S-D logic to the context of the logistics industry, specifically to examine how firms' innovation activities would reshape production and consumption patterns. Furthermore, the exploratory nature of this thesis helped redefine the role of distribution activities (e.g., logistics service, energy service, and transport service) in socio-technical systems. Previously, logistics and transport activities were considered services between production and consumption systems and only a handful of studies focused on this research area (Guo et al., 2019; Karslen et al., 2019). However, empowered by digital transformation, logistics activities could play a proactive role in reconfiguring production and consumption systems. Therefore, logistics innovations also help us to understand the notion of local niche and global network (global) as firms can adopt these innovations in different locations to solve local issues, such as Company A's distributed manufacturing hubs across the world. Framing production and consumption systems into a service ecosystem also highlights the importance of how to build and sustain the ecosystem. unlike traditional product or service businesses, an ecosystems view should focus on establishing value propositions for different stakeholders by adopting different technologies or practices. This view would particularly contribute to the understanding multiple innovations from the system reconfiguration perspective to overcome the bottom-up change bias in the MLP.

By adopting an S-D logic, service ecosystems view, logistics innovations in this thesis were considered different value propositions aiming at shaping inter- (intra) niche interactions (micro-level), industry structures (meso-level), and production and consumption systems (macro-level). Hence, the thesis provided an additional theoretical lens beyond the dichotomy between the business model and technology innovation to understand firms' innovation activities in socio-technical transitions (Köhler et al., 2019). Consequently, innovations can 'travel' horizontally in/across the niche level and spread vertically to higher levels, such as meso- and macro-levels. As discussed in Chapter 7, these three levels may change at different rates. Thus, we defined logistics innovations as value propositions aiming to shape short-term logistics strategies at the micro-level. Then, the further enactment of these value propositions would lead to the establishment of logistics trends at the meso-level. Finally, aggregated interactions contributed to the formation of logistics trends at the macro-level. Thus, firm-level innovation activities are part of these logistics strategies/ trends, helping to form them but also being shaped by them. This theoretical contribution is specifically helpful to guide firms' business model innovation design. Because we can consider business model innovation as how to design value propositions for different stakeholder groups to be line with firms' innovation strategies, business strategies, and industry trends.

8.3.2 Empirical contributions

To our best knowledge, this thesis is one of the first studies to examine logistics innovations from a socio-technical transition perspective (Pettit et al., 2018; Damman and Steen, 2021). As discussed by McMeekin et al. (2019), previous transitions studies have focused on part of the entire chain to understand a single and radical technology innovation. Therefore, logistics services are often overlooked by transitions scholars for the following reasons: 1) In the past, logistics companies were more likely to adopt innovations rather than to create innovations (Grawe, 2009); 2) logistics activities often serve as the link between production and consumption systems, which implies the 'entire chain' is impacted by logistics activities; 3) logistics innovations are often 'incremental' with the primary focus on operational efficiency (Cichosz and Wallenburg, 2020). As an exploratory study, the thesis contributed to understanding the role of logistics innovations in transitions studies and responding to these empirical gaps:

1) The multiple case studies have covered different firms' innovation activities in the era of digitalisation. For example, Company A, a logistics service provider, engaged in developing radical manufacturing solutions alone or with partners. Company C and D both tried to enter the logistics industry by disruptive business models.

2) By adopting an S-D logic, service ecosystems view, we provided a framework that bridged production and consumption at a system level to study broader system reconfigurations (Köhler et al., 2019). Moreover, this framework could be used in other socio-technical systems such as mobility, electricity, or the manufacturing sector.

8.4 Practical implications

The findings of the thesis also have implications for business practices in managing innovation activities. First, innovation can be seen as a process that reconfigures the institutionalised rules of resource integration among different actors. As discussed in response to RQ1, managers need to balance their innovation efforts to disrupt and change resource integration rules while maintaining some institutionalised rules. To do this, managers need to choose the right resources and integrate them into suitable practices (Skålén et al., 2015). For example, Company A's additive manufacturing solution could lead to a 'lock-in' situation if the company makes a heavy investment in 3D printers. This finding is consistent with previous research suggesting that innovation can be inhibited if too many institutionalised rules are challenged (Koskela-Huotari et al., 2016; Sovacool et al., 2017). Thus, managers are required to review the surrounding service ecosystem to include new actors and external resources rather than a narrow focus on service offerings.

Second, according to S-D logic, value is co-created by multiple actors. Thus, innovation activities should aim at enhancing customers' co-creation capability (Vargo and Lusch, 2016). Managers should reconsider the role of customers from passive to active during the innovation process. Moreover, managers need to build more communication channels to include new actors in service ecosystems, and novel ideas could be generated by forming these new partnerships and collaborations. At last, managers should also consider their companies as one of the value co-creators during the innovation process. This would allow managers to be reflective with regard to their innovation strategies. For example, Maglio and Spohrer (2013) suggest that four primary stakeholders – customer, provider, authority, and competitor – have to be considered when developing value propositions. In other words, the consideration of further enactments of value propositions is essential to implement innovation activities.

8.5 Research strategy

This thesis is based on an abductive, multiple-case study design to explore a new research avenue (logistics innovations) in transitions studies. Also, the abductive approach helped us begin with real-life observation and go back and forth from empirical investigation to theoretical knowledge (Kovács and Spens, 2005), leading to an extension of existing theory by adding a firm-level perspective in socio-technical transitions studies. The multiple-case design enabled us to conduct research via a theoretical replication logic (Yin, 2018). As a result, four representative case studies were conducted based on information-oriented selection for yielding new insights into the whole system reconfiguration approach (McMeekin et al., 2019).

In this thesis, semi-structured interviews were conducted with the executive managers of the case studies companies, which provided us with rich information about each innovation project as well as the companies' innovation strategies. The triangulation of multiple data sources (e.g., documents, recorded interviews, and company presentations) generated considerable information that helped ensure our understanding of firms' innovation activities to enhance construct validity. Furthermore, reflexive triangulation of empirical investigation and theoretical knowledge was specifically achieved by using the 'longitudinal immersion' approach in the case study of Company A, which helped us modify research strategies and conceptual framework during the case studies (Wells and Nieuwenhuis, 2017).

However, the research strategy has some limitations. First, the breadth of the empirical investigation into the innovation projects was limited due to the modest resources of a PhD student. For example, customers are crucial in developing innovation projects and co-creating value through their interactions with the case study companies. However, it was not easy to get access to conduct interviews with customers. Thus, quantitative methods for data collection (in particular, surveys) could be useful to collect data from customers with permission from the case study companies in the future. Second, interviews and secondary evidence contributed to understanding the causal mechanisms between logistics innovations and the institutional structure of service ecosystems, leading to the maintenance, disruption, and change of the structure. However, the exploratory nature of this thesis led us to use these loosely defined notions because there was a lack of a clear definition for the term 'maintenance', 'disruption', or 'change'. These notions could be elaborated further based on the resources and practices adopted and developed by the case study companies in the future, and a longitudinal design is needed to capture these changes.

8.6 Potential research avenues

This thesis contributed to the extension of existing transition theories by adopting an S-D logic, service ecosystems view. We would recommend the following research directions:

First, the notion of 'landscape pressure' could be borrowed into service ecosystems because recent studies have focused on how value propositions shape or are shaped by service ecosystems. The socio-technical landscape represents an exogenous environment beyond the direct influence of actors, which would contribute to understanding how landscape pressures (e.g., the COVID-19 pandemic) may impact the value proposition development in a given period of time.

Second, from a service science perspective, the concept of 'resource liquefaction[4]' and 'resource density[5]' could be helpful to understand the boundary issues between different industries in socio-technical transitions (Lusch and Nambisan, 2015). For example, we can see the leading new entrants in the automotive industry are not always manufacturers and

[4] Resource liquefaction: refers to the ability to decouple information from its physical form.
[5] Resource density: refers to the ability to mobilise resources for specific needs and situations.

can be considered ‘mature entrants’ from the high-tech industry (Manders et al., 2018). Therefore, the concept of ecosystem’s value propositions (EVP) could be adopted to understand how the transition process itself is influenced by an aggregation of actors rather than a single entity (i.e., firm) (Walrave et al., 2018). As a result, transitions studies would be benefit from introducing S-D logic for understanding multi-regime interactions (Rosenbloom, 2020) and the interactions between multiple systems (Geels et al., 2015).

9. References

Abdirad, M. and Krishnan, K., 2020. Industry 4.0 in logistics and supply chain management: A systematic literature review. *Engineering Management Journal*, pp.1-15.

Adams, R., Bessant, J. and Phelps, R., 2006. Innovation management measurement: A review. *International journal of management reviews*, *8*(1), pp.21-47.

Aiello, L., Dulskaia, I. and Menshikova, M., 2016. Supply chain management and the role of ICT: DART-SCM perspective. In *Information and Communication Technologies in Organizations and Society* (pp. 161-176). Springer, Cham.

Aitken, R., 2017. IBM forges blockchain collaboration with Nestlé & Walmart in global food safety. Available at: https://www.forbes.com/sites/rogeraitken/2017/08/22/ibm-forges-blockchain-collaboration-with-nestle-walmart-for-global-food-safety/#27c26de93d36.[Accessed: 25/October/2020].

Akkermans, H.A., Bogerd, P., Yücesan, E. and Van Wassenhove, L.N., 2003. The impact of ERP on supply chain management: Exploratory findings from a European Delphi study. *European Journal of operational research*, 146(2), pp.284-301.

Åkesson, M., Skålén, P., Edvardsson, B. and Stålhammar, A., 2016. Value proposition test-driving for service innovation: How frontline employees innovate value propositions. *Journal of Service Theory and Practice*, 26(3), pp. 338-362.

Akyelken, N. and Keller, H., 2014. Framing the nexus of globalisation, logistics and manufacturing in Europe. *Transport Reviews*, 34(6), pp.674-690.

Anderhofstadt, B. and Spinler, S., 2020. Preferences for autonomous and alternative fuel-powered heavy-duty trucks in Germany. *Transportation Research Part D: Transport and Environment*, 79, 102232.

Andersen, A.D. and Markard, J., 2020. Multi-technology interaction in socio-technical transitions: How recent dynamics in HVDC technology can inform transition theories. *Technological Forecasting and Social Change*, *151*, 119802.

Andreini, D., Pedeliento, G., Zarantonello, L. and Solerio, C., 2018. A renaissance of brand experience: Advancing the concept through a multi-perspective analysis. *Journal of Business Research*, 91, pp.123-133.

Andersson, B.A. and Jacobsson, S., 2000. Monitoring and assessing technology choice: the case of solar cells. *Energy Policy*, 28(14), pp.1037-1049.

Attaran, M., 2017. The rise of 3-D printing: The advantages of additive manufacturing over traditional manufacturing. *Business Horizons*, *60*(5), pp.677-688.

Audretsch, D.B., Martínez-Fuentes, C. and Pardo-del-Val, M., 2011. Incremental innovation in services through continuous improvement. *The Service Industries Journal*, *31*(12), pp.1921-1930.

Baah, C., Jin, Z. and Tang, L., 2020. Organizational and regulatory stakeholder pressures friends or foes to green logistics practices and financial performance: investigating corporate reputation as a missing link. *Journal of cleaner production*, 247, 119125.

Baden-Fuller, C. and Morgan, M.S., 2010. Business models as models. *Long range planning*, *43*(2-3), pp.156-171.

Bahemia, H., Sillince, J. and Vanhaverbeke, W., 2018. The timing of openness in a radical innovation project, a temporal and loose coupling perspective. *Research Policy*, *47*(10), pp.2066-2076.

Bakker, S., Maat, K. and Van Wee, B., 2014. Stakeholders interests, expectations, and strategies regarding the development and implementation of electric vehicles: The case of the Netherlands. *Transportation Research Part A: Policy and Practice*, *66*, pp.52-64.

Barras, R., 1986. Towards a theory of innovation in services. *Research policy*, *15*(4), pp.161-173.

Barrett, M., Davidson, E., Prabhu, J. and Vargo, S.L., 2015. Service innovation in the digital age. *MIS quarterly*, *39*(1), pp.135-154.

Barry, A. and Slater, D., 2002. Technology, politics and the market: an interview with Michel Callon. *Economy and Society*, 31, pp. 285-306.

Basit, T., 2003. Manual or electronic? The role of coding in qualitative data analysis. *Educational research*, *45*(2), pp.143-154.

Bell, E., Bryman, A. and Harley, B., 2018. *Business research methods*. Oxford university press.

Bellantuono, N., Pontrandolfo, P. and Scozzi, B., 2021. Measuring the openness of innovation. *Sustainability*, *13*(4), p.2205.

Ben-Daya, M., Hassini, E. and Bahroun, Z., 2019. Internet of things and supply chain management: a literature review. *International Journal of Production Research*, 57(15-16), pp.4719-4742.

Ben-Ner, A. and Siemsen, E., 2017. Decentralization and localization of production: The organizational and economic consequences of additive manufacturing (3D printing). *California Management Review*, 59(2), pp.5-23.

Benvegnù, C., Cuppini, N., Frapporti, M., Milesi, F. and Pirone, M., 2019. Logistical gazes: introduction to a special issue of Work Organisation, Labour and Globalisation. *Work Organisation, Labour & Globalisation*, 13(1), pp.9-14.

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S. and Rickne, A., 2008. Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. *Research policy*, *37*(3), pp.407-429.

Bergek, A., Hekkert, M., Jacobsson, S., Markard, J., Sandén, B. and Truffer, B., 2015. Technological innovation systems in contexts: Conceptualizing contextual structures and interaction dynamics. *Environmental Innovation and Societal Transitions*, *16*, pp.51-64.

Berggren, C., Magnusson, T. and Sushandoyo, D., 2015. Transition pathways revisited: established firms as multi-level actors in the heavy vehicle industry. *Research policy*, *44*(5), pp.1017-1028.

Berkhout, F., Smith, A. and Stirling, A., 2004. Socio-technological regimes and transition contexts. *System innovation and the transition to sustainability: Theory, evidence and policy*, 44(106), pp.48-75.

Bidmon, C.M. and Knab, S.F., 2018. The three roles of business models in societal transitions: New linkages between business model and transition research. *Journal of Cleaner Production*, *178*, pp.903-916.

Birtchnell, T. and Urry, J., 2013. 3D, SF and the future. *Futures*, *50*, pp.25-34.

Birtchnell, T., Daly, A. and Heemsbergen, L., 2020. Digital swadeshi and 3D printing intellectual property in India: The multi-level perspective, causal layered analysis and backcasting. *Futures*, *122*, 102596.

Björklund, M. and Forslund, H., 2018. A framework for classifying sustainable logistics innovations. *Logistics Research*, *11*(1), pp.1-12.

Black, I., 2006. The presentation of interpretivist research. *Qualitative Market Research: An International Journal*, 4, pp.319-324.

Blaikie, N., 2007. *Approaches to social enquiry: Advancing knowledge*. Polity.

Blaikie, N. and Priest, J., 2019. *Designing social research: The logic of anticipation*. John Wiley & Sons.

Bocken, N.M., Short, S.W., Rana, P. and Evans, S., 2014. A literature and practice review to develop sustainable business model archetypes. *Journal of cleaner production*, *65*, pp.42-56.

Bogers, M., Hadar, R. and Bilberg, A., 2016. Additive manufacturing for consumer-centric business models: Implications for supply chains in consumer goods manufacturing. *Technological forecasting and social change*, *102*, pp.225-239.

Bogue, R., 2016. Growth in e-commerce boosts innovation in the warehouse robot market. *Industrial Robot: An International Journal*, 43(6), pp.583-587.

Bogue, R., 2018. Exoskeletons–a review of industrial applications*. Industrial Robot: An International Journal*. 45(5), pp. 585-590.

Bohnsack, R., Pinkse, J. and Kolk, A., 2014. Business models for sustainable technologies: Exploring business model evolution in the case of electric vehicles. *Research Policy*, 43(2), pp.284-300.

Bolton, R. and Hannon, M., 2016. Governing sustainability transitions through business model innovation: Towards a systems understanding. *Research Policy*, *45*(9), pp.1731-1742.

Bonilla, D., 2016. Urban vans, e-commerce and road freight transport. *Production Planning & Control*, *27*(6), pp.433-442.

Boon, W.P., Edler, J. and Robinson, D.K., 2020. Market formation in the context of transitions: A comment on the transitions agenda. *Environmental Innovation and Societal Transitions*, *34*, pp.346-347.

Boons, F. and Lüdeke-Freund, F., 2013. Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. *Journal of Cleaner production*, *45*, pp.9-19.

Borowy, I., 2013. Road traffic injuries: social change and development. *Medical history*, 57(1), pp.108-138.

Bos, J.J. and Brown, R.R., 2012. Governance experimentation and factors of success in socio-technical transitions in the urban water sector. *Technological Forecasting and Social Change*, *79*(7), pp.1340-1353.

Bower, J.L. and Christensen, C.M., 1995. Disruptive technologies: catching the wave.

Brem, A., Viardot, E. and Nylund, P.A., 2021. Implications of the coronavirus (COVID-19) outbreak for innovation: Which technologies will improve our lives?. *Technological forecasting and social change*, *163*, 120451.

Brennan, L., Ferdows, K., Godsell, J., Golini, R., Keegan, R., Kinkel, S., Srai, J.S. and Taylor, M., 2015. Manufacturing in the world: where next?. *International Journal of Operations & Production Management*, 35(9), pp.1253-1274.

Brettel, M., Strese, S. and Flatten, T.C., 2012. Improving the performance of business models with relationship marketing efforts–An entrepreneurial perspective. *European Management Journal*, *30*(2), pp.85-98.

Brinkmann, S. and Kvale, S., 2015. *Interviews: Learning the craft of qualitative research interviewing* (Third Edition), Sage: Thousand Oaks.

Bruscaglioni, L., 2016. Theorizing in grounded theory and creative abduction. *Quality & Quantity*, *50*(5), pp.2009-2024.

Bryman, A., 2016. *Social research methods*. Oxford university press.

Bulmer, M., 1979. Concepts in the analysis of qualitative data. *The Sociological Review*, *27*(4), pp.651-677.

Busse, C. and Wallenburg, C. M., 2011. Innovation management of logistics service providers: Foundations, review, and research agenda. *International Journal of Physical Distribution & Logistics Management*, 41(2), pp. 187-218.

Busse, C. and Wallenburg, C. M. 2014. Firm-level innovation management at logistics service providers: an exploration. *International Journal of Logistics Research and Applications*, 17(5), pp. 396-419.

Buttle, F.A., 1998. Rules theory: understanding the social construction of consumer behaviour. *Journal of Marketing Management*, *14*(1-3), pp.63-94.

Büyüközkan, G. and Göçer, F., 2018. Digital supply chain: literature review and a proposed framework for future research. *Computers in Industry*, *97*, pp.157-177.

Çabukoglu, E., Georges, G., Küng, L., Pareschi, G. and Boulouchos, K., 2019. Fuel cell electric vehicles: An option to decarbonize heavy-duty transport? Results from a Swiss case-study. *Transportation Research Part D: Transport and Environment*, 70, pp.35-48.

Campbell, P., 2020. Jeff Bezos invests in UK digital logistics start-up Beacon. Available at: https://www.ft.com/content/1ee07f6f-4f91-462c-93ee-2096731591ff [Accessed: 25/November/2020].

Caniëls, M.C. and Romijn, H.A., 2008. Supply chain development: insights from strategic niche management. *The Learning Organization*, 15(4), pp.336-353.

Carbone, V., Rouquet, A. and Roussat, C., 2017. The rise of crowd logistics: a new way to co-create logistics value. *Journal of Business Logistics*, *38*(4), pp.238-252.

Carbone, V., Rouquet, A. and Roussat, C., 2018. A typology of logistics at work in collaborative consumption. *International Journal of Physical Distribution & Logistics Management*, 48(6), pp. 570-585.

Casadesus-Masanell, R. and Ricart, J.E., 2010. From strategy to business models and onto tactics. *Long range planning*, *43*(2-3), pp.195-215.

CBI, 2020. The European market potential for integrated internet of things and big data services. Available at: https://www.cbi.eu/market-information/outsourcing-itobpo/intergrated-internet-things/market-potential#:~:text=The%20European%20IoT%20market%20size%20is%20growing%20rapidly&text=According%20to%20the%20IDC%27s%20Worldwide,%E2%82%AC891%20billion%20in%202022%20. [Accessed: 25/October/2020].

Chakkol, M., Johnson, M., Raja, J., & Raffoni, A., 2014. From goods to solutions: How does the content of an offering affect network configuration*? International Journal of Physical Distribution and Logistics Management*, 44(1), 132–154.

Chamberlain, G.P., 2006. Researching strategy formation process: An abductive methodology. *Quality and quantity*, *40*(2), pp.289-301.

Chapman, R. L., and Soosay, C. and Kandampully, J., 2003. Innovation in logistic services and the new business model: a conceptual framework*. International Journal of Physical Distribution & Logistics Management,* 33(7), pp. 630-650.

Chesbrough, H., 2010. Business model innovation: opportunities and barriers. *Long range planning*, *43*(2-3), pp.354-363.

Chester Goduscheit, R. and Faullant, R., 2018. Paths toward radical service innovation in manufacturing companies—A service-dominant logic perspective. *Journal of Product Innovation Management*, *35*(5), pp.701-719.

Chottani, A., Hastings, G., Murnane, J. and Neuhaus, F., 2018. Distraction or Disruption? Autonomous Trucks Gain Ground in US Logistics. McKinsey Smith Co.[Online]. Available at: https://www. mckinsey. com/industries/travel-transport-and-logistics/our-insights/distraction-or-disruption-autonomous-trucks-gainground-in-us-logistics.[Accessed: 10/November/2020].

Choudary, S.P., Alstyne, M.W.V. and Parker, G.G., 2019. Platforms and Blockchain Will Transform Logistics. *Harvard Business Review*. Available at: https://hbr.org/2019/06/platforms-and-blockchain-will-transform-logistics [Accessed: 16/May/20].

Christensen, T.B., Wells, P. and Cipcigan, L., 2012. Can innovative business models overcome resistance to electric vehicles? Better Place and battery electric cars in Denmark. *Energy Policy*, *48*, pp.498-505.

Christopher, M. and Ryals, L.J., 2014. The supply chain becomes the demand chain. *Journal of Business Logistics*, *35*(1), pp.29-35.

Cichosz, M., Wallenburg, C.M. and Knemeyer, A.M., 2020. Digital transformation at logistics service providers: barriers, success factors and leading practices. *The International Journal of Logistics Management*, 31(2), pp.209-238.

Clarke, S., 2002. Learning from experience: psycho-social research methods in the social sciences. *Qualitative research*, *2*(2), pp.173-194.

Coenen, L., Benneworth, P. and Truffer, B., 2012. Toward a spatial perspective on sustainability transitions. *Research policy*, *41*(6), pp.968-979.

Coffey, A. and Atkinson, P., 1996. *Making sense of qualitative data: Complementary research strategies*. Sage Publications, Inc.

Cohen, B. and Kietzmann, J., 2014. Ride on! Mobility business models for the sharing economy. *Organization & Environment*, *27*(3), pp.279-296.

Cole, R.E. and Matsumiya, T., 2007. Too much of a good thing? Quality as an impediment to innovation. *California Management Review*, *50*(1), pp.77-93.

Colicchia, C., Creazza, A. and Menachof, D.A., 2019. Managing cyber and information risks in supply chains: insights from an exploratory analysis. *Supply Chain Management: An International Journal*, 24(2), 215-240.

Colin, M., Galindo, R. and Hernández, O., 2015. Information and communication technology as a key strategy for efficient supply chain management in manufacturing SMEs. *Procedia Computer Science*, 55, pp.833-842.

Collignon, S.E. and Sternberg, H.S., 2020. Adoption of multiple electronic marketplaces: Antecedents from a grounded theory study. *Journal of Business Logistics*, 41(4), pp.310-333.

Crotty, M. and Crotty, M.F., 1998. *The foundations of social research: Meaning and perspective in the research process*. Sage.

CSCMP, 2013. CSCMP Supply Chain Management Definitions and Glossary. Available at: https://cscmp.org/CSCMP/Educate/SCM_Definitions_and_Glossary_of_Terms.aspx. [Accessed: 25/October/2020].

Daimler Trucks, 2020. Comprehensive ecosystem for entry into e-mobility for truck customers. Available at: https://www.daimler-truck.com/innovation-sustainability/efficient-emission-free/emobility-daimler-trucks.html. [Accessed: 25/October/2020].

Damman, S. and Steen, M., 2021. A socio-technical perspective on the scope for ports to enable energy transition. *Transportation Research Part D: Transport and Environment*, *91*, 102691.

Danermark, B., Ekström, M. and Karlsson, J.C., 2019. *Explaining society: Critical realism in the social sciences*. Routledge.

DaSilva, C.M. and Trkman, P., 2014. Business model: What it is and what it is not. *Long range planning*, *47*(6), pp.379-389.

Davis, R., 2015. Industry 4.0 Digitalisation for productivity and growth. Available at: https://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568337/EPRS_BRI(2015)568337_EN.pdf. [Accessed: 21/October/2020].

Dekhne, A., Hastings, G., Murnane, J. and Neuhaus, F., 2019. Automation in logistics: Big opportunity, bigger uncertainty. *McKinsey Q*, pp.1-12.

Deloitte Insights, 2018. The Fourth Industrial Revolution is here—are you ready? Available at: https://www2.deloitte.com/content/dam/Deloitte/tr/Documents/manufacturing/Industry4-0_Are-you-ready_Report.pdf. [Accessed: 18/October/2020].

Deloitte, 2019. Brexit Industry Insights: Logistics. Available at: deloitte-uk-brexit-industry-insights-logistics.pdf. [Accessed: 25/October/2020].

Demil, B. and Lecocq, X., 2010. Business model evolution: in search of dynamic consistency. *Long range planning*, 43(2-3), pp.227-246.

Denzin, N.K. and Lincoln, Y.S., 2005. Introduction: The discipline and practice of qualitative research.

Department for Transport. 2018. Regulatory Changes to Support the Take-up of Alternatively-fuelled Light Commercial Vehicles. Available at: https://www.gov.uk/government/consultations/category-b-driving-licence-derogation-for-alternatively-fuelled-commercial-vehicles. [Accessed: 10/November/2020].

DHL, 2010. Towards Sustainable Logistics. Available at: http://www.dhl.co.uk/content/dam/downloads/g0/logistics/green_logistics_sustainable_logistics_study_en.pdf. [Accessed: 15/March/2018].

DHL, 2012. Logistics 2050-A Scenario Study. Available at: https://www.dhl.com/content/dam/Local_Images/g0/aboutus/SpecialInterest/Logistics2050/szenario_study_logistics_2050.pdf. [Accessed: 18/October/2020].

DHL., 2019. Logistics Trend Radar. Available at: https://www.logistics.dhl/global-en/home/insights-and-innovation/insights/logistics-trend-radar/thank-you.html. [Accessed: 10/November/2020].

DHL, 2020. *The Logistics Trend Radar 5th Edition*. Available at: https://www.dhl.com/content/dam/dhl/global/core/documents/pdf/glo-core-logistics-trend-radar-5thedition.pdf?j=509039&sfmc_sub=254530860&l=59_HTML&u=29946215&mid=7275327&jb=189. [Accessed: 18 October 2020].

Diaz, M., Darnhofer, I., Darrot, C. and Beuret, J.E., 2013. Green tides in Brittany: What can we learn about niche–regime interactions?. *Environmental Innovation and Societal Transitions*, *8*, pp.62-75.

Dijk, M., Wells, P. and Kemp, R., 2016. Will the momentum of the electric car last? Testing an hypothesis on disruptive innovation. *Technological Forecasting and Social Change*, *105*, pp.77-88.

Dubois, A. and Gadde, L.E., 2002. Systematic combining: an abductive approach to case research. *Journal of business research*, *55*(7), pp.553-560.

Dwivedi, G., Srivastava, S.K. and Srivastava, R.K., 2017. Analysis of barriers to implement additive manufacturing technology in the Indian automotive sector. *International Journal of Physical Distribution & Logistics Management*, 47(10), pp.972-991.

Egger, J. and Masood, T., 2020. Augmented reality in support of intelligent manufacturing–a systematic literature review. *Computers & Industrial Engineering*, *140*, 106195.

Eisenhardt, K.M., 1989. Making fast strategic decisions in high-velocity environments. *Academy of Management journal*, *32*(3), pp.543-576.

Eisenhardt, K.M. and Graebner, M.E., 2007. Theory building from cases: Opportunities and challenges. *Academy of management journal*, *50*(1), pp.25-32.

Ellinger, A.D., Watkins, K.E. and Marsick, V.J., 2005. Case study research methods. *Research in organizations: Foundations and methods of inquiry*, pp.327-350.

Ellram, L.M., 1996. The use of the case study method in logistics research. *Journal of business logistics*, *17*(2), pp.93-138.

E-mobility NSR, 2013. Comparative analysis of European examples of schemes for freight electric vehicles. Available at: http://archive.northsearegion.eu/files/repository/20130716114415_Final_Report_-_Activity_7.3.pdf. [Accessed: 10/November/2020].

Eriksson, P. and Kovalainen, A., 2011. *Qualitative methods in business research: A practical guide to social research*. Sage.

Escrig-Tena, A.B., Segarra-Ciprés, M. and García-Juan, B., 2021. Incremental and radical product innovation capabilities in a quality management context: Exploring the moderating effects of control mechanisms. *International Journal of Production Economics*, *232*, 107994.

Esper, T. L., Fugate, B. S. and Davis-Sramek, B., 2007. Logistics learning capability: sustaining the competitive advantage gained through logistics leverage. *Journal of Business Logistics.* 28(2), pp.57-82.

European Commission, 2001. WHITE PAPER: European transport policy for 2010: time to decide. Available at: https://ec.europa.eu/transport/sites/transport/files/themes/strategies/doc/2001_white_paper/lb_com_2001_0370_en.pdf [Accessed: 15/October/2020].

European Commission, 2011. WHITE PAPER: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0144&from=EN. [Accessed: 15/October/2020].

European Commission, 2015. Fact-finding studies in support of the development of an EU strategy for freight transport logistics. Available at: https://op.europa.eu/en/publication-detail/-/publication/4c60a2c5-969e-11e7-b92d-01aa75ed71a1 [Accessed: 15/October/2020].

European Commission, 2016. A European Strategy for low-emission mobility. Available at: https://ec.europa.eu/commission/presscorner/detail/et/MEMO_16_2497. [Accessed 16/October/2020].

European Commission, 2017. Intermodal transport. Available at: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SWD:2017:0362:FIN:EN:PDF [Accessed 21/October/2020].

European Commission, 2018a. Support study for an impact assessment on measures for the streamlining of TEN-T. Available at: https://ec.europa.eu/transport/sites/transport/files/studies/2018-09-19-support-study-ia-measures-streamlining-ten-t.pdf. [Accessed: 15/October/2020].

European Commission, 2018b. New determination of CO2 emissions and fuel consumption of trucks from 1 January 2019. Available at: https://ec.europa.eu/growth/content/new-determination-co2-emissions-and-fuel-consumption-trucks-1-january-2019_en. [Accessed: 15/October/2020].

European Commission, 2019. Sustainable mobility, the European Green Deal. Available at: https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6726. [Accessed: 15/October/2020].

European Commission, 2020a. Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0021&from=EN. [Accessed: 15/October/2020].

European Commission, 2020b. Circular economy action plan: for a cleaner and more competitive Europe. Available at: https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf. [Accessed: 15/October/2020].

European Parliament. 2017. Research for TRAN committee-road transport hauliers in the EU: social and working conditions. Available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2017/602000/IPOL_STU(2017)602000_EN.pdf. [Accessed: 10/11/2020].

Eurostat. 2016. Road freight transport methodology. Available at: https://ec.europa.eu/eurostat/documents/3859598/7731279/KS-GQ-16-005-EN-N.pdf/555702cd-f4f4-491e-92d3-e725a6656389. [Accessed: 10/November/2020].

Eurostat, 2019. Road freight transport statistics. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php/Road_freight_transport_statistics#EU_road_freight_transport_continues_to_grow. [Accessed: 05/October/2020].

Eurostat, 2020a. Preliminary flash estimate for the second quarter of 2020. Available at: https://ec.europa.eu/eurostat/documents/2995521/11156775/2-31072020-BP-EN.pdf/cbe7522c-ebfa-ef08-be60-b1c9d1bd385b. [Accessed: 20/October/2020].

Eurostat, 2020b. Online shopping continues to grow. Available at: https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20200420-2. [Accessed: 20/October/2020].

Evangelista, P., McKinnon, A. and Sweeney, E., 2013. Technology adoption in small and medium-sized logistics providers. *Industrial Management & Data Systems*, 113(7), pp. 967-989.

Eyers, D.R., Potter, A.T., Gosling, J. and Naim, M.M., 2018. The flexibility of industrial additive manufacturing systems. *International Journal of Operations & Production Management*, 38(12), pp.2313-2343.

Fallde, M. and Eklund, M., 2015. Towards a sustainable socio-technical system of biogas for transport: the case of the city of Linköping in Sweden. *Journal of Cleaner production*, *98*, pp.17-28.

Farooque, M., Zhang, A., Thürer, M., Qu, T. and Huisingh, D., 2019. Circular supply chain management: A definition and structured literature review. *Journal of Cleaner Production*, 228, pp.882-900.

Farquhar, J.D., 2012. *Case study research for business*. Sage.

Farquhar, J., Michels, N. and Robson, J., 2020. Triangulation in industrial qualitative case study research: Widening the scope. *Industrial Marketing Management*, *87*, pp.160-170.

Flint, D.J., Larsson, E., Gammelgaard, B. and Mentzer, J.T., 2005. Logistics innovation: a customer value-oriented social process. *Journal of business logistics*, 26(1), pp.113-147.

Flyvbjerg, B., 2006. Five misunderstandings about case-study research. *Qualitative inquiry*, *12*(2), pp.219-245.

Foss, N.J. and Saebi, T., 2017. Fifteen years of research on business model innovation: How far have we come, and where should we go?. *Journal of Management*, *43*(1), pp.200-227.

Fox, J., 2018. *Amazon's Great R&D Gift to the Nation*. 5 April, Bloomberg. Available at: https://www.bloomberg.com/opinion/articles/2018-04-05/amazon-s-technology-and-content-spending-a-huge-gift-to-economy [Accessed: 10 January 2021].

Foxon, T.J., Hammond, G.P. and Pearson, P.J., 2010. Developing transition pathways for a low carbon electricity system in the UK. *Technological Forecasting and Social Change*, *77*(8), pp.1203-1213.

Fraske, T. and Bienzeisler, B., 2020. Toward smart and sustainable traffic solutions: a case study of the geography of transitions in urban logistics. *Sustainability: Science, Practice and Policy*, *16*(1), pp.353-366.

Fraunhofer IML, 2018. Moving in circles: logistics as key enabler for a circular economy. Available at: https://www.iml.fraunhofer.de/content/dam/iml/de/documents/101/09_Whitepaper_CE_EN_WEB.pdf. [Accessed: 26/October/2020].

Frehe, V., Mehmann, J. and Teuteberg, F., 2017. Understanding and assessing crowd logistics business models–using everyday people for last mile delivery. *Journal of Business & Industrial Marketing*, 32(1), pp.75-97.

Frémont, A. and Franc, P., 2010. Hinterland transportation in Europe: Combined transport versus road transport. *Journal of transport geography*, 18(4), pp.548-556.

Fritschy, C. and Spinler, S., 2019. The impact of autonomous trucks on business models in the automotive and logistics industry–a Delphi-based scenario study. *Technological Forecasting and Social Change*, *148*, 119736.

Frow, P., McColl-Kennedy, J.R., Hilton, T., Davidson, A., Payne, A. and Brozovic, D., 2014. Value propositions: A service ecosystems perspective. *Marketing Theory*, *14*(3), pp.327-351.

Frow, P., McColl-Kennedy, J.R. and Payne, A., 2016. Co-creation practices: Their role in shaping a health care ecosystem. *Industrial Marketing Management*, *56*, pp.24-39.

Fuenfschilling, L. and Binz, C., 2018. Global socio-technical regimes. *Research policy*, *47*(4), pp.735-749.

Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research policy*, *31*(8-9), pp.1257-1274.

Geels, F.W., 2004. From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research policy*, *33*(6-7), pp.897-920.

Geels, F.W., 2005a. The dynamics of transitions in socio-technical systems: a multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860–1930). *Technology analysis & strategic management*, *17*(4), pp.445-476.

Geels, F., 2005b. Co-evolution of technology and society: The transition in water supply and personal hygiene in the Netherlands (1850–1930)—a case study in multi-level perspective. *Technology in society*, *27*(3), pp.363-397.

Geels, F. and Raven, R., 2006. Non-linearity and expectations in niche-development trajectories: ups and downs in Dutch biogas development (1973–2003). *Technology Analysis & Strategic Management*, 18(3-4), pp.375-392.

Geels, F.W., 2007. Analysing the breakthrough of rock 'n'roll (1930–1970) Multi-regime interaction and reconfiguration in the multi-level perspective. *Technological Forecasting and Social Change*, *74*(8), pp.1411-1431.

Geels, F.W. and Kemp, R., 2007. Dynamics in socio-technical systems: Typology of change processes and contrasting case studies. *Technology in society*, *29*(4), pp.441-455.

Geels, F.W. and Schot, J., 2007. Typology of sociotechnical transition pathways. *Research Policy*, 36(3), pp.399-417.

Geels, F.W., 2010. Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. *Research policy*, *39*(4), pp.495-510.

Geels, F.W., 2011. The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental innovation and societal transitions*, 1(1), pp.24-40.

Geels, F.W., 2012. A socio-technical analysis of low-carbon transitions: introducing the multi-level perspective into transport studies. *Journal of transport geography*, *24*, pp.471-482.

Geels, F.W., McMeekin, A., Mylan, J. and Southerton, D., 2015. A critical appraisal of Sustainable Consumption and Production research: The reformist, revolutionary and reconfiguration positions. *Global Environmental Change*, *34*, pp.1-12.

Geels, F.W., Kern, F., Fuchs, G., Hinderer, N., Kungl, G., Mylan, J., Neukirch, M. and Wassermann, S., 2016. The enactment of socio-technical transition pathways: a reformulated typology and a comparative multi-level analysis of the German and UK low-carbon electricity transitions (1990–2014). *Research Policy*, 45(4), pp.896-913.

Geels, F.W., 2018a. Low-carbon transition via system reconfiguration? A socio-technical whole system analysis of passenger mobility in Great Britain (1990–2016). *Energy research & social science*, *46*, pp.86-102.

Geels, F.W., 2018b. Disruption and low-carbon system transformation: Progress and new challenges in socio-technical transitions research and the Multi-Level Perspective. *Energy Research & Social Science*, *37*, pp.224-231.

Genus, A. and Coles, A.M., 2008. Rethinking the multi-level perspective of technological transitions. *Research policy*, *37*(9), pp.1436-1445.

Giddens, A., 1984. *The constitution of society: Outline of the theory of structuration*. Univ of California Press.

Giorgi, L. and Schmidt, M., 2002. European transport policy-a historical and forward-looking perspective. *German Policy Studies/Politikfeldanalyse*, 2(4)

Goddard, G. and Farrelly, M.A., 2018. Just transition management: Balancing just outcomes with just processes in Australian renewable energy transitions. *Applied Energy*, *225*, pp.110-123.

Goehrke, S., 2018. *Digital Inventory: How 3D Printing Lets Manufacturers Rely Less On Warehouses Of Stuff*. 5 November, Forbes. Available at: https://www.forbes.com/sites/sarahgoehrke/2018/11/05/digital-inventory-how-3d-printing-lets-manufacturers-rely-less-on-warehouses-of-stuff/?sh=63bc57ba913e [Accessed: 10/January/2021].

Goel, A., 2018. Legal aspects in road transport optimization in Europe. *Transportation research part E: logistics and transportation review*, 114, pp.144-162.

Goldsby, T. J. and Zinn, W., 2016. Technology Innovation and New Business Models: Can Logistics and Supply Chain Research Accelerate the Evolution? *Journal of Business Logistics,* 37(2), pp.80-81.

Gorissen, L., Vrancken, K. and Manshoven, S., 2016. Transition thinking and business model innovation–towards a transformative business model and new role for the reuse centers of Limburg, Belgium. *Sustainability*, *8*(2), p.112.

Grawe, S.J., 2009. Logistics innovation: a literature-based conceptual framework. *The International Journal of Logistics Management*, 20(3), pp.360-377.

Grawe, S.J., Daugherty, P.J. and Roath, A.S., 2011. Knowledge synthesis and innovative logistics processes: Enhancing operational flexibility and performance. *Journal of Business Logistics*, *32*(1), pp.69-80.

Guarnieri, P., Cerqueira-Streit, J.A. and Batista, L.C., 2020. Reverse logistics and the sectoral agreement of packaging industry in Brazil towards a transition to circular economy. *Resources, Conservation and Recycling*, 153, 104541.

Guba, E.G. and Lincoln, Y.S., 1994. Competing paradigms in qualitative research. *Handbook of qualitative research*, *2*(163-194), p.105.

Guerrero, D. and Rodrigue, J.P., 2014. The waves of containerization: shifts in global maritime transportation. *Journal of Transport Geography*, 34, pp.151-164.

Gummerus, J. and Pihlström, M., 2011. Context and mobile services' value-in-use. *Journal of Retailing and Consumer Services*, *18*(6), pp.521-533.

Gungor, O.E. and Al-Qadi, I.L., 2020. All for one: Centralized optimization of truck platoons to improve roadway infrastructure sustainability. *Transportation Research Part C: Emerging Technologies*, *114*, pp.84-98.

Guo, X., Jaramillo, Y.J.L., Bloemhof-Ruwaard, J. and Claassen, G.D.H., 2019. On integrating crowdsourced delivery in last-mile logistics: A simulation study to quantify its feasibility. *Journal of Cleaner Production*, *241*,118365.

Gustafsson, A., Kristensson, P. and Witell, L., 2012. Customer co-creation in service innovation: a matter of communication? *Journal of Service Management*, 23(3), pp.311-327.

Hahn, R. and Ince, I., 2016. Constituents and characteristics of hybrid businesses: A qualitative, empirical framework. *Journal of Small Business Management*, *54*, pp.33-52.

Hall, S. and Roelich, K., 2016. Business model innovation in electricity supply markets: The role of complex value in the United Kingdom. *Energy Policy*, *92*, pp.286-298.

Hamwi, M., Lizarralde, I. and Legardeur, J., 2021. Demand response business model canvas: A tool for flexibility creation in the electricity markets. *Journal of Cleaner Production*, *282*, 124539.

Hansmeier, H., Schiller, K. and Rogge, K.S., 2021. Towards methodological diversity in sustainability transitions research? Comparing recent developments (2016-2019) with the past (before 2016). *Environmental Innovation and Societal Transitions*, *38*, pp.169-174.

Haraldsson, K., Lindgren, E.C., Mattsson, B., Fridlund, B. and Marklund, B., 2011. Adolescent girls' experiences of underlying social processes triggering stress in their everyday life: a grounded theory study. *Stress and Health*, *27*(2), pp.e61-e70.

Harkonen, J., Haapasalo, H. and Hanninen, K., 2015. Productisation: A review and research agenda. *International Journal of Production Economics*, *164*, pp.65-82.

Harris, I., Wang, Y. and Wang, H., 2015. ICT in multimodal transport and technological trends: Unleashing potential for the future. *International Journal of Production Economics*, 159, pp.88-103.

Hatzl, S., Seebauer, S., Fleiß, E. and Posch, A., 2016. Market-based vs. grassroots citizen participation initiatives in photovoltaics: A qualitative comparison of niche development. *Futures*, *78*, pp.57-70.

Hawkey, D.J., 2012. District heating in the UK: A Technological Innovation Systems analysis. *Environmental Innovation and Societal Transitions*, *5*, pp.19-32.

Hermwille, L., 2016. The role of narratives in socio-technical transitions—Fukushima and the energy regimes of Japan, Germany, and the United Kingdom. *Energy Research & Social Science*, *11*, pp.237-246.

Hess, D.J., 2016. The politics of niche-regime conflicts: distributed solar energy in the United States. *Environmental Innovation and Societal Transitions*, *19*, pp.42-50.

Hesse, M. and Rodrigue, J.P., 2004. The transport geography of logistics and freight distribution. *Journal of transport geography*, 12(3), pp.171-184.

Hockerts, K. and Wüstenhagen, R., 2010. Greening Goliaths versus emerging Davids—Theorizing about the role of incumbents and new entrants in sustainable entrepreneurship. *Journal of business venturing*, *25*(5), pp.481-492.

Hofmann, E. and Rüsch, M., 2017. Industry 4.0 and the current status as well as future prospects on logistics. *Computers in Industry*, 89, pp.23-34.

Holl, A. and Mariotti, I., 2018. Highways and firm performance in the logistics industry. *Journal of Transport Geography*, 72, pp.139-150.

Hoogma, R., Kemp, R., Schot, J. and Truffer, B., 2002. *Experimenting for sustainable transport*. Taylor & Francis.

Hopkins, J. and Hawking, P., 2018. Big Data Analytics and IoT in logistics: a case study. *The International Journal of Logistics Management*, 29(2), pp.575-591.

Huang, G.Q. and Xu, S.X., 2013. Truthful multi-unit transportation procurement auctions for logistics e-marketplaces. *Transportation Research Part B: Methodological*, 47, pp.127-148.

Huang, Y.H., Blazquez, C.A., Huang, S.H., Paredes-Belmar, G. and Latorre-Nuñez, G., 2019. Solving the feeder vehicle routing problem using ant colony optimization. *Computers & Industrial Engineering*, 127, pp.520-535.

Huijben, J.C. and Verbong, G.P., 2013. Breakthrough without subsidies? PV business model experiments in the Netherlands. *Energy Policy*, *56*, pp.362-370.

Hutcheson, G., 2013. Methodological reflections on transference and countertransference in geographical research: relocation experiences from post-disaster Christchurch, Aotearoa New Zealand. *Area*, *45*(4), pp.477-484.

IRU, 2019. Tackling driver shortage in Europe. Available at: https://www.ecta.com/resources/Documents/Other%20publications/Tackling%20the%20European%20Driver%20Shortage%20-%20IRU%20report.pdf. [Accessed: 10/November/2020].

Jaeger, J., 2019. Volvo becomes latest company to join Responsible Sourcing Blockchain Network. Compliance Week, 6th November, 2019. Available at: https://www.complianceweek.com/supply-chain/volvo-becomes-latest-to-join-responsible-sourcing-blockchain-network/27990.article. [Accessed: 25/October/2020].

Jensen, T., Hedman, J. and Henningsson, S., 2019. How TradeLens Delivers Business Value With Blockchain Technology. *MIS Quarterly Executive*, *18*(4).

Jentzsch, A., Melcher, N., Gildemeister, J., Schellong, D., Höfer, C., Wiedenhoff, P. and Riedl, J. 2018. Why Road Freight Needs to Go Digital—Fast. Available at: https://www.bcg.com/publications/2018/why-road-freight-needs-go-digital-fast. [Accessed: 10/November/2020].

Jiang, R., Kleer, R. and Piller, F.T., 2017. Predicting the future of additive manufacturing: A Delphi study on economic and societal implications of 3D printing for 2030. *Technological Forecasting and Social Change*, *117*, pp.84-97.

John, A. and Lawton, T.C., 2018. International political risk management: Perspectives, approaches and emerging agendas. *International Journal of Management Reviews*, *20*(4), pp.847-879.

Kandampully, J., 2002. Innovation as the core competency of a service organisation: the role of technology, knowledge and networks. *European journal of innovation management*, 5(1), pp.18-26.

Kapetaniou, C., Rieple, A., Pilkington, A., Frandsen, T. and Pisano, P., 2018. Building the layers of a new manufacturing taxonomy: How 3D printing is creating a new landscape of production eco-systems and competitive dynamics. *Technological Forecasting and Social Change*, 128, pp.22-35.

Karslen, R., Papachristos, G. and Rehmatulla, N., 2019. An agent-based model of climate-energy policies to promote wind propulsion technology in shipping. *Environmental Innovation and Societal Transitions*, *31*, pp.33-53.

Kelly, C., Ellis, G. and Flannery, W., 2018. Conceptualising change in marine governance: learning from transition management. *Marine Policy*, *95*, pp.24-35.

Kemp, R., Schot, J. and Hoogma, R., 1998. Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. *Technology analysis & strategic management*, *10*(2), pp.175-198.

Ketokivi, M. and Mantere, S., 2010. Two strategies for inductive reasoning in organizational research. *Academy of management review*, *35*(2), pp.315-333.

Ketokivi, M. and Choi, T., 2014. Renaissance of case research as a scientific method. *Journal of Operations Management*, *32*(5), pp.232-240.

Kille, C. 2009. The financial crisis and its impact on the road transport market. Public Hearing of the EP and the EC Brussels, Belgium. Available at: http://ec.europa.eu/transport/sites/transport/files/modes/road/events/doc/2009_04_20/2009-04-20_kille_fraunhofer.pdf. [Accessed: 10/11/2018]

Kim, Y., Lee, J. and Ahn, J., 2019. Innovation towards sustainable technologies: A socio-technical perspective on accelerating transition to aviation biofuel. *Technological Forecasting and Social Change*, *145*, pp.317-329.

Kim, J.J., Kim, I. and Hwang, J., 2021. A change of perceived innovativeness for contactless food delivery services using drones after the outbreak of COVID-19. *International Journal of Hospitality Management*, *93*, p.102758.

Kirwan, J., Ilbery, B., Maye, D. and Carey, J., 2013. Grassroots social innovations and food localisation: An investigation of the Local Food programme in England. *Global Environmental Change*, *23*(5), pp.830-837.

Koc, T. and Bozdag, E., 2017. Measuring the degree of novelty of innovation based on Porter's value chain approach. *European Journal of Operational Research,* 257(2), pp.559-567.

Köhler, J., Geels, F.W., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., Alkemade, F., Avelino, F., Bergek, A., Boons, F. and Fünfschilling, L., 2019. An agenda for sustainability transitions research: State of the art and future directions. *Environmental Innovation and Societal Transitions*, *31*, pp.1-32.

Koirala, B.P., van Oost, E. and van der Windt, H., 2018. Community energy storage: A responsible innovation towards a sustainable energy system?. *Applied energy*, *231*, pp.570-585.

Kollmann, T., Hensellek, S., de Cruppe, K. and Sirges, A., 2020. Toward a renaissance of cooperatives fostered by Blockchain on electronic marketplaces: a theory-driven case study approach. *Electronic Markets*, 30(2), pp.273-284.

König, C., Caldwell, N.D. and Ghadge, A., 2019. Service provider boundaries in competitive markets: the case of the logistics industry. *International Journal of Production Research*, 57(18), pp.5624-5639.

Koskela-Huotari, K., Edvardsson, B., Jonas, J.M., Sörhammar, D. and Witell, L., 2016. Innovation in service ecosystems—Breaking, making, and maintaining institutionalised rules of resource integration. *Journal of Business Research*, *69*(8), pp.2964-2971.

Kovács, G. and Spens, K.M., 2005. Abductive reasoning in logistics research. *International Journal of Physical Distribution & Logistics Management*, 35(2), pp.132-144.

Kovács, G. and Falagara Sigala, I., 2021. Lessons learned from humanitarian logistics to manage supply chain disruptions. *Journal of Supply Chain Management*, 57(1), pp.41-49.

Kucukaltan, B., Saatcioglu, O.Y., Irani, Z. and Tuna, O., 2020. Gaining strategic insights into Logistics 4.0: expectations and impacts. *Production Planning & Control*, pp.1-17.

Kuhn, T.S., 1996. *The structure of scientific revolutions*. University of Chicago press.

Kumar, M. and Sanchez Rodrigues, V., 2020. Synergetic effect of lean and green on innovation: A resource-based perspective. *International Journal of Production Economics*, *219*, pp.469-479.

Kvale, S. and Brinkmann, S., 2009. *Interviews: Learning the craft of qualitative research interviewing*. sage.

Lafkihi, M., Pan, S. and Ballot, E., 2019. Freight transportation service procurement: A literature review and future research opportunities in omnichannel E-commerce. *Transportation Research Part E: Logistics and Transportation Review*, *125*, pp.348-365.

Lafontaine, F., and Valeri, L.M., 2009. The deregulation of international trucking in the European Union: form and effect. *Journal of Regulatory Economics*, 35(1), pp.19-44.

Lagorio, A., Zenezini, G., Mangano, G. and Pinto, R., 2020. A systematic literature review of innovative technologies adopted in logistics management. *International Journal of Logistics Research and Applications*, pp.1-24.

Lauria, M. and Wagner, J.A., 2006. What can we learn from empirical studies of planning theory? A comparative case analysis of extant literature. *Journal of Planning Education and Research*, *25*(4), pp.364-381.

Lawrence, T.B., Suddaby, R. and Leca, B. eds., 2009. *Institutional work: Actors and agency in institutional studies of organizations*. Cambridge university press.

Lehoux, P., Daudelin, G., Williams-Jones, B., Denis, J.L. and Longo, C., 2014. How do business model and health technology design influence each other? Insights from a longitudinal case study of three academic spin-offs. *Research Policy*, *43*(6), pp.1025-1038.

Leising, E., Quist, J. and Bocken, N., 2018. Circular Economy in the building sector: Three cases and a collaboration tool. *Journal of Cleaner production*, *176*, pp.976-989.

Leitch, C.M., Hill, F.M. and Harrison, R.T., 2010. The philosophy and practice of interpretivist research in entrepreneurship: Quality, validation, and trust. *Organizational Research Methods*, *13*(1), pp.67-84.

Lemoine, W. and Dagnæs, L., 2003. Globalisation strategies and business organisation of a network of logistics service providers. *International Journal of Physical Distribution & Logistics Management*, 33(3), pp.209-228.

Leoni, V., 2020. Stars vs lemons. Survival analysis of peer-to peer marketplaces: the case of Airbnb. *Tourism Management*, 79, 104091.

Levinson, M., 2016. Th*e Box: How the Shipping Container Made the World Smaller and the World Economy Bigger*. Princeton University Press.

Li, Y., Zhan, C., de Jong, M. and Lukszo, Z., 2016. Business innovation and government regulation for the promotion of electric vehicle use: lessons from Shenzhen, China. *Journal of Cleaner Production*, *134*, pp.371-383.

Liimatainen, H., van Vliet, O. and Aplyn, D., 2019. The potential of electric trucks–An international commodity-level analysis. *Applied Energy*, 236, pp.804-814.

Lin, C.Y., 2008. Determinants of the adoption of technological innovations by logistics service providers in China. *International Journal of Technology Management & Sustainable Development*, *7*(1), pp.19-38.

Lin, X., Wells, P. and Sovacool, B.K., 2018. The death of a transport regime? The future of electric bicycles and transportation pathways for sustainable mobility in China. *Technological Forecasting and Social Change*, *132*, pp.255-267.

Lincoln, Y.S. and Guba, E.G., 1985. Establishing trustworthiness. *Naturalistic inquiry*, *289*(331), pp.289-327.

Liu, Z. and Song, Z., 2018. Dynamic charging infrastructure deployment for plug-in hybrid electric trucks. *Transportation Research Part C: Emerging Technologies*, 95, pp.748-772.

Liu, H., Purvis, L., Mason, R. and Wells, P., 2020. Developing logistics value propositions: Drawing Insights from a distributed manufacturing solution. *Industrial Marketing Management*, *89*, pp.517-527.

Loorbach, D., van Bakel, J.C., Whiteman, G. and Rotmans, J., 2010. Business strategies for transitions towards sustainable systems. *Business strategy and the environment*, *19*(2), pp.133-146.

Loorbach, D. and Wijsman, K., 2013. Business transition management: exploring a new role for business in sustainability transitions. *Journal of cleaner production*, *45*, pp.20-28.

Lusch, R.F., 2011. Reframing supply chain management: a service-dominant logic perspective. *Journal of supply chain management*, *47*(1), pp.14-18.

Lusch, R.F. and Nambisan, S., 2015. Service innovation. *MIS quarterly*, *39*(1), pp.155-176.

Lusch, R.F., Vargo, S.L. and Gustafsson, A., 2016. Fostering a trans-disciplinary perspectives of service ecosystems. *Journal of Business Research*, 69(8), pp.2957-2963.

Maglio, P.P. and Spohrer, J., 2013. A service science perspective on business model innovation. *Industrial Marketing Management*, *42*(5), pp.665-670.

Malmqvist, J., Hellberg, K., Möllås, G., Rose, R. and Shevlin, M., 2019. Conducting the pilot study: A neglected part of the research process? Methodological findings supporting the importance of piloting in qualitative research studies. *International Journal of Qualitative Methods*, *18*, 1609406919878341.

Mander, S., 2017. Slow steaming and a new dawn for wind propulsion: A multi-level analysis of two low carbon shipping transitions. *Marine Policy*, *75*, pp.210-216.

Manders, T.N., Wieczorek, A.J. and Verbong, G.P.J., 2018. Understanding smart mobility experiments in the Dutch automobility system: Who is involved and what do they promise?. *Futures*, *96*, pp.90-103.

Manski, S., 2017. Building the blockchain world: Technological commonwealth or just more of the same?. *Strategic Change*, 26(5), pp.511-522.

Marcus, J.S., Petropoulos, G. and Yeung, T., 2019. Contribution to Growth: The European Digital Single Market Delivering economic benefits for citizens and businesses. Available at: https://www.europarl.europa.eu/thinktank/en/document.html?reference=IPOL_STU(2019)631044 [Accessed: 25/October/2020].

Markard, J., and Truffer, B., 2008. Technological innovation systems and the multi-level perspective: Towards an integrated framework. *Research policy,* 37(4), pp.596-615.

Markard, J., Raven, R. and Truffer, B., 2012. Sustainability transitions: An emerging field of research and its prospects. *Research policy*, *41*(6), pp.955-967.

Markard, J., Bento, N., Kittner, N. and Nunez-Jimenez, A., 2020. Destined for decline? Examining nuclear energy from a technological innovation systems perspective. *Energy Research & Social Science*, *67*, 101512.

Marletto, G., 2014. Car and the city: Socio-technical transition pathways to 2030. *Technological Forecasting and Social Change*, *87*, pp.164-178.

Marx, R., de Mello, A.M., Zilbovicius, M. and de Lara, F.F., 2015. Spatial contexts and firm strategies: applying the multilevel perspective to sustainable urban mobility transitions in Brazil. *Journal of Cleaner Production*, *108*, pp.1092-1104.

Mason, R., 2019. Developing a Profitable Online Grocery Logistics Business: Exploring Innovations in Ordering, Fulfilment, and Distribution at Ocado. In *Contemporary Operations and Logistics* (pp. 365-383). Palgrave Macmillan, Cham.

Maxwell, J.A., 2012. *Qualitative research design: An interactive approach*. Sage publications.

Maye, D., 2019. 'Smart food city': conceptual relations between smart city planning, urban food systems and innovation theory. *City, Culture and Society*, *16*, pp.18-24.

McKinnon, A.C., 2007. Decoupling of road freight transport and economic growth trends in the UK: An exploratory analysis. *Transport Reviews*, 27(1), pp.37-64.

McKinnon, A.C. and Edwards, J., 2010. Opportunities for improving vehicle utilization A. McKinnon, S. Cullinane, M. Browne, A. Whiteing (Eds.), *Green Logistics: Improving the Environmental Sustainability of Logistics*, Kogan Page Limited, London, pp. 195-214.

McKinnon, A., Flöthmann, C., Hoberg, K. and Busch, C., 2017. *Logistics competencies, skills, and training: a global overview*. The World Bank.

McKinsey & Company, 2018. Distraction or disruption? Autonomous trucks gain ground in US logistics. Available at: https://www.mckinsey.com/industries/travel-logistics-and-transport-infrastructure/our-insights/distraction-or-disruption-autonomous-trucks-gain-ground-in-us-logistics.[Accessed: 25/October/2020].

McKinsey & Company, 2019. Automation in logistics: Big opportunity, bigger uncertainty. Available at: https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/automation-in-logistics-big-opportunity-bigger-uncertainty. [Accessed: 25/October/2020].

McMeekin, A., Geels, F.W. and Hodson, M., 2019. Mapping the winds of whole system reconfiguration: Analysing low-carbon transformations across production, distribution and consumption in the UK electricity system (1990–2016). *Research Policy*, *48*(5), pp.1216-1231.

Meelen, T., Frenken, K. and Hobrink, S., 2019. Weak spots for car-sharing in The Netherlands? The geography of socio-technical regimes and the adoption of niche innovations. *Energy Research & Social Science*, *52*, pp.132-143.

Melo, S. and Baptista, P., 2017. Evaluating the impacts of using cargo cycles on urban logistics: integrating traffic, environmental and operational boundaries. *European transport research review*, 9(2), p.30.

Mikl, J., Herold, D.M., Ćwiklicki, M. and Kummer, S., 2020. The impact of digital logistics start-ups on incumbent firms: a business model perspective. *The International Journal of Logistics Management*, [Epub ahead of print].

Milioti, C., Pramatari, K. and Kelepouri, I., 2020. Modelling consumers' acceptance for the click and collect service. *Journal of Retailing and Consumer Services*, *56*, 102149.

Mills, J., Bonner, A. and Francis, K., 2006. The development of constructivist grounded theory. *International journal of qualitative methods*, *5*(1), pp.25-35.

Mills, M., Van de Bunt, G.G. and De Bruijn, J., 2006. Comparative research: Persistent problems and promising solutions. *International Sociology*, *21*(5), pp.619-631.

Mills, A.J., Durepos, G. and Wiebe, E. eds., 2009. *Encyclopedia of case study research*. Sage Publications.

Mills, J., Chamberlain-Salaun, J., Christie, L., Kingston, M., Gorman, E. and Harvey, C., 2012. Australian nurses in general practice, enabling the provision of cervical screening and well women's health care services: a qualitative study. *BMC nursing*, 11(1), pp.1-8.

Miorandi, D., Sicari, S., De Pellegrini, F. and Chlamtac, I., 2012. Internet of things: Vision, applications and research challenges. *Ad hoc networks*, 10(7), pp.1497-1516.

Mitchell, D. and Coles, C., 2003. The ultimate competitive advantage of continuing business model innovation. *Journal of Business Strategy*, 24(5), pp. 15-21.

Moallemi, E.A., de Haan, F.J., Webb, J.M., George, B.A. and Aye, L., 2017. Transition dynamics in state-influenced niche empowerments: Experiences from India's electricity sector. *Technological Forecasting and Social Change*, *116*, pp.129-141.

Monios, J. and Bergqvist, R., 2020. Logistics and the networked society: A conceptual framework for smart network business models using electric autonomous vehicles (EAVs). *Technological Forecasting and Social Change*, *151*,119824.

Montecchi, M., Plangger, K. and Etter, M., 2019. It’s real, trust me! Establishing supply chain provenance using blockchain. *Business Horizons*, 62(3), pp.283-293.

Monti, M., 2010. A new strategy for the single market. Report to the President of the European Commission José Manuel Barroso, May, 10. Available at: http://cms.horus.be/files/99931/Newsletter/MM%201%20-%20Single-Market-New-Strategy-Monti-Report-09.05.10.pdf [Accessed: 20/October/2020].

Moore, J.F., 1993. Predators and prey: a new ecology of competition. *Harvard business review*, 71(3), pp.75-86.

Morganti, E. and Browne, M., 2018. Technical and operational obstacles to the adoption of electric vans in France and the UK: An operator perspective. *Transport Policy*, 63, pp.90-97.

Morone, P., Lopolito, A., Anguilano, D., Sica, E. and Tartiu, V.E., 2016. Unpacking landscape pressures on socio-technical regimes: Insights on the urban waste management system. *Environmental Innovation and Societal Transitions*, *20*, pp.62-74.

Navas-Anguita, Z., García-Gusano, D. and Iribarren, D., 2019. A review of techno-economic data for road transportation fuels. *Renewable and Sustainable Energy Reviews*, *112*, pp.11-26.

Naujoks, T., 2020. Marketing functions and B2C e-marketplaces: An exploratory analysis. *Journal of Marketing Channels*, *26*(4), pp.250-262.

Nelson, R.R. and Winter, S.G., 1982. The Schumpeterian tradeoff revisited. *The American Economic Review*, *72*(1), pp.114-132.

NHTSA, 2020. Automated vehicles for safety. Available at: https://www.nhtsa.gov/technology-innovation/automated-vehicles. [Accessed: 26/October/2020].

Notteboom, T. and Rodrigue, J.P., 2008. Containerisation, box logistics and global supply chains: The integration of ports and liner shipping networks. *Maritime economics & logistics*, 10(1), pp.152-174.

Nudurupati, S.S., Bhattacharya, A., Lascelles, D. and Caton, N., 2015. Strategic sourcing with multi-stakeholders through value co-creation: An evidence from global health care company. *International Journal of Production Economics*, 166, pp.248-257.

Núñez-Merino, M., Maqueira-Marín, J.M., Moyano-Fuentes, J. and Martínez-Jurado, P.J., 2020. Information and digital technologies of Industry 4.0 and Lean supply chain management: a systematic literature review. *International Journal of Production Research*, *58*(16), pp.5034-5061.

Oke, A., 2007. Innovation types and innovation management practices in service companies. *International Journal of Operations & Production Management*, 27(6), pp.564-587.

Oke, A., 2008. Barriers to innovation management in logistics service providers. Managing Innovation. *The New Competitive Edge for Logistics Service Providers*, Schweiz, Berne, pp.13-31.

Ordanini, A. and Pol, A., 2001. Infomediation and competitive advantage in B2B digital marketplaces. *European Management Journal*, 19(3), pp.276-285.

Ordanini, A. and Parasuraman, A., 2011. Service innovation viewed through a service-dominant logic lens: a conceptual framework and empirical analysis. *Journal of Service Research*, *14*(1), pp.3-23.

Osterwalder, A. and Pigneur, Y., 2010. *Business model generation: a handbook for visionaries, game changers, and challengers*. John Wiley & Sons.

O'Sullivan, D., 1997. Logistics in Europe - the vision and the reality. *Logistics Information Management*, 10(1), pp.14-19.

Ottosson, M., Magnusson, T. and Andersson, H., 2020. Shaping sustainable markets—A conceptual framework illustrated by the case of biogas in Sweden. *Environmental Innovation and Societal Transitions*, *36*, pp.303-320.

Panayides, P.M., 2007. Effects of organizational learning in third-party logistics. *Journal of Business Logistics*, *28*(2), pp.133-158.

Pani, A., Mishra, S., Golias, M. and Figliozzi, M., 2020. Evaluating public acceptance of autonomous delivery robots during COVID-19 pandemic. *Transportation research part D: transport and environment*, *89*, 102600.

Palmer, A., Mortimer, P., Greening, P., Piecyk, M. and Dadhich, P., 2018. A cost and CO2 comparison of using trains and higher capacity trucks when UK FMCG companies collaborate. *Transportation Research Part D: Transport and Environment*, *58*, pp.94-107.

Paprocki, W., 2017. Digital economy as an environment for virtual platform operators. *Journal of Management and Financial Sciences*, (30), pp.11-26.

Paradowska, M., Platje, J. and Joost, P., 2016. Key challenges facing the European transport labour market (No. 2016-03). Available at: https://www.econstor.eu/bitstream/10419/126201/1/846671751.pdf. [Accessed: 15/October/2020].

Park, A., Jabagi, N. and Kietzmann, J., 2021. The truth about 5G:It's not (only) about downloading movies faster!. *Business Horizons*, 64(1), pp.19-28.

Pedrosa, A., Blazevic, V. and Jasmand, C., 2015. Logistics innovation development: a micro-level perspective. *International Journal of Physical Distribution & Logistics Management*, *45*(4), pp.313-332.

Pelzer, P., Frenken, K. and Boon, W., 2019. Institutional entrepreneurship in the platform economy: How Uber tried (and failed) to change the Dutch taxi law. *Environmental Innovation and Societal Transitions*, *33*, pp.1-12.

Pettit, S., Wells, P., Haider, J. and Abouarghoub, W., 2018. Revisiting history: Can shipping achieve a second socio-technical transition for carbon emissions reduction?. *Transportation Research Part D: Transport and Environment*, *58*, pp.292-307.

Petzer, B.J.M.B., Wieczorek, A.A. and Verbong, G.G., 2020. Cycling as a service assessed from a combined business-model and transitions perspective. *Environmental Innovation and Societal Transitions*, *36*, pp.255-269.

Pisano, G.P., 2015. You need an innovation strategy. *Harvard Business Review*, 93(6), pp.44-54.

Polydoropoulou, A., Pagoni, I., Tsirimpa, A., Roumboutsos, A., Kamargianni, M. and Tsouros, I., 2020. Prototype business models for Mobility-as-a-Service. *Transportation Research Part A: Policy and Practice*, *131*, pp.149-162.

Premack, R., 2019. Freight startup Flexport just nabbed $1 billion through a SoftBank-led funding round, and it's now worth $3.2 billion. Business Insider. Feb 2019. Available at: https://www.businessinsider.com/freight-startup-flexport-softbank-investment-2019-2?r=US&IR=T. [Accessed: 10/November/2020].

PwC, 2016. Shifting patterns- the future of the logistics industry. Available at: https://www.pwc.com/gx/en/transportation-logistics/pdf/the-future-of-the-logistics-industry.pdf. [Accessed: 15/October/2020].

PwC, 2020. Lockdown, Shake Up: The New Normal for Shopping in Europe. Available at: https://www.pwc.de/en/retail-and-consumer/european-consumer-insights-series-2020-new-normal.html [Accessed: 10 January 2021].

Qin, X., Liu, Z. and Tian, L., 2020. The strategic analysis of logistics service sharing in an e-commerce platform. *Omega*, *92*, p.102153.

Rajahonka, M. and Bask, A., 2016. The development of outbound logistics services in the automotive industry. *The International Journal of Logistics Management*, 27(3), pp.707-737.

Ramírez, A.M., 2012. Product return and logistics knowledge: Influence on performance of the firm. *Transportation Research Part E: Logistics and Transportation Review*, *48*(6), pp.1137-1151.

Ranieri, L., Digiesi, S., Silvestri, B. and Roccotelli, M., 2018. A review of last mile logistics innovations in an externalities cost reduction vision. *Sustainability*, 10(3), p.782.

Ratnayake, R.M., 2019. Enabling RDM in challenging environments via additive layer manufacturing: enhancing offshore petroleum asset operations. *Production Planning & Control*, 30(7), pp.522-539.

Raven, R., Schot, J. and Berkhout, F., 2012. Space and scale in socio-technical transitions. *Environmental Innovation and Societal Transitions*, *4*, pp.63-78.

Rayna, T. and Striukova, L., 2016. From rapid prototyping to home fabrication: How 3D printing is changing business model innovation. *Technological Forecasting and Social Change*, *102*, pp.214-224.

Richardson, J., 2008. The business model: An integrative framework for strategy execution. *Strategic Change*, 17, pp.133-144.

Rip, A. and Kemp, R., 1998. Technological change. *Human choice and climate change*, *2*(2), pp.327-399.

Ritala, P., Golnam, A. and Wegmann, A., 2014. Coopetition-based business models: The case of Amazon. com. *Industrial marketing management*, *43*(2), pp.236-249.

Roome, N. and Louche, C., 2016. Journeying toward business models for sustainability: A conceptual model found inside the black box of organisational transformation. *Organization & Environment*, *29*(1), pp.11-35.

Rosenbloom, D., 2020. Engaging with multi-system interactions in sustainability transitions: a comment on the transitions research agenda. *Environmental Innovation and Societal Transitions*, *34*, pp.336-340.

Rossi, S., Colicchia, C., Cozzolino, A. and Christopher, M., 2013. The logistics service providers in eco-efficiency innovation: an empirical study. *Supply chain management: an international journal*, 18(6), pp.583-603.

Rothwell, R., 1992. Successful industrial innovation: critical factors for the 1990s. *R&D Management*, *22*(3), pp.221-240.

Roy, R., Shehab, E., Tiwari, A., Aurich, J.C., Wolf, N., Siener, M. and Schweitzer, E., 2009. Configuration of product-service systems. *Journal of Manufacturing Technology Management*, 20(5), pp. 591-605.

Ruggiero, S., Kangas, H.L., Annala, S. and Lazarevic, D., 2021. Business model innovation in demand response firms: Beyond the niche-regime dichotomy. *Environmental Innovation and Societal Transitions*, *39*, pp.1-17.

Russell, D. M. and Hoag, A. M., 2004. People and information technology in the supply chain: social and organizational influences on adoption. *International Journal of Physical Distribution & Logistics Management,* 34(2), pp.102-122.

Ryan, M.J., Eyers, D.R., Potter, A.T., Purvis, L. and Gosling, J., 2017. 3D printing the future: scenarios for supply chains reviewed. *International Journal of Physical Distribution & Logistics Management*, 47(10), pp.992-1014.

Sabatier, V., Craig-Kennard, A. and Mangematin, V., 2012. When technological discontinuities and disruptive business models challenge dominant industry logics: Insights from the drugs industry. *Technological Forecasting and Social Change*, *79*(5), pp.949-962.

Sampaio, A., Savelsbergh, M., Veelenturf, L. and Van Woensel, T., 2019. Crowd-based city logistics. In *Sustainable Transportation and Smart Logistics* (pp. 381-400). Elsevier.

Sanchez Rodrigues, V. and Kumar, M., 2019. Synergies and misalignments in lean and green practices: a logistics industry perspective. *Production Planning & Control*, *30*(5-6), pp.369-384.

Sarasini, S. and Linder, M., 2018. Integrating a business model perspective into transition theory: The example of new mobility services. *Environmental innovation and societal transitions*, *27*, pp.16-31.

Sarkis, J., Cohen, M.J., Dewick, P. and Schröder, P., 2020. A brave new world: lessons from the COVID-19 pandemic for transitioning to sustainable supply and production. Resources, Conservation, and Recycling. 159.

Sasson, A. and Johnson, J.C., 2016. The 3D printing order: variability, supercenters and supply chain reconfigurations. *International Journal of Physical Distribution & Logistics Management*, 46(1), pp.82-94.

Saunders, M.N. and Lewis, P., 2012. *Doing research in business & management: An essential guide to planning your project*. Pearson.

Sauvage, T., 2003. The relationship between technology and logistics third-party providers. International *Journal of Physical Distribution & Logistics Management,* 33(3), pp.236-253.

Savills, 2017. European Logistics: Warehousing the future. Available at: 2017-sim-european-logistics-warehousing-the-future-final.pdf (savillsim.com) [Accessed: 15/October/2020].

Sayer, A., 1999. *Realism and social science*. Sage.

Schaltegger, S., Lüdeke-Freund, F. and Hansen, E.G., 2012. Business cases for sustainability: the role of business model innovation for corporate sustainability. *International journal of innovation and sustainable development*, *6*(2), pp.95-119.

Schaltegger, S., Lüdeke-Freund, F. and Hansen, E.G., 2016. Business models for sustainability: A co-evolutionary analysis of sustainable entrepreneurship, innovation, and transformation. *Organization & Environment*, *29*(3), pp.264-289.

Schipper, F., 2007. Changing the face of Europe: European road mobility during the Marshall Plan years. *The Journal of Transport History*, 28(2), pp.211-228.

Schliwa, G., Armitage, R., Aziz, S., Evans, J. and Rhoades, J., 2015. Sustainable city logistics—Making cargo cycles viable for urban freight transport. *Research in Transportation Business & Management*, 15, pp.50-57.

Schot, J. and Geels, F.W., 2008. Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy. *Technology Analysis & Strategic Management*, 20(5), pp.537-554.

Schwandt, T.A., 2003. Back to the rough ground! Beyond theory to practice in evaluation. *Evaluation*, *9*(3), pp.353-364.

Sheffi, Y., 2004. RFID and the innovation cycle. *The international journal of logistics management*, *15*(1), pp.1-10.

Shomali, A. and Pinkse, J., 2016. The consequences of smart grids for the business model of electricity firms. *Journal of Cleaner production*, *112*, pp.3830-3841.

Skålén, P., Gummerus, J., Von Koskull, C. and Magnusson, P.R., 2015. Exploring value propositions and service innovation: a service-dominant logic study. *Journal of the Academy of Marketing Science*, *43*(2), pp.137-158.

Skeete, J.P., 2018. Level 5 autonomy: The new face of disruption in road transport. *Technological Forecasting and Social Change*, *134*, pp.22-34.

Sklyar, A., Kowalkowski, C., Tronvoll, B. and Sörhammar, D., 2019. Organizing for digital servitization: A service ecosystem perspective. *Journal of Business Research*, *104*, pp.450-460.

Slayton, R. and Spinardi, G., 2016. Radical innovation in scaling up: Boeing's Dreamliner and the challenge of socio-technical transitions. *Technovation*, *47*, pp.47-58.

Smith, A., Stirling, A. and Berkhout, F., 2005. The governance of sustainable socio-technical transitions. *Research policy*, *34*(10), pp.1491-1510.

Smith, A., 2007. Translating sustainabilities between green niches and socio-technical regimes. *Technology analysis & strategic management*, *19*(4), pp.427-450.

Smith, A., Voß, J.P. and Grin, J., 2010. Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. *Research policy*, *39*(4), pp.435-448.

Sosna, M., Trevinyo-Rodríguez, R.N. and Velamuri, S.R., 2010. Business model innovation through trial-and-error learning: The Naturhouse case. *Long range planning*, *43*(2-3), pp.383-407.

Sovacool, B.K., Noel, L. and Orsato, R.J., 2017. Stretching, embeddedness, and scripts in a sociotechnical transition: Explaining the failure of electric mobility at Better Place (2007–2013). *Technological Forecasting and Social Change*, *123*, pp.24-34.

Sovacool, B.K., Axsen, J. and Sorrell, S., 2018. Promoting novelty, rigor, and style in energy social science: towards codes of practice for appropriate methods and research design. *Energy Research & Social Science*, *45*, pp.12-42.

Sovacool, B.K., Hess, D.J., Amir, S., Geels, F.W., Hirsh, R., Medina, L.R., Miller, C., Palavicino, C.A., Phadke, R., Ryghaug, M. and Schot, J., 2020. Sociotechnical agendas: Reviewing future directions for energy and climate research. *Energy Research & Social Science*, *70*, 101617.

Spens, K.M. and Kovács, G., 2006. A content analysis of research approaches in logistics research. *International Journal of Physical Distribution & Logistics Management*, 36(5), pp.374-390.

Stake, R.E., 1995. *The art of case study research*. Sage.

Stalmokaitė, I. and Hassler, B., 2020. Dynamic capabilities and strategic reorientation towards decarbonisation in Baltic Sea shipping. *Environmental Innovation and Societal Transitions*, 37, pp.187-202.

Steinhilber, S., Wells, P. and Thankappan, S., 2013. Socio-technical inertia: Understanding the barriers to electric vehicles. *Energy policy*, *60*, pp.531-539.

Stephan, A., Schmidt, T.S., Bening, C.R. and Hoffmann, V.H., 2017. The sectoral configuration of technological innovation systems: Patterns of knowledge development and diffusion in the lithium-ion battery technology in Japan. *Research Policy*, *46*(4), pp.709-723.

Sternberg, H.S., Hofmann, E. and Overstreet, R.E., 2020. Perils of road freight market deregulation: cabotage in the European Union. *The International Journal of Logistics Management*, 31(2), pp. 333-355.

Storey, C., Cankurtaran, P., Papastathopoulou, P. and Hultink, E.J., 2016. Success factors for service innovation: A meta-analysis. *Journal of Product Innovation Management*, *33*(5), pp.527-548.

Strale, M., 2019. Sustainable urban logistics: What are we talking about?. *Transportation Research Part A: Policy and Practice*, 130, pp.745-751.

Strauss, A. and Corbin, J., 1998. *Basics of qualitative research techniques*. Thousand Oaks, CA: Sage publications.

Su, S.I.I., Gammelgaard, B. and Yang, S.L., 2011. Logistics innovation process revisited: insights from a hospital case study. *International Journal of Physical Distribution & Logistics Management*, 41(6), pp.577-600.

Sunio, V., Gaspay, S., Guillen, M.D., Mariano, P. and Mora, R., 2019. Analysis of the public transport modernization via system reconfiguration: The ongoing case in the Philippines. *Transportation Research Part A: Policy and Practice*, *130*, pp.1-19.

Sushandoyo, D. and Magnusson, T., 2014. Strategic niche management from a business perspective: taking cleaner vehicle technologies from prototype to series production. *Journal of cleaner production*, *74*, pp.17-26.

Sutherland, L.A., Peter, S. and Zagata, L., 2015. Conceptualising multi-regime interactions: The role of the agriculture sector in renewable energy transitions. *Research Policy*, *44*(8), pp.1543-1554.

Svensson, O. and Nikoleris, A., 2018. Structure reconsidered: Towards new foundations of explanatory transitions theory. *Research Policy*, *47*(2), pp.462-473.

Talebpour, A. and Mahmassani, H.S., 2016. Influence of connected and autonomous vehicles on traffic flow stability and throughput. *Transportation Research Part C: Emerging Technologies*, 71, pp.143-163.

Tang, C.S. and Veelenturf, L.P., 2019. The strategic role of logistics in the industry 4.0 era. *Transportation Research Part E: Logistics and Transportation Review*, *129*, pp.1-11.

Tanskanen, K., Holmström, J. and Öhman, M., 2015. Generative mechanisms of the adoption of logistics innovation: the case of on-site shops in construction supply chains. *Journal of Business Logistics*, *36*(2), pp.139-159.

Täuscher, K. and Laudien, S.M., 2018. Understanding platform business models: A mixed methods study of marketplaces. *European Management Journal*, 36(3), pp.319-329.

Teece, D.J., 2010. Business models, business strategy and innovation. *Long range planning*, *43*(2-3), pp.172-194.

Tielmann, A. and Schiereck, D., 2017. Arising borders and the value of logistic companies: Evidence from the Brexit referendum in Great Britain. *Finance Research Letters*, 20, pp.22-28.

Tokman, M. and Beitelspacher, L.S., 2011. Supply chain networks and service-dominant logic: suggestions for future research. *International Journal of Physical Distribution & Logistics Management,* 41(7), pp. 717-726.

Tongur, S. and Engwall, M., 2014. The business model dilemma of technology shifts. *Technovation*, *34*(9), pp.525-535.

Tou, Y., Watanabe, C., Moriya, K., Naveed, N., Vurpillat, V. and Neittaanmäki, P., 2019. The transformation of R&D into neo open innovation-a new concept in R&D endeavor triggered by amazon. *Technology in Society*, *58*, 101141.

Transport Intelligence, 2017. Leading European transport and logistics markets. Available at: https://www.ti-insight.com/product/leading-european-transport-and-logistics-markets-report/ [Accessed: 20/October/2020].

Truffer, B. and Coenen, L., 2012. Environmental innovation and sustainability transitions in regional studies. *Regional studies*, *46*(1), pp.1-21.

Truffer, B., Schippl, J. and Fleischer, T., 2017. Decentering technology in technology assessment: prospects for socio-technical transitions in electric mobility in Germany. *Technological Forecasting and Social Change*, *122*, pp.34-48.

Turner III, D.W., 2010. Qualitative interview design: A practical guide for novice investigators. *The qualitative report*, *15*(3), p.754.

Turnheim, B. and Geels, F.W., 2019. Incumbent actors, guided search paths, and landmark projects in infra-system transitions: Re-thinking Strategic Niche Management with a case study of French tramway diffusion (1971–2016). *Research Policy*, *48*(6), pp.1412-1428.

UK Parliament, 2020. Statistics on UK-EU trade. Available at: Statistics on UK-EU trade - House of Commons Library (parliament.uk) [Accessed: 22/December/2020].

Unruh, G.C., 2000. Understanding carbon lock-in. *Energy policy*, *28*(12), pp.817-830.

Urbinati, A., Chiaroni, D. and Chiesa, V., 2017. Towards a new taxonomy of circular economy business models. *Journal of Cleaner Production*, *168*, pp.487-498.

Vahrenkamp, R., 2010. Driving globalization: The rise of logistics in Europe 1950 – 2000. *European Transport*, 45, pp.1-14.

Van der Heide, G., Buijs, P., Roodbergen, K.J. and Vis, I.F.A., 2018. Dynamic shipments of inventories in shared warehouse and transportation networks. *Transportation Research Part E: Logistics and Transportation Review*, *118*, pp.240-257.

Van Waes, A., Farla, J., Frenken, K., de Jong, J.P. and Raven, R., 2018. Business model innovation and socio-technical transitions. A new prospective framework with an application to bike sharing. *Journal of Cleaner Production*, *195*, pp.1300-1312.

Vargo, S.L. and Lusch, R.F., 2004. Evolving to a new dominant logic for marketing. *Journal of marketing*, *68*(1), pp.1-17.

Vargo, S.L. and Lusch, R.F., 2008. Service-dominant logic: continuing the evolution. *Journal of the Academy of marketing Science*, *36*(1), pp.1-10.

Vargo, S.L. and Lusch, R.F., 2014. Inversions of service-dominant logic. *Marketing theory*, *14*(3), pp.239-248.

Vargo, S.L., Wieland, H. and Akaka, M.A., 2015. Innovation through institutionalization: A service ecosystems perspective. *Industrial Marketing Management*, *44*, pp.63-72.

Vargo, S.L. and Lusch, R.F., 2016. Institutions and axioms: an extension and update of service-dominant logic. *Journal of the Academy of marketing Science*, *44*(1), pp.5-23.

Vargo, S.L. and Lusch, R.F., 2017. Service-dominant logic 2025. *International Journal of Research in Marketing*, *34*(1), pp.46-67.

Vargo, S.L., Akaka, M.A. and Wieland, H., 2020. Rethinking the process of diffusion in innovation: A service-ecosystems and institutional perspective. *Journal of Business Research*, *116*, pp.526-534.

Veldhuizen, C., 2020. Smart Specialisation as a transition management framework: Driving sustainability-focused regional innovation policy?. *Research Policy*, *49*(6), 103982.

Verboeket, V. and Krikke, H., 2019. The disruptive impact of additive manufacturing on supply chains: A literature study, conceptual framework and research agenda. *Computers in Industry*, *111*, pp.91-107.

Verganti, R., 2008. Design, meanings, and radical innovation: A metamodel and a research agenda. *Journal of product innovation management*, *25*(5), pp.436-456.

Vural, C.A., Göçer, A. and Halldórsson, Á., 2019. Value co-creation in maritime logistics networks: A service triad perspective. *Transport policy*, *84*, pp.27-39

Wagner, S.M., 2008. Innovation management in the German transportation industry. *Journal of Business Logistics*, *29*(2), pp.215-231.

Wagner, S.M. and Sutter, R., 2012. A qualitative investigation of innovation between third--party logistics providers and customers. *International Journal of Production Economics*, *140*(2), pp.944-958.

Wainstein, M.E. and Bumpus, A.G., 2016. Business models as drivers of the low carbon power system transition: a multi-level perspective. *Journal of Cleaner Production*, *126*, pp.572-585.

Wallenburg, C.M., 2009. Innovation in logistics outsourcing relationships: proactive improvement by logistics service providers as a driver of customer loyalty. *Journal of supply chain management*, *45*(2), pp.75-93.

Walrave, B., Talmar, M., Podoynitsyna, K.S., Romme, A.G.L. and Verbong, G.P., 2018. A multi-level perspective on innovation ecosystems for path-breaking innovation. *Technological Forecasting and Social Change*, *136*, pp.103-113.

Wang, Y., Potter, A., Naim, M. and Beevor, D., 2011. A case study exploring drivers and implications of collaborative electronic logistics marketplaces. *Industrial Marketing Management*, *40*(4), pp.612-623.

Wang, Y., Singgih, M., Wang, J. and Rit, M., 2019a. Making sense of blockchain technology: How will it transform supply chains?. *International Journal of Production Economics*, *211*, pp.221-236.

Wang, X., Yuen, K.F., Wong, Y.D. and Teo, C.C., 2019b. Consumer participation in last-mile logistics service: an investigation on cognitions and affects. *International Journal of Physical Distribution & Logistics Management*, 49(2), pp.217-238.

Wang, H., Han, J., Su, M., Wan, S. and Zhang, Z., 2020. The relationship between freight transport and economic development: A case study of China. *Research in Transportation Economics*, p.100885.

Watanabe, C. and Tou, Y., 2019. Transformative direction of R&D–lessons from Amazon's endeavor. *Technovation*, *88*, e102081.

Wass, V. and Wells, P. 1994. Research Methods in Action. In: Wass, V. and Wells, P. eds. *Principles and Practices in Business Management Research*. Aldershot: Dartmouth, pp. 1-34.

Weiss, R.S., 1995. *Learning from strangers: The art and method of qualitative interview studies*. Simon and Schuster.

Weking, J., Stöcker, M., Kowalkiewicz, M., Böhm, M. and Krcmar, H., 2020. Leveraging industry 4.0–A business model pattern framework. *International Journal of Production Economics*, *225*, 107588.

Wells, P.E., 2013. *Business models for sustainability*. Edward Elgar Publishing.

Wells, P. and Nieuwenhuis, P., 2012. Transition failure: Understanding continuity in the automotive industry. *Technological Forecasting and Social Change*, *79*(9), pp.1681-1692.

Wells, P. and Lin, X., 2015. Spontaneous emergence versus technology management in sustainable mobility transitions: Electric bicycles in China. *Transportation Research Part A: Policy and Practice*, *78*, pp.371-383.

Wells, P., 2016. Economies of scale versus small is beautiful: A business model approach based on architecture, principles and components in the beer industry. *Organization & Environment*, *29*(1), pp.36-52.

Wells, P. and Nieuwenhuis, P., 2017. Operationalizing deep structural sustainability in business: Longitudinal immersion as extensive engaged scholarship. *British Journal of Management*, *28*(1), pp.45-63.

Wells, P., 2018. Degrowth and techno-business model innovation: The case of Riversimple. *Journal of Cleaner Production*, *197*, pp.1704-1710.

Wells, P., Wang, X., Wang, L., Liu, H. and Orsato, R., 2020. More friends than foes? The impact of automobility-as-a-service on the incumbent automotive industry. *Technological Forecasting and Social Change*, *154*, p.119975.

Wesseling, J.H., Bidmon, C. and Bohnsack, R., 2020. Business model design spaces in socio-technical transitions: The case of electric driving in the Netherlands. *Technological Forecasting and Social Change*, *154*, 119950.

Whitmarsh, L., 2012. How useful is the Multi-Level Perspective for transport and sustainability research?. *Journal of Transport Geography*, *24*, pp.483-487.

Wieland, H., Hartmann, N.N. and Vargo, S.L., 2017. Business models as service strategy. *Journal of the Academy of Marketing Science*, *45*(6), pp.925-943.

Willand, N., Maller, C. and Ridley, I., 2019. Addressing health and equity in residential low carbon transitions–Insights from a pragmatic retrofit evaluation in Australia. *Energy Research & Social Science*, 53, pp.68-84.

Winkelhaus, S. and Grosse, E.H., 2020. Logistics 4.0: a systematic review towards a new logistics system. *International Journal of Production Research*, 58(1), pp.18-43.

Wirtz, B.W., Pistoia, A., Ullrich, S. and Göttel, V., 2016. Business models: Origin, development and future research perspectives. *Long range planning*, *49*(1), pp.36-54.

Witkamp, M.J., Raven, R.P. and Royakkers, L.M., 2011. Strategic niche management of social innovations: the case of social entrepreneurship. *Technology Analysis & Strategic Management*, *23*(6), pp.667-681.

Wolfram, M., 2018. Cities shaping grassroots niches for sustainability transitions: Conceptual reflections and an exploratory case study. *Journal of Cleaner Production*, *173*, pp.11-23.

World Bank, 2018. Logistics Performance Index. Available at: https://lpi.worldbank.org/international/aggregated-ranking [Accessed: 22/December/2020].

World Economic Forum, 2017. Digital Transformation Initiative: Unlocking B2B Platform Value. Available at: https://reports.weforum.org/digital-transformation/wp content/blogs.dir/94/mp/files/pages/files/wef-platform-report-final-3-26-17.pdf [Accessed: 18 January 2021].

Xue, Z., Lin, H. and You, J., 2021. Local container drayage problem with truck platooning mode. *Transportation Research Part E: Logistics and Transportation Review*, 147, 102211.

Yavas, V. and Ozkan-Ozen, Y.D., 2020. Logistics centers in the new industrial era: A proposed framework for logistics center 4.0. *Transportation Research Part E: Logistics and Transportation Review*, *135*, 101864.

Yin, R.K., 2003. Designing case studies. *Qualitative Research Methods*. Sage publications.

Yin, R.K., 2014. *Case study research design and methods*. Sage publications.

Yin, R.K., 2018. *Case study research and applications: Design and methods*. Sage publications.

Yu, Y., Wang, X., Zhong, R.Y. and Huang, G.Q., 2017. E-commerce logistics in supply chain management. *Industrial Management & Data Systems*, 117(10), pp.2263-2286.

Zissis, D., Aktas, E. and Bourlakis, M., 2018. Collaboration in urban distribution of online grocery orders. *The International Journal of Logistics Management*, 29(4), pp. 1196-1214.

Zhu, J., Lean, H.S. and Ying, S.K., 2002. The third-party logistics services and globalization of manufacturing. *International Planning Studies*, 7(1), pp.89-104.

Zhu, F. and Liu, Q., 2018. Competing with complementors: An empirical look at Amazon. com. *Strategic management journal*, 39(10), pp.2618-2642.

Zott, C. and Amit, R., 2007. Business model design and the performance of entrepreneurial firms. *Organization science*, *18*(2), pp.181-199.

10. APPENDICES

Appendix A Case study protocol (case study brief)

Cardiff Business School
Ysgol Busnes Caerdydd

Part A: Case study brief (example):

Title: Socio-technical transitions in the logistics sector: how companies manage their innovation in the era of digitalisation

Project scope & aim: This research investigates the relationship between firms' innovation activities and the transformation of the logistics industry. The project is primarily responsible for studying innovation strategies under societal and technological changes.

Research Questions:

- What are the main factors that make firms develop their innovation activities?
- How firms develop their innovation projects in order to create value in the context of changing pressure around societal, technological, and environmental issues?
- What is the role of firms in the sustainability transitions of the logistics industry?

Data collection methods:

- Documentation: official documents such as company reports, industry research reports, and internal memoranda
- Semi-structured interviews with relevant stakeholder groups in project development, including executives, project managers, R&D engineers, research partners, technology providers, and customers.

Potential benefits:

This research will evaluate the past and current innovation activities of the company. More specifically, we investigate how these new technologies/practices contribute to business development and the potential for business model innovation in the future.

Project outcome:

- We provide a case study report for our participants.
- A presentation will be made to our project participants if it is required.

Date:

Changelog:

Appendix B Case study protocol (interview topic guide)

Cardiff University / Prifysgol Caerdydd — Cardiff Business School / Ysgol Busnes Caerdydd

Part B: Interview topic guide (example)
Case study company: Company D
Part A: General questions about the company 1. Could you please tell me your formal job title? Could you briefly summarise your main responsibilities? **Part B: Main factors that make firms develop innovation activities** 1. Could you tell me what past experience has shaped the way that your business intended to take this project? 2. Were there any factors that change your decision-making during the project implementation? **Part C: How firms develop their innovation activities** 1. What was the role of your key partner organisations in order to make this project successful? 2. How would you describe the customer relationship within your business? To what degree was this innovation project driven by the customer? Did they get involved in the project? 3. Will your new service (solution) focus on the status quo or create a new market? 4. What resources did you use in the project (e.g., human, financial, and other resources)? 5. Could you tell me the main revenue streams your company will generate a profit? How do you think about your revenue streams would differ from your existing business with the integration of these new technologies/practices? **Part D: What is the role of firms in the sustainability transitions of the logistics industry** 1. Could you describe your learning experience from this innovation project? 2. How would you anticipate your business model development under technological and social changes? 3. How would you characterise the current state of the logistics industry in Europe? How does it change over time? What factors have been important in shaping this change? 4. How has government policy affected the innovation project? Have you had any concerns about regulatory changes?

Appendix C Case study protocol (interview questions)

Cardiff Business School
Ysgol Busnes Caerdydd

Part C: Interview question guide and instructions for data analysis (example)		
Research questions: What is the role of firms in socio-technical transitions in the logistics industry? (RQ1) What is the role of logistics innovations in socio-technical transitions? (RQ2) How are value propositions developed and evolved? (RQ3) How firms' innovation activities contribute to the transition of the logistics industry? (RQ4)		
Topic	**Example questions**	**Theoretical theme**
Respondent profile	Can you tell me what your formal job title is? Could you briefly summarise your primary responsibilities?	N/A
Innovation activities	What motivated the innovation project?	Value proposition development; Innovation strategy
	What is your company's main competitive advantage? How does it differ from its competitors?	Value proposition development
	Can you explain how this project contributes to the transformation of the current business?	Value proposition development
	What motivated the project? Could you describe briefly how the decision making took place with this project? Was it at the Head Office level? Division level? Who decided the project implementation? Were there any factors that change your decision making during the project?	Value proposition development; Innovation strategy
Organisation strategy and goals	Could you tell me your company's main medium to the long-term goal? What are you going to achieve in the next 3-5 years?	Value proposition development
	How would you anticipate your business development by integrating these core technologies/practices into your business model in the future?	
	Could you tell me which strategies your company have undertaken to reach your medium to a long-term goal, as just mentioned? Furthermore, could you tell me any changes, actions that have been made in order to achieve this goal?	
Project-specific questions	Could you tell me what past-experience that motivated your business to undertake this project?	Value proposition development Innovation strategy
	To what degree was this innovation project that created internally or by external pressure (e.g., customers' requirement)	
	What were your key partners during this innovation project?	Value proposition development; Co-creation
	What key resources did you want to obtain from the collaboration?	Value proposition development; Co-creation
	Could you tell me any strategic partnerships have been formed for this project? How do they work now and in the future?	Enactment of value propositions
	Can you describe the customer relationship within your business? To what degree was this innovation project driven by customers demand?	Enactment of value propositions
	How to maintain customers' interests in terms of your strategies?	Enactment of value propositions

	Can you tell me what customer segments are you going to target at?	Enactment of value propositions
	For your innovation activities, will your new service (solution) focus on the current status quo or create a new market?	Enactment of value propositions
	What resources did you use in this project in order to create value?	Value proposition development; Enactment of value propositions
	Can you tell me the human resources required to realise this project?	
	What channels are you going to deliver your new service?	Enactment of value propositions
	Regarding societal/environmental impacts, do you consider the service can be delivered with social/environmental benefits compared to the traditional business?	Enactment of value propositions
	Any essential expenses used in the project development?	Value proposition development
	Could you tell me the most valuable resource used in your innovation project?	Value proposition development
	How to make sure that the mainstream market can accept the new service?	Value proposition development; Enactment of value propositions
	Could you tell me the main revenue streams your company generates a profit?	Value proposition development
	How would you believe your revenue streams will differ from the existing business model by integrating this new service?	Value proposition development; Enactment of value propositions
Expectations and interests regarding this innovation project	Could you tell me your expectations for this project?	Enactment of value propositions
	Could you describe what your motivation for participation in the project is?	Value proposition development; Innovation strategy
	What is the project leader's vision about these activities?	Value proposition development; Innovation strategy
Learning on innovation activities	Could you tell me any evidence of learning of these innovation projects?	Value proposition development
	Does the learning lead to other stakeholder groups' support (e.g. customers, consumers, technology providers, and policymakers)?	Co-creation; Enactment of value propositions
Existing and future logistics industry structure	How would you think about the social and technological trends of the logistics industry?	Value proposition development; Co-creation; Enactment of value propositions
	How has the industry changed over time? What factors have been influential in shaping this change?	
	How were regulatory requirements taken into consideration during the project implementation?	
	Was the project affected by competitive pressure among other actors in the industry?	
	What factors might disrupt these current practices in the logistics industry?	

Appendix D An example of a coded interview

Extract from the transcription (7D) in Company D case study	Coding categories
H: I heard about the presentation in which you mentioned you are going to focus on the long-haul market. 7D: Yes, it is best automated because you can use regular carriers on regular lines, pretty much you can fully automate some processes. So, when the technology is better, you could optimise it. At the moment, lots of full-truckload freights are sub-contracted. Shippers, like DHL, Schenker, and K&N, sub-contracted onto middle-size players, then sub-contracted onto smaller players, and maybe some of the trucks. So often 3-4, sometimes 7 or 8 layers, taking money from the chain. Basically, it will flatten with technology. We want to be one of them connecting small carriers. We could sell the big capacity to the big shippers. That helps them save costs, and we have a lot less waste in the middle, so that is why we see the opportunity.	**Value proposition development: network reconfiguration** o Full truckload market structure: multiple-layered o Connecting big shippers directly with small carriers o Cost-reduction role in logistics innovations
H: Are you going to be involved in autonomous truck development or collaborate with other partners in the future? 7D: What we see is that connectivity is so important because, for autonomous trucks drive, you have to have precise data points. The more we grow this digital platform, the better the place we are, to give that data to autonomous trucks in the right place, right time, and optimise the use of trucks. So, I think the truck manufacturers, there are lots of testing opportunities. My personal opinion is not about money-saving in 2%-6% by truck platooning, but take the driver out means 30%. Drivers are short in Germany, UK, all sophisticated markets. The pressure is high when the driver is expensive.	**Enactment of value propositions** o Potential for value co-creation with data in autonomous vehicle development o Change in industry structure o A shortage of skilled truck drivers in the sector

Appendix E Case study interviewees

Case Study	Dates	Interview Number	Job Title
Company A	14/06/2017	1A	Global Head of Strategy and Innovation
	06/12/2017	2A	Research Leader of University Research Centre
	09/08/2017	3A	Logistics Service Analyst
	04/08/2017	4A	Logistics Service Analyst
Company B	18/12/2017	1B	Head of Marketing
	11/08/2017	2B	Regional Managing Director
Company C	24/11/2017	1C	Head of the innovation centre
Company A (revisit)	12/02/2020	1A	Global Head of Strategy and Innovation
	11/02/2018	(informal)	Research Partner A
	12/04/2018	(informal)	Research Partner B
Company D	07/11/2019	1D	Executive Manager A
	07/11/2019	2D	Executive Manager B
	07/11/2019	3D	Executive Manager C
	06/11/2019	4D	Operation Manager
	06/11/2019	5D	Software Engineer Manager
	06/11/2019	6D	Business Development Manager
	07/11/2019	7D	Senior Director

Appendix F (Ethical approval 1)

Cardiff Business School

Ysgol Busnes Caerdydd

Haokun Liu
Cardiff Business School
Cardiff University

21 October 2019

Dear Liu,

Ethics Approval Reference: 1617035
Project Title: Socio-technical transitions in the logistics sector: how companies develop their innovation projects in the era of digitalisation.

I would like to confirm that your project has been granted ethics approval as it has met the review conditions. We note that the end date of your project has been amended and is now 30 September 2020.

Should there be a material change in the methods or circumstances of your project, you would in the first instance need to get in touch with us for re-consideration and further advice on the validity of the approval.

I wish you the best of luck on the completion of your research project.

Yours sincerely,

Electronic signature via email

Dr. Debbie Foster
Chair of the School Research Ethics Committee
Email: CARBSResearchEthics@cardiff.ac.uk

Appendix G (Ethical approval 2)

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYD

Cardiff Business School

Ysgol Busnes Caerdydd

Liu, Haokun
Cardiff Business School

17 July 2017

Dear Haokun:

Ethics Approval Reference: 1617035
Project Title: Socio-technical transitions in the logistics sector: how companies develop their innovation projects in the era of digitalisation.

I would like to confirm that your project has been granted ethics approval as it has met the review conditions.

Should there be a material change in the methods or circumstances of your project, you would in the first instance need to get in touch with us for re-consideration and further advice on the validity of the approval.

I wish you both the best of luck on the completion of your research project.

Yours sincerely,

Electronic signature via email

Debbie Foster
Chair of the ethics sub-committee
Email: CARBSResearchOffice@cardiff.ac.uk

Appendix H Consent form

CARDIFF UNIVERSITY PRIFYSGOL CAERDYDD

Cardiff Business School
Ysgol Busnes Caerdydd

CARDIFF BUSINESS SCHOOL
RESEARCH ETHICS

Consent Form –

This research investigates the relationship between firms' innovation activities and the transformation of the logistics industry. The project is primary responsible for studying innovation strategies under societal and environmental changes.

I understand that my participation in this project will involve

Provide documents like company reports, industry research reports; and semi-structured interviews will require approximately 30 minutes to 1 hour.

I understand that participation in this study is entirely voluntary and that I can withdraw from the study at any time without giving a reason.

I understand that I am free to ask any questions at any time. If for any reason I have second thoughts about my participation in this project, I am free to withdraw or discuss my concerns with Professor Peter Wells (WellsPE@cardiff.ac.uk).

I understand that the information provided by me will be held confidentially and securely, such that only the researcher and supervisory team (Peter Wells, Vasco Sanchez Rodrigues and Maneesh Kumar) can trace this information back to me individually. The information will be retained for up to 1 year and will then be anonymised, deleted or destroyed. I understand that if I withdraw my consent I can ask for the information I have provided to be anonymised/deleted/destroyed in accordance with the Data Protection Act 1998.

I, ________________________________(*NAME*) consent to participate in the study conducted by Haokun Liu (LiuH23@cardiff.ac.uk), PhD student of Cardiff Business School, Cardiff University, under the supervision of Professor Peter Wells.

Signed:

Date: