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Strategic Sourcing of Digital Platforms in the Industrial Internet of Things

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Abstract

The Industrial Internet of Things (IIoT) consists of the Internet of Things (IoT) implemented in industrial settings. Use cases range from the monitoring of manufacturing processes to the servitization of physical industrial products, which are supported by digital platforms. Through more pervasive information, businesses can benefit not only from minimizing inefficiencies in operations and reducing costs, but also unlock novel revenue streams. Although the literature on the IoT has flourished over recent years, the research area is still in its infancy and the IIoT, as a subset of the IoT, remains relatively unexplored. In particular, extant literature provides no theoretical understanding of the strategic sourcing decisions of IIoT platforms. With this identified research gap, this paper ties back to previous literature on sourcing decisions with theories such as resource-based view (RBV) and transaction cost theory (TCT). In addition to the more classical theories, this research encompassed recent literature on platform-driven ecosystems, with the goal to develop a modern model for make or buy decisions in the context of the IIoT. The conceptual model was evaluated through a multi-case study, based on data gathered via in-depth interviews with 25 research participants, representing 12 different stakeholder companies in the IIoT. The resulting theoretical model, derived through a synthesis of TCT, RBV, and the ecosystem view of interfirm relationships, provides substantial contributions for both scholars and practitioners.

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1 Introduction

The Internet of Things (IoT) is a global infrastructure consisting of interconnected physical and virtual things, based on an evolving set of technology standards, which enables advanced services (ITU-T, 2012, p. 9). The IoT unlocks an unprecedented amount of information at a low cost (The Economist, 2019), rendering it a commodity that individuals and businesses can utilize in various activities (Lucero, Builta, Morelli, Byrne, & Song, 2016).

Even though connecting things to the internet is not a novel idea, the IoT in its modern configuration has only recently achieved a substantial level of maturity. This was possible due to the convergence of several technology and market trends, such as the widespread availability of connectivity, the decrease in costs for computation and miniaturization of processor chips, as well as the rise of cloud computing and data analytics (Rose, Eldridge, & Chapin, 2015). Furthermore, the IoT has benefitted from the decentralization of computation, the integration of technology standards as well as advancements in network technologies such as 5G (Behrendt, et al., 2021).

The IoT carries important implications, especially in industrial settings, where its implementation has a substantial impact on firms’ costs, revenues and organizational structures. In industrial contexts, investments are expected to reach USD 500 billion by 2025 (Behrendt, et al., 2021).

> *“[The IIoT] will be a must have for companies to be able to keep up the edge with the competition in the future”* (Interviewee 14, 2020).

Despite the IoT recently gaining traction as a research area in the Information Systems (IS) community, it is a relatively novel topic and still under-researched in business studies. The Industrial Internet of Things (IIoT), as a subset of the IoT, subsequently suffers from inadequate attention by scholars. Figure 1 reports the yearly publications on the IoT and IIoT across business, management, and economics studies (Web of Science, 2021).

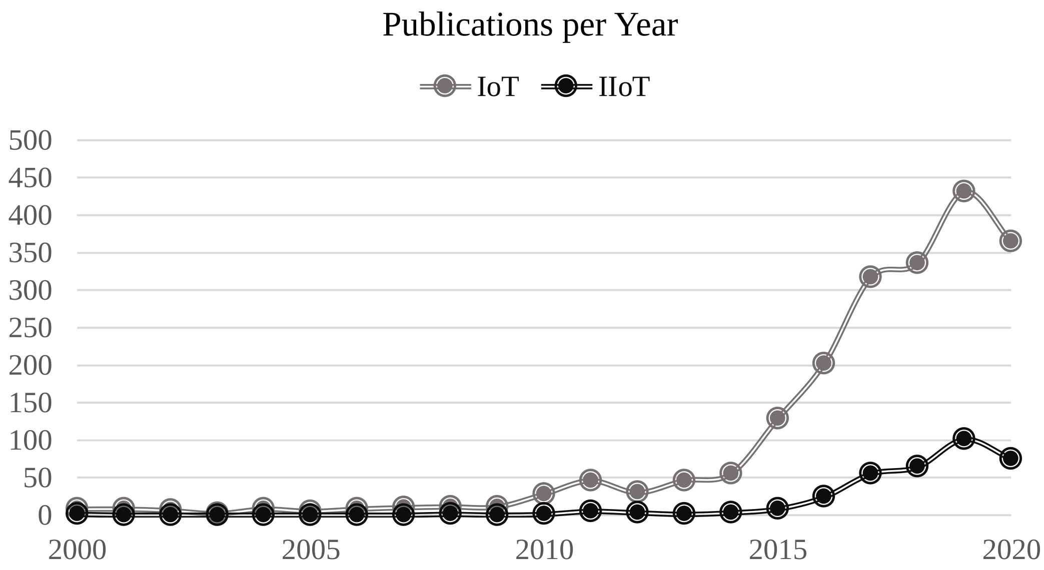

***Figure 1**. Yearly publications on the IoT and IIoT (Web of Science, 2021).*

1.1 Problem Statement

Most of the extant business literature addressing the IIoT focuses on the tight interplay between the IIoT and digital platforms. IIoT platforms are complex digital assets that support IIoT use cases through a set of standard interfaces. Moreover, open, digital platforms foster innovation through the combined activities of participants, or in other words, the surrounding ecosystem (Gawer & Cusumano, 2002). Inherited from research in biology, the term ecosystem found broad consensus among business strategy scholars (Moore, 1993; Iansiti & Levien, 2004). Moreover, several authors, in recent times, highlighted the need investigate the dynamics of ecosystem within the context of digital platforms for the IIoT (Mazhelis, Luoma, & Warma, 2012; Lucero, Builta, Morelli, Byrne, & Song, 2016; Guth, Breitenbucher, Falkenthal, Leymann, & Reinfurt, 2016; Smedlund, Ikävalko, & Turkama, 2018; Ikävalko & Turkama, 2018; Hejazi, Rajab, Cinkler, & Lengyel, 2018; Petrik & Herzwurm, 2018; Petrik, Straub, & Herzwurm, 2020).

Despite initial efforts by various researchers, the implications of platform ecosystems in IIoT implementations remain widely unexplored. More specifically, while some scholars highlighted the importance of platform ecosystems for companies entering the IIoT space (Mazhelis, Luoma, & Warma, 2012; Smedlund, Ikävalko, & Turkama, 2018), very little attention has been given to the development of strategic decision support for companies that want to adopt the IIoT. The lack of theoretically grounded, strategic decision guidelines is especially evident in the context of procurement strategies for IIoT platforms. Industrial companies, in fact, face the decision whether to develop their own IIoT platform, or to buy access to an existing IIoT platform provided by the market. This problem is especially noteworthy, given the platform ecosystem dynamics observed in multiple industries, where strong positive network effects lead to a convergence of participants on fewer platforms (Eisenmann, Parker, & Van Alstyne, 2011). Recent advancements on IIoT platform ecosystem research found that a rich ecosystem of platform participants is also vital for a successful platform strategy in the IIoT (Pauli, Marx, & Matzner, 2020). Given the high relevance and influence of platform ecosystem dynamics, it seems surprising that very little research had been done to support companies in their IIoT decisions, and what implications on their strategies those dynamics would have.

First, this paper sought to identify a research gap within the IIoT and, second, to contribute to advance the state of research in this area. To fulfill those premises, the work was characterized by an exercise of iteration. During the early stages, the researchers conducted a literature review on the IIoT, thus building an understanding of issues of interest for both scholars and practitioners. Therefore, the researchers gathered preliminary information from practitioners through in-depth exploratory interviews, which helped to shape a sensible research question.

1.2 Research Question

In the light of the stated research problem, a research question was formulated as follows: "What are the strategic factors, and how do they influence making or buying a digital platform in the Industrial Internet of Things?" This construction allowed for a two-folded approach towards the study. First, the relevant factors influencing the strategic decision had to be identified. In doing so, various streams of research were critically reviewed and embedded into a comprehensive conceptual model. At a later stage, a thorough analysis based on rich qualitative data permitted the induction of a theory anchored on the conceptual model. Furthermore, the articulation of the research question fixed the research focus on a particular asset, digital platforms, and in a specific context, the one of the Industrial Internet of Things. At the same time, it left enough room for the extraction of new insights and the generation of a novel theoretical model.

1.3 Structure of the Paper

The thesis is structured as follows. A literature review (Chapter 2) explores the current state of research addressing the IIoT. The focus is placed on popular research streams, such as IIoT platforms (2.2) and IIoT platform ecosystems (2.3). Based on the identified corpus of works, a promising research gap is identified (2.4). The latter resides in the lack of theoretical understanding of what factors drive industrial companies in pursuing make or buy decisions on IIoT platforms. Chapter 3 reviews scholarly contributions on similar issues in diverse contexts. This review of different theories provides a foundation for the development of a conceptual model (3.5), which establishes the theoretical angle for the work of analysis in Chapter 5. Prior to a thorough presentation of the analysis, the methodology followed by the researchers illustrates the research approach, including data collection, the qualitative analysis procedure and how internal and external validity were ensured. The adopted approach takes an interpretivist standpoint and falls in-between induction and deduction due to the immaturity of the IIoT research field. The research design allowed for both exploration and explanation of the research context. In presenting the results of the analysis, Chapter 5 is characterized by a two folded structure. Cases are first investigated on an individual basis to expose patterns and insights. Those are later compared across cases via a divergent technique. This approach was strongly inspired by Eisenhardt's process for building theory from case study research. In Chapter 6, the emerged findings are discussed through an engagement with extant literature, after which the researchers conclude with a generalization of the conceptual model. The proposed model, therefore, answers the original research question. In particular, it addresses both the validation of the identified concepts of interest and how they influence the dependent variable. This paper subsequently proposes an articulation of contributions derived from the work of research (6.3) as well as implications for practitioners (6.4). After clarifying the limitations of the research (6.5), the paper concludes with a high-level summary of the entire work and avenues for future research (Chapter 7).

2 Literature Review

This chapter explicitly describes the method followed in systematically identifying, evaluating and synthesizing the existing literature produced by researchers, scholars and practitioners to build a deep understanding of the field of research, key theories, concepts, ideas and active debates in the IoT and IIoT (Fink, 2019). The followed approach was consistent with best practices advanced by a series of authors and is reproducible by future research. The gathered body of works was consolidated by synthesizing both consistent and contrasting contributions (Schwarz, Mehta, Johnson, & Chin, 2007). The material evaluation allowed the authors to identify a promising research gap, driving the rest of the work (Rowe, 2014).

The reviewed literature mainly consisted of top journal articles and conference proceedings, gathered through search queries on scientific search engines such as Web of Science and Google Scholar, and online databases such as Emerald, JSTOR or ScienceDirect. A substantial amount of material emerged in the process, and critical selection and filtering were needed along the way. To achieve this, both practical and methodological screening criteria were applied (Fink, 2019). Purely Information Technology research papers were discarded, as the focus of the pursued study was on the business aspect of the IIoT. Papers that showed a weak theoretical foundation, that exhibited bad quality in terms of presentation, or that were not deemed as relevant by reading their abstracts and findings, were also discarded. Non-English works were checked for availability of an English version, and when the latter was not available, they were rejected. Literature was further collected by propagating the review among cited works, retaining the criteria described above.

The extensive review was structured into two main steps. In the first phase, the researchers were interested in building an overview of the research streams around IoT and IIoT (Schwarz, Mehta, Johnson, & Chin, 2007). The literature contributions were synthesized independently by the researchers, and they were later jointly clustered into various categories. This approach allowed the authors to identify additional research streams popular within IIoT literature, such as digital platforms and ecosystems. A detailed specification of the search terms used in the systematic literature review is provided in Table 1.

Table 1*. List of search queries run on academic databases.*

	Search Query	
IIoT	*OR*	Industrial Internet of Things
IoT	*OR*	Internet of Things
IoT	*AND*	Ecosystems
IIoT	*AND*	Ecosystems
IoT	*AND*	Digital Platforms
IIoT	*AND*	Digital Platforms
Digital Platforms	*AND*	Ecosystems

The first iteration, in framing the status of research in the field, also exposed a promising gap. While scholars were comfortable with what the IoT consisted of, what benefits and challenges it implied, strategic contributions were scarce. In particular, even if there was general consensus on digital platforms being the right asset to support industrial IoT implementations, no study had investigated the strategic implications of its sourcing decisions: what lessons could be learned by early adopters, what strategies could be suggested for managers, and what theoretical insights could be abstracted for future research. The importance and relevance of this topic were confirmed through a preliminary round of five in-depth interviews, which featured the participation of various representatives of industrial companies. Hence, a second iteration of the literature review was carried out to build an understanding of how sourcing (i.e., make or buy) decisions had been approached by previous research: what theories and models had been advanced throughout the years, what explanatory power or limitations they presented, consistent with best practices for literature reviews (Rowe, 2014). The search queries run for this purpose are presented in Table 2.

***Table 2**. Search queries run for gathering literature on sourcing decisions.*

	Search Query	
Theory	*AND*	Make or Buy decisions
Theory	*AND*	Vertical Integration
Theory	*AND*	Sourcing decisions
Theory	*AND*	IT outsourcing
Theory	*AND*	IT insourcing

In doing so, the researchers reflected on the premises of existing theory on sourcing decisions and addressed them in the formulation of a conceptual model (Section 3.5), used to drive both Analysis (Chapter 5) and Discussion (Chapter 6). For reasons of clarity, the two-folded approach to the literature review (see Table 3) is reflected in the structure of the following chapters. The remaining sections in this chapter focus on IoT, IIoT and digital platforms, concluding that new research is needed to understand make or buy decisions in the context of the IIoT. Tying back to this gap, Chapter 3 reflects both on past predominant approaches to explain asset sourcing problems and on what is sensible to study in the context of the IoT, thus laying down the foundations for the rest of the paper.

Table 3. *Approach to the systematic literature review.*

Phase	*Protocol*	*Objective*
Literature Review (*Chapter 2*)	Systematic search on popular search engines and databases of sensible queries (see Table 1), to build a deep understanding of the current status of research (Schwarz, Mehta, Johnson, & Chin, 2007). Application of practical and methodological screening criteria throughout the process (Fink, 2019).	Identifying research streams around the IIoT and exploring contributions with the aim to expose a promising gap for research.
Theoretical Framework (*Chapter 3*)	Systematic search on popular search engines and databases of sensible queries (see Table 2), to gather and understanding of established theories aligned with the research gap (Rowe, 2014; Fink, 2019).	Reviewing past theoretical approaches in addressing the identified gap in different contexts, with the aim to shape a conceptual model to drive the rest of the work.

2.1 The Industrial Internet of Things (IIoT)

The Internet of Things consists of the "*pervasive presence around us of a variety of things or objects, [such as sensors, actuators, mobile phones and RFID tags,] which, through unique addressing schemes, are able to interact with each other and cooperate with their neighbors to reach common goals*" (Atzori, Iera, & Morabito, 2010, p. 2787). The IoT is supported by various enabling technologies, ranging from sensing and identification to middleware and software applications (Atzori, Iera, & Morabito, 2010). These technologies can be represented via a layered model: physical devices, network, virtualization, combination, and application (Floris & Atzori, 2016). Physical devices embed *sensors*, hardware responsible for mining information from the physical world, as well as *actuators*, hardware capable of taking physical actions triggered by specific instructions. The information is transported away and to physical devices by the network layer. This function can be fulfilled in various forms, depending on energy, resilience, amount of information and other constraints.

The network is key in uploading and downloading information to data servers, where each physical device is virtualized.

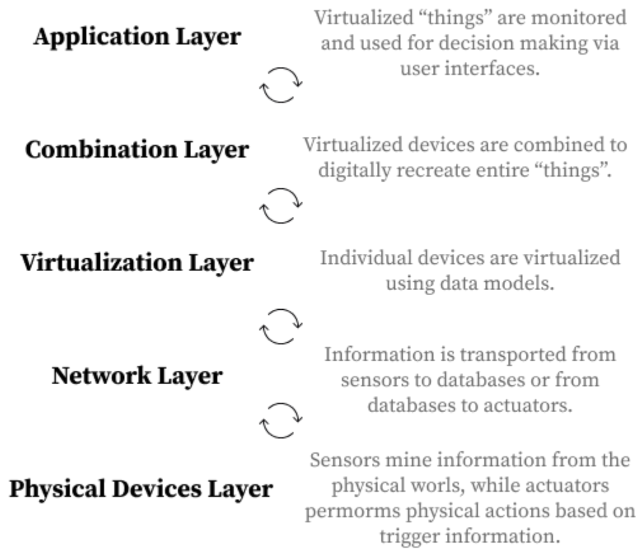

Figure 2*. The IoT architecture layered model (Floris & Atzori,2016).*

The virtualization of physical components allows for complex combinations, resulting in the digital reproduction of real physical machines like pumps, decanters, refrigerators etc. The application layer provides a user interface where digital twins of physical objects can be monitored (Floris & Atzori, 2016). By extracting a wide range of information from the physical world, the IoT effectively empowers people by enabling them to make better informed decisions, both in private and in business contexts. When it comes to the latter, IoT applications were found to unlock the generation of additional revenue, reduction of operating costs, extension of business scope, gain of competitive advantage, better risk assessment and the enrichment of relationships with customers (Suppatvech, Godsell, & Day, 2019).

As a subset of the IoT, the Industrial Internet of Things (IIoT) refers to a network of connected devices in manufacturing applications, for instance, within factories. The value proposition of the IIoT has profound consequences on business models across industries: it facilitates the optimization of resources by minimizing waste and quickly detecting malfunctions inside production plants (Sisinni, Saifullah, Han, Jennehag, & Gidlund, 2018; Boyes, Hallaq, Cunningham, & Watson, 2018). To live up to its promises, the IIoT pushes firms to restructure their workforce since successful implementations of IIoT use cases require specific cognitive and processual competencies (Arnold & Voigt, 2016; Butschan, Heidenreich, Weber, & Kraemer, 2019). Simultaneously, IIoT plays a vital role in the servitization of industrial products by making it possible for companies to track their products' consumption and utilization, thus unlocking different configurations of revenue models (Kiel, Arnold, & Voigt, 2017). Lee and Lee (2015) investigated how industrial companies apply IoT technology, finding that its value proposition originates from property protection and energy savings, big data and business analytics, information sharing and collaboration between people, or even between things. These considerations go in line with the argument that the IIoT essentially unlocks critical information, allowing for better informed and timely-made decisions. The strict link between data and decision-making encourages firms to couple the IIoT with artificial intelligence algorithms capable of learning from data and taking appropriate decisions on behalf of humans.

Value proposition aside, companies adopt technologies like the IIoT because of competitive pressure, in other words, in order not to fall behind competitors who move early or to gain an edge over competitors by adopting the technology before they do. This pressure wins over hesitations caused by perceived challenges in implementing of IIoT (Arnold & Voigt, 2018) and convinces top management to embrace the IoT in business operations. Seetharaman et al. (2019) found that factors such as the existence of legacy systems, security and privacy concerns, the required high upfront capital investments, and the need to collaborate with different stakeholders explain why some firms are still hesitant towards making investments in the IIoT. Moreover, increased environmental uncertainty is inversely related to IIoT adoption, possibly because companies might be less inclined to invest in IIoT given its unknown development, for instance, in terms of common standards. The above challenges resonate with the risks identified by Ehret and Wirtz (2016), which include undermining privacy, increasing complexity of manufacturing systems, and drawing in new competitors. Suppatvech et al. (2019) stated that manufacturers should consider utilizing IoT as a core element in offering advanced product-service bundles that support their customers' core business processes. This, however, is challenging as it heavily relies on a close collaboration between multiple actors involved in advanced service provisioning. In general, IIoT use cases require substantial and often irreversible investments, and forecasting the return on investment represents a daunting task due to the yielded uncertainty and risks (Li & Johnson, 2002; Fichman, Keil, & Tiwana, 2005; Lee & Lee, 2015). Moreover, companies have, until recent times, considered data about product usage as an inimitable resource (Barney, 1991) that needs to be protected, which in turn stresses the data concerns linked with the IIoT. This seems no longer to be the case, as companies do not perceive data possession or exclusive access to data as a competitive advantage in itself (Turunen, Eloranta, & Hakanen, 2018). On the contrary, both companies that provide a service within the IIoT and industrial end customers are focusing on forming new combinations of diverse data sources. The former can use this aggregation to improve their capabilities and offerings, while the latter can benefit from their usage data being analyzed together with data points from other sources. In short, information sharing and collaboration-based strategies would be emerging in IIoT settings (Turunen, Eloranta, & Hakanen, 2018). However, this is difficult to implement, in practice, due to the increasing fear of total surveillance and raising concerns on the buyer’s willingness to collaborate with the vendor. In the IIoT domain, trust between companies, credibility and data safety are significant factors that drive successful collaborations between firms (Falkenreck & Wagner, 2017).

To summarize, the IIoT offers substantial opportunities for businesses across industries. It unlocks information from manufacturing and consumption processes, paving the way for information-driven innovation for end users and business model innovation, and the realization of competitive advantage for manufacturers (Ehret & Wirtz, 2016; Arnold & Voigt, 2018; Suppatvech, Godsell, & Day, 2019). At the same time, the IIoT is inherently complex, as it consists of a network of rapidly evolving technologies, supported by a myriad of different companies (Li & Johnson, 2002; Fichman, Keil, & Tiwana, 2005; Lee & Lee, 2015). Industrial companies are especially concerned about the requirements of novel competencies (Arnold & Voigt, 2016; Butschan, Heidenreich, Weber, & Kraemer, 2019) and about the exposure to market and technology-related risks (Ehret & Wirtz, 2016; Falkenreck & Wagner, 2017; Seetharaman, Patwa, Saravanan, & Sharma, 2019).

2.2 IIoT Platforms

To the challenging complexity which characterizes the IIoT, industrial companies have responded with IIoT platforms. These are *"cloud-based and on-premise software packages and related services that enable and support sophisticated IoT services"* (Lucero, Builta, Morelli, Byrne, & Song, 2016, p. 13), or, more abstractly, multi-sided markets[1] where machine tool companies provide platform-based applications for machine operating companies across

[1] Two-sided markets, which are also referred to as multi-sided markets, can be defined as markets that involve multiple actors enabled to conduct transactions and interact with each other through the means of one or multiple platforms. These platforms want to onboard the different actors and are trying to charge them each appropriately while not losing money overall (Rochet & Tirole, 2006). One example for two or multi-sided markets are payment card systems that need to attract both merchants and end-consumers.

different industries (Petrik & Herzwurm, 2018). IIoT platforms promise to reduce the complexities that derive from the IoT and to provide shared core functionality, so that platform users do not have to reinvent the wheel. Basic functionality consists of multiprotocol support, device onboarding, diagnostics, triggers for alert notifications and more. IIoT platforms enable business users to focus on creating differentiated services, applications or solutions and reducing their needed investments, expertise, capabilities, risk, and most importantly, their time to market (Lucero, Builta, Morelli, Byrne, & Song, 2016). In practice, IIoT platforms represent a structure of modular nature that includes tangible and intangible resources facilitating the collaboration of actors so that they may bundle their resources and capabilities. A main issue within service platforms regards the interfaces and standards through which the actors communicate and collaborate via the platform (Lusch & Nambisan, 2015). Hejazi et al. (2018) found five reasons for the justification of the existence of IIoT platforms. First, they take care of supporting multiple network connectivity tasks, providing the flexibility to choose an option for the IIoT solution. Second, IIoT platforms provide an interface to manage data and integrate it with business workflows. Third, IIoT platforms facilitate normalization and security for data coming from different sources. Fourth, IIoT platforms often provide ready to use tools for information visualization, enabling analytics to support business decisions. When this is not possible on the platform itself, the data can be exposed to third-party visualization tools via available Application Programming Interfaces (API's).

In conclusion, to overcome known challenges and realize successful IoT implementations in industrial settings, companies rely on digital platforms. IIoT platforms are packages of software and services, running either on cloud or local environments, enabling and supporting IoT services tailored to industrial contexts (Lucero, Builta, Morelli, Byrne, & Song, 2016). Moreover, the value of information unlocked via IIoT services increases when data is aggregated and shared through a digital platform. New insights are made available by combining different data sources (Turunen, Eloranta, & Hakanen, 2018). Therefore, companies involved in the IIoT need platforms for retrieving information, analyzing it, and making it actionable (Ehret & Wirtz, 2016; Hejazi, Rajab, Cinkler, & Lengyel, 2018).

2.3 IIoT Platform Driven Ecosystems

Platforms arise when assets such as components, processes, knowledge, people, and relationships, are shared to a substantial extent across products (Meyer & Lehnerd, 1997; Robertson & Ulrich, 1998; Simpson, Maier, & Mistree, 2001). The most important attribute of a platform, according to Baldwin and Woodard (2009), is the reusability of core components, which enables economies of scale and the reduction of costs for an extensive array of complementary component development. Many platforms currently support the addition of several third-party tools to take advantage of shared data resources (Tilson, Lyytinen, & Sørensen, 2010). Yoo et al. (2012) noted that the adoption of platforms implies the adherence to standardized tools and sharing of data and processes across organizational boundaries. The sharing of data and processes through digital means questions the traditional views on roles and ownership, challenging the extant relationships between actors involved in innovations. This happens because the platform and its modules form an ecosystem (Gawer & Cusumano, 2002; Gawer, 2009; Tiwana, Konsynski, & Bush, 2010) that include heterogeneous actors (Boudreau, 2012).

In the context of the IIoT, an ecosystem describes a "*special type of business ecosystem which is comprised of the community of interacting companies and individuals along with their socio-economic environment, where the companies are competing and cooperating by utilizing a common set of core assets related to the interconnection of the physical world of things with the virtual world of Internet*" (Mazhelis, Luoma, & Warma, 2012, p. 5). A business ecosystem is usually driven by hardware or software components (e.g. a software platform), representing the core, technical artefact around which the business ecosystem can arise. IIoT platform-driven ecosystems are, according to Lucero et al. (2016), an optimal way to deploy complex IIoT solutions in vertical markets, since digital platforms provide a landscape where interactions and exchanges between IIoT stakeholders are facilitated (Guth, Breitenbucher, Falkenthal, Leymann, & Reinfurt, 2016). The IIoT platforms are set to create most of the value for their end-users through their ecosystems, very similar to how cloud computing platforms developed (Mazhelis, Luoma, & Warma, 2012). Furthermore, the value in platform-driven ecosystems is jointly created by the various participants, and their activities are facilitated by the platform itself (Parker, Van Alstyne, & Choudary, 2016).

It appears that ecosystems are a critical aspect of digital platforms, though some clarity must be provided in differentiating loose business ecosystems and platform-driven ecosystems. The difference between the two resides within the core around which the ecosystem forms. While the platform ecosystem revolves around a protected technology core (i.e., the platform), the ecosystem core is far more complex in broad IoT ecosystems (Smedlund, Ikävalko, & Turkama, 2018). IoT stakeholders have little individual influence over the evolution and growth of the business ecosystems, as the resources that come into play to produce the offerings are majorly distributed among third parties. In contrast, in platform driven ecosystems, platform owners exercise a more central role. In general, platform-driven ecosystems are easier to isolate compared to the endless opportunities and relationships firms have with other actors in broad ecosystems (Leminen, Rajahonka, Wendelin, & Westerlund, 2020). Therefore, platform driven ecosystems are also more suitable to be studied. Industrial companies should reflect on the role they wish to play in such ecosystems. One of them would consist of driving a closed ecosystem by operating a proprietary system (e.g. a platform) with a bound set of actors, often contractually tied to the platform owner. The business model for the platform owner is to profit *"from the end users, or if the service system is a multi-sided market, to profit from all participants"* (Smedlund, Ikävalko, & Turkama, 2018, p. 1595).

By providing a set of tangible and intangible resources, digital platforms facilitate the collaboration of actors to bundle their resources and capabilities (Henfridsson, Nandhakumar, Scarbrough, & Panourgias, 2018), thus complementing the basic offering of the platform (Lusch & Nambisan, 2015). The so-called complementors usually have fixed contracts with the platform provider. Their business model is to profit from customizing and maintaining their solution, which extends the core functionalities of the platform. Through running their offers on a platform, they wish to benefit from network externalities resulting in access to new markets, more customers and novel partners. Petrik and Herzwurm (2019) reported a strategy on how healthy ecosystems around IIoT platforms can be fostered. During a first, less mature phase, the platform owner should prioritize developing relationships with infrastructure and software technology providers to extend the platform core. At the same time, the platform owner must focus on establishing partnerships with consultancy firms to support early customers with the adoption. When the solution becomes more mature at a later stage, the platform owner should shift towards onboarding complementary hardware and software companies. The result is a digital platform surrounded by an ecosystem that is highly appealing for complementors. By contributing to downstream value creation, complementors can play an essential role in shaping the platform ecosystem. The integration of IIoT platforms on behalf of hardware suppliers unlocks an evolutionary development of digital services like demand-oriented supply, monitoring of production, servitization, and eventually, provision of an industry platform (Petrik, Straub, & Herzwurm, 2020). Within open IIoT platforms, the role of complementors is exercised by software companies, who contribute by developing software solutions for other industrial companies and Original

Equipment Manufacturers (OEMs), who leverage the platform to deploy service solutions for customers of their own machines.

The above paragraphs show that the limited available literature on IIoT ecosystems has primarily focused on a platform owner-centric view, while not much attention has been given to platform end-users and their preferences for one digital platform as opposed to another. Although the functionality provided by IIoT platforms is similar (Lucero, Builta, Morelli, Byrne, & Song, 2016), the technology stack they rely on, and their implementation can differ substantially. Despite the apparent value of IIoT, industrial companies struggle to identify which IIoT platform better suits their requirements, and currently, no platform leader exists on the market (Petrik & Herzwurm, 2018). This struggle is shared by both industrial-end users, companies that consume the platform resources for powering their IIoT use cases, and OEMs, who act as complementors and offer IIoT solutions to their customers through the platform. Hejazi et al. (2018) suggested that the choice of an IIoT platform solution should be informed by factors such as the stability and scalability of the solution and its pricing scheme. Pelino and Miller (2019) suggested that IIoT platform customers should look for providers that satisfy different requirements. For one, an ideal IIoT platform provider should offer both edge and cloud as deployment models. They report that both OEMs and industrial end customers recognize that IoT solutions will most likely be hybrid between edge and cloud. Also, IIoT platform solutions must not limit themselves to enable the onboarding and management of fleets of devices. They should, go beyond that to facilitate connecting the customers' IIoT workflow to relevant processes in their businesses. This means offering applications out-of-the-box accelerating time to value, easing integrations with third-party applications and allowing data to flow from the platform to other environments where it can be combined and drive decision-making processes. Furthermore, IIoT platforms should ease carrying out analysis and generating actionable insights. The reason being, that transforming IIoT to actions and processes requires expertise and tools that many business analysts still lack (Pelino & Miller, 2019).

In conclusion, part of the research on digital platforms has increasingly focused on their ecosystem implications (Gawer & Cusumano, 2002; Gawer, 2009; Tiwana, Konsynski, & Bush, 2010). Platform-driven ecosystems consist of communities of companies cooperating and competing on a common set of assets provided by a platform owner (Mazhelis, Luoma, & Warma, 2012). Value creation in platform-driven ecosystems through complementors is fundamentally different from traditional value creation purely within the focal firm (Parker, Van Alstyne, & Choudary, 2016). Scholarly efforts have neglected the perspective of actors from these communities, since extant literature mainly addressed design and governance issues of companies that seek to provide a digital platform (Smedlund, Ikävalko, & Turkama, 2018; Pelino & Miller, 2019; Petrik & Herzwurm, 2019). The need to concentrate more research efforts to provide theoretical business references to other stakeholders was highlighted by multiple contributions (Lucero, Builta, Morelli, Byrne, & Song, 2016; Hejazi, Rajab, Cinkler, & Lengyel, 2018; Pelino & Miller, 2019), though it had so far remained unheard.

2.4 Lessons from the IIoT and IIoT Platforms Literature

Different areas have been studied and discussed when it comes to the IIoT. Initially, various scholars focused on defining the term, clarifying its benefits (Ehret & Wirtz, 2016; Suppatvech, Godsell, & Day, 2019) and challenges (Li & Johnson, 2002; Fichman, Keil, & Tiwana, 2005; Lee & Lee, 2015). As the implications of the IIoT on companies' business models became clearer, industrial companies progressively looked into implementing IIoT use cases to reduce costs and augment value propositions (Li & Johnson, 2002; Fichman, Keil, & Tiwana, 2005; Lee & Lee, 2015; Seetharaman, Patwa, Saravanan, & Sharma, 2019; Suppatvech, Godsell, & Day, 2019). Most of the issues and question marks connected to the IIoT found an answer in digital platforms. IIoT platforms are digital assets that handle the virtualization, combination, and application layers of the IoT stack (Floris & Atzori, 2016). More in detail, these assets carry the technological burden of ensuring up-to-date multiprotocol support. They simplify the onboarding of physical devices, and they provide user interfaces to manage asset monitoring, setting up notifications and business automations (Ehret & Wirtz, 2016; Lucero, Builta, Morelli, Byrne, & Song, 2016; Hejazi, Rajab, Cinkler, & Lengyel, 2018; Petrik & Herzwurm, 2018). IIoT platforms are governed by a platform owner, who, by acting on the spectrum between openness and control, allows for different degrees of participation and innovation to take place (Gawer & Cusumano, 2002; Baldwin & Woodard, 2009; Tiwana, Konsynski, & Bush, 2010). A substantial degree of uncertainty for those companies that are only just looking into implementing and benefitting from the IIoT comes from how they should approach such a decision (Petrik & Herzwurm, 2018). Literature, so far, has only provided technical arguments on what IIoT platforms should offer (Lucero, Builta, Morelli, Byrne, & Song, 2016; Hejazi, Rajab, Cinkler, & Lengyel, 2018; Pelino & Miller, 2019). What remains unclear, under a business point of view, is what factors influence industrial companies in approaching the implementation of an IIoT platform. Important insights could be gathered from the experience of early adopters, thus providing implications for both scholars and practitioners. What drives industrial firms in sourcing IIoT platforms through markets, as opposed to developing them internally? What role do platform-driven ecosystems play in this context? Scholars have stressed the need for a deeper understanding of the dynamics, strategies and associated organizations in platform-driven ecosystems (de Reuver, Sørensen, & Basole, 2018), since ecosystem thinking is becoming highly important for decision makers in interconnected business contexts (Basole, 2014). While surely providing a good understanding of the IIoT and why it matters, existing research, has so far failed to propose theoretical, and actionable, strategic contributions in this regard. The presented work of research is the first answer to the identified gap. In particular, the objective is to answer the following research question:

> *“What are the strategic factors, and how do they influence making or buying a digital platform in the Industrial Internet of Things?”*

3 Theoretical Framework

As presented throughout Chapter 2, the IIoT has a substantial impact on businesses and their business models regarding associated benefits and challenges. Industrial companies rely on digital platforms as the foundation upon which they develop IIoT use cases. In practice, IIoT platforms are either developed by the industrial firm or sourced from the market. In other words, the strategic choice of developing or sourcing an IIoT platform entails a decision-making process to in-source, i.e., carry out an economic activity internally in an organization, or to out-source, i.e., rely on markets (Williamson, 1973). The dilemma of sourcing is also known as make versus buy decisions, a strategic issue which several research efforts have addressed. Established theory addressing this issue was gathered and reviewed through the process described in Chapter 2, anchored around the search queries illustrated in Table 2 (see p. 8).

Table 4. *Search queries run on classical theories.*

	Search Query	
TCT	*AND*	Make or Buy decisions
TCT	*AND*	Vertical Integration
TCT	*AND*	Sourcing decisions
RBV	*AND*	Make or Buy decisions
RBV	*AND*	Vertical Integration
RBV	*AND*	Sourcing decisions

The review exposed how some contributions have attempted to explain how make or buy decisions are taken by organizations relying on transaction cost theory (TCT), also referred to as transaction cost economics (TCE). A different stream of research has approached the study of vertical integration taking a resource-based view (RBV) stance. More recently, several contributions have proposed a more comprehensive approach to this strategic issue with mixed results. Once identified the theories of interest, the researchers gathered and reviewed a body of works featuring them in the light of similar researched issues (see Table 4).

As much as previous works addressed the same strategic issue at the core of this paper, those theories developed in the context of physical, and not digital, assets. This difference is substantial since digital assets such as IIoT platforms carry distinct characteristics like the ignition of an ecosystem of companies around them (Petrik & Herzwurm, 2019; Pelino & Miller, 2019). Therefore, to capture the strategic implications of digital platforms, the more classical theories were supported with more recent literature around platform ecosystem. Therefore, the theoretical framework entails not only transaction cost theory and resource-based view, but also the theoretical contributions coming from the platform ecosystem literature. The following sections review contributions underneath each research stream, concluding with the formulation of the comprehensive conceptual model developed by the researchers in Section 3.5.

3.1 Transaction Cost Theory

Under the assumption that markets are coordinated through a price mechanism, Coase (1937) advanced an explanation for why some economic activity is organized within firms, as opposed to markets. The reason to organize activities internally is due to the organization of market production being subject to price discovery costs, bargaining costs and other types of costs. This view was subsequently built upon by Williamson (1979), who predicted why some transactions would be organized within firms rather than in markets, thus formalizing transaction cost economics. Both Coase and Williamson saw firms and markets as *"alternate means of coordination, the firm being characterized by coordination through authority relations and the market being characterized* *by coordination through the price mechanism"* (Madhok, 2002, p. 536). TCT, therefore, holds that the objective of organizations is to maximize efficiency by minimizing transaction costs. According to the theory, transactions can be described through three main dimensions: uncertainty, the frequency with which they recur and the degree to which durable transaction-specific investments are incurred (Williamson, 1979). Each dimension is thoroughly reviewed following this introductory section.

In general, TCT has demonstrated to provide a solid support for studying vertical integration, or make-or-buy decisions, within organizations by a series of works (Monteverde & Teece, 1982; Anderson, 1985). Drawing on Williamson's (1981) model of efficient boundaries, Walker and Weber (1984) empirically proven that transaction costs are a significant predictor for make-or-buy decisions. However, comparative production costs also present a strong predictive power. The latter, however, requires firms to accurately estimate the cost of producing or developing a complex product, or service, so that they can compare it with market alternatives, which is not an obvious task. Williamson (1985) later asserted that vertical integration would be a strategy for organizations to protect themselves against supplier opportunism. Later contributions to TCT suggested that a higher innovation pace in technology pushes firms to outsource (Poppo & Zenger, 1998) while increasing levels of asset specificity lead to the diminishing effectiveness of market governance (Poppo & Zenger, 1998; Lonsdale, 2001; Madhok, 2002). The latter also applies in the context of information technology assets (Thouin, Hoffman, & Ford, 2009). Furthermore, the firms usually account for the cost monitoring market performance itself, which can be substantial (Ngwenyama & Bryson, 1999). To make sense of the various contributions to vertical integration based on TCT, the researchers approached a review of findings on a concept-by-concept basis. Following this brief introduction to TCT, the paper moves on to assessing scholarly discussions around asset specificity (3.1.1), frequency (3.1.2), and finally, uncertainty (3.1.3).

3.1.1 Asset Specificity

By asset specificity, Williamson (1979, p. 234) intended the *"transaction-specific investments in human and physical capital"* required when transacting an asset. Nonspecific transactions are susceptible to being standardized, and their preferred governance is through markets. On the contrary, highly idiosyncratic transactions challenge the realization of standardized contracting, rendering market governance hazardous (Williamson, 1979, p. 234). In transactional contexts characterized by a high degree of specificity, therefore, firms internalize the economic activity. The underlying idea is that internal governance costs can be recovered if the transaction itself is recurrent. Choosing the right governance structure to the level of asset specificity is extremely important since a mistake can lead to substantial negative consequences for the firm and ultimately to business failure (Walker & Weber, 1984). Riordan and Williamson (1985) researched the impact of asset specificity on minimizing transaction costs and found that asset specificity was the most critical attribute to describe transactions. Companies with low asset specificity find the best option to source from the market, while internal organization should be chosen with high asset specificity. Lieberman (1991) confirmed the findings and added that firms are also more likely to integrate an activity internally to avoid bargaining problems with suppliers. Increasing levels of asset specificity were found to diminish the effectiveness of market governance by a series of authors (Poppo & Zenger, 1998; Lonsdale, 2001; Madhok, 2002). These empirical findings were later extended to information technology assets (Thouin, Hoffman, & Ford, 2009). IT assets that are perceived as a commodity are outsourced to the market because they imply minimal transaction costs.

As much as extant literature highlighted a clear relationship between the specificity of an asset and its transactional governance, asset specificity is linked to the two other dimensions that characterize a transaction. Researchers have found that high asset specificity leads to insourcing decisions in contexts of high uncertainty (Coles & Hesterly, 1998; Poppo & Zenger, 1998). Similarly, vertically integrating the production of a highly specific asset is preferred by firms for repeated transactions (Williamson, 1979), even in information technology contexts (Thouin, Hoffman, & Ford, 2009). Implications of both frequency and uncertainty are addressed in the coming pages.

3.1.2 Frequency

When Williamson (1979) conceived TCT, he argued that a fundamental attribute of transactions is the *frequency* with which they recur between the seller and buyer. Transactions can be executed in isolation, periodically, or on a more recurrent basis. The cost of insourcing an economic activity, according to TCT, is easier to recover for substantial and recurring transactions. If the frequency is low instead, firms are incentivized to leave the activity to the market, where it can be aggregated to serve demands of similar but independent transactions. Although the literature has investigated asset specificity and uncertainty rather exhaustively, the focus has not been placed on frequency just as much. Williamson himself contributed to dismissing the importance of frequency in a later work by suppressing a discussion around it in favor of asset specificity and uncertainty (Williamson, 1981). Stucky and White (1993) wrote that high transaction frequency, together with high asset specificity, promote vertical integration since frequent transactions raise costs due to repeating negotiations and allow for regular exploitation. Differently, the effects of increased frequency would be mitigated by low degrees of asset specificity because negotiations are not as complex and can therefore be standardized. Within relational contracts, where specific parties enter similar transactions over time, frequency has been argued to negatively correlate with insourcing. The reason is found in the strong incentive to maintain a good reputation; the more transactions two firms enter together, which mitigates opportunistic behavior (Baker, Gibbons, & Murphy, 2002). This contrasts with TCT, where increases in the transaction frequency result in a higher likelihood of insourcing.

Mostly, confusion has arisen from the use of frequency, by some authors, in identifying *uncertainties*. For instance, Walker and Weber (1984) only discussed frequency in defining technological uncertainty, whilst they made no mention of it as a stand-alone attribute of transactions. Makhlouf (2020), in researching the reliability of TCT within the cloud context, defined frequency as to how often cloud services are utilized, a definition that shares very little in common with how Williamson originally intended the concept. In that context, frequency no longer describes a property of a transaction for the acquisition of an asset, but a property of the usage of that asset, independent of the transaction itself. Makhlouf's finding consists of cloud services having high transaction frequency, which would compensate investments encouraged by uncertainty and asset specificity, however, there is no clarity on how these conclusions were reached.

What emerges is that frequency is a complicated unit of analysis in studying how transactions are organized, be it through markets or internal hierarchies. A possible explanation for this resides in the servitization of physical assets. When Williamson initiated the discussion around transaction costs, firms were mainly transacting physical assets, such as machines and other equipment. The advent of the internet has enabled the commercialization of digital tools, which are not physically consumed, and are nowadays mostly served via subscription models (Porter & Heppelmann, 2015). One single asset, a digital asset, is the object of the transaction, and scaling operations does not require the negotiation of additional units. In sourcing digital assets, firms negotiate once and pay for actual usage on a recurring basis. The servitization perspective possibly explains Makhlouf's attempt to reinterpret frequency in the age of SaaS. However, introducing asset utilization frequency poses a logical challenge, since on its own, it can hardly explain preferences towards markets or hierarchies. A better-suited approach would be to understand the importance of utilizing that asset for the firm. This angle, however, does not fall within the dichotomy of make versus buy decisions that ore object of the conducted research, but it describes whether companies are interested in a digital asset or not, which is outside the scope of this work.

3.1.3 Uncertainty

Hayek (1945) maintained that it is *change* that causes the rise of economic problems and that society constantly battles the issue of maximizing the *"utilization of knowledge which is not given to anyone in its totality"* (Hayek, 1945, p. 519). Therefore, society faces the central economic challenge of adapting to ever-evolving circumstances. *Uncertainty* has long been a central component of various theories of organization and strategy without any differentiation among its various forms (Sutcliffe & Zaheer, 1998). Koopmans (1957) first advanced separate definitions for *primary* and *secondary* uncertainty. The former reflects a lack of knowledge about states of nature, discoveries, and changes in preferences, while the latter reflects a lack of knowledge about the actions of other economic actors, in how it is not possible to find out about concurrent plans and decisions made by others. Notably, the articulation of secondary uncertainty in Koopmans' work lacked any form of strategic characterization. Therefore, in classifying Koopmans' primary and secondary uncertainty types as innocent, Williamson introduced a third form, *behavioral*, to identify a specific form of uncertainty arising from *"strategic nondisclosure, disguise, or-distortion of information"* (Williamson, 1985, p. 57). Contrary to Koopman's uncertainty types, behavioral uncertainty does not merely involve a lack of information but the conscious supply of misleading information. Sutcliffe and Zaheer (1998) observed that primary uncertainty appears to encompass technological uncertainty, which can be described as the degree of uncertainty originating from technological innovations, inventions, and discoveries. Interestingly, Sutcliffe and Zaheer empirically found that different sources of uncertainty (i.e., primary and secondary) affect vertical integration decisions independently of each other. This result suggests that uncertainty must not be studied as a unique concept but by addressing its different types.

In general, a high degree of uncertainty tends to raise monitoring costs, thus leading to insourcing decisions (Williamson, 1979; Poppo & Zenger, 1998; Madhok, 2002; Makhlouf, 2020). Moreover, Williamson (1985) refined his uncertainty argument (1979) by advancing *behavioral* uncertainty as to the main driver for vertical integration. Subsequently, John and Weitz' (1988) research highlighted how, under high supplier behavioral uncertainty, vertical integration is more likely. Both findings were later confirmed by Sutcliffe and Zaheer (1998). On an interesting note, Sutcliffe and Zaheer's analysis also suggested that high uncertainty of competitors' behavior does not positively correlate with vertical integration, possibly because firms prefer to limit the insourcing scope in the presence of scarce information regarding competitors' strategies (Sutcliffe & Zaheer, 1998). Concerning *technological uncertainty*, various authors reported that increasing degrees of this type of unknown decrease the likelihood of vertical integration (Balakrishnan & Wernerfelt, 1986; Heide & John, 1990; Sutcliffe & Zaheer, 1998). Walker and Weber (1984; 1987) noted that it is not technological, but market uncertainty determining the make or buy decision. Although suggestive, this finding must be contextualized within the trading of a simple technological asset (Walker & Weber, 1987) and should not be generalized a priori in scenarios featuring more complex assets like industrial IIoT platforms.

3.2 Resource Based View

Over time, transaction cost theory has been challenged in explaining vertical integration by a stream of research in strategic management that views companies as a bundle of resources. According to the resource-based view

(RBV), a *resource* is defined as anything that could positively or negatively impact the firm of focus, and it may be of tangible or intangible nature (Wernerfelt, 1984). The RBV states that aligning and "*uniquely combining complementary and specialized resources and capabilities (which are heterogeneous within an industry, scarce, durable, not easily traded and difficult to imitate)*" (Amit & Zott, 2001, p. 497) enables firms to pursue strategies that competitors cannot emulate, thus achieving a competitive advantage (Barney, 1991). Furthermore, RBV stresses that economic activities are not conducted within firms because of market failures but due to firms pursuing an organizational advantage in organizing activities that markets cannot realize (Madhok, 2002).

RBV provides an interesting perspective on make or buy decisions. Make decisions consist of the in-housing of activities comprising a set of competences, thus strengthening a firm's core capabilities (Quinn & Hilmer, 1994). As the uniqueness of a resource increases, the internalization of the production activity improves a firm's performance, compared to the outsourcing alternative (Murray, Kotabe, & Wildt, 1995). Since companies often deal with different sets of resources, incumbents in the same industry can follow opposing strategies. In other words, firms organize their activities differently, in line with the resources and capabilities they possess (Madhok, 2002). When the alignment between resources and strategy is lacking, the result may be as disastrous as a business failure (Ngwenyama & Bryson, 1999). In general, among firms featuring different sizes, the larger ones are more likely to vertically integrate an activity (Riordan & Williamson, 1985). In the context of industrial make or buy decisions of high technology assets, Yasuda (2005) argued that RBV is better suited than TCT to explain outsourcing. The reason would be that the main motivations behind outsourcing can be classified under either access to the partner's resources, thus shortening the time to market (or production) reducing costs. Yasuda suggested that since the criticality of time coincides with resources, RBV yields better explanatory power than TCT in explaining outsourcing. However, it shall be noted, that Yasuda's work explored outsourcing in the form of strategic alliances in the semiconductor industry. It is unclear whether Yasuda's conclusion holds in the context of specific digital assets (e.g. digital platforms) traded across different industries.

In concluding this brief introduction to RBV, the takeaway is that the theory is concerned with the internal states of firms (Wernerfelt, 1984), contrary to TCT, which addresses exchanges between firms. According to RBV, every firm is characterized by a more or less unique combination of tangible and intangible resources, which influence the strategy they follow for make or buy decisions (Madhok, 2002). Arguably, the most popular contribution to RBV was provided by Barney (1991), who contextualized Porter's competitive advantage under the light of owning rare, valuable and inimitable resources. Barney suggested that firms should strive to control resources that grant a long term, sustainable, competitive advantage. The consequence of this proposition is that companies are expected to delegate production or development to the markets for resources where ownership does not guarantee an edge over the competition. The following subsections review the basics of the two fundamental constructs associated with RBV: resources and competitive advantage.

3.2.1 Resources

As previously stated, RBV is anchored around the concept of *resources*. The definition of a firm's resource proposed by Wernerfelt (1984) embraces the set of both tangible and intangible assets which are tied semi-permanently to a firm. Tangible resources comprehend machines and plants, while intangible resources include knowledge and skills possessed by employees. Murray, Kotabe and Wildt (1995) found that the more specific resources are required to develop a product or service, the more companies benefit from insourcing the production. Furthermore, companies which are already in possession of particular knowledge and experience are more likely to internalize the production activities (Leiblein & Miller, 2003; Argyres, 1996). On the other hand, when specific knowledge must be acquired to support the internal production of an asset, firms lean towards outsourcing (Argyres, 1996). Furthermore, firms constantly have to balance a finite amount of resources, which are often immobilized into ongoing operational processes (Foss & Foss, 2004). Therefore, companies cannot always opt to inhouse the production of assets (Cánez, Platts, & Probert, 2000). Possession of the right resources should not be confused with possession of any resources. That is to say; firms do not necessarily insource the larger they are, as Benlian and Hess (2009) noted. The decision of the sourcing form is usually informed by the vicinity between the activity and the core of the business (Espino-Rodríguez & Padrón-Robaina, 2006). In terms of strategy, internalization of the production activity increases in likelihood, the more unique the final product is (Murray, Kotabe, & Wildt, 1995). Interestingly, this observation shares a lot of similarities to TCT's concept of asset specificity.

In conclusion, firms constantly deal with the strategic problem of optimal resource allocation. Since firms realistically deal with a finite amount of resources (Foss & Foss, 2004), they strive to own those closer to the core of the business or which grant a competitive advantage (Murray, Kotabe, & Wildt, 1995). The size of a firm is supposedly not a good predictor for make or buy decisions since large firms often feature immobilized resources, which are locked into ongoing processes and cannot be easily repurposed for other activities (Benlian & Hess, 2009). Companies are likely to internalize a production activity if it requires similar knowledge and competencies to those already possessed (Leiblein & Miller, 2003; Argyres, 1996).

3.2.2 Competitive Advantage

Competitive advantage is achieved through a value-creating strategy that is not simultaneously implemented by competitors. It allows a firm to benefit from higher profit margins compared to the competition. Moreover, for the competitive advantage to be sustained over time, competitors must not be easily able to emulate the same strategy (Barney, 1991). A sustainable competitive advantage originates from the possession of key resources, which are:

“(a) […] valuable, in the sense that it exploit opportunities and/or neutralizes threats in a firm’s environment, (b) it must be rare among a firm’s current potential competition, (c) it must be imperfectly imitable, and (d) there cannot be strategically equivalent substitutes for this resource that are valuable but neither rare or imperfectly imitable” (Barney, 1991, pp. 105-106).

Porter (1985) initially argued that two strategies lead to competitive advantage: cost leadership and differentiation strategy. Cost leadership entails that the focal firm can systematically produce at a lower cost that no competitor can match. Therefore, the firming holding the advantage can sell products and services at a lower price point whilst maintaining comparable profit margins. Differentiation strategy achieves an advantage by making the product or service in focus being perceived as unique by customers, and therefore appear superior to competing offerings. Business researchers have argued, however, that competitive advantage does not only arise from the internal states of firms. In fact, companies may benefit from a competitive advantage arising from specific formations of their network of suppliers (Hines & Rich, 1998). The idea is that the unique combination of external and internal resources may provide additional value to the operations of a firm, and competitors would have to establish a comparable supply chain to match it (Corbett, 2004). Welch and Nayak (1992) argued that, for technologies that provide significant competitive advantage, and are not readily available through markets, the more desirable decision is to internalize development of that technology, thus preventing the competition from benefiting from it as well.

The notion of competitive advantage brings an important focus to long term strategy to RBV, which is missing in TCT (Riordan & Williamson, 1985). Competitive advantage is a core construct of RBV (Barney, 1991). It synthesizes the ability of a firm, as a unique bundle of resources, to systematically outperform competition. Past contributions to make or buy decisions, addressing the pursue of competitive advantage, suggest that insourcing is chosen when the underlying asset cannot be easily procured via the market. Therefore, a sustainable competitive advantage can arise (Welch & Nayak, 1992).

3.3 Blended Theoretical Approaches

The theories discussed above, TCT and RBV, originated from two different perspectives. The former focuses on the degree of costs associated with a transaction, while the latter addresses the issue of combining resources during production processes. Both have found support in scholarly investigations of make or buy decisions. More ambitious research, however, has proposed a broader approach, encompassing both TCT and RBV. For instance, Walker and Weber (1984) found that both production and transaction costs matter in the make-or-buy decision, although production costs overshadow transaction costs. Silverman (1999) noted that firms prioritize their diversification efforts based on both the possessed resource base and the intensity of hazards surrounding contractual alternatives to diversification.

Furthermore, Benlian and Hess (2009) argued that, if the objective is to obtain a better explanation of how and why digital assets are transacted, classical economic (TCT) and strategic (RBV) theories must be complemented with behavioral theories, such as the theory of planned behavior (Ajzen, 1991). While some authors such as Silverman suggest that TCT and RBV have conflicts, no justification or explanation was given on how the two theories conflict. Silverman also integrated the two theories in his study and pointed out their complementarities. He argued that RBV could be improved by measuring resources at a more refined level through elements of TCT (Silverman, 1999). Yasuda (2005) tried to compare the distinct predictive power of the two classic theories in a study about strategic alliances. His results suggested that whilst TCT is not to be dismissed, RBV performs better in explaining vertical integration. The fact that a convincing strategic theory of the firm cannot be limited to either TCT or RBV was highlighted by several other contributions. Williamson himself stated that RBV and TCT are simultaneously rivals and complementary with one another since they have relevant but different units of analysis in addressing the organizations of firms (Williamson, 1999). It has been noted that TCT completely neglects the importance of competitive advantage (Madhok, 2002), and it would be sensibly complemented by RBV's focus on competencies and knowledge. On a similar note, Holcomb and Hitt (2007) augmented transaction-based arguments with resource-based perspectives by linking value chain activities with markets to gain access to valuable resources.

These contributions imply that a composite theoretical approach to make or buy decisions must neither neglect the issue of production, addressed by RBV nor the issue of transactions, at the core of TCT. Still, both theories fail to account for the specific characteristics of digital platforms. As seen in 2.3, previous works highlighted the importance of the business ecosystem that industrial digital platforms foster. Conducting a study on make or buy decisions on IIoT platforms would be substantially undermined by a failure to account for that dimension. Hence, the following section departs from more classic theories and thoroughly explores the body of works centered around platform ecosystems.

3.4 Platform Ecosystem Literature

This paper now moves away from the most influential organizational frameworks and investigates the nature of the transacted asset. The underlying idea is that other than the internal state of the firm (RBV) and the external environment (TCT), the procurement form of a digital asset may be affected by the dynamics characterizing the digital asset itself. As reviewed in sections 2.2 and 2.3, industrial digital platforms facilitate the interconnectedness and joint value creation of a multitude of businesses (Parker, Van Alstyne, & Choudary, 2016). The term business ecosystem was first acknowledged by Moore (1993), who introduced the *business ecosystem* as an analogy to biological ecosystems, describing the loose interconnections between different species. Moore developed this analogy to create a strategic framework that would enable managers to understand the logics and structures of the modern type of business communities. The underlying idea of the business ecosystem is that joint value offerings of multiple firms create more value for the end-customer as one company could create on its own (Moore, 1993). The trend that Moore observed was fueled by the emergence of high-technology industries, which require a new form of leadership perspective towards customers and suppliers, where *"companies coevolve capabilities around a new innovation"* (Moore, 1993, p. 76).

Even though the term business ecosystem has received wide acceptance and resonance from the research community, the analogy to biological ecosystems has also faced criticism. Moore's claim that competition only exists among ecosystems and no longer among firms does not really align well with the biological analogy. Ecosystems in nature do not necessarily compete; neither do they have a central body of control which a business ecosystem usually presents (Koenig, 2013). Second, different business ecosystems may compete to win members of rival ecosystems, while this is not the case in nature. Third, the goal of business ecosystems is to thrive through increased profitability and innovation, while ecosystems in nature prosper in conditions of equilibrium (Peltoniemi, 2006).

Iansiti and Levien (2004) built on top of Moore's biological analogy and presented a framework for practitioners, highlighting the different roles and few strategies companies can pursue within ecosystems. In line with Moore, they argued that, as a whole, business ecosystems are characterized by a set of many interconnected and interdependent companies and their ability to co-create innovations. Companies within ecosystems, therefore, often share a common fate, being strongly coupled to the success of the entire ecosystem (Iansiti & Levien, 2004). Despite their proposition being accepted by both practitioners and researchers, their framework lacks theoretical foundation.

This deficiency has been addressed by several researchers in an attempt to advance the stream of research, though without major breakthroughs. Adner (2006) described ecosystems as innovative structures with "*collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution"* (Adner, 2006, p. 2). This observation opposes the traditional view of inter-organizational relationships. Within the conventional supply chain, a company creates value by purchasing commodities or components and transforming them into final products (Eisenmann, Parker, & Van Alstyne, 2006). In this context, a single company stands before the end-customer, which has no contact with the rest of the supply chain (Lambert & Cooper, 2000). Instead, a business ecosystem structure allows complementors to deliver complementary innovations directly to the end-customers (Adner & Kapoor, 2010; Gawer & Cusumano, 2014). In short, while the supplier enables the production of a product or service, the complementor enables its use (Adner & Kapoor, 2010).

The ecosystems' structure also stands in contrast to the collaborative organizational structure of strategic alliances (Jacobides, Cennamo, & Gawer, 2018). Strategic alliances are characterized by a direct contractual partnership of two or more independent firms for the joint accomplishment of individual goals (Parkhe, 1993). Due to arising uncertainties regarding the individual goals of companies participating in an alliance, a lot of emphasis lies on the structuring of costly and binding contractual agreements. More loosely connected ecosystems, in turn, provide companies with the ability to rely on a global network of partners they might not even have met otherwise (Parker, Van Alstyne, & Jiang, 2016). In the entirely self-contained system, mutual value is created through service exchange facilitated by a common institution. Service ecosystems, therefore, must fulfill a series of requirements. A common vision among the various participating actors needs to be established, ensuring structural flexibility and integrity of the ecosystem (Jacobides, Cennamo, & Gawer, 2018). Additionally, an architecture for the coordination between actors and their service exchanges needs to be implemented to minimize exchange friction (Lusch & Nambisan, 2015).

As described by Moore (1996), the basis for innovations within an ecosystem is to be found in the common set of resources with which actors can interplay. Since digital platforms serve precisely the purpose of making available a common toolset to its users, a broad spectrum of ecosystem literature has been developed around digital platforms. In substance, digital platforms are viewed as the central hub of innovation upon which the business ecosystem evolves (Gawer & Cusumano, 2002; Ceccagnoli, Forman, Huang, & Wu, 2012). As described in Section 2.2, a digital platform consists of a layered architecture of digital resources combined with a governance model (Yoo, Henfridsson, & Lyytinen, 2010; Tiwana, Platform ecosystems: Aligning architecture, governance, and strategy, 2014; Parker, Van Alstyne, & Jiang, 2016). The platform ecosystem literature has identified different digital platforms with different configurations due to their different use case objective. Product platforms are firm-proprietary platforms with no third-party involvement and consequently, no evolving ecosystem. External or industry platforms are open for third-party contributions and allow different ecosystem architectures (Eisenmann, Parker, & Van Alstyne, 2009; Gawer & Cusumano, 2014). An industry platform is, therefore not under full control of the focal company even if it is proprietary (Gawer, 2009). Gawer and Cusumano (2014) identified different degrees of openness of external platforms such as supply platforms (many-to-one), demand platforms (one-to-many) and industry platforms (many-to-many) with different relationships among suppliers, competitors and complementors. Moreover, the platform ecosystem literature stream has recognized different roles and accompanying strategies for open platform ecosystem participation. Demand-side platform users are commonly referred to as *end-users.* Supply-side actors who provide complementary offerings to the end-users are called *complementors*. The platform facilitator that mediates the ecosystem is often referred to as the *platform owner* (Eisenmann, Parker, & Van Alstyne, 2009; Brandenburger & Nalebuff, 1996). Iansiti and Levien (2004) offered a different perspective by introducing the terms *keystone*, *niche player* and *value dominator,* building upon Moore's biological analogy. Keystones, or platform owners, occupy a central hub in the ecosystem and are the facilitators of a platform-mediated network. Niche players, equivalent to complementors, bring value to the ecosystem using specialized capabilities from their verticals. Value dominators are keystones that exploit their central position in the ecosystem and simultaneously compete with the verticals on the platform, which puts the rents of complementors at risk (Iansiti & Levien, 2004).

Information systems researchers have contributed to the literature stream with various strategic considerations for platform owners and complementors. Following this introductory section, both theoretical perspectives are reviewed.

3.4.1 Platform Owners

Several considerations have to be made by corporations that want to become platform leaders (Gawer & Cusumano, 2015). According to Huang et al. (2009), market leaders usually follow an open platform approach where third parties can join (Gawer & Cusumano, 2014). An open platform approach allows platform owners to tap into the value created by externals' innovations. Also, as the central player, they take advantage of indirect network effects that arise from complementary products or services (Rochet & Tirole, 2003; Katz & Shapiro, 1994).

Before evaluating whether a product or service is viable for a platform strategy, companies need to understand the industry dynamics within their market, as not all markets are subject to "winner-takes-all" dynamics. In these markets, a few products or services that are only slightly better than their competing offerings generate a disproportionate amount of revenue share among that product or service category (Roger, 2007). Even in winner-takes-all markets, more than one platform leader may exist. Other than assessing the market characteristics, firms must reflect on whether the underlying product or service can indeed be served as a platform. The product-platform fit should be assessed by verifying that the product can solve a technological problem faced by an industry. Further, the product should be able to easily connect to other systems, or facilitate the development of higher-level services, enabling even unanticipated use cases (Gawer & Cusumano, 2015). To become a leader, a platform must find the critical balance between facilitating value creation and capture (i.e. making profits) for itself and for complementing players. The platform leader must carry out activities targeted at establishing the right economic incentives to lure participants into its ecosystem and foster innovation and development of complementary products and services by those third parties (Gawer & Cusumano, 2015).

To facilitate easy adoption of the platform by complementors, platform owners face the challenge of remaining in control of the platform while transferring design capabilities to these third parties (Ghazawneh & Henfridsson, 2010). One way of allowing a partial knowledge transfer while remaining in a certain structure is through boundary resources. Ghazawneh & Henfridsson (2013) defined boundary resources as *"the software tools and regulations that serve as the interface for the arm's-length relationship between the platform owner and the application developer"* (Ghazawneh & Henfridsson, 2013, p. 176). The arm's-length relationship hereby refers to the remaining control over the platform by the platform owner. Boundary resources for digital platform ecosystems typically consist of technical developer tools such as software development kits (SDK's) and application programming interfaces (API's). The enabling of complementary innovation through boundary resources highlights the importance for the platform owner not to retain full control over the entire platform, but rather limit it to the key interfaces and components (Thomas, Autio, & Gann, 2014).

In summary, aspiring platform owners need to carefully evaluate whether they are well-positioned to pursue a platform strategy (Gawer & Cusumano, 2015). Platform owners need to balance openness towards complementary contributions while constantly assuring to remain in control over critical components (Ghazawneh & Henfridsson, 2010; Thomas, Autio, & Gann, 2014). Furthermore, aspiring platform owners need to ensure that the ecosystem provides opportunities to all ecosystem members (Iansiti & Levien, 2004). Prior to the decision of becoming a platform owner, the market has to be assessed, as well as the focal firm's market strength and appeal in relation to it (Gawer & Cusumano, 2015). Platform owners also seek to benefit from direct or indirect network effects, which often only materialize for the largest, and therefore very few, competing ecosystems (Rochet & Tirole, 2003).

3.4.2 Complementors

Digital platform research has frequently taken the perspective of the platform owner instead of the complementor. Thus, the existing literature on complementor strategies in platform ecosystems is still infancy (Petrik, Straub, & Herzwurm, 2020). Past contributions to ecosystems literature suggested that complementors can exploit multiple levels of leverage (Huang, Ceccagnoli, Forman, & Wu, 2009; Thomas, Autio, & Gann, 2014). For example, the so-called production leverage is realized by using and combining the already available digital assets, interfaces and standards to drive economies of scale and scope (Iansiti & Levien, 2004). Moreover, innovation leverage derives from the immediate possibility to innovate on top of the available assets, interfaces and standards (Gawer & Henderson, 2007). Finally, complementors benefit from transaction leverage in terms of market access, high transaction efficiency between their activities on the platform in relation to the other ecosystem members' (Rochet & Tirole, 2003; Eisenmann, Parker, & Van Alstyne, 2009).

Huang et al. (2009) argued that companies are incentivized to take the role of the complementor because of two main reasons. First, they can combine their activities with complementary resources and services, thus achieving a richer end product. Second, they can gain access to the platform owners installed customer base and therefore unlock larger revenue streams. Platform-driven ecosystems can also yield risks for complementors, originating from being challenged for downstream markets by the platform owner. When this risk is high, companies are less inclined to enter platform ecosystems. The best defense mechanism for complementors is to protect their IPR and expertise in the vertical they compete, to maintain an edge over the unspecialized platform owner (Huang, Ceccagnoli, Forman, & Wu, 2009). This observation aligns with the known tensions between complementors and platform owners, which arise due to the risk of a complementor's niche being invaded by the platform owner (Gawer & Henderson, 2007).

In conclusion, companies that are intrigued by the idea to become platform owners must first assess their position in their vertical and whether their product or service is suited to be made into a platform (Gawer & Cusumano, 2014). Platforms can consist of closed product platforms, which do not permit the emergence of an ecosystem, or open industry platforms, which aim at fostering innovation through a rich network of third-party actors (Gawer & Cusumano, 2015). The platform-driven ecosystem only thrives if the platform owner strikes the right balance in how captured value is distributed between itself and the complementors compared to rival ecosystems (Thomas, Autio, & Gann, 2014). Companies are inclined to participate in an ecosystem because of two main reasons: tapping into the resources provided by the platform owner to produce enhanced services and exploiting the customer base reachable through the digital platform to increase revenues, possibly entering adjacent markets (Rochet & Tirole, 2003; Gawer & Henderson, 2007; Eisenmann, Parker, & Van Alstyne, 2009).

3.5 Conceptual Model

Extant literature, reviewed in Chapter 3, mainly approached make or buy decisions either from a transaction cost perspective or a resource-based view stance. Blended approaches were rare and presented ambiguous outcomes. Therefore, it was essential for the advancement of research, to take a clear step forward in the synthesis of those two theories through an empirical study, as no previous study had attempted to do so. At the same time, research on the procurement of industrial digital platforms could not dismiss the impact of ecosystems, which represent a powerful lens to look at the modern relationships between organizations (Iansiti & Levien, 2004), especially in the contexts of digital platforms (Gawer & Cusumano, 2002).

> *"It seems to me that we cannot construct an adequate theory of industrial organization and in particular to answer our question about the division of labor between firm and market unless the elements of organization, knowledge, experience, and skill are brought back to the foreground of our vision." (Richardson, 1972, p. 888)*

This section, therefore, builds the conceptual model at the core of this study. The two most influential theories of organization, transaction cost theory and resource-based view, are complemented with the perspective of literature on platform-driven ecosystems.

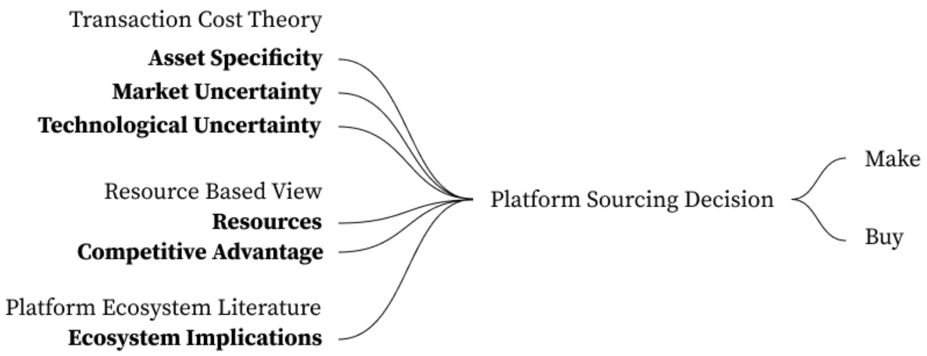

Figure 3. *Conceptual model embedding literature streams of interest.*

Williamson (1979), assuming decisions are taken in a context of bounded rationality and opportunism, identified in *uncertainty*, *frequency* and *asset specificity* the critical dimensions for describing transactions. Two constructs were inherited from transaction cost theory. Both *uncertainty* and *asset specificity* were drawn from TCT, in their original definition, to analyze the data and enable the discussion. To strike the right balance between clarity and depth, and following extant literature (3.1.3), the decision was made to disaggregate *uncertainty* among its economic and technological components (Sutcliffe & Zaheer, 1998). Hence, throughout the analysis, the overall transaction uncertainty was addressed using a combination of *market uncertainty* and *technological uncertainty*. By *market uncertainty*, the authors identified uncertainty arising from arbitrary strategic behaviors adopted by platform suppliers or risks associated with market concentration among the platform suppliers (i.e. supplier uncertainty and competitive uncertainty). Following the same rationale for excluding frequency, *volume uncertainty* was as well disregarded since companies are only interested in one digital platform and do not transact multiple over time. *Technological uncertainty*, instead, included critical technological aspects associated with the IIoT, in accordance with existing literature (Chapter 2), such as evolution of common standards, IT security and solution scalability.

Differently, *asset specificity* was reprised in its original formalization. Williamson (1979, p. 239) explained that an asset is specific in regard to the *"degree to which durable transaction-specific investments are incurred"* in its realization. Williamson (1983) further explained that investments could be deemed as specific either because they were anchored to specific logistic sites or because they required substantial, long-term, expenses in physical or human capital that are non-re-deployable in alternative use cases.

TCT also stressed frequency as a key factor in describing transactions and explaining sourcing decisions. By *frequency*, Williamson (1979; 1981; 1985) intended to convey how often, on a timely basis, two firms would participate in a transaction. Hence, whether the transaction was characterized by occasionality, reoccurrence or isolation. However, *frequency* was a priori disregarded because it was similar across studied cases. The platform asset, in fact, was traded as a service, meaning that buyers would not acquire the asset in its entirety but a license to access it. This feature was shared across all suppliers, the reason for which frequency was not valuable in informing the make or buy decision. This consideration does not imply that the dimension is irrelevant when studying how transactions are organized, just that this particular concept did not serve as a discriminant factor in the context observed in this study.

Consistent with the vast body of works ignited by the resource-based view (Wernerfelt, 1984), fundamental concepts like *resources* and *competitive advantage* (Barney, 1991) were adopted to explain digital asset sourcing decisions. More specifically, it was important to understand which role the *resources* of industrial companies played and the approach of industrial firms in committing those resources to a particular strategy. Both *tangible resources* like liquidity, as well as *intangible resources* (Caves, 1980), such as human knowledge and capabilities were considered in analyzing the data. Furthermore, under a RBV perspective, it was of uttermost importance to understand what platform sourcing decisions meant in terms of *competitive advantage*, defined as the ability of a firm to implement *"a value creating strategy not simultaneously implemented by any current competitor"* (Barney, 1991, p. 102). Strategies that enable firms to dominate a particular industry could be cost leadership or differentiation. The former entails that the focal firm has the lowest production or input cost compared to its competitors and therefore, can offer its products or services for the lowest price that no competitor can match. The latter strategy is based on the substantial differentiation of products and services from competitors to achieve a unique placement in the perceptions of customers, therefore rendering the offering more attractive (Porter, 1980).

Lastly, a study on digital platform sourcing could not ignore the implications at the ecosystem level. As observed by more modern literature streams, digitalization resulted in an explosion in the interconnectedness of organizations and an amplification of opportunities and risks they share (Moore, 1993; Iansiti & Levien, 2004). Given that governed ecosystems arise around a digital platform (Gawer & Cusumano, 2002), it was worth exploring how ex-post ecosystem dynamics affected the ex-ante platform sourcing decision. In line with Parker, Van Alstyne and Jiang (2016), platforms are defined as core resources which ecosystem members can use to create innovations such as digital applications, including products and services. The surrounding ecosystem is defined following Adner (2006) as a governed collaborative structure that allows complementors to deliver complementary, vertical innovations in a coherent solution to the end-customer. Gawer and Cusumano (2014) offered a combined definition for platform ecosystems that defines a platform as a product, service or technology that external innovators, typically arranged in an ecosystem use as a foundation to innovate and develop complementary products, services, or technologies.

Table 5. *Definitions of the strategic factors.*

Concept	*Definition*
Resources	The combination of physical (e.g. liquidity) and human capital (e.g. knowledge and capabilities) required to develop an IoT platform. It encompasses both tangible and intangible resources.
Competitive Advantage	The degree to which ownership of the IoT platform is perceived to grant long-term competitive advantage, whether it is in the form of cost leadership or service differentiation.
Asset Specificity	The degree to which a platform requires custom development to satisfy a firm's requirements, as opposed to the simple configuration of market solutions.
Market Uncertainty	Uncertainty arising from arbitrary strategic behaviours adopted by platform suppliers or risks associated with market concentration among the platform suppliers (i.e. supplier uncertainty and competitive uncertainty).
Technological Uncertainty	The degree of uncertainty that arises from changes in technology or perceived technological risks arising around the IoT platform, such as the evolution of standards, cybersecurity and service scalability.
Ecosystem Implications	The set of inter-business dynamics, opportunities and risks associated with the ecosystem of an open platform, which provides the foundation to innovate and develop complementary products, services, or technologies (Gawer & Cusumano, 2014).

Ecosystem dynamics are meant to capture several considerations pointed out by the ecosystem literature. For example, whether the objective to play a particular ecosystem role (Iansiti & Levien, 2004; Eisenmann, Parker, & Van Alstyne, 2009; Tiwana, Platform ecosystems: Aligning architecture, governance, and strategy, 2014) translated into market sourcing or internalization. And whether firms were sensitive towards governance and incentives mechanisms for joining a particular ecosystem (Rochet & Tirole, 2003; Iansiti & Levien, 2004; Gawer & Henderson, 2007; Huang, Ceccagnoli, Forman, & Wu, 2009; Eisenmann, Parker, & Van Alstyne, 2009; Tiwana, Platform ecosystems: Aligning architecture, governance, and strategy, 2014). These dynamics must be considered by businesses that seek to thrive with technological artifacts such as digital platforms. The introduction of *ecosystem implications* as a relevant concept in researching make or buy decisions represented a novel and sensible attempt to complement TCT and RBV in explaining sourcing strategies of digital platforms. Table 5 provides an overview of the applied definitions in this study regarding the strategic factors derived from the underlying theoretical foundations for the platform asset sourcing decision, namely TCT, RBV and platform ecosystem view.

4 Methodology

This work was driven by an interpretivist philosophy. In this light, organizations were researched from the perspectives of diverse groups of employees representing them, and the complexity of the addressed phenomenon was tackled by collecting what is meaningful to the research participants. Interpretivism yields the axiological assumption that interpretation of the gathered data and information plays a profound role in the research work. Throughout the process, the researchers sought to enter the social environment of the research participants and empathize with the way they see the world. Although highly subjective, interpretivism is an highly sensible approach to take when pursuing business and management research, given the wide complexity and uniqueness of time-dependent interactions that often characterize business contexts (Saunders, Lewis, & Thornhill, 2016). Although possibilities for generalization of the findings of this research exist, this work should not be mistaken for proposing an objective, in the positivist sense, truth. Overall, the process described in the following sections was highly iterative and tightly linked to primary and secondary data. This strategy is well suited for conducting a study in new research areas such as digital platforms and the IIoT. In general, the objective of the work was to induce a novel and empirically valid theory to identify strategic factors and explain how they influence industrial companies in undertaking strategic decisions related to a digital asset. For this reason, the research question was articulated as follows: "*What are the strategic factors, and how do they influence making or buying a digital platform in the Industrial Internet of Things?*"

4.1 Research Approach

The social process by which a scientific researcher proceeds from various grounds to certain claims, in their attempt to convince an audience, is defined as practical reasoning (Toulmin, 2003). Practical reasoning is conventionally approached in two distinct ways: deduction and induction (Ali & Birley, 1999). Deduction consists of analytically deriving conclusions from a set of general premises. Induction, instead, refers to the process of deriving generalization from individual data. Ketokivi and Mantere (2010) suggested a third approach towards practical reasoning, abduction, which combines elements of deduction and induction.

Saunders, Lewis and Thornhill (2016) stated that when a research topic is fostering a lot of debate, and only insufficient literature is available, it may be more appropriate to adopt an inductive approach, thus reflecting on what theories the collected data and subsequent analysis point to. As shown in the literature review, the domain of business ecosystems research is still in its infancy, and it lacks theoretical grounds to justify a deductive study. At the same time, due to time constraints, performing a second round of data collection was out of scope for this study. For the same reason, a thorough abductive approach was not pursued. Nevertheless, the adopted approach still falls within the continuum between induction and deduction. In fact, extant literature played an important role in highlighting potentially relevant constructs and variables, which were considered throughout the outlining of the interviews, their conduction, analysis of the data and discussion. In this sense, the research is in part deductive. However, the above processes were not limited to known variables and theories, thus avoiding predetermined theoretical perspectives to bias, or limit, the findings (Eisenhardt, 1989). Even though, traditionally, works of research have distinguished between deductive and inductive studies based on the presence, or absence, of a theory, a middle-ground stance provides a favorable basis for a researcher to discover issues and dynamics which they did not have in mind when the research process began (Ali & Birley, 1999). The approach of using models composed of constructs, which centers in the continuum between induction and deduction, provides two significant advantages. First, identifying a model before data collection facilitates making sense of the disparate information provided by the various respondents. Furthermore, the researcher is set to analyze the collected data and identify links between variables and constructs. These relationships can be different within the contexts of the respondents and studying them is simplified by having a reference model in the first place. Second, although delimiting the scope of research work, constructs are, by definition, more general than variables, thus leaving open the scope for generating unintended findings. The flexibility between identifying specific constructs with which to work, and the opportunity to formulate new ones, is a strength of the approach adopted in pursuing this work, and it was inspired by Eisenhardt (1989) and Ali and Birley's (1999) argumentations.

4.2 Research Design

Interpretivist studies often leverage qualitative research design (Denzin & Lincoln, 2011). The choice to rely on qualitative methods is further justified by the research approach present in the previous section. Developing a theory in an emerging context, or enriching an existing theoretical perspective from the literature, is a work that requires access to the research context to ensure participation and access to in-depth understanding, which can only be guaranteed by a qualitative type of study (Saunders, Lewis, & Thornhill, 2016). However, the flexibility allowed by a qualitative design should not harm the methodological rigor and should demonstrate the capability to contribute to theory (Bansal & Corley, 2011). The presented work did not leverage a strictly standardized data collection process. A critical factor for the research to succeed was to demonstrate sensitivity in building a rapport with the participants to exploit cognitive access to their information. Data was collected primarily through in-depth and semi-structured interviews. Further elaborations on this topic can be found in section 4.4.

Additional data was gathered through secondary sources, such as other academic works and economic reports, digital resources from participants such as documentation, marketing and business material.

As previously stated in section 1.2, the pursued research question was, after several iterations, defined as follows: "*What are the strategic factors, and how do they influence making or buying a digital platform in the Industrial Internet of Things?*" This formulation anchors the research context to IIoT platforms, although allowing for both an exploration and an explanation of the phenomenon. Exploratory studies are relatively unstructured, making them flexible and adaptable to change. Thus, they rely significantly on the quality of contributions of the participants. Ideally, such contributions help in clarifying the nature of the problem. Instead, an explanatory type of study seeks to explain the relationship between constructs and variables (Saunders, Lewis, & Thornhill, 2016). To answer the above research question, the authors relied on a case study involving various companies playing a stakeholder role in IIoT platforms. A case study represented the best strategy as it sets out to understand the dynamics of the topic being studied, the subject of the case, within its setting or context. Furthermore, case studies can generate insights from in-depth research into a phenomenon in its real-life context, which in turn leads to detailed descriptions and theory generation or extensions (Eisenhardt, 1989; Eisenhardt & Graebner, 2007; Ridder, Hoon, & Baluch, 2012; Yin, 2018). Given the wide range of available IIoT platforms (Petrik & Herzwurm, 2018), as well as the diverse nature of the industries in which stakeholder companies operated, the researchers opted to study multiple embedded cases of interest. The aim was to replicate findings across different cases, also called literal replication (Yin, 2018). Due to time constraints and the general scope of this master thesis, the multiple case study was carried out in a cross-sectional fashion, as insights around IIoT platform ecosystems from participants were gathered at a single point in time.

4.3 Reliability and Validity

Reliability, in research, is defined as the extent to which a measuring procedure yields the same results on repeated attempts (Neuendorf, 2017). The Validity, on the other hand, is the extent to which a measuring procedure represents the intended concept (Saunders, Lewis, & Thornhill, 2016; Neuendorf, 2017).

Threats to reliability can arise from errors and biases on both the participant's side and the researcher's side (Saunders, Lewis, & Thornhill, 2016). In general, the goal of this study was to minimize all types of biases and errors. Interviews with all 25 participants were conducted consistently, following a pre-defined structure, thoroughly illustrated in the following section. Researcher error and bias were addressed by conducting every interview with the presence of at least two out of three researchers. The researchers aimed at ensuring internal reliability for both data collection, analysis and discussion. Data collection was approached in a way to prevent subjective inferences. The interview data was coded with an agreed-upon coding scheme, and later, inter-coder reliability was calculated (see Section 4.5). The analysis and discussions were jointly carried out by the researchers, through independent reflections, reducing subjective interpretations to the definitions of the conceptual model. This diligent exercise, transparently described throughout Chapter 4 and 5, was stressed to ensure internal validity. Lastly, in the limits of the adopted research design and approach, the researchers took adequate actions to ensure the external validity of the pursued study. The researchers selected a representative sample of companies across all platform-related industrial roles: platform vendors, OEMs and industrial end-user. The reason was that having multiple cases within each role would enhance replicability, in turn facilitating generalizability (Gersick,

1988) and solidify the insights of the study via triangulation (Yin, 2018). Research participants consisted of 25 different individuals (4.4), to ensure saturation of potential new findings. The participants offered multi-faceted and rich perspectives on the researched phenomenon. In conjunction with the high level of reliability achieved within this study, these observations suggest that the induced theory is generalizable in similar contexts.

4.4 Data Collection

Inductive research is concerned with the context in which the studied phenomenon takes place. For this reason, the data to be analyzed is often collected by studying a small sample of subjects rather than a large number, which is a strategy primarily pursued for quantitative methods (Saunders, Lewis, & Thornhill, 2016). Primary data was collected through in-depth, semi-structured interviews, which provide profound contextual material for exploratory studies, and help explain relationships between constructs. Moreover, in-depth, semi-structured interviews allow for probing the answers of the participants, encouraging them to explain and expand on their responses. This is of particular importance for studies informed by an interpretivist philosophy (Saunders, Lewis, & Thornhill, 2016).

The iterative character of the research guided the execution strategy for the collection of data. In particular, the researchers were first interested in identifying substantial theoretical gaps through exploratory conversations with a selection of industrial companies. During this phase, the research question was loosely focused on challenges around IIoT, and the exploratory interview protocol (Appendix B) openly accounted for various constructs from the IIoT literature. Similar to Bettenhausen and Murnighan (1985), the exploratory interview process was informed by a tentative research question, which served the purpose of sharpening the researchers’ focus for the rest of the work.

Table 6. *Data collection strategy.*

Phase	*Protocol*	*Objective*
Exploratory In-Depth Interviews	A list of seven questions broadly touching upon the challenges and value of IIoT platforms. Substantial room for the interviewee to elaborate on topics (see Appendix B).	Collecting insights from a selection of stakeholders to identify and confirm a research gap in the IIoT (Bettenhausen & Murnighan, 1985).
Semi-Structured In-Depth Interviews	A list of nine to ten questions specifically addressing a company type (see Appendix C). Room for the interviewers to follow up with additional questions in encouraging the participant to elaborate more on their answers.	Limiting the collected data around factors influencing the make or buy decision, while not restricting the collection to a preordained theory (Eisenhardt, 1989). Gathering perspectives from different organizations on the same underlying issue (Gersick, 1988; Yin, 2018).
Secondary Data	The researchers scanned financial documents, case-studies and other public documents for each case company.	Complementing the information gathered via in-depth interviews and facilitating triangulation (Eisenhardt, 1989).

The research team then openly discussed patterns from the initial batch of interviews and agreed on coordinating efforts in understanding the approach of industrial companies in sourcing IIoT platforms. At this point, the articulation of the overarching research question was very close to its final formulation. The researchers shaped the protocol of the second batch of interviews throughout several workshops. This process was challenging due to the need to establish interview questions that would extract as much information as possible, around the same strategic issue, from the perspective of diverse stakeholders (OEMs, industrial-end companies, and platform vendors). The second interview protocol can be examined in Appendix C. It consisted of approximately ten pre-determined questions for each company type. The list of questions was guided by a specific logic, picking up from the business challenges to be solved through

IIoT use cases, moving to a description of the employed digital platform, exploring why the platform was sourced a certain way under business and technological perspectives, and eventually touching upon the long-term strategic visions of the companies in regard to the IIoT. Similar to the exploratory interviews, the semi-structured interviews were designed as close as possible with no theory yet in consideration to limit bias from extant literature (Eisenhardt, 1989).

To build a theoretical model applicable across organization types, in-depth interviews were carried out with a non-random selection of diverse organizations, ranging from OEMs and industrial end-users to platform vendors, all of which playing an important role in and around IIoT platforms. The rationale was that having multiple cases within each category would allow findings to be replicable, thus facilitating generalizability (Gersick, 1988). Moreover, since the objective of the study was to induce a theory of sourcing, the selection of OEMs and industrial end-users was evenly split between outsourcing companies and insourcing companies, while platform vendors were selected for data triangulation purposes, as they could provide insights from business relationships resulting in either outcome (Yin, 2018). In synthesis, the multi-case study features six industrial companies and is complemented with data from six platform vendors for a total of 25 individual in-depth interviews. Guest, Bunce and Johnson (2006) suggest that 12 in-depth interviews should suffice if the aim is to understand commonalities within a homogenous group. Given the relatively wide-ranging focus of the research question and the heterogeneous nature of the target population, the authors opted to adhere to the recommended 5 to 30 in-depth interviews range recommended by Creswell and Poth (2017). Research participants were approached via the social network LinkedIn, and they needed to fulfil two criteria. First, they needed to be employed, or have been employed in the recent past, by either a company that owned an open IoT platform, a company that operated as an OEM or by an industrial end-customer. Secondly, the employee had to demonstrate a deep understanding of the IoT landscape both within and outside their organization. As a result, most participants were picked among IoT consultants, Heads of IoT, Presales IoT specialists, CIOs and Digital Transformation managers. Prior to analyzing the data, the interviewees were fully anonymized. However, their employing companies were kept explicit unless specifically requested (e.g. Company X). Interviewer bias was limited by maintaining a neutral tone when asking questions, and at least two researchers were present during every interview session. On the interviewees' side, bias regarding limited discussion around sensible topics was expected. To complement the substantial amount of primary data (approximately 126.000 words), the researchers relied on publicly available documents such as financial statements or existing case studies. The multiple data collection methods provided a robust ground for the analysis (Section 4.5) by facilitating triangulation (Eisenhardt, 1989). As it is often the case with case-study research, this work is characterized by a frequent overlap of data collection and analysis (Glaser & Strauss, 1967), as described in the following section.

4.5 Data Analysis

The analysis was carried out in thoroughly structured phases. It was inspired by best practices in qualitative research (Glaser & Strauss, 1967; Miles & Huberman, 1984) and Eisenhardt's (1989) process for building theory from case-study research. As outlined in 4.4, the data collection questions were carefully designed to strike the right balance between focus on the research issue and to leave enough freedom for the 25 research participants to articulate relevant insights. This resulted in a substantial amount of data of over 120.000 words and the demand for a well-planned analysis process. To make sense of the overwhelming interview data, the researchers openly coded each transcription by labelling passages using key concepts from the IIoT literature review (Chapter 2). Notably, no pure theoretical perspective had been adopted at this time, as preordained theoretical propositions could have biased and limited the findings (Eisenhardt, 1989). This initial large-scale processing resulted in 504 codes, out of which 108 were unique. At this stage, the objective was to gather a collection of patterns that would help identify relevant theories for the continuation of the analysis.

Table 7. *Overview of the data analysis process.*

Phase	*Procedure*	*Objective*
Open Coding	Transcriptions of 25 conducted interviews were divided and coded separately by the researchers.	Identifying consistent patterns, informed by the literature review on the IIoT, across the 25 interviews (Miles & Huberman, 1984).
Consolidation of Codes	Researchers jointly discussed and agreed on eliminating redundancies and streamlining the 108 codes obtained through the open coding.	Data reduction to simplify the selection of appropriate theories in building a conceptual model (Glaser & Strauss, 1967; Thomas & Harden, 2008; Butler, 2016).
Selective Coding	Researchers independently coded interview data limiting to conceptual model factors.	Categorize data informing the make or buy decision under specific concepts (Glaser & Strauss, 1967; Miles & Huberman, 1984).
Within-Case Analysis	Combining primary and secondary data in building a presentation of each individual case.	Gaining familiarity with data and preliminary pattern identification (Eisenhardt, 1989).
Cross-Case Analysis	Using multi-layer matrices to identify patterns across strategic outcomes.	Fostering a deeper look into data and derive evidence through multiple lenses (Eisenhardt, 1989).

The 108 codes were furthermore streamlined into a corpus of 25, on which all three researchers agreed through a hermeneutic process (Miles & Huberman, 1984; Thomas & Harden, 2008; Butler, 2016). The initial extensive output of codes and the reduction into a selection of 25 codes can be found in Appendix D. Table 7 provides an overview of the sequential data analysis process.

Subsequently, a review of theories addressing the identified codes translated into the development of a conceptual model. The theoretical literature review presented in Chapter 3 was intentionally carried out only after the first coding to not bias the researchers in dismissing any pattern of interest. The iterative process is popular within case-study research and was encouraged by Glaser and Strauss' (1967) advocation for overlapping data-collection, coding, and analysis. Once the theoretical framework was fixated, a second coding iteration, where the set of labels were limited to the conceptual model (3.5), was carried out independently by each researcher on commonly segmented data (Campbell, Quincy, Osserman, & Pedersen, 2013). An extract for exemplifying purposes can be found in Appendix E. Inter-coder reliability (ICR) for the selective coding was estimated as follows. If a passage was labelled differently by every researcher, it was marked with an ICR of 0%. A value of 66% was assigned to a specific quote if two out of three researchers had agreed on the same concept label from the coding scheme. Finally, a value of 100% was assigned to a quote if all researchers had coded it using the same concept label. The final ICR, calculated as an average of the above (Kolbe & Burnett, 1991), was 71%, which reflects substantial agreement according to Landis and Koch's (1977) scale. The high ICR indicates that, on average, more than two researchers out of three agreed on the same coding. The relatively high ICR suggests a satisfying convergence of the researchers on the same interpretation of data (O'Connor & Joffe, 2020). More importantly, it indicates clear boundaries between theoretical concepts that minimize their overlap. Hence, it greatly strengthens the reliability of this study (Neuendorf, 2017).

The subsequent processing work is presented throughout Chapter 5 and was executed as follows. OEMs and Industrial-end users were first classified based on the sourcing strategy (i.e., make or buy decision). Each case was explored independently (Section 5.1) to familiarize in-depth with each context. The so-called *within-case* analysis (Eisenhardt, 1989) was backed by a combination of primary data from the interviews and secondary data from firms' financial documents and other publically available resources. Notably, there is no standard format for within-case analyses. They usually consist of detailed case study write-ups, which are often simple descriptions, but are key to the generation of insights (Gersick, 1988), since they help to make sense of enormous volume of data and structure the rest of the research work (Eisenhardt, 1989).

Once a detailed overview of each case company had been realized, the researchers employed a structured strategy to execute a cross-case analysis. In accordance with Eisenhardt (1989), matrices of concepts were used to focus on the implications of each factor in the light of the make or buy decision. As an additional analysis layer, cases were grouped not just based on the strategic decision but also on the use case framed through the within-case analysis. Performing the analysis without acknowledging the differences between external and internal IIoT use cases would have severely impaired the study's depth and findings.

Table 8 *Matrix template employed throughout the cross-case analysis.*

External (or Internal) use cases		
Decision	Make	Buy
Resources	“x” or “-“	“x” or “-“

Table 8 illustrates the matrix template employed in the analysis for each factor from the conceptual model during the inter-case analysis (5.3). In this final process of the case study analysis, the objective was to assess whether literature concepts were indeed suitable in labelling a company's driver for choosing one strategy as opposed to the other. In doing so, the researchers picked up the frequency of codes obtained in the first part of the analysis. The frequency was a helpful indicator as it gave a synthetic overview of traces for each concept at the company level. In other words, a theoretical concept was assigned to a company if the researchers had coded it in at least one interview conducted with that company. This initial proxy was subsequently validated through a work of interpretation of the data. The researchers critically reflected on whether a concept was informing the sourcing decision, using a combination of primary and secondary data. Primary data consisted of both the analysis of research participants interviews from decision-making companies and research participants data from platform vendor companies. Combinations of different sources of primary data and cross-checking it with the aid of secondary sources was highly synergistic, since it kept the researchers from being carried away by vivid but false first impressions on one class of data. Where the analysis pointed to a certain construct in being relevant across cases, it was marked with *x* (see Table 8). The underlying interpretation is presented in the inter-case analysis of each concept throughout Section 5.3.

5 Analysis and Findings

As outlined in the previous section, the structure of the analysis presented below draws on Eisenhardt's (1989) combination of a detailed and independent write-up for each case company (i.e. *within* or *intra-case* analysis) and a comparison between cases (i.e. *cross* or *inter-case* analysis). Section 5.1 focusses on the context and dynamics around each case company, framed by both the strategy pursued and the underlying IIoT use case. The input of this first process of analysis consisted of the selective coding, several consultations of the interview transcripts, and relevant company information obtained through secondary data. An overview of the insights from the within-case analysis is provided in 5.2. A different approach to analysing the data was taken in a second phase by focusing on the different concepts comprising the conceptual model. The so-called cross-case analysis (5.3) illustrates similarities and divergences across cases, thus leading to a more sophisticated understanding of the phenomenon. The findings are synthesized in Section 5.4.

5.1 Within-Case Analysis

No standardized practice exists among scholars in regard to how intra-case analyses should be approached. The researchers pursued a structured strategy by defining information requirements that each case description should fulfill. In this paper, individual case descriptions address the company's size, the sector in which it operates, the IIoT use-case and the decision towards making or buying the IIoT platform. The basis for the analysis consisted of a combination of primary data sources obtained from companies, patterns detected in the coding and secondary data obtained from public sources. By pre-determining a structure for the within-case analysis, the researchers set up the subsequent cross-case evaluation.

5.1.1 Danfoss

Danfoss is an original equipment manufacturer (OEM) operating worldwide with its headquarter based in Scandinavia. Danfoss represents an interesting case as its offerings vary from cooling and heating to engines and hydraulic components, together with a long history of developing innovative energy-efficient solutions. Furthermore, the company counts 27,871 employees as of 2019 and a turnover of 6,285M Euro (Danfoss, 2020). In 2019, Danfoss partnered with Microsoft to bring domain expertise in refrigeration and heating to the cloud (Danfoss, 2020). The company offers two main IoT platforms to its business customers. Their goal is to provide additional value through services, with the overall business model shifting to enable Danfoss to differentiate against the competition, anticipating its competitor's future. "*We see a trend of servitization, so we have to be on top of that one*" (Interviewee 16, 2020). One of the platforms supports Danfoss' cooling solutions, and it is especially popular in supermarkets worldwide. This IIoT platform assists with energy management for 16.000 supermarkets and enables reducing energy consumption by supermarkets of up to 40% (Interviewee 16, 2020).

According to Interviewee 16 (2020), one factor that played a role in the decision to rely on the Microsoft cloud infrastructure was the absence of Microsoft in the food retail market. For example, an alternative cloud solution to Microsoft, provided by Amazon, was discarded because Amazon operates in the food retail segment. This concern was also brought to light by Danfoss's customers. Next, the insurance of data security was an important factor during the decision. Regardless of the underlying cloud infrastructure, Danfoss opted to develop its own platform as opposed to buying access to platform solutions from the market and focusing on the configuration. One reason was that "*if you want to expand, it is easier on your own platform*" (Interviewee 16, 2020).

Danfoss offers a second IIoT platform within its power solutions, hydraulic components that play a crucial role in machines built by its customers. This IIoT platform supports monitoring use cases as well as proactive maintenance based on data. Danfoss is currently in the process of training AI algorithms to provide predictive maintenance to its customers (Interviewee 18, 2020). Danfoss supplies its power-solutions IIoT platform to two main types of customers. The first group of customers buys both the physical product as well as access to the IIoT platform, where they can consume information via real-time monitoring and benefit from data-based proactive maintenance recommendations. They are mainly small or medium-sized companies that lack the resources needed to develop their own IIoT platform. The second group of customers, represented by large companies, only buys the physical product but no access to the IIoT platform. Instead, this second type prefers, as per Danfoss' experience, to develop their IIoT platform, which is integrated with Danfoss' cloud. These companies "*want to deliver that value to their end customers themselves*" (Interviewee 18, 2020). According to Danfoss, for companies that possess an adequate size and scale, it makes sense to prioritize the development and maintenance of their platform. Although being complex and challenging to approach, it brings opportunities such as complete control over the data from machines, freedom over what IoT services to offer, and delivery of the value unlocked by IoT directly to the end customers (Interviewee 18, 2020).

A similar argument appears to have influenced Danfoss's decision not to source an IIoT platform from the market. According to Interviewee 18 (2020), Danfoss had the necessary size and resources to carry out the development of the platform. Furthermore, Danfoss perceived the available solutions on the market to be overall too expensive. Interestingly, Danfoss reported that an unexpected consequence of insourcing was the required maintenance and support efforts.

> *"[At the beginning] we did not even understand that we needed to support the cloud. We thought we would just build it, we would put it out there, and everything would be great. Then we learned slowly that it would have not worked out that way. It has to be*

maintained all the time and somebody has to monitor it. Somebody has to make sure it is up and running" (Interviewee 18, 2020).

As an infrastructure provider for its IIoT platform, Danfoss chose Microsoft due to their pre-existing partnership and historical relationship: *"it was an obvious choice, because we are a Microsoft-based company"* (Interviewee 18, 2020). Looking back, Danfoss has no regrets over its decision and has no intention to move away from its internally developed platform because of the sunk costs and the overall satisfaction with the achieved solution. It supports primary IIoT use cases, and the company is now focusing on improving its IIoT based services through iterative learning from mined data. The main business goal for Danfoss is to bring together its product line to form a robust ecosystem of offerings.

The use cases covered during the interviews held with Danfoss were limited to their customer-facing solutions. The interviewees did not describe internal solutions supporting Danfoss' manufacturing processes. Table 9 provides an overview of the concepts that have been coded in the primary interview data from Danfoss.

Table 9. *Concepts coded in primary data from Danfoss.*

Danfoss					
Resources	*Competitive Advantage*	*Asset Specificity*	*Market Uncertainty*	*Technological Uncertainty*	*Ecosystem*
x	*x*	-	*x*	*x*	*x*

5.1.2 Maersk

Maersk is an end-to-end logistics service provider that drives global trade. Its operations account mainly for supply chain management and port operations. While the ocean business accounts for the major business activity of the corporation, inland logistics and airfreight are offered, as well. Maersk employed 83.512 people as of 2019 and had a turnover of 32,078M Euro (Maersk, 2020). Since many products need to be constantly cooled during transportation, the company also offers refrigerated transport. Because the company's business is very asset-intensive, IIoT became very appealing for both internal optimization and automation, and to offer new data-driven services to their customers. An employee directly involved in the make or buy decision for the IIoT platform stated the following:

> *"The key driver there was really to see and to try and optimize operational performance and get a closer concept onshore to what was going on with the container offshore, which allowed us to take some better measures when we were preparing the container, when it came to maintenance and repair, and those type of things"* (Interviewee 8, 2020).

The company decided to build its own IoT platform on top of Microsoft Azure. The decision was heavily influenced by various of factors, such as costs, required capabilities, strategy and the pre-existing partnership with Microsoft (Interviewee 6, 2020; Interviewee 7, 2020; Interviewee 8, 2020).

> *"I think the long-term cost structure of that model is simple. I think it's too high. I think there's too many hidden costs in outsourcing your development and your digital capabilities like that. You might be able to shed off 30% from people employed versus monthly or yearly out-of-pocket costs for an external provider, but the hidden costs in terms of also knowledge and all of that I think is way higher than what those type of cases typically include. It's just hard to put a number to it"* (Interviewee 8, 2020).

It was not only cost considerations that were a driver for the make decision but also scalability played a role. Interviewee 9 (2020) stressed that if the IoT solution had not scaled reliably, mismanagement of hundreds of thousands of containers worldwide would have meant massive losses in revenue. Maersk could not have decided to build its own platform if it did not have sufficient resources in-house. Interviewee 9 (2020) mentioned time to market and availability of resources as the main factors for the decision. Interestingly, time to market would have further increased with a market-sourced IIoT platform solution. Time to market, therefore, seemed to play a minor role compared to the strategic goal of gaining a competitive advantage through the IoT initiatives.

> *"So there are aspects of such a solution, which can give you a competitive advantage. But those are more along the lines of having, you know that insight, you can get in front of the data. Making, you know these devices on the side of a container, I mean, there's lots of companies that can do that and there's lots of companies that will be better than that we could ever be able to be"* (Interviewee 9, 2020).

While the interviewee identified insights derived from data as a competitive advantage, IoT sensor hardware production was not perceived the same way. Maersk thought that its own IIoT platform, and the unlocked ability to offer novel data-driven services for its customers, would be a differentiator in their respective industry.

> *"[...] we believe, more and more, that the competitive advantage in a very commoditized industry like ours, the competitive advantage lies in what you can do from a tech point of view. So, we're moving to what's in sourcing quite a lot and building our own internal tech dev capabilities. And we also believe owning IP will, in the long run, serve as a competitive advantage rather than off the shelf solutions that you then try and fit, and tailor"* (Interviewee 8, 2020).

In summary, Maersk developed an IIoT platform on top of the cloud infrastructure provided by Microsoft to support their internal use case around tracking refrigerated containers. Table 10 provides an overview of the concepts that have been coded in the interviews with Maersk.

***Table 10**. Concepts coded in primary data from Maersk.*

Maersk					
Resources	*Competitive Advantage*	*Asset Specificity*	*Market Uncertainty*	*Technological Uncertainty*	*Ecosystem*
x	*x*	x	*x*	*x*	-

5.1.3 Alfa Laval

Alfa Laval is a Swedish OEM for heat transfer, separation and fluid handling machines. With more than 17.387 employees and a turnover of 4,630M Euro, the company mainly serves its customers in the energy, environment, food and marine industries (Alfa Laval, 2020). Since Alfa Laval is producing machines, its business is focused on physical asset sales. However, the company wants to extend and complement its core business with value added services the customers. Interviewee 5 explained that they grouped IIoT driven services into three categories: visualization of machine data, predictive maintenance and process optimization to increase efficient machine utilization (Interviewee 5, 2020).

Alfa Laval decided to make its own IIoT solution for several reasons. First, it saw data sharing among ecosystem partners and especially with a platform owner as threat since the platform owner could become a direct competitor and potentially intermediate the customer relationship between Alfa Laval and its end customers. On the other hand, Interviewee 5 was also aware of the potential benefits of sharing data with an ecosystem to provide an enriched information representation to the end customer. Second, they wanted to keep close control over data, IP and domain knowledge since these resources make their business defensible. Third, Alfa Laval saw an opportunity to gain a temporary competitive advantage by differentiating their offering with additional services in the three mentioned areas. Alfa Laval did not initially possess the capabilities to build IIoT solutions in-house. Interviewee 5 reported a trade-off between going with a market-ready solution, thus decreasing time-to-market and quickly realizing a return on the investment, against building new capabilities over a longer time frame. The company decided to build IT capabilities in-house because top management identified the digitalization as strategically important and heavily supported the transformation. Additionally, the company did not see enough maturity of existing platform solutions on the market.

> *"We face many customers that they say we don't allow data to get out of the factory. We don't allow external communication. Right. I mean, years ago, many offices, they didn't allow an internet connection, they didn't allow email because they were too concerned that information will leak out via email. I mean, are we crazy not to have email today. The way I see it is it's just the maturity level, but this is new for us; this is new for our customers"* (Interviewee 5, 2020*).*

However, the pressure to bring an IIoT platform solution to the market was low due to Alfa Laval's customers still being in the early stages of understanding the value proposition of the IIoT. This granted Alfa Laval the necessary time windows to develop its digital platform. Lastly, while Alfa Laval had identified the value in being part of a platform with an ecosystem, it had not estimated it to be substantial enough.

> *"[...] it has to be beneficial for everyone in the game, like if it doesn't add value for you, then you just leave the game, or you look for something different [...]. And I think there's a lot of value with being part of a platform."* (Interviewee 5, 2020)

Even though Alfa Laval opted for a *make* solution, the company did not reject the possibility of joining a third-party ecosystem in the future.

> *"So there is a value in participating in an ecosystem. For example, a communication value and an access value. So, the question is do we see the value of participating in ecosystems. Yes, absolutely. If you ask me, do you have a clear plan. No idea."* (Interviewee 5, 2020)

Alfa Laval decided to develop its own IIoT platform on top of the cloud infrastructure to support its external use case and deliver additional value to its customers. Table 11 shows the concepts in the make-or-buy decision process that were coded in the primary data.

***Table 11**. Concepts coded in primary data from Alfa Laval.*

Alfa Laval					
Resources	*Competitive Advantage*	*Asset Specificity*	*Market Uncertainty*	*Technological Uncertainty*	*Ecosystem*
x	x	x	x	-	x

5.1.4 Vestas

Vestas is the leading global manufacturer of wind turbines with a market share of 17% of the entire installed base of wind energy plants. With more than 25.000 employees worldwide and a turnover of 12,147M Euro, Vestas offers their customers an end-to-end service from manufacturing to installations and post-sales services (Vestas, 2020). Throughout the value chain, Vestas has deployed different IIoT platform-based solutions. Its 5.000 manufacturing workers, distributed over 20 different production facilities, perform highly complex and often manual labor. Having relied heavily on paper-based documentation and facing the nearing retirement of the most experienced workers, Vestas decided to digitize its manufacturing processes.

> *"We face a big challenge of very different knowledge levels in our workforce. This will become even more difficult for us since a lot of our employees will retire in the next years while we work in one of the fastest-growing industries. Our main goal, therefore, is to provide meaningful assistance for our employees through IoT and AR."* (Interviewee 20, 2020)

Once identified the need for an industrial IIoT platform to support the digitalization of the entire production process, from design to manufacturing, Vestas decided to rely on a well-functioning standard industrial IIoT platform solution. After a careful evaluation of the available solutions, Vestas chose to rely on the PTC ThingWorx IIoT platform. Besides matching the identified specific needs of the use case with the vendor offering, the integration capabilities and the previously established relationship with PTC for the programmable logic controller systems (PLCs) were drivers in the decision outcome. Moreover, PTC's platform was attractive because of its accompanying ecosystem of partners and consultants, which would have provided additional value to Vestas.

> *"What matters most for us is that the people working in manufacturing have the digital tools they need ready and accessible. We need to make sure that these tools provide a great UX so that they can be easily used. […] We rely on the PTC ThingWorx applications, they already come with a pleasant UX which is not just tested by our 5.000 employees working in manufacturing, but by millions all over the world. This makes it way easier for us."* (Interviewee 20, 2020)

In line with its digitalization effort, Vestas carried out the implementation of an IIoT platform to support its customer base. Unfortunately, the interviews with Vestas were limited to the IIoT platform supporting internal use cases and did not provide any information on the external use case. Table 12 displays the concepts that were coded in regard to the sourcing decision in the primary data from Vestas' interviews.

***Table 12**. Concepts coded in primary data from Vestas.*

Vestas					
Resources	*Competitive Advantage*	*Asset Specificity*	*Market Uncertainty*	*Technological Uncertainty*	*Ecosystem*
x	-	x	x	-	x

5.1.5 Grundfos

Grundfos is a Danish manufacturing company and the largest pump manufacturer globally, with more than 19.060 employees and a turnover of 3,577M Euro (Grundfos, 2020). Grundfos is seeking to enhance the utilization of their pumps with digital services adjoining the physical products. Besides working on incrementally increasing the efficiency of the pumps, by heavily investing in R&D every year, the company foresees great potential in connecting the devices and developing software solutions that could improve its solutions' energy efficiency. Through the IIoT, Grundfos achieved improvements as high as 100% (Interviewee 11, 2020).

Grundfos entered a partnership with Siemens to co-develop their vertical digital service offerings on Siemens' IIoT platform, MindSphere. There was a variety of reasons to go with an already existing IIoT platform solution, according to Grundfos. As a 75-year-old company, Grundfos had to adapt to the technological change and build the necessary capabilities to excel in the digital age. This brought many challenges in terms of cultural change and understanding.

> *"This is not business as usual and they [Siemens] have actually built into their business structures, a lot of hindering, a lot of structures to hinder this transformation to happen. And that is also why they have carved out Mindsphere as a standalone entity, a separate part of the organization, to be able to work freely without a strong influence from the traditional business units."* (Interviewee 11, 2020)

With Siemens, Grundfos found a partner to overcome these hurdles and co-developed their first industrial service. The MindSphere platform offered a set of resources ready to be put into use by Grundfos, which would have, otherwise, been costly to develop internally. Interestingly, the ecosystem surrounding Siemens'platform was the main driver for Grundfos' decision.

> *"Those systems, business systems, not technical but business systems, will be our new suppliers, or better "distributors", our new channel to market. In some areas, it will be the only channel. That means that if we're not positioning ourselves as an OEM within that channel, within that ecosystem, we will be out of business. So that's basically why we are moving in this direction, why we kicked off a new journey two years ago to build up the capabilities to be able to work with ecosystems, to be able to understand them and position ourselves as a company within that one."* (Interviewee 11, 2020)

While Grundfos, as the global market leader for pumps, arguably had the size and resources to develop an IIoT platform on their own, the company saw a clear advantage in terms of future access to new customers with the ecosystem surrounding the MindSphere platform. By being the preferred horizontal OEM for pumps on the vertical smart city IIoT platform Grundfos sought to acquire more insights from its customer base.

> *"I actually think that through a platform like this you will get even closer to the end customer than what we are today. That's also a little bit difficult not to, because we are only delivering to distributors and then we lose sight of our products. So we are completely blindfolded today and maybe we'll get a little bit of sight into the end customers by using a platform like Siemens Mindsphere."* (Interviewee 11, 2020)

It was Grundfos's understanding that the end-customer would eventually prefer solutions that bring a concentrated interface for a set of offerings from various stakeholders, all of which would be orchestrated through the Siemens MindSphere platform. The decision to buy access to an existing platform helped Grundfos to further focus its core competencies on serving their customers:

> *"We need to offer what we are proud of, which is not strictly products, but our capabilities, our people's ability to get the application knowledge and convert that into end-customer value. We know about our applications and that is the difference between being a horizontal player like Siemens and a vertical like us."* (Interviewee 11, 2020)

In summary, Grundfos based its IIoT use case on the Siemens MindSphere platform to enable advanced services for their end-customers. Grundfos was especially driven by the low resource requirements of Siemen's IIoT platform, as well as the possibility to tap into the open platform's business ecosystem. Table 13 provides an overview of the coded concepts in the primary interview data of the decision process from Grundfos.

***Table 13**. Concepts coded in primary data from Grundfos.*

Grundfos					
Resources	*Competitive Advantage*	*Asset Specificity*	*Market Uncertainty*	*Technological Uncertainty*	*Ecosystem*
x	x	-	x	-	x

5.1.6 Company X

The firm's identity is here anonymized with the fictive name Company X, upon the wish expressed by the company. Company X is an industrial company with 18.800 employees and a turnover of 5,180M Euro producing consumer products (MIT Case, 2020). The company was close to bankruptcy in the early 2000s, but it had a strong financial comeback thanks to its digitalization efforts. Despite the success with digital innovation, management at the company was still worried about the risk of reacting quickly to opportunities and threats posed by the digital economy (MIT Case, 2016).

There is not a particular point in time when Company X started to implement IIoT within its factories. In fact, the company has been busy connecting machines for some decades now (Interviewee 21, 2020).

> *"We are doing a lot of projects where we connect to different machines, and we can go down to the layer where we can see the running parameters of the machine: it can be a sensor, it can be how much they produce, it can be a lot of things. Some machines have 500,000 tags each."* (Interviewee 21, 2020)

Company X's primary business goal in this use case is to optimize the production line, improving its operational efficiency by limiting the waste of resources. One of the major challenges Company X faced throughout the IIoT journey was not having a standard protocol to interface with the devices (Interviewee 22, 2020). Once this had been tackled, Company X suffered from an overwhelming flow of data, making it difficult to understand what information was valuable and what was noise. To overcome these challenges, the company had to leverage a combination of IT engineers and machine knowledge experts. The decision to employ an IIoT platform for its production line had a noticeable impact on the workforce. In fact, employees had to move towards a new way of working, where tasks were intertwined with the new data platform. This increased the transparency of the production processes for employees from a business line (Interviewee 22, 2020).

The company has been following some IT principles coming from top management, based on which it avoids pursuing internal development and prioritizes sourcing SaaS solutions from the market if they prove to be a good fit for the company's requirements. Company X was certain that, if they had embraced internal development, the output would have not been as good as the products available out there in the market.

> *"It's a matter of the quality of the output and also being realistic about your* resources *[emphasis added]. You know, if we were to dedicate all of our best programmers to build something equivalent to Thingworx, then that wouldn't be differentiating us against our competitors because you can bring in software from the outside that solves the goal better. This way, we can focus more on integrating the different services together, building stuff on top of layers that actually differentiates us."* (Interviewee 22, 2020)

It is worth mentioning that Company X did not lean on outsourcing by default because the question of insourcing or outsourcing had to be thoroughly addressed each time a decision had to be made. Moreover, Company X would not restrain itself from sourcing assets from markets or putting external collaborations into place, but it would be careful in selecting what must be built in-house, based on whether the asset in question grants competitive advantage or if it requires particular domain knowledge (Interviewee 22, 2020).

As an IIoT platform, Company X opted for ThingWorx from PTC. The company was satisfied with what the platform allowed and, most importantly, it strongly believed that a do-it-yourself solution would have had major scalability drawbacks. Furthermore, the option of internal development was rejected because of security and uncertainty concerns. Having no previous experience in such an IT domain, Company X feared they would come across critical unanticipated challenges (Interviewee 21, 2020). The choice to source the IIoT platform from PTC was somewhat influenced by the pre-existing relationship between PTC and Company X, as the former has been supplying various products and services to Company X over the years. According to Interviewee 21 (2020), extending the commercial relationship between the companies felt like the most viable option.

Company X featured a rich landscape of integrated digital solutions. The IIoT infrastructure alone combined PTC's Thingworx, KEPServer and Microsoft's Azure cloud. The decision to fragment the IT infrastructure behind the IIoT platform came as a strategy to avoid strong lock-in: *"to us, it's important that we are able to replace any piece in the picture, and not be too hardly tied into one specific technology"* (Interviewee 22, 2020).

As indicated above, Company X's IIoT implementation was strictly internal. However, Company X was planning to introduce IIoT-powered customer-facing solutions in the near future, focusing on product customization for consumers. Table 14 shows the concepts that were coded in the primary interview data from Company X on the sourcing decision of its IIoT platform.

Table 14. *Concepts coded in primary data from Company X.*

Company X					
Resources	*Competitive Advantage*	*Asset Specificity*	*Market Uncertainty*	*Technological Uncertainty*	*Ecosystem*
x	x	x	x	x	x

5.2 Findings from the Within-Case Analysis

The six independent IIoT platform cases showed various considerations leading to either make or buy decisions. The use case consideration was at the very core of the strategy. An internal or closed platform architecture supports industrial production monitoring and does not allow the participation of unanticipated parties (Gawer & Cusumano, 2014; Eisenmann, Parker, & Van Alstyne, 2009). Maersk, Vestas and Company X all featured a digital platform for internal IIoT applications.

Table 15. *Overview of use cases among studied companies.*

		Use case	
		Internal	**External**
Decision	**Make**	Maersk	Danfoss Alfa Laval
	Buy	Company X Vestas	Grundfos

In contrast, in Danfoss, Alfa Laval and Grundfos' cases, the IIoT platform was deployed to support services consumed by their respective customers. In this sense, they all presented an external platform. External product platforms, or industry platforms, are defined through a degree of openness towards third-party involvement on the platform (Gawer & Cusumano, 2014; Eisenmann, Parker, & Van Alstyne, 2009).

Table 15 shows an overview of the respective case companies' decisions and the two identified use case patterns, namely internal or external IIoT platform use cases.

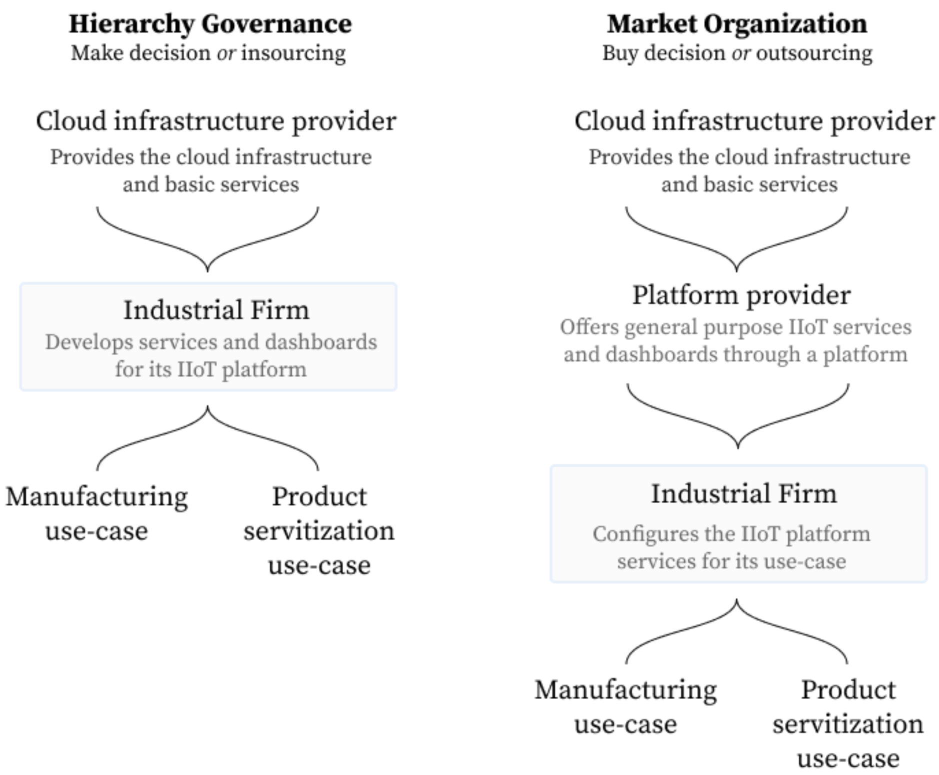

Figure 4. *Rival platform sourcing options.*

In this case study, the sample of firms was skewed towards make decisions in external platform deployments (Danfoss, Alfa Laval), while IIoT platforms leveraged within the firm were mostly sourced from markets (Vestas, Company X). In *make* cases, firms acquired cloud infrastructure assets from third parties and developed the needed microservices on top. Therefore, in these scenarios, industrial companies carried out consistent work on the application layer of the IoT architecture (Floris & Atzori, 2016). Differently, with Grundfos, Vestas and

Company X, who purchased a license to access open, cross-industry platforms like PTC's ThingWorx and Siemens' MindSphere. These industrial companies did not carry out development across the IoT architecture. Their activity was limited to a configuration of the digital platform. The two different procurement configurations of IIoT platforms are illustrated in Figure 4.

To summarize, companies pursued two different strategies in sourcing IIoT platforms. Moreover, the IIoT platforms were needed for two specific applications: monitoring and control of internal production or the servitization of products sold to customers. The theoretical constructs were observed in almost every within-case analysis. Following this section, the cross-case analysis goes beyond initial impressions and descriptions of primary and secondary data, exploring the consistency of patterns across case companies.

5.3 Cross-Case Analysis

The cross-case analysis is focused on divergent techniques to expose similarities and contrasts between cases. In particular, the exercise of analysis consisted of understanding whether a certain strategic factor introduced in the Conceptual Model (3.5) informed the decision-making of companies sharing similar use cases and outcomes. As a result, each factor was labeled as either evident (x) or not evident (-) in influencing a make or buy decision (Table 16). The interpretations are described throughout the following subsections and are accompanied by instances of Table 8 (see 4.5 Data Analysis). The objective was to validate each component of the adopted conceptual model and enhance the probability of capturing novel findings, thus paving the way for a thorough discussion in Chapter 6.

***Table 16**. Adopted metrics for the cross-case analysis.*

Metric	*Definition*
x	The concept was identified, through the cross-case analysis, to have informed the sourcing decision.
-	The concept was *not* identified, through the cross-case analysis, to have informed the sourcing decision.

5.3.1 Resources

The discussion around resources was substantial both in primary data from the interviews with featured case companies, as well as in primary data from interviews with platform vendors (Interviewee 1, 2020; Interviewee 2, 2020; Interviewee 3, 2020; Interviewee 10, 2020; Interviewee 12, 2020).

> *"The reality is only really big customers would build their own version of [platform], themselves, like a private cloud, and they can choose; I want it on Azure, or I want to have it on Amazon. Doesn't matter. They have that choice"* (Interviewee 3, 2020).

When it comes to the case companies, a general trend was observed in the association of resources and the strategy of the firm: larger companies with higher capacity were able to commit resources to produce the asset themselves. This applied to both Danfoss, as well as to Danfoss' customers. As described in 5.1.1, their bigger customers decided to deliver the value derived from the IIoT platform themselves, while smaller-sized customers relied on the out-of-the-box solution from Danfoss (Interviewee 18, 2020). Similar to Danfoss, Maersk invested substantially in its proprietary IIoT platform. As much as the insourcing decision was driven by the will to build internal capabilities, pursuing this path was only possible due to the vast amount of resources in possession by the company (Interviewee 7, 2020; Interviewee 8, 2020; Interviewee 9, 2020). The fact that resources play an important role in insourcing decisions emerged from Alfa Laval's case as well, where substantial resources had to be committed to develop the IIoT platform (Interviewee 5, 2020).

Across buy-outcome cases, the importance of resources was not as obvious. If, on the one hand, *time* stood out as a critical resource in Vestas' case, where the purchased platform asset drastically reduced time to market (Interviewee 20, 2020), the same considerations did not unfold during the interviews with Grundfos and Company X. Grundfos mentioned resources as a relevant factor in the decision. However, it committed to an outsourcing strategy, regardless of the resources in possession (Interviewee 11, 2020). Differently, Company X focused on investing its resources where it could produce the most considerable advantage against competitors. The IIoT platform acquisition was not perceived to unlock any lasting competitive advantage per se, or at least not to the same extent as the layer of services developed on top (Interviewee 21, 2020; Interviewee 22, 2020). Therefore, overall resources were also accounted for in the sourcing decision across the companies that decided to outsource.

Table 17. *Evidence of resources across internal use cases.*

Internal use cases		
Decision	Make	Buy
Resources	x	x

Table 18. *Evidence of resources across external use cases.*

External use cases		
Decision	Make	Buy
Resources	x	x

Considerations around resources were found evident in the decision-making process across all studied cases, as summarized in Table 17 and Table 18. Nevertheless, the extent to which the possession of resources influenced the sourcing decision varied between the cases. Among the internal use cases, a high availability of both tangible and intangible resources correlated with the insourcing of the development of the IIoT platform. On the contrary, restricted availability of resources led to outsourcing. Among companies with external use cases, the same pattern was not observed.

5.3.2 Competitive Advantage

Often tied to resources, *competitive advantage* was clearly a focus for most companies. Those which insourced the IIoT platform development, like Maersk and Alfa Laval, had highly prioritized to develop core capabilities and processes within the company, which would further set them apart from competitors (Interviewee 5, 2020; Interviewee 6, 2020; Interviewee 7, 2020; Interviewee 8, 2020; Interviewee 9, 2020). In particular, the mentioned companies sought to achieve a competitive advantage through a strategy-mix of differentiation and cost leadership.

Companies that sourced an IIoT platform solution to support their internal use case, instead, had a different perception of competitive advantage. In their view, the biggest advantage was either associated with the company's ability to focus its efforts elsewhere, instead of investing in self-development (Interviewee 21, 2020; Interviewee 22, 2020). Similarly, for Grundfos and its external use case, achieving a competitive advantage was associated with establishing a solid presence in one of the most popular market solutions before any competitor could, to gain a first-mover advantage. Despite having the chance to develop its IIoT platform, Grundfos chose to partner with Siemens, believing that insourcing would lead to a significant disadvantage in the long term. Grundfos' view, entailed that Siemens was in front of everybody else in terms of building a industry-wide platform and would soon own the distribution channel for industrial solutions. This made it critical for Grundfos to establish a presence on Siemens' platform, as otherwise, the OEM would eventually be driven out of business (Interviewee 11, 2020).

> *"We need to offer what we are proud of, which is not strictly products, but our capabilities, our people's ability to get the application knowledge and convert that into end-customer value"* (Interviewee 11, 2020).

***Table 19**. Evidence of competitive advantage across internal use cases.*

Internal use cases		
Decision	Make	Buy
Competitive Advantage	x	x

***Table 20**. Evidence of competitive advantage across external use cases.*

External use cases		
Decision	Make	Buy
Competitive Advantage	x	x

Overall, considerations around achieving or maintaining a competitive advantage were evident and relevant across all cases (see Table 19 and Table 20). The path to achieving a competitive advantage, in turn, clearly differed between the case companies that decided to develop their own IIoT platform and the companies that decided to buy, who focused on the development on top of existing solutions. Further, achieving or sustaining a competitive advantage appeared to be of high importance during the case companies' sourcing decision.

5.3.3 Asset Specificity

Asset specificity of the IIoT platforms varied among the use cases. Maersk leaned towards insourcing because of the particular use case they were looking to support. Connecting sensors moving around the oceans attached to containers on vessels required a highly specialized IIoT platform. Consequently making it more difficult to source market solution that supports the specificity requirements (Interviewee 8, 2020). Accordingly, asset specificity informed the make decision of Maersk to a high extend. On the contrary, within the internal use cases, Company X and Vestas were looking for an IIoT platform to support stationary manufacturing use cases. Solutions were found readily available on the market to support the more generic use cases. Company X and Vestas' decision to buy a third-party platform offering showed that, since the market solution required minimal additional investments, the firm preferred to source the IIoT platform from the market (Interviewee 20, 2020; Interviewee 21, 2020).

This line of thought was shared by Grundfos (Interviewee 11, 2020) to support their external use case, even though, in this particular occurrence, the importance of asset specificity was overshadowed by Grundfos' ecosystem strategy.

> *"I think that there is a fine balance there right to what you can buy and what you have to develop yourself. [...] There's certain obvious things that we can go out into the market and buy them because they already exist, but there are others that don't fit you. Because maybe Siemens has some standards, [...], but those standards might not necessarily fit what we need. Hopefully they do because then it saves us a lot of money."* (Interviewee 5, 2020)

Comparing asset specificity among the external use cases, the cases of Alfa Laval and Danfoss show similarities with the Grundfos case. All three companies decided on an IIoT platform to provide industrial applications such as monitoring, predictive maintenance and process optimization to their end-customers (Interviewee 18, 2020; Interviewee 5, 2020; Interviewee 11, 2020).

Even though companies showed differences on the device level and the used sensors, the requirements for the IIoT platforms to support the mentioned use cases were reasonably similar. The companies further mentioned the relevance of the asset specificity consideration within the make or buy process. Looking at the outcome of the decision among the three cases, it is apparent that the considerations led to different sourcing decisions. While Grundfos decided to source a solution from the market, Danfoss and Alfa Laval decided to develop their IIoT platforms.

In brief, the cross-case analysis showed asset specificity to be relevant for the sourcing decision (Table 21 and Table 22). The perceived specificity of the IIoT platform pointed to clear decision outcomes for the internal use cases. Case companies that deemed market solutions as adequately configurable for their specific use case opted for outsourcing, or buy, decisions. Differently, studied companies that perceived their use case as unique and challenging to enable through market solutions chose to pursue internal development of the IIoT platform. These patterns were further corroborated by insights from platform vendors (Interviewee 12, 2020; Interviewee 19, 2020). Furthermore, platform vendors manifested that the closer the vendor-client relationship the easier it would be for the client to buy into the market solution. Even though important, asset specificity alone did not provide strong explanatory power to elucidate the considerations and the outcome for the external use cases.

Table 21. *Evidence of asset specificity across internal use cases.*

Internal use cases		
Decision	Make	Buy
Asset Specificity	x	x

Table 22. *Evidence of asset specificity across external use cases.*

External use cases		
Decision	Make	Buy
Asset Specificity	x	x

5.3.4 Market Uncertainty

Case companies had a very diverse perception of market uncertainty around IIoT platforms. When it came to customer relationships, Grundfos (5.1.5) was certain that Siemen's MindSphere would provide the future market distribution channel, while developing a proprietary solution would potentially exclude the company from the market (Interviewee 11, 2020). On the contrary, Alfa Laval feared that, by joining an existing platform, they would lose a direct channel to their customers (Interviewee 5, 2020).

> *"That to me is really a huge opportunity, of course, but it is a huge risk, and that we lose track of this customer contact and then all of a sudden we have someone in-between"* (Interviewee 5, 2020).

Interestingly, Alfa Laval (5.1.3) was also concerned regarding the maturity and evolution of the IIoT platform market. Among other reasons, Alfa Laval was induced to internalize the IIoT platform development due to the worry of entering business with a supplier that could have pushed them out of the market by direct competition. Under this light, the company's decision to develop its

IIoT platform can be seen as a wait-and-see approach by not committing to a particular vendor until the market would be more consolidated. In turn, this suggested to some extent that Alfa Laval was not strongly committed to its initial make decision, despite the initial investment it had already made into the development. Furthermore, Alfa Laval articulated concerns on how industrial platform vendors could exploit customer data and use it to compete at a later stage. For this reason, Alfa Laval's unwillingness to rely on market solutions worked as a barrier against the potential entry of new players in their market.

Moreover, companies showed concerns regarding the lack of information on what longer-term consequences a buy decision would have implied. In explaining Maersk's decision (5.1.2), Interviewee 8 (2020) suggested that the company risked facing a negative impact by outsourcing, in the form of unanticipated costs such as the missed opportunity of building knowledge and capabilities.

> *"I think the long-term cost structure of that model is simply[…] I think it's too high. I think there's too many hidden costs in outsourcing your development and your digital capabilities like that. You might be able to shed off 30% from people employed versus monthly or yearly out of pocket costs for an external provider, but the hidden costs in terms of also knowledge and all of that I think is way higher than what those type of cases typically include."* (Interviewee 8, 2020)

In the cases of Vestas and Company X, the choice of sourcing the IIoT platform from the market was influenced by the trust in existing market solutions. More specifically, behavioral uncertainty of suppliers was accounted for through pre-existing relationships, and therefore already established trust with the platform supplier. Both Vestas (5.1.4) and Company X (5.1.6) featured a long history of partnership with PTC, cemented over the years through other digital solutions that had been supplied. For this reason, Vestas and Company X perceived a low risk in potential opportunistic supplier behavior. Notably, a similar pattern can be found in Danfoss's case, however, with a different outcome. Similar to how Company X and Vestas had pre-existing partnerships in place with PTC, Danfoss developed a proprietary platform on top of Azure IoT services, a cloud infrastructure provided by its partner, Microsoft. Notably, the importance of pre-existing relationships with other players was reported to influence the sourcing decision by platform vendors, too (Interviewee 23, 2020).

In general, traces of market uncertainty as drivers for the make or buy decision were found across every outcome and use case (see Table 23 and Table 24).

Table 23. *Evidence of market uncertainty across internal use cases.*

Internal use cases		
Decision	Make	Buy
Market Uncertainty	x	x

Table 24. *Evidence of market uncertainty across external use cases.*

External use cases		
Decision	Make	Buy
Market Uncertainty	x	x

A clear pattern regarding the influence of factors was observed across the analyzed cases. High perceived market uncertainty led to insourcing, while low perceived market uncertainty favored a buy outcome. Instances of increased market uncertainty were found in the fear of opportunistic behavior from the platform provider, immaturity of market solutions, and unanticipated costs. Low market uncertainty was associated with pre-existing relationships with market vendors and certainty of future market developments.

5.3.5 Technological Uncertainty

Most research participants highlighted the criticality of understanding and dealing with the technological challenges coming with IIoT platforms. One of the platform vendors' value propositions is to take the burden in ensuring security and robustness of the data processed by the solution and support for a wide range of standards (Interviewee 4, 2020; Interviewee 15, 2020), as well as scalability of the solution. To tackle both, in fact, firms had to maintain up-to-date knowledge and capabilities among employees. Actors like Company X and Vestas, in general, prioritized bringing the platform-based services to aid their production as fast as possible by skipping the platform development. This was also due to concerns regarding unexpected development delays (Interviewee 21, 2020; Interviewee 22, 2020; Interviewee 25, 2021). In these cases, a great deal of technological uncertainty is aligned with trusting market vendors.

> *"I would say that, overall, the main reasons companies buy from us are security and scalability. We stress these factors a lot. The reason being, Industrial use cases involve billions, trillions of devices. It is crucial to ensure the integrity of the data because it is the data that triggers business operations or technical automation."* (Interviewee 12, 2020)

A symmetrically opposite approach can be observed in Maersk, Danfoss, and Alfa Laval. All companies went through a learning journey, taking the time to build and correct their solutions. In these cases, it appears that technological uncertainty was perceived as an obstacle to overcome to build crucial expertise. Most case companies reported scalability of the IIoT platform solution as a critical aspect, even though this resulted in inconsistent decisions being made. On the one hand, Maersk and Danfoss considered themselves more capable than market vendors in realizing a product that could scale well with millions of devices in use. *"If you want to expand, it is easier on your own platform*"

(Interviewee 16, 2020). Differently, Company X was worried that a self-developed solution would fail to scale in serving substantial traffic of data.

All the technical pain points associated with platform development and maintenance were thoroughly addressed by several platform vendors (Interviewee 1, 2020; Interviewee 3, 2020; Interviewee 4, 2020; Interviewee 10, 2020; Interviewee 12, 2020; Interviewee 13, 2020; Interviewee 15, 2020). In particular, developing a platform was described as *"complex. It's expensive. It takes a lot of time, and the risk of failing is really high. So, generally, you need to have, you know, complex development skills to build and do that, even on Azure that's got all the building blocks"* (Interviewee 3, 2020).

In summary, technological uncertainty appeared relevant across both internal and external use cases (Table 25 and Table 26). However, similar considerations regarding scalability and security concerns were mitigated with opposing IIoT platform sourcing decisions.

***Table 25**. Evidence of technological uncertainty across internal use cases.*

Internal use cases		
Decision	Make	Buy
Technological Uncertainty	x	x

***Table 26**. Evidence of technological uncertainty across external use cases.*

External use cases		
Decision	Make	Buy
Technological Uncertainty	x	-

5.3.6 Ecosystem Implications

The set of considerations around the IIoT platform was another factor for some companies during the sourcing decision. Looking at Danfoss and Alfa Laval's decision to develop a proprietary platform to support their external product use cases revealed differences in the ecosystem considerations. While at the time Alfa Laval decided to develop its own platform, the question of whether to join an ecosystem or to create its own was not of immediate importance. The company reported a growing concern about the topic in more recent times. Joining an IIoT platform ecosystem could provide great opportunities for the highly specialized OEM, given that the value distribution would be mutually beneficial among the ecosystem participants (Interviewee 5, 2020). On a different note, Danfoss attempted to position itself as the keystone organization in their IIoT platform ecosystem (Interviewee 16, 2020; Interviewee 18, 2020). Serving over 16.000 end-users with their proprietary platform solution for supermarkets, the company has proven capable of being the ecosystem facilitator (Interviewee 16, 2020). Within power solutions and hydraulic components, Danfoss followed the same strategy, but the company also offered their bigger OEM clients to integrate the backend of Danfoss's platform in their own platform ecosystem (Interviewee 18, 2020).

On the contrary, Grundfos emphasized that the ecosystem considerations were at the very core of their decision to outsource the external IIoT platform (Interviewee 11, 2020). Consequently, Grundfos started to develop vertical OEM services for their customers and deployed them on the horizontal Siemens MindSphere platform. Grundfos needed to establish a solid presence in the most appropriate IIoT platform ecosystem to remain the preferred hardware supplier in the future. Grundfos viewed the IIoT platform from an ecosystem-centric perspective, regarding future access to customers and their own IoT data (Interviewee 11, 2020). The company was on a journey to co-develop solutions together with Siemens to serve pilot customers and establish itself within the ecosystem owned by Siemens. Furthermore, Grundfos was aiming for a future multi-homing strategy, per which it would establish a presence in different IIoT platform ecosystems and use them as additional distribution channels (Interviewee 11, 2020).

Vestas and Company X both leveraged IIoT for internal production use cases and relied on data structures offered by cloud providers. Other IIoT platform capabilities are delivered through PTC ThingWorx. In addition to the use case similarity, the considerations that led to their respective decisions were very similar between the two companies. The rationale for both companies to choose PTC ThingWorx as their platform supplier was to be found in the generic integration capabilities of the PLCs, which both companies already sourced from PTC. Rather than for the platform's surrounding ecosystem, both companies were looking into platform capabilities to empower employees across the organization to develop valuable services (Interviewee 20, 2020; Interviewee 21, 2020; Interviewee 22, 2020). None of the above-mentioned companies had integrated IIoT solutions from their equipment suppliers, possibly because of the missing alignment on standard interfaces to integrate the solutions into their own platforms (Interviewee 25, 2021).

In summary, the relevance of the ecosystem considerations differed between the cases. It appeared to be of higher relevance for companies focusing on an external use case, regardless of whether they had decided to establish their own IIoT ecosystem or joined another player's existing ecosystem (Table 27). The importance of analyzing the ecosystem implications associated with the platform sourcing decision for external use cases was also stressed by platform vendors (Interviewee 1, 2020; Interviewee 23, 2020).

> *"No one, to my knowledge, is selling standalone IoT services because it doesn't really make sense. I mean, what you really need is that ecosystem."* (Interviewee 23, 2020)

Table 27. *Evidence of ecosystem considerations across external use cases.*

External use cases		
Decision	Make	Buy
Ecosystem Implications	x	x

For companies focusing on internal use cases only, the ecosystem aspect appeared to have a relatively minor significance on the make or buy decision (Table 28).

Table 28. *Evidence of ecosystem considerations across internal use cases.*

Internal use cases		
Decision	Make	Buy
Ecosystem Implications	-	-

5.4 Findings from the Cross-Case Analysis

The cross-case analysis shows that the strategic sourcing factors presented in the conceptual model in 3.5 were relevant in describing the drivers for either make or buy decisions. Depending on the underlying internal or external use case and the respective decision, not all strategic factors showed the same relevancy during the sourcing process. Table 29 provides an overview of the identified strategic factors in the sourcing decision and whether the researchers found evidence of them depending on the outcome and the use case.

Table 29. *Summary of the relevancy of each concept across cases.*

	Make decision		Buy decision	
	Internal Case	*External Case*	*Internal Case*	*External Case*
Resources	x	x	x	x
Competitive Advantage	x	x	x	x
Asset Specificity	x	x	x	x
Market Uncertainty	x	x	x	x
Technological Uncertainty	x	x	x	-
Ecosystem Implications	-	x	-	x

Overall, most of the constructs of interest found evidence in the case study, although with some exceptions. The interviewees' perceptions towards competitive advantage, asset specificity, market uncertainty, and technological uncertainty inconsistently pointed towards a make or buy decision. In general, firms such as Maersk, Alfa Laval, and Danfoss identified an opportunity for establishing a competitive advantage through the development of the IIoT platform. Company X and Vestas were of the opposite opinion and prioritized a fast time to market through readily available solutions. The choice of the platform supplier was influenced by the degree of market uncertainty. For example, the solid inter-firm relationship between PTC and Company X nudged the latter to a buy decision.

Interestingly, technological uncertainty drove firms inconsistently towards insourcing and outsourcing. For instance, Maersk was especially concerned about the scalability of its IIoT platform. It believed that the only way to ensure it was to take control of the solution. Alfa Laval was similarly not taken aback by the steep technical learning curve that a make-decision implied. Differently, Company X showed significant concerns over the viability of rolling out a secure and scalable IIoT platform. Failure to do so would have meant dealing with major issues at a later stage. For this reason, Company X decided to tap into the technological expertise and know-how of an open platform vendor. Introducing an additional layer of differentiation in the analysis, based on the type of IIoT use case, enabled the researchers to extract more conclusive insights. This is further elaborated on in Chapter 6.

The ecosystem perspective introduced in this study was the main driving factor in Grundfos' case. Additional proof in supporting the importance of ecosystemic thinking was highlighted by Alfa Laval and several interviews with other stakeholders in IIoT platforms. Given no previous study had attempted to explain make or buy decisions through the ecosystem dynamics unlocked by the asset, the exposure of this pattern was especially fascinating. Possible explanations for the dynamics identified through the within and cross-case analyses, accounting for previous theoretical contributions, are discussed in the following chapter.

6 Discussion

The work of analysis provided essential insights in addressing both issues from the research question. In particular, a combination of the within and cross-case analysis (Eisenhardt, 1989) enabled the researchers to assess the appropriateness of the conceptual model in identifying *what* factors drive industrial companies in either making or buying an IIoT platform. The factors were inherited by the most influential theories of the firm, transaction cost theory, the resource-based view and the most recent ecosystem literature stream related to the nature of the asset at the core of the decision. From RBV, the researchers inherited the theoretical constructs of resources and competitive advantage. The concepts of asset specificity, market, and technological uncertainty, are consistent with TCT literature. Lastly, digital platform ecosystem literature was accounted for by the construct ecosystem implications.

Moreover, the cross-case analysis, consistent with its premises, exposed preliminary findings in describing *how* the identified factors influenced the sourcing decisions (see 5.3 and 5.4). In detail, the patterns are strictly tied to the type of IIoT use case pursued by a firm. A depiction of the undertaken decision in relation to the use case is laid out in Table 30.

Table 30. *Make or Buy decisions and use case*

		Use Case	
		Internal	**External**
Decision	**Make**	Maersk	Danfoss Alfa Laval
	Buy	Company X Vestas	Grundfos

This chapter builds on top of the work of analysis carried out in Chapter 5. The objective and structure followed in engaging with the literature are described in Section 6.1. The discussion enabled the researchers to elevate the process and abstraction, thus deriving a final theoretical model, articulated in Section 6.2. The model provides answers to both issues characterizing the original research question. Once answered the original research question, the researchers reflected on what the theoretical model implied for current debates and research streams pursued by scholars (see Section 6.3). Moreover, the practical nature of the decision hereby studied can benefit from actionable insights for practitioners. These were formalized with the intent to provide valuable information to managers facing such or similar strategic issues (see Section 6.4). Finally, several limitations of the research are transparently addressed and discussed in Section 6.5.

6.1 Literature Engagement

Consistent with Eisenhardt’s (1989) methodology for inducing theory from case-study research, the findings are discussed in the following sub-sections by engaging with both similar and contrasting literature. Carrying out this exercise is fundamental as it helped in achieving internal validity of the research, elevating the overarching theoretical quality of the study, and driving the generalizability of a sharp model. Consistent with the structure adopted throughout the paper, each theoretical construct was discussed separately. Previous contributions, reviewed in Chapter 3, were assessed against the findings of the analysis. This not only helped in augmenting the confidence in the researchers’ findings, but the juxtaposition of conflicting results encouraged the researchers into deriving a more interesting theoretical model. Throughout each subsection abstractions are always tied to observations from the case companies, to maintain a transparent level of discussion. This was achieved by projecting case-study companies on a chart featuring the relationship between individual concepts and the sourcing decision. Conflicts, as well as consistencies, were explained by weighing relevant theories and informed interpretations of the researchers against each other. This process was carried out on a concept-to-concept basis, and culminates with the articulation of the induced theoretical model in Section 6.2.

6.1.1 Resources

A set of tangible (e.g. machines) or intangible resources (e.g. knowledge and capabilities) are required for the development of an IIoT platform (Arnold & Voigt, 2016; Butschan, Heidenreich, Weber, & Kraemer, 2019). Extant literature is unanimous in suggesting that if firms possess adequate resources, the favorable action is to utilize them, thus internalizing production activities (Murray, Kotabe, & Wildt, 1995; Argyres, 1996; Leiblein & Miller, 2003). On the contrary, lack of resources and capabilities in particular areas turns firms towards outsourcing (Cánez, Platts, & Probert, 2000; Espino-Rodríguez & Padrón-Robaina, 2006). Resources represent an important constraint for organizations. Immediate resource availability allows for greater selection freedom, in the sense that firms are not constrained to market options only, which are the cheaper alternative in the short term. Therefore, firms can weigh other factors and make the most informed decision to maximize medium- and long-term performance. Previous works have tried to explain a different form of exploitation of comparable resources by stating that some firms are comfortable with having temporarily non-allocated resources, as they may function as a hedge against unforeseen risks, or as a chance to seize opportunities more flexibly. Others prioritize the employment of all available resources at any given time, thus minimizing opportunity costs.

As highlighted by Section 5.3, *resources* are a relevant factor to explain the make or buy decision across all the studied cases. To what extent they influence the strategic decision, however, is to be discussed. In Figure 5, each case company is projected on a chart where the horizontal axis represents the level of possessed resources, while the vertical axis delineates the adopted strategy. The turnover of each firm, at the time of the decision, was used as a proxy measure for the possessed level of resources (see Appendix F). According to previous contributions, higher level of resources should be associated with an insourcing strategy, and vice versa. Interestingly, comparable companies in terms of resources, like Danfoss, Alfa Laval, Grundfos and Company X took diverging strategic decisions. This suggests that, although resources are a constraint that companies inevitably deal with, their commitment is subordinate to other considerations.

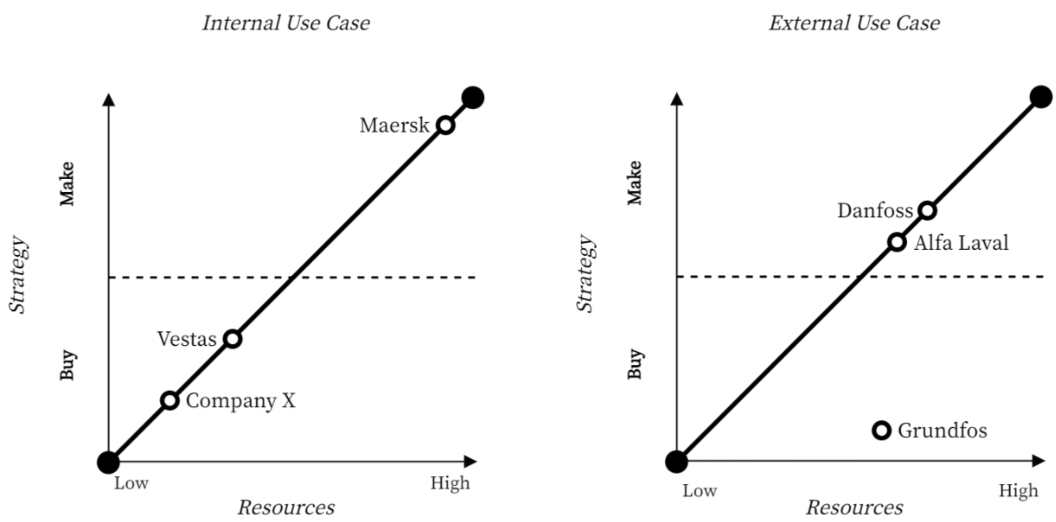

Figure 5. *Resources and asset sourcing decisions.*

Maersk's decision, for example, goes well in line with what the literature suggests. As presented in the analysis, Maersk is a large corporation with a robust IT department, and its size overshadows other companies' IT departments from the case study. However, to state that mere availability of resources implies insourcing would be an oversimplification. It is both the possession of adequate resources together with the willingness to commit them, that characterizes insourcing decisions. For example, both Vestas and Company X in this case study were unwilling to commit resources for internal production, although featuring comparable scale and expertise with companies like Danfoss and Alfa Laval that decided to insource. Development of the IIoT platform requires substantial upfront investments, in terms of knowledge, capabilities, and other assets, while sourcing from the market only demands recurring subscription payments and comparably lower upfront investment in human resources. Moreover, this case study highlights how firms evaluate the opportunity cost of employing their resources on specific projects. In Company X's case, the available resources were destined to create value for higher-level services on top of the IIoT platform, rather than locking them up in the development of the IIoT platform itself.

Resources, when considered independently, still offer a decent basic understanding of companies' strategies (e.g. Maersk and Company X), which resonates with what other authors have found. However, they are not sufficient to clearly explain all decisions from this case study (e.g. Grundfos, Alfa Laval, and Danfoss). In particular, Figure 5 suggests that the shortcoming of existing literature is restricted to use cases supporting downstream activities.

6.1.2 Asset Specificity

Asset specificity refers to the extent to which market solutions support the IIoT use case of a firm without incurring specific investments (see 3.5). According to transaction cost literature, low asset specificity is usually associated with outsourcing, while an internalization strategy should be chosen when dealing with high asset specificity (Riordan & Williamson, 1985; Lieberman, 1991; Coles & Hesterly, 1998; Thouin, Hoffman, & Ford, 2009). If an asset exhibits low specificity, it is more likely to be marketed by multiple vendors and thus available at competitive prices with a low risk of vendor lock-in and little room for opportunistic vendor behavior. In this situation, markets represent the least costly option in comparison with internalization. Moreover, this proposition holds not only for physical assets but also for information technology assets

(Thouin, Hoffman, & Ford, 2009). Differently, highly specific assets require greater efforts in their production and transaction. These complicate market transactions and, as a result, firms prefer to internalize the activity, thus retaining a greater degree of control and transparency.

In this case study, asset specificity was found to be highly relevant in informing the sourcing decision, and its implications partially align with previous theory. In internal contexts, where the IIoT platform is deployed to e.g. support the monitoring of an organization's production, the generic configuration options of existing market solutions appear to satisfy a firm's needs. This allows companies to concentrate efforts on the configuration of the IIoT platform, instead of the development. This reasoning explains the behavior of Vestas (5.1.4) and Company X (5.1.6). However, simply because the use case is limited to production monitoring, it does not mean that companies should always outsource. In presence of a high degree of asset specificity, where the business requirements cannot be satisfied with the mere configuration of market solutions, internalizing the creation of an IIoT platform is the superior solution.

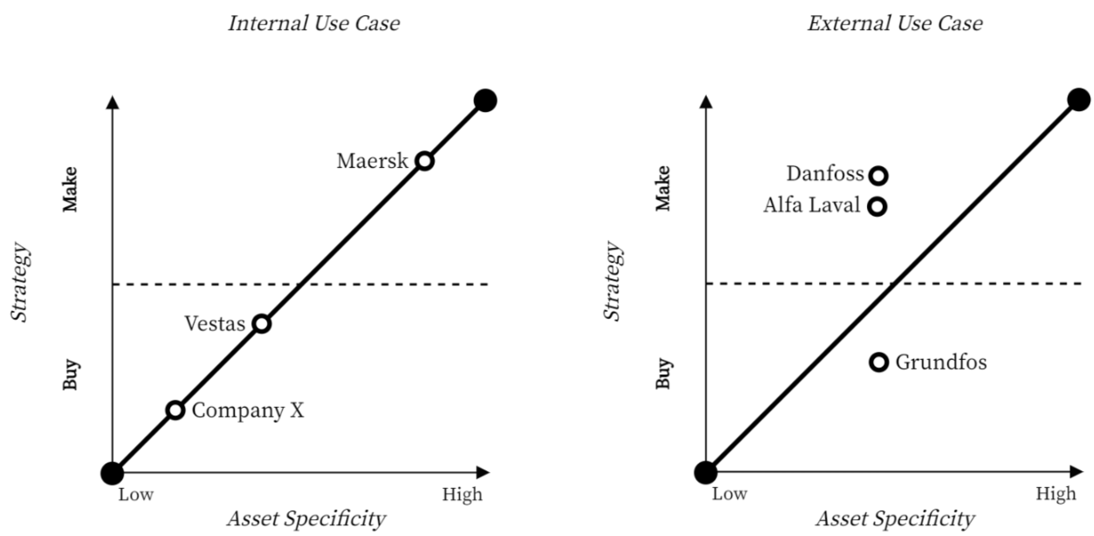

Figure 6. *Asset specificity and asset sourcing decision across use cases.*

None of the IIoT platforms offered on the market were adequate to serve Maersk's particular monitoring needs, and the company had to enter into a co-creation journey with infrastructure provider Microsoft. While the argumentation along the previous literature holds well within internal IIoT use cases, it struggles to explain companies' decisions when deploying customer-facing solutions. In this context, asset specificity is not a valid predictor for either insourcing or outsourcing. As seen in 0, Danfoss, Alfa Laval, and Grundfos shared very similar requirements, where specificity was linked to the parameters of certain assets and not the actual platform assets. If, for example, Alfa Laval was concerned about vibrations, rotations of the components inside decanters, Danfoss was tracking similar parameters among its mechanical equipment products, and Grundfos had to monitor how their static pumps were performing. These classic industrial applications can be addressed using general-purpose IIoT platforms, focusing on offering generic IIoT solutions by providing tools for modeling most common assets and relevant parameters. A plausible explanation for why similar asset specificity can lead to such different outcomes can only be obtained if other contextual factors are addressed.

To sum up, the implications of asset specificity in the light of an asset sourcing decision are intertwined with the use case specifications. Within production-related use cases, asset specificity retains good explanatory power in predicting the sourcing strategy. This is consistent with classic transaction cost literature. Yet, if the IIoT platform serves as a channel for customers, *asset specificity* alone fails to clearly pinpoint either a make or buy decision.

6.1.3 Market Uncertainty

Since uncertainty is determined by heterogeneous forces (see 3.1.3), its discussion must be carried out in separate stances. Market uncertainty has been investigated by transaction cost literature by addressing the variation in quantities associated with a transaction, i.e., volume uncertainty, and the risk of opportunistic supplier behavior (Williamson, 1979; Williamson, 1981; Walker

& Weber, 1984; Williamson, 1985; Walker & Weber, 1987). As noted in section (3.5), volume-related uncertainty is insignificant in the context of digital IIoT assets. Buyers do not need to assess fluctuations in the demand for the asset, nor do they need to plan for or anticipate the supply side. Furthermore, buyers do not need to be concerned about physical consumption and deterioration of the asset, as these traits do not exist in the same way for digital assets. Risks deriving from market uncertainty or opportunistic supplier behavior are instead worthy of more consideration in the context of digital platforms. The former reflects the degree to which firms are uncertain regarding the changes in market players and market solutions as time passes by. Essentially, it refers to Koopman (1957) and Williamson's (1985) concept of *primary* uncertainty, which is influenced by exogenous sources. In the presence of a still deeply fragmented market with an overwhelming amount of options, as is the case for IIoT platforms, the potential buyers struggle to perform a satisfying assessment. Therefore, organizations may be more comfortable with avoiding committing to an immature market solution (e.g. Alfa Laval). This case study has exposed how firms are afraid of betting on the wrong horse. In other words, vertical integration may be the preferred solution in emerging industrial markets in their early stages, where major consolidation dynamics are expected. This observation is in line with early transaction cost literature (1979), though it apparently clashes with what was found by Sutcliffe and Zaheer (1998). A closer investigation of Sutcliffe and Zaheer's findings, however, reveals that their construct of primary uncertainty departs from the concept of market uncertainty intended in this study because it strongly overlaps with technological uncertainty, which will be explained in the following section. When it comes to behavioral uncertainty of suppliers, the findings of this research are consistent with John and Weitz (1988). In particular, the risks associated with opportunistic supplier behavior seem to be mitigated by existing commercial relationships with suppliers, possibly because the incentive to maintain a good reputation is stronger the more transactions two firms enter together (Baker, Gibbons, & Murphy, 2002). This can be observed in multiple contexts, for instance in Company X's (5.1.6), Vestas' (5.1.4), but also in Danfoss (5.1.1) and Maersk's (5.1.2) case. In general, companies prefer to enter contractual relationships with others that they are already accustomed to. This observation allows reflecting on the previously mentioned cases from an interesting point of view. A make strategy, or insourcing, translates into becoming a customer of one of the few cloud infrastructure providers, who also supply IIoT platform vendors. If a firm is set to decide between insourcing or outsourcing, having established relationships with a cloud infrastructure provider indeed increases the attractiveness of an insourcing strategy. Maersk and Danfoss provide clear examples of the illustrated dynamic. The two organizations reported to have pursued outsourcing (on an infrastructure level), among other reasons, because of the opportunity to leverage a long-lasting partnership with Microsoft. Furthermore, this observation is consistent with the findings from Falkenreck and Wagner (2017), who noted that collaborations between firms in the IIoT are driven by mutual trust and credibility, and with Baker, Gibbons and Murphy (2002), who stated that repeated transactions between parties mitigate risks of opportunistic behavior.

If low behavioral supplier uncertainty positively correlates with outsourcing, as also seen in Grundfos' case, it then is expected that a higher degree of uncertainty steers firms away from the market. This conclusion is supported by Alfa Laval's case (5.1.3). The company feared that an industrial platform vendor would gain information about their products, resulting in an insourcing decision. This observation is in line with a finding from Huang et al. (2009), who noticed that unintended disclosure of sensitive information to a competing supplier may significantly undermine the competitiveness of a firm.

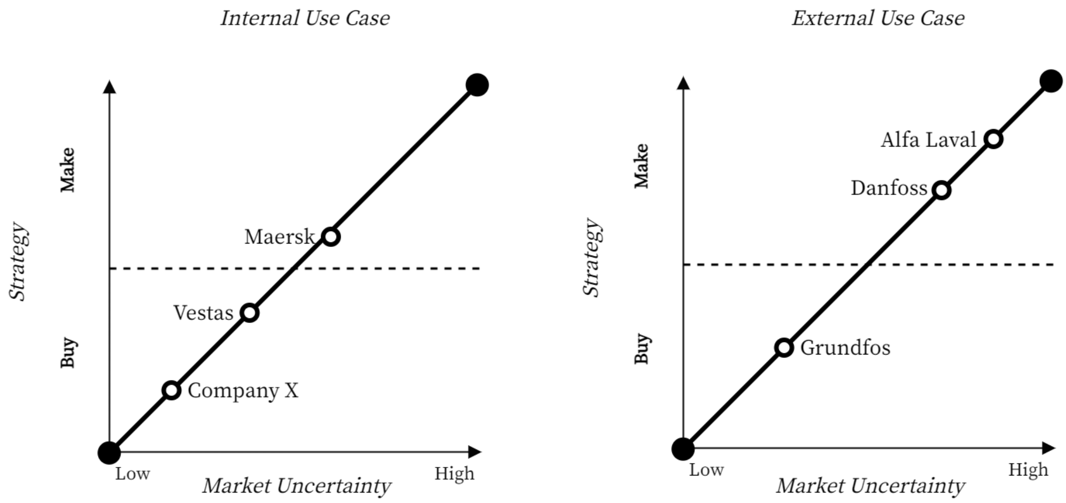

Figure 7. *Market uncertainty and asset sourcing decisions.*

In conclusion, uncertainty, limited to its market traits, possesses satisfying explanatory power in describing why companies decide to make or buy. Substantial concerns with opportunistic supplier behavior drive firms towards insourcing, while companies prefer markets when vendors cannot exploit their position. This also relates to the overall maturity of the market. If the latter is fragmented, and further consolidation is expected, then outsourcing development of the platform loses appeal.

6.1.4 Technological Uncertainty

Previous literature advanced that a higher degree of technological uncertainty pinpoints vertical integration (Walker & Weber, 1984; Balakrishnan & Wernerfelt, 1986; Sutcliffe & Zaheer, 1998; Madhok, 2002; Leiblein & Miller, 2003). However, this seems not always to be the case. In specific scenarios (see Danfoss' case under 5.1.1), firms may prefer insourcing as a way to mitigate technological uncertainty. This contradicts with previous contributions, where firms were found to prioritize the more flexible approach of outsourcing to markets.

As extant IoT literature pointed out, major technical challenges associated with the IoT are commonly identified in scalability and security. Industrial companies that perceive a great risk originating from ensuring security and scalability in a stand-alone proprietary solution will most likely not internalize development and will leverage vendor's investments and expertise (Madhok, 2002). Concerning data security, its importance in determining collaborations between firms was already highlighted by Falkenreck and Wagner (2017). This case study goes beyond that observation, finding that companies mitigate technology-related risks in different ways. While Danfoss and Maersk used scalability and security as arguments for in-housing the platform development, Vestas and Company X mentioned the same arguments for explaining their outsourcing choice. One explanation for these contradicting arguments resides in the time horizons of the companies and the traits of their use cases. In a way, an interplay between asset specificity and technological uncertainty seems to exist. Maersk faced both great concerns in regard to scalability, but also a peculiar implementation of the IIoT use case. Differently, Company X and Vestas relied on market vendors, allegedly in a better position to deal with technology-related risks due to their expertise and scope of activities.

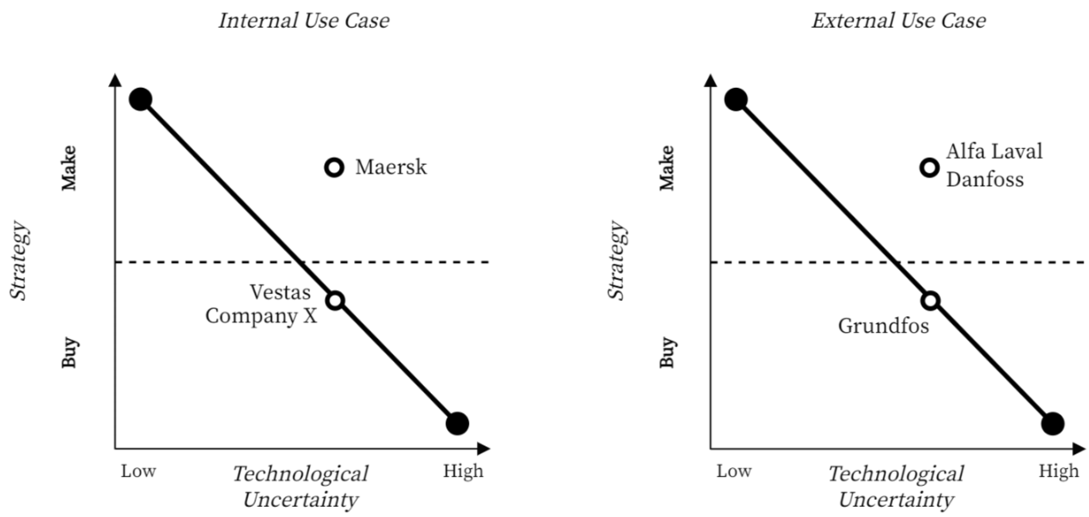

Figure 8. *Technological uncertainty and asset sourcing decisions.*

The third type of technological uncertainty, emerging from the case study, is related to the burden of maintenance. It was previously established that one of the main challenges the IIoT brings is the evolution of common standards. Even if this consolidation is not something that firms actively pursue, IIoT solutions must support up-to-date interfaces through which machines communicate. This creates the issue of maintenance, a hardship that is taken on by the platform vendor. Both Company X, Vestas, and Grundfos consciously prepared for this kind of uncertainty through outsourcing.

Technological uncertainty appears to be an important factor in driving the make or buy decision, and not being secondary to market uncertainty, as Walker and Weber (1984; 1987) noted. However, in some circumstances, it lacks the explanatory power that market uncertainty possesses. A possible explanation is that technological uncertainty would benefit, much like the overarching construct of uncertainty, from a further breakdown into several subconstructs. Plausible constructs, under IIoT literature, would be scalability and security (Hejazi, Rajab, Cinkler, & Lengyel, 2018). Another possible explanation is that a technological uncertainty would yield greater explanatory power if coupled with another arbitrary factor from the conceptual model. However, as stated in introducing the engagement with literature (Section 6.1), the exploration of cross-concept dynamics in explaining make or buy decision was outside the scope of this study. In general, substantial concerns in either the ability of a firm to ensure the IT security of the asset, the willingness to keep up with the pace at which technology standards change, and the possibility to deliver a platform that scales well along with the business raise doubts regarding the feasibility of an insourcing strategy.

6.1.5 Competitive Advantage

Organizations benefit from an advantage over their competition if they have implemented a value-creating strategy, that no competitor has implemented or can reap the same benefits in other ways (Barney, 1991). Competitive advantage is a widely used construct to explain why, within the same industry, some firms are more profitable than others. In particular, superior profitability can be achieved via two strategies: cost leadership or differentiation (Porter, 1985). A stream of research, which was spun off from RBV, argues that several conditions must be met for a firm to sustain either strategy in the long run. Since organizations are viewed as bundles of resources, which they transform to obtain a marketable product or service, possessing at least one key resource that is *valuable*, *rare*, *inimitable*, and *non-substitutable*, puts them in a superior position compared to competitors (Barney, 1991). What emerges from this case study is that competitive advantage impacts the way companies approach make or buy decisions. If the ownership of the IIoT platform translates into ownership of a VRIN resource, firms are better off with the internalization of the development efforts. An illustration for this case is provided by Maersk (5.1.2). The company perceived the in-housing of the IIoT platform as the least costly option in the long term, and as a way to uniquely empower business processes. In other words, vertical integration was chosen to eventually realize both a cost leadership advantage and differentiation from competitors. In regard to whether Maersk can achieve a *sustainable* competitive advantage or not, is out of scope for this study. The implications that can be derived from the role that perceived competitive advantage plays in make or buy decisions, can be pictured as follows: Whether corporations rely on markets or a hierarchy structure to source an IIoT platform, depends on if the ownership of that asset can grant a sustainable advantage or not. In different terms, the exercise to be made by organizations is to assess if by controlling the development of an IIoT platform, they actually control a VRIN resource. Shall that be the case, sourcing from the market would be a strategically wrong choice. Interestingly, the pursue of competitive advantage explains why companies deal with the constraint of resources, and the issues of uncertainty, in different ways.

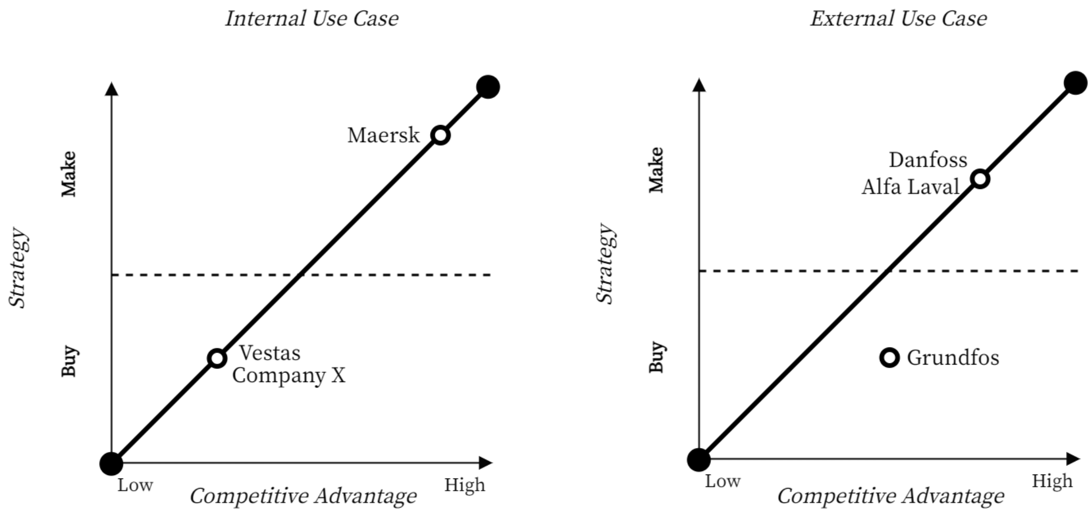

Figure 9. *Competitive advantage and asset sourcing decisions.*

A perceived significant competitive advantage pushes companies to go beyond technical challenges and commit resources to the development of an IIoT platform. This is consistent with Welch and Nayak's (1992) findings, suggesting that companies are, to some extent, driven by the ambition to achieve a sustainable competitive advantage when they make sourcing decisions on a technological asset. On the other hand, when ownership of the asset only leads to a low, or only temporary, competitive advantage, organization prefer to outsource to markets. This argument holds well across different sourcing decisions and use cases. Both Vestas and Company X perceived the IIoT platform as a commodity, and their buy decision was justified in this light. Locking resources into internalizing the development would have meant a longer time to value with a more uncertain outcome in the long term. On the contrary, Maersk, Danfoss, and Alfa Laval perceived the IIoT platform as an enabler of both cost leadership and/or differentiation. Thus, committing to a buy decision would have meant giving up on an edge against competition.

Nevertheless, this case study also provides evidence that the pursue of competitive advantage may not be the only primary driver for the sourcing decision of an IIoT platform. Similar to what Corbett (2004) and Hines and Rich (1998) found in companies trying to achieve a competitive advantage through external factors such as unique supplier networks, the example of Grundfos leads to the conclusion that, although competitive advantage as such holds good explanatory power in predicting make or buy decisions, a more comprehensive theory must go beyond constructs limited to transaction cost theory and the resource-based view.

6.1.6 Ecosystem Implications

When the digital asset is destined to serve internal IIoT use cases, factors such as *resources*, *asset specificity*, *uncertainty* and *competitive advantage* suffice in explaining make or buy decisions. However, those factors struggle to explain decisions that regard IIoT platforms that support solutions that are offered to end-customers. In particular, constructs from TCT and RBV are insufficient to explain why allegedly comparable firms (e.g. Alfa Laval, Danfoss and Grundfos) follow divergent paths. To provide a satisfactory resolution to this issue, the discussion must be shifted to the research stream on platform ecosystems (see 3.4).

The ecosystem of IIoT platforms is a collaborative structure through which different participants develop vertical innovations based on the platform resources, in order to serve a coherent proposition to industrial end-customers (Adner, 2006; Gawer & Cusumano, 2014). This is important because firms exhibit different types and degrees of control, depending on the role they play in a certain ecosystem (Eisenmann, Parker, & Van Alstyne, 2009; Brandenburger & Nalebuff, 1996). This case study illustrates an example for each role identified in the literature: platform owner, complementor or industrial end-user (see Table 31). The decision to develop an IIoT platform (e.g. Maersk, Alfa Laval, and Danfoss) ultimately brings the company to the position of a platform owner, in which they exercise governance over the degree of openness or control of the platform. Differently, a buy decision translates into the role of either an *end-user*, or a *complementor*.

Table 31. *Overview of the platform ecosystem roles.*

		Use case	
		Internal	**External**
Decision	**Make**	Platform Owner	Platform Owner
	Buy	Industrial End-User	Complementor

Gawer and Cusumano (2008) found that most companies want to pursue an industry platform strategy. However, they fail to correctly evaluate the industry conditions and market strength during the decision process. After all, most of the literature focuses on the challenges and benefits of platform owners, leading to believe that every organization should provide an industry platform to stay relevant, while this should not be the case. Digital platforms may exhibit network effects (Gawer & Cusumano, 2014; Katz & Shapiro, 1994), which lead to the convergence of users on a selection of successful platforms (Eisenmann, Parker, & Van Alstyne, 2011), which is the economic incentive for the platform owner role. Given the tight interplay of different stakeholders that bring IIoT solutions to life, it is clear that platforms will be successful as long as they foster a rich ecosystem of complementors (Pauli, Marx, & Matzner, 2020).

> *"We're seeing an emergence of new ecosystems where we see the platform and marketplaces, where enterprises who have critical mass in an industry are establishing a platform, and then every single player has to determine where they play, which platforms they will play on or whether they are strong enough to create their own ecosystem."* (Interviewee 23, 2020)

It appears, from the results of this case study, that the decision between making or buying is subordinate to an assessment of the dynamics between and within ecosystems. Companies like Grundfos are driven, more than anything else, by the possibility to tap into the value of existing ecosystems, which renders internal development of establishing a platform (i.e. pursuing vertical integration) a waste of resources. The findings of this study deviate from the previous innovation ecosystem literature (Adner, 2006) which identifies technological innovation as the main value derived from the ecosystem. In particular, this aligns with the argumentation of a few authors, suggesting that the fundamental value offered by ecosystems is the facilitation of business interactions (Thomas, Autio, & Gann, 2014; Wheelwright & Clark, 1992; Boudreau, 2012). In particular, the larger market access through the established customers of the platform owner, is one of the main decision drivers for a complementor strategy (Pauli, Marx, & Matzner, 2020; Huang, Ceccagnoli, Forman, & Wu, 2009). Industrial digital platforms represent a way to interconnect not just streams of data, but most importantly, businesses themselves. In the already mentioned case of Grundfos, the priority of the company was to stay relevant in the context of smart cities, and Siemens' IIoT platform was already accommodating many of the important stakeholders.

> *"Interconnectivity is not about data connectivity, it's about business connectivity."* (Interviewee 11, 2020)

Misunderstanding the importance to determine the right ecosystem strategy can be costly. For example, Alfa Laval was mainly driven to internalize the platform development by the pursue of competitive advantage, however, the fact that the platform was kept proprietary and not opened to third parties prevented the emergence of an ecosystem. One issue, in that particular case, was that the company's decision was taken in a context of immature solutions and still evolving ecosystems (see 5.1.3). Moreover, the ecosystem consideration is closely related to the dynamics of the market and its uncertainties. Assuming the role of a complementor comes with concerns over potentially losing the direct customer relationship to the platform owner and being dominated in terms of how value is distributed among the ecosystem participants, makes a join decision into an existing ecosystem difficult. As a keystone (Iansiti & Levien, 2004), the platform owner may exploit its central position as a mediator between the complementors and end-users to compete vertically with the complementors. In doing so, the keystone becomes a value dominator (see 3.4). The proposition from Iansiti and Levien has found consensus among a variety of authors (Gawer & Henderson, 2007; Huang, Ceccagnoli, Forman, & Wu, 2009), though the literature is slim in regard to how complementors can defend themselves against value domination. The risk posed by the latter is greater, the less specialized the industrial complementor is (Ceccagnoli, Forman, Huang, & Wu, 2012).

This case study provides some clarification as to how industrial complementors may mitigate this risk. First, firms must defend their strong downstream capabilities, which decreases the likelihood of a competing platform owner (Huang, Ceccagnoli, Forman, & Wu, 2009). Second, the complementor should increase the number of hosting platforms, or in other words, pursue a multi-homing strategy. Multi-homing refers to offering the applications, services, and products on multiple platform ecosystems. In doing so, the complementor faces a trade-off between the burden of establishing and maintaining a presence on multiple platforms, while benefitting from greater access to industrial customers (Eisenmann, Parker, & Van Alstyne, 2006). As an example, Grundfos was planning to establish parallel presences on other platform ecosystems, as soon as the landscape would have been more mature.

In conclusion, the ecosystem lens provides an appropriate way to comprehend make or buy decisions. When sourcing a digital platform, the value of the ecosystem yielded by either solution affects the degree to which a certain option is appealing in comparison to the alternative. For some firms, it makes sense to pursue a keystone strategy, due to the fear of value domination (e.g. Danfoss), while others may prefer to take a complementor role and tap into the value of already existing ecosystems established by others (e.g. Grundfos). These dynamics go beyond the factors addressed in previous sections, and they allow for a greater understanding of make or buy decisions.

6.2 Findings from the Literature Engagement

Two main conclusions can be drawn from what has been discussed in Section 6.1. First, the conceptual model embraced for the purpose of this work is well suited for modeling make or buy decisions on industrial digital platforms, across very different contexts. All studied factors allow scholars to understand the dynamics that drive make or buy decisions in industrial companies in the context of IIoT. Firms have to deal with a *resource* constraint, which entails the appropriate allocation of e.g. human resources. Those are locked-in in a make decision, the greater the *specificity* of the asset is. Moreover, firms make such a decision in environments characterized by various degrees of *market uncertainty*. This is coupled with the *unknowns* of the underlying technology associated with the traded asset, which may delay the time to market of the IIoT solution in the case of insourcing. In the case of an outsourcing decision, the risk companies expose themselves to is the potential missed opportunity of internalizing technical capabilities to achieve an advantage. These considerations are, although with some exceptions, fairly aligned with extant literature on make or buy decisions. Besides, firms are attracted to either alternative (make or buy), by the perception of achieving sustainable *competitive advantage*. Lastly, organizations are drawn to IIoT platforms that are surrounded by a rich *ecosystem* that enables mutual value creation. In case of no pre-existing ecosystem, firms are incentivized to build and orchestrate their own business ecosystem around a proprietary platform core.

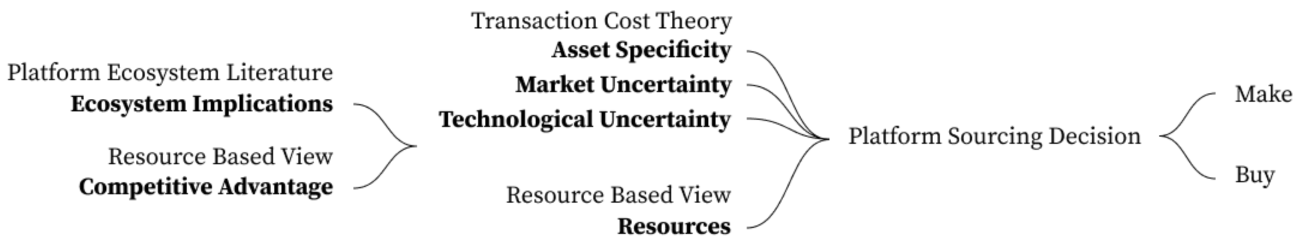

Figure 10. *Conceptual model emerging from the discussion.*

In isolation, however, the above factors are only able to partially explain the issue at hand, which leads to a second, more profound argument. While some factors are either constraints (e.g. resources) or contingent elements (e.g. market uncertainty), organizations experience a certain dependency order in which the competitive advantage and ecosystem implications have to be considered first. These two components appear to provoke cascading effects on the more dependent factors. For example, when firms perceive a promising chance to establish a competitive advantage, they are willing to accept substantial levels of technological uncertainty. In a scenario where a firm must choose between making or buying, and assuming alternatives are comparable in terms of costs, risks, and adequacy of existing platform offerings, it will be the ecosystem associated with either options that will dictate the winner. So long, at least, as the firm does not have the ambition to play the keystone role, or as it is not edged by a value dominator. Pursuing the right ecosystem strategy is important in the context of highly interconnected businesses, because industries have been disrupted and are still being disrupted by the new ways of interactions between stakeholders, and they overshadow the implications of some of the other factors.

6.3 Theoretical Contributions

This research paper contributes to the existing literature in different, intertwined, ways. First, the dispute regarding whether TCT or RBV is better suited in theorizing vertical integration should be dismissed. Scholars have long debated over the appropriateness of using specific theories of the firm in explaining make or buy decisions. As much as those theories are popular among scholars (see Chapter 3), limiting the discussion around either is naive and proven to bring inconclusive results. As noted by Madhok (2002), it is illogical to contrapose those theories, as they are interested in two different aspects of economic activity. While TCT is concerned with frictions around *exchanges*, RBV seeks to explain *production* differences across firms. If the objective is to model what factors influence decision-making around an industrial asset sourcing decision, then the theoretical foundation cannot dismiss a consideration of either exchange or production. After all, when deciding on the form of sourcing, organizations choose between procuring an asset through transactions on markets or structuring internal processes for development purposes. In other words, the two issues are tightly interconnected and require a comprehensive theoretical solution (Richardson, 1972; Lorenzoni & Lipparini, 1999). The latter is cemented in the work of analysis and consequent discussion presented throughout this paper.

> *"A truly strategic theory of the firm should address not just the decision with respect to hierarchical governance or market governance, i.e., production or exchange, but also take into account how a firm's resources and capabilities can best be developed and deployed in the search for competitive advantage."* (Madhok, 2002, p. 541)

This research provides an answer to Madhok's call to propose a comprehensive approach for a theory of the firm. Notably, this void had been highlighted throughout the years by several authors, starting as early as Coase (1937), though no substantial contribution had yet been advanced to amend the gap.

Second, theoretical approaches to make-or-buy decisions, in being limited to TCT and RBV literature, have accumulated debt with the digital age. Digital assets such as platforms can disrupt industries regardless of geographical boundaries, by fostering value-creating interactions between different user-groups (Parker, Van Alstyne, & Choudary, 2016). Since classic theories developed in a very different social, economic, and technological context, they fall short in providing a deep understanding of the implications for digital platforms. In particular, the business ecosystem behind these interactions is brought in the foreground of a theory. This study not only points to the rising importance of the ecosystem implications, but it represents the first sensible attempt to introduce the ecosystem perspective in modeling make or buy decisions. Tiwana (2014), argued for a multiplicity of organizational factors to be considered simultaneously during the platform ecosystem evolvement. This work provides decision-makers and researchers with a more holistic map to master a multiplicity of considerations during the make-or-buy-decision, including the ecosystem perspective.

Third, this study contributes to the platform ecosystem literature by emphasizing the transition towards interconnected manufacturing industries. Platform-driven ecosystems entail a fundamental shift in value creation. Contrary to traditional businesses where value is mainly created within the firm (Van Alstyne, Parker, & Choudary, 2016), platform-driven ecosystems facilitate value creation through interactions between multiple participants (Pauli, Marx, & Matzner, 2020; Huang, Ceccagnoli, Forman, & Wu, 2009; Thomas, Autio, & Gann, 2014; Boudreau, 2012). This study has not only shown that this disruptive shift in value creation can be observed in the manufacturing industry, but it also emphasizes the rising importance of business interconnectivity in industries, fostered by the IIoT. This implication is as essential for scholars as it is for practitioners, especially given how managers still struggle to understand or acknowledge this shift. In Section 6.4, this finding is articulated to provide guidance to industrial firms that are facing the strategic dilemma between making or buying an IIoT platform.

6.4 Managerial Implications

As the issue at hand is grounded in organizational practices, this study is suitable to provide actionable strategic insights to managers facing an IIoT platform sourcing decision. After all, much can be learned from the experience of various organizations, operating in diverse contexts. One recommendation to managers is the importance of assessing factors with the right priority and sequence.

First, different use cases are associated with different implications. If a firm is set to deploy IIoT solutions with the purpose of monitoring and optimizing production processes internally, the customers of that solution consist of the people working in the production. Differently, if the IIoT solution is supposed to enhance products or services, the customers consist of the downstream businesses or end-customers using that product or service. The requirements of business customers can be substantially different from internal stakeholders. For example, in the external case, the platform might need to support complex integrations with the customer's production platform, while the internal case might require interconnecting machines from multiple vendors.

Second, firms must pay attention to the ecosystem implications. This means that managers need to approach the make or buy decision by assessing the opportunities and risks that originate from IIoT platforms. In this regard, no one size fits all solution exists. Perhaps, as a complementor, a firm can gain access to a substantial number of partners and new customers, which otherwise could not be accessed. Furthermore, not only the platform provides an advantage through network effects to the platform owner, but also to the complementors. If industrial companies' source digital assets almost exclusively via digital platforms in the future, OEMs must be present on either platform to secure a spot on the predominant exchange channels with customers (e.g Grundfos). Otherwise, they run the risk of disintermediation and therefore go out of business. Industrial end-users which aim to support internal IIoT use cases, the ecosystem considerations have shown to be less critical (e.g. Company X). However, the ecosystem surrounding IIoT platforms yields important long-term consequences for the business operations and should be accounted for. This case study highlights how the concept of business ecosystems is something managers still struggle to fully understand.

Third, managers must understand which option better facilitates the achievement of a sustainable competitive advantage. Although at a different pace, all industrial companies are in the middle of a digitalization effort. The risk here lies in the assumption that by simply building as many technology-related capabilities as possible, incumbents will standout against their competition. This case study suggests that such an approach only produces positive results when very high asset specificity is at play. In this scenario, the competition cannot easily copy the strategy and neither source a comparable platform from the market, nor build it in-house, because the first-mover advantage by the early adopter puts a high barrier to entry in place. Differently, if the use case is sufficiently covered by existing market solutions, embracing the journey of internalization represents a pessimal deployment of a firm's resources, as competitors can obtain access to comparable assets with minimal efforts.

As much as the other factors are worthy of consideration, they are subject to both the informed assessment of a strategy designed to maximize the value of ecosystems as well as maximizing the chance to gain and sustain a long-term competitive advantage. These two drivers command in fact how managers are willing to commit resources, and what approach they should adopt when facing varying degrees of market and technological uncertainty. Nevertheless, the main managerial contribution of this work lies in the combination of the strategic decision-making factors which support managers with a clear outline to consider during the process, instead of overly focusing on single dimensions.

6.5 Limitations

This research paper does not come without limitations. First, despite taken due diligence in designing and following a structured research approach (see 4.4 and 4.5), external validity may be questioned, due to the nature of the study. However, the fact that some findings align with a multitude of works in different streams of research (see 6.1) seems promising. Moreover, the time horizon at disposal did not permit carrying out a longitudinal study. Possibly, more thorough data could have been obtained by collecting information both before, after, and during the decision-making of each case company. At the same time, this limitation was somewhat offset by carrying out in-depth interviews with a variety of platform vendors. These stakeholders shared experiences and knowledge regarding the entire journey of industrial companies when they approach the studied strategic issue. Furthermore, a longitudinal study would have not helped in answering the original research question. The objective, in fact, was to understand what factors drove the decision-making of companies in sourcing an IIoT platform. It was not the focus of this study to understand how these factors develop over time. Still, the latter question can extend the findings of this study.

Second, the design of this qualitative research could have benefitted from the consistent perspective of participants holding comparable positions in the studied companies. As stated in Section 4.4, the research participants featured diverse roles ranging from top management positions to operation-related employees. This, however, did not impair the quality of the findings, due to the diligent measures adopted by the researchers, such as the triangulation of data sources.

Third, a limitation exists in the comprehensiveness of the adopted theoretical framework. As much as it accounted for the most popular theories, TCT and RBV, factored in by a number of researchers (see Chapter 3) when studying similar issues, it dismissed some potentially relevant or related other theories. For instance, knowledge-based theory (Grant, 1996), by explicitly focusing on *knowledge* as the most strategically important resource of a firm, represents an interesting branch of RBV. Throughout this research, knowledge was addressed at a higher level, in synergy with other resources, under RBV. Further exploring the implications of knowledge could have helped in clarifying the dynamics between competitive advantage and how resources are committed by firms. On a similar note, TCT literature holds that decisions within firms are taken by individuals subject to bounded rationality. Rationality is limited by the processing capacity possessed by people, cognitive biases, and time-constraints. Traces in the collected primary data would suggest that bounded rationality would extend the quality of the proposed conceptual model. This limitation is acknowledged by the researchers and was attributed to the limited scope of this master thesis. As much as behavioral theories such as the Theory of Planned Behavior (TPB) by Ajzen (1991) are popular within strategic research, extant literature had so far not found them of use in explaining make or buy decisions. Hence, the researchers' efforts were limited to classic theories, TCT and RBV, as well as more novel research areas, like ecosystem literature, more relevant to the research area.

7 Conclusion and Future Research

Common implementations of the IIoT involve monitoring of production plants or the servitization transformation of industrial assets, through which companies can drastically improve efficiencies. However, implementing the IoT in industrial companies represents challenges. In practice, early adopters of IIoT rely on digital platforms to host applications at the service layer. Unfortunately, only scarce literature on IIoT platforms exists., The presented study proposed to contribute to this area of research. Through a rigorous review of the extant literature and a set of in-depth exploratory interviews, a specific research gap was identified to understand why some industrial companies insource digital platform development, while some others outsource it. In particular, the research question was, upon several iterations, formulated as follows: "*What are the strategic factors, and how do they influence making or buying a digital platform in the Industrial Internet of Things?*" In trying to answer it, the researchers carried out a qualitative multi-case study characterized by a mixture of inductive and deductive reasoning. Case study data was gathered by conducting in-depth semi-structured interviews with 25 research participants from 12 different companies. Half of them consisted of organizations utilizing an IIoT platform, equally split between companies that decided either to make or buy a platform. The remaining other half consisted of relevant market players selling IIoT platforms as a service, who could share their own experiences with the strategic decision object of the research. The primary data consisted of over 120.000 words. Its processing and analysis were structured as follows. First, the researchers carried out a process of open coding. The resulting data corpus was streamlined through a joint effort by the researchers and guided the identification of theories of interest and the shaping of a conceptual model. Subsequently, the researchers executed the second phase of coding, limited to the factors comprised in the conceptual model. The outcome provided a basis for the within and cross-case analyses inspired by Eisenhardt's methodology for inducing theory from case study research. A series of findings emerged from the work of analysis, which was later discussed in light of existing contributions from the literature. Subsequently, the researchers argued how transaction cost theory, resource-based view, and platform ecosystem literature are all highly appropriate for theorizing make or buy decisions. Moreover, the developed model suggests that the strategy of a firm in terms of either ecosystem considerations or the pursue of competitive advantage has implications on how organizations decide to commit their resources, and over the degree of market and technological uncertainty they are willing to deal with. In turn, these factors, together with the specificity of the IIoT use case, drive industrial companies towards either a make or a buy decision around platforms.

Several contributions can be derived, both for scholars and practitioners. There has been somewhat of a dispute, among the former, over what theoretical stance between TCT and RBV is better suited in predicting make or buy decisions. This case study proves that such a dichotomy needs to be surpassed because both theories are highly synergistic in explaining the strategic issue. This had already been suggested by a few authors, but no research had so far been conducted to either validate or reject that proposition. A second contribution to theory is the advancement of a comprehensive conceptual model to explain make or buy decisions for industrial digital platforms. The model is grounded in research streams from three areas: production, transaction, and digital platforms. The production issue was accounted for by the resource-based view. The transaction of the asset on the market was modeled through the dimensions of asset specificity, market, and technological uncertainty derived from transaction cost theory. Finally, a third theoretical contribution points to the peculiarity of the underlying asset, which consists of its unique property to facilitate the interconnectedness of businesses, a perspective that is derived from the ecosystem literature on digital platforms.

This work provides opportunities that can be enhanced by future research. For example, both theory and practice could benefit from additional clarification as to how the studied factors interplay with each other. As discussed in Section 6.3, the qualitative analysis sustaining this paper suggests that ecosystem and competitive advantage strategies command how firms approach sourcing decisions in regard to resources, asset specificity, market, and technological uncertainty. More ambitious research could investigate the magnitude of the decision drivers identified in this work and explore whether a shift in how companies approach the outsourcing process is changing over time. Lastly, this paper represents a first step in accounting for interfirm dynamics which are peculiar to digital platforms. A promising avenue for future research comes from the additional exploration of the ecosystem dynamics. Theories like the relational view (Dyer & Singh, 1998) could help in further cementing the theoretical underpinning behind the promises of business ecosystems literature.

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