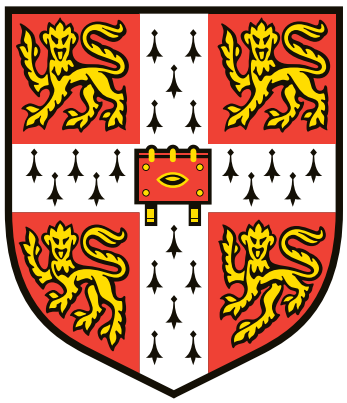
An Investigation of Multisided Digital Platform Boundaries

This dissertation is submitted for the degree of Doctor of Philosophy



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DECLARATION

- This thesis is the result of my own work and includes nothing which is the outcome of work done in collaboration except as declared in the Preface and specified in the text.
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ABSTRACT

Multisided digital platforms (MSDPs) are software systems that attract at least two distinct groups of users and generate network effects. They have attracted the attention of scholars and practitioners in recent years, as they have disrupted how firms create and capture value and have blurred their boundaries. Firms implementing MSDPs may make different boundary decisions when configuring the complements of their MSDPs. In some cases, they build complements in-house, while in others, they rely on third-party complementors. Despite efforts to understand the complex phenomenon of MSDPs, there is still confusion about what they are, and little is known about the determinant of their boundaries. This study aimed to provide a clear definition of MSDPs and investigated the factors influencing their boundaries as well as how firms respond to these factors.

To answer these questions, first, this thesis synthesised a definition of MSDPs by integrating various streams of literature. Based on this, MSDPs have been defined as an organising logic characterised by a layered modular architecture and satisfying three conditions: (1) multisidedness, (2) modularity and (3) codebase extension. Second, this thesis implemented a qualitative case study of Uber, a ridesharing MSDP that disrupted the taxi industry worldwide, to understand the factors influencing MSDP's boundaries. An in-depth analysis of Uber's boundary decisions regarding its payment and maps complements was conducted. This showed that supply side factors identified in the literature, such as the need to reduce transactional hazards and build core competencies, influenced MSDP boundary decisions. In addition, demand side factors that have not been considered by previous research influenced firm boundaries. These demand side factors were complement localisation (adapting to local market conditions), customer heterogeneity realisation (addressing customers' heterogenous needs and preferences) and supermodular complementarity ignition (increasing user numbers and investment in the MSDP).

The findings suggested that an MSDP firm is more likely to rely on third-party complementors to respond to demand side factors, even though this may increase transactions costs. An exception to this is when a third-party complementary asset cannot be customised to meet the requirements of

the MSDP. In these cases, an MSDP is more likely to build a complement in-house. These findings have offered new insights into MSDP boundaries by shifting the focus of existing theories of firm boundaries from the supply side to the demand side and from value capture to value creation. These new theoretical findings have complemented existing theories of firm boundaries and enhanced our understanding of MSDP boundaries. Moreover, these findings have important theoretical and practical implications, such as the need for future research to better understand demand side factors and for managers to evaluate the tension between supply side and demand side factors strategically.

DEDICATION

To the most important people in my life:

Amal, Mohammed, Almaha

GLOSSARY

AI	Artificial Intelligence
API	Application Programming Interface
App	Application
ETA	Estimated Time of Arrival
GPS	Global Positioning System
HTML	Hypertext Markup Language
IPO	Initial Public Offering
IS	Information Systems
MSDP	Multisided Digital Platform
QDAS	Qualitative Data Analysis Software
RBV	Resource Based View
SDK	Software Development Kit
TCE	Transaction Cost Economics
XML	Extensible Markup Language

ACKNOWLEDGEMENTS

Finally, after four years filled with both joyful and stressful moments, my PhD journey has come to an end. During this endeavour, I dealt with a number of challenges, and many lessons were learned from them. Prior to starting my PhD, I had always thought that the challenges I would face would only be intellectual – that they would be related only to the results that I would contribute to the existing knowledge and on meeting the high standards of my university. However, I quickly realized that a PhD is not only about reading journal articles or writing dissertation chapters; it is also about balancing that work with other aspects of life, including family, personal health and relationships with others. When I first started my PhD, my son was only four months old. By the end of my second year, my daughter was born. Even though my children were the best things that have ever happened to me, doing a PhD while having children under the age of five was very challenging and required me to make both family and studies-related sacrifices. Despite these challenges, I was able to make it to the end, and for that I am grateful.

Completing my dissertation would not have been possible without the support from my supervisors, family, research colleagues and friends. I am particularly grateful for my supervisor, Dr Chander Velu, who always strove to provide guidance and helped me overcome the challenges I faced, both personal and related to my studies. I would also like to acknowledge the support I received from my advisor, Dr Tim Minshall, who helped me with narrowing the scope of my PhD studies during my first year.

Additionally, I am very grateful for the assistance I received from Professor Youngjin Yoo, who collaborated with Dr Velu and me to write a high-quality journal article. This collaboration and the frequent discussions we had, both remotely and in person, widened my knowledge and helped enhance my interpersonal and writing skills that I may have not otherwise developed.

I would also like to acknowledge the support I received from Dr Sarah Bulloch and Dr Christina Silver, who provided invaluable feedback related to my methodology and provided me with training on how to use qualitative data analysis software to conduct my data analysis.

Completing my dissertation would also not have been possible without the encouragement I received from my wife, Amal. I am very grateful for her support, her understanding and the sacrifices she made to ensure that I had a suitable environment in which to conduct my studies. She took on the task of taking care of our two young children, spending days and nights to look after them and meet their needs so that I only had to worry about completing my studies.

Furthermore, I am grateful for the support I received from my parents and siblings, who were always there for me when I needed extra help or support regarding family issues or my studies.

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While this dissertation marks the end of my PhD journey, it is the beginning of a new chapter in my life!

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1 INTRODUCTION

1.1 Phenomenon of interest

Digitalisation is transforming the way firms are organised (Yoo, Henfridsson and Lyytinen, 2010) and how firm boundaries are drawn. Digitalisation has made the multisided digital platform (MSDP)—a platform that connects distinct groups of users and third-party complementors using an extensible software codebase to tap into direct and indirect network effects—an integral element of the contemporary economy (Parker, Van Alstyne and Choudary, 2016). Firms operating MSDPs co-create value along with the other actors participating in the platform ecosystem, including users, third-party complementors and sometimes even competitors (Jacobides, Cennamo and Gawer, 2018; Parker and Van Alstyne, 2017). MSDPs are 'inverting' firms; now firms must manage external value co-creation with third-party complementors and customers in addition to managing internal value creation activities (Parker, Van Alstyne and Jiang, 2017). In doing so, firms are moving away from resource control and towards resource orchestration, from internal optimisation to external interaction and from customer value to ecosystem value co-creation (Parker, Van Alstyne and Choudary, 2016).

Inspired by the success of firms, such as Google, Facebook, Uber and Airbnb, scholars and practitioners have suggested the 'platformisation' of traditional products and services as a way of improving existing business models and performance (Constantinides, Henfridsson and Parker, 2018). Some researchers have gone even further, suggesting that the MSDP is the ultimate organising logic[1] (Gawer, 2014) and the recipe for firms' survival in the digital economy (Downes and Nunes, 2018). Researchers have called for an increased examination and understanding of this new organising logic (Yoo, Henfridsson and Lyytinen, 2010) because existing theories reach their limits when applied to it (Gawer, 2009). Yoo et al. (2012, p. 1401) underlined this need and stated that 'in the context of multisided markets, uncontrollable third parties and platform generativity, there is a need to develop theories that explain how such complex contexts unfold over time'.

The focus of this thesis was influenced by increasing interest in MSDPs, which has spiked since the 2009 emergence of Uber, a ride-sharing MSDP, and the 2008 founding of Airbnb, an accommodation-sharing MSDP. These MSDPs implemented disruptive business models made

[1]An organising logic is defined as a 'managerial rationale for designing and evolving specific organisational arrangements in response to an enterprise's environmental and strategic imperatives' (Sambamurthy and Zmud, 2000, p. 107). Examples of organising logics include but are not limited to markets, hierarchies and multisided digital platforms.

possible by digital infrastructures and the digitalisation of products, services and processes (Constantinides, Henfridsson and Parker, 2018; Porter and Heppelmann, 2015; Yoo, Henfridsson and Lyytinen, 2010). These MSDPs transcended geographic areas and borders, rapidly scaling and expanding into international markets and blurring industry boundaries (Nambisan, Zahra and Luo, 2019).

To develop a better understanding of the new organising logic of MSDPs and to narrow the focus of this research, the author conducted preliminary exploratory research on Uber in early 2016 using secondary data collected from Factiva, a business information and research tool (see Appendix A for additional details about the preliminary exploratory research). Uber was selected as the focus of the research at the time because it was disrupting the taxi industry and had become a model for other start-ups, with many attempting to become the 'Uber for X' in various industries (Madrigal, 2019). In addition, Uber was rapidly expanding into new markets and beginning to offer new services. As of February 2016, Uber was operating in more than 400 cities and 68 countries (Kalanick, 2016). At one point in 2014, Uber was launching in a new city every other day (Huet, 2014). At the same time, the firm was beginning to offer new services, such as food and grocery delivery, yacht and helicopter rides and item transport. The firm was also highly successful at raising money and achieved an unprecedented valuation for a private start-up, reflecting investor faith in start-ups based on the organising logic of MSDPs. As of June 2016, Uber had raised about $15 billion in equity and debt and was valued at $68 billion (Kosoff, 2016).

Preliminary exploratory research has indicated that digitalisation enabled Uber to disrupt the taxi industry by relying on third-party complementors (drivers) who brought in their own cars. To render the service, Uber relied on systems and algorithms developed in-house as well as GPS information provided by the devices participants used to access the platform. The ubiquity of digital technology (i.e. smartphones with GPS) enabled Uber to scale rapidly because anyone with a car and a smartphone could become an Uber driver and anyone with a smartphone could become a rider. As Uber expanded globally, its MSDP added new features and began relying on more complementors to supply the different components necessary to render the main service of the platform: moving a passenger from point A to B with a seamless customer experience. Due to its reliance on third-party complementors, Uber was not an identical MSDP in each country it operated in; its components were configured differently based on geographic location. For example, Uber relied on Google Maps to provide mapping services for its MSDP globally; however, Uber in China relied on Baidu Maps for mapping services. Payment components also varied by location; Uber relied on Braintree and Adyen to process payments globally, but in some locations, it relied on local payment providers, such as

Paytm in India and Paga in Nigeria. In addition to partnering with a variety of different complementors, Uber began building some complementary components in-house. For example, Uber developed its own mapping system, poaching many mapping engineers from Google, acquiring some of the technology behind Bing Maps from Microsoft and establishing research centres in Bangalore and Pittsburgh. Uber also developed some payment components in-house, creating its own payment system to process cash payments in developing markets, such as in India and in parts of Africa.

1.2 The puzzle

The above examples raise some interesting questions regarding Uber's growth and the nature of MSDPs. Although digitalisation dissolves geographic borders, Uber configured its components differently and shifted its firm boundaries[2] inward or outward in different geographic locations. Moreover, firm decisions regarding how to configure the components of its MSDP vary situationally. Uber built components in-house at some points, relied on third-party complementors at other points, and later on, both built in-house and relied on third-party complementors simultaneously. This observation raises an important question: how do MSDP firms make decisions regarding where to draw the boundaries of the firm? In other words, which factors explain Uber's decisions to build some components of its platform in-house while relying on third-party complementors for others? Addressing these questions is an important task for academia and practice. From an academic perspective, understanding the impact of digitalisation on the organisation of firms requires assessing existing theories and determining whether they are still applicable to understanding digitally-enabled organising logics, such as those of MSDPs. From a practical perspective, understanding the strategic drivers of MSDP firm boundaries in the digital era enables managers to make well-informed strategic decisions as they configure their MSDP's components and expand into new markets. This in turn enables a better allocation of financial resources to battle challenges arising from internationalising the MSDP.

[2] In this thesis, shifting boundaries refers to when the MSDP firm draws its firm boundaries. When a firm builds a complement in-house, this is described as shifting the boundaries of the MSDP inward, as it makes the firm more closely resemble a traditional hierarchal organisation. When the firm relies on third-party complementors to provide a complement, this is described as shifting the boundaries of the firm outward towards the market.

1.3 Research gap and research questions

This thesis aims to address the limitations of traditional theories of the firm in explaining the boundary decisions of MSDPs and how they choose to configure their components. Addressing this gap in the literature first requires addressing another shortcoming of existing research: the ambiguity surrounding the definition of a multisided digital platform. Therefore, this thesis attempts to answer the following questions:

1. What is a multisided digital platform?
2. What factors influence shifts in MSDP boundaries as they configure their complements, and how do MSDP firms respond to these factors?

1.3.1 The conceptual ambiguity of multisided digital platforms

Defining what makes a platform an MSDP is essential to examining the boundary decisions associated with the configuration of MSDP components (Gawer, 2015). Despite the considerable efforts of scholars in advancing the understanding of MSDPs, there is still some conceptual ambiguity about what exactly MSDPs are (de Reuver, Sørensen and Basole, 2017). This ambiguity stems from the fact that the literature on MSDPs comes from various disciplines, each of which carries its own limitations. In general, the literature on MSDPs can be categorised as falling under three perspectives: strategy/economics, engineering design and digital innovation.

Scholars of strategic management and economics have conceptualised digital platforms as multisided markets where the platform owner facilitates interactions between two sides of the market, taking advantage of direct and indirect network effects (Rochet and Tirole, 2003; Katz and Shapiro, 1985). According to this perspective, the foundations of value creation are the interactions between complementors on one side and buyers on the other, including the subsequent network effects that such interactions generate; however, by treating all digital platforms as multisided markets, this view fails to recognise the different design choices and innovative product models that can arise from different combinations of digital and physical resources. From this view, a digital platform comprised of a web browser with add-on software plug-ins on one side and users on the other is the same as a digital platform of a taxi service with drivers with their private vehicles on one side and passengers on the other.

Scholars of engineering design literature view MSDPs as modular systems with core and periphery components (Clark, 1985; Ulrich, 1995; Baldwin and Clark, 2000). The main sources of value creation

from this perspective are economies of scope in supply, resulting from the reuse of the platform components across a family of products (Gawer, 2014). Scholars of this perspective have focused on decomposing systems into stable core and periphery components to reduce complexity and interdependency between modules, hence allowing firms to specialise in certain modules and to facilitate innovation (Baldwin and Woodard, 2009; Gawer, 2014). From this perspective, any system with a stable core and variable peripherals can be examined through the lens of modularity. One of its main limitations is ignoring the dynamics of competition between MSDP owners and their complementors (Gawer, 2014).

Scholars of innovation management have conceptualised MSDPs as extensible software codebases, enabling value creation through the addition of complementary third-party modules (Tiwana, Konsynski and Bush, 2010; Tiwana, 2014). These scholars have focused on how firms create boundary resources, such as application programming interfaces (APIs) and software development kits (SDKs), to attract third-party software developers to conceptualize and to create apps for their software-based platforms (Ghazawneh and Henfridsson, 2013). By doing so, these firms gain economies of both scale and scope. One of the key theoretical issues emphasised by this perspective is the dialectic tension between the control and the generativity of the digital platforms (Eaton et al., 2015); however, by focusing on software codebase extension as the main source of value creation, this perspective is unable to explain platforms such as Airbnb and Uber, where value is co-created by complementors who contribute their own physical resources (i.e. accommodation units and cars).

To develop a better understanding of MSDPs, such as Uber, Airbnb, Apple iOS and Facebook, these three research perspectives should be integrated and the conceptual ambiguity surrounding MSDPs clarified. Therefore, the first task addressed in the literature review prior to delving into the investigation of the boundary decisions of MSDPs in the digital era is the integration of these research perspectives to present a definition of a MSDP.

1.3.2 The limitations of existing theories of the firm in the digital world

From a governance and organising perspective, the boundary of the MSDP firm is determined by decisions regarding which complements to build in-house and which complements to rely on third-party complementors for. There are two main theoretical perspectives of firm boundaries that address such boundary decisions in traditional non-MSDP firms: (1) efficiency and (2) competence (Santos and Eisenhardt, 2005).

The efficiency perspective relies on transaction cost economics (TCE), which focus on *ex ante* and *ex post* costs of economic exchange as the primary determinants of firm boundary decisions, meaning when to build a complement in-house using a hierarchical organisation or when to rely on third-party complementors using the market[3] (Coase, 1937; Williamson, 1975). The general idea of this perspective is that a firm should seek to minimise its transaction costs by evaluating the cost of building a complement in-house versus accessing it from the market via third-party complementors. A transaction cost analysis views a single transaction between two transacting agents at a time (Jacobides and Billinger, 2006) and makes predictions based on behavioural and transactional factors (i.e. opportunism, bounded rationality, asset specificity and uncertainty) (Foss, Peter and Klein, 2013). The general recommendation is that a firm should internalise a resource if the cost of transacting in the market, which is driven by the behavioural and transactional factors, is higher than the cost of developing the resource internally (Williamson, 1975; 1985).

While this efficiency-focused theoretical perspective had been dominating the literature on firm boundaries, scholars identified a major limitation of this perspective. The efficiency perspective ignored the role that firms' internal resources and capabilities play in determining firm boundaries. Specifically, by focusing on internalising the development of a resource to minimise costs, the efficiency perspective neglected whether the firm has the required capabilities and knowledge to develop the resource internally (Argyres, Felin, Foss and Zenger, 2012; Barney, 1999). The competence-focused theoretical perspective was developed to address this shortcoming. It focuses on a firm's internal capabilities and resources (Jacobides and Winter, 2005). The competence perspective is based on the resource-based view (RBV), which views the firm as a bundle of heterogenous resources (Penrose, 1959; Barney, 1986; 1991; Dierickx and Cool, 1989; Peteraf, 1993). The core tenet of this perspective is that firms should internalise activities when they have superior capabilities to develop them in-house and externalise activities when other firms have a comparative advantage in performing these activities (Argyres and Zenger, 2012; Barney, 1999). Externalising activities that the firm is less competent at frees up resources that can be reallocated to support the capabilities that they are superior at, maximising revenue and strengthening the firm's competitive advantage (Cuevro-Cazurra, Mudambi and Pedersen, 2018; Santos and Eisenhardt, 2005; Jacobides, 2005).

[3] The literature usually uses the term 'make-or-buy' to refer to these types of boundary decisions; however, this thesis frames the decision as one between building in-house or relying on third-party complementors because it is more relevant to the terminology used in the MSDP literature. Moreover, make-or-buy usually implies dichotomy, meaning that the firm either makes or buys the component as a discrete choice; however, this thesis limits this connotation because firms can also simultaneously build in-house and rely on third-party complementors (Parmigiani, 2007).

While the efficiency and competence perspectives have been used to examine firm boundaries in a wide variety of industries, there is a shortage of studies adapting these theories to examine the boundaries of MSDPs. As pointed out by Boudreau (2017), there is limited research on the application of existing theories of firm boundaries to the digital world, and it is unknown whether these theories would translate directly in the context of MSDPs. Similarly, Helfat and Raubitscheck (2018) argued that how TCE and capabilities affect the boundaries of MSDPs is still unknown. Gawer (2015) framed this limitation as stemming from the conceptual ambiguity surrounding the definition of an MSDP, a gap that this thesis aims to fill. As illustrated in the previous section, MSDPs have been examined from a variety of perspectives, which has contributed to the knowledge of MSDPs but has also caused confusion. The characterisation of MSDPs as various multisided markets or modular systems has made it unclear whether traditional theoretical perspectives of organisation can be applied to the study of MSDP boundaries (Gawer, 2014; 2015).

The literature indicates that traditional boundary theories are challenged by digitalisation and the emergence of MSDPs as a new organising logic. First, MSDPs create value in a different way than traditional firms do. Typically, value creation at traditional firms follows a pipeline model of business (Van Alstyne and Parker, 2017), as depicted by Porter's value chain (Porter, 1985), in which a firm controls different stages of value creation activities, while managing firm-supplier relationships, to produce a product. Customers are not typically part of this process, and the firm engages with them only when the product is to be sold in the market. However, in the context of MSDPs, customers are becoming value co-creators who are heterogeneous, dispersed and autonomous, thus blurring the boundary of the firm (Nambisan et al., 2017; Peppard and Rylander, 2006). Secondly, digitalisation reduced asset specificity (Autio et al., 2018; Autio and Zander, 2016), which is a major element of the efficiency perspective used to explain firm boundary decisions. Digitalisation has made firms more reliant on digital assets that are reprogrammable (Yoo, Henfridsson and Lyytinen, 2010), meaning they can be reprogrammed for different purposes and are not confined to limited uses, as is the case for physical assets. As assets become less specific, traditional theories of firm boundaries are challenged, because they are 'mostly silent' on the impact of low asset specificity on firm boundaries (Baldwin, 2018).

These aspects of MSDPs and the digital era suggest that applying existing theories of firm boundaries to MSDPs may not be a straightforward task. For example, when deciding whether to build a complement in-house or to rely on a third-party complementor, in addition to minimising costs (as recommended by the efficiency perspective) and maximising revenues (as recommended by the competence perspective), MSDPs must also consider how customers will be impacted by the

decision (Cennamo, 2018; Gawer and Henderson, 2007). For example, building in-house may be the best option from the efficiency and competence perspectives, but customers might not join the MSDP if they cannot find their preferred complement (Cennamo, 2018). In addition, because digitalisation reduces asset specificity, applying existing theories of firm boundaries is not likely to be straightforward: what might seem to be a highly specific asset at the time of the boundary decision may become a low-specificity asset in a short period of time due to the reprogrammable nature of digital assets (Yoo, Henfridsson and Lyytinen, 2010).

In affecting how value is being created and in challenging some of the underlying assumptions of the existing theories of the firm, digitalisation demands the re-examination of the boundary decisions of MSDPs. Existing theories of the firm may need to be extended or complemented by new theoretical perspectives to increase their applicability in the digital world and to understand the factors that may influence firm boundary decisions beyond efficiency and competence. By extending or complementing existing theories of the firm, scholars can develop a better theoretical apparatus for examining fluid firm boundaries in the digital world. As such, this thesis focuses on MSDPs as a unit of analysis representing firms in the digital world. MSDPs represent an interesting avenue for research because they are a new organising logic enabled by digitalisation, entail unprecedented combination and recombination of digital and physical resources and involve heterogenous and dispersed users who co-create value.

1.4 Research overview

The main aim of this research was to fill gaps in the literature regarding the definition of MSDPs and the determinants of their boundaries. The literature review indicates that additional theoretical understanding of MSDPs is needed, as the articulation of the concept is scattered across various disciplines, including strategy/economics, engineering design and digital innovation. As a result of the diversity of the strands of literature on MSDPs, there is conceptual ambiguity that makes it unclear whether existing theoretical perspectives on firm boundaries, such as efficiency and competence, can be applied to explain the boundaries of MSDPs in the digital world.

To address the gaps in the literature, this thesis critically examines the different strands of literature on platforms and offers an integrated definition and conceptualisation of MSDPs as an organising logic based on three features: (1) multisidedness (i.e. having at least two distinct groups of users), (2) modularity (i.e. having core and periphery components) and (3) enabling codebase extension (i.e. based on software that can be extended through APIs).

By synthesising an integrated definition of MSDPs based on the existing literature, this thesis can then examine the factors that influence the boundaries of the firms implementing MSDPs. To achieve this goal, a qualitative research design was implemented using an embedded case study of Uber, which is considered a role model of business model innovation and industry disruption. The purpose of the embedded case study of Uber is to address the research question related to boundary decisions by examining two subcases: the payment and map complements of Uber's MSDP. Data were collected from Uber's MSDP from its inception in 2010 until December 2018, enabling a longitudinal understanding of the evolution of Uber and responding to calls for long-term studies of MSDPs to build on the point-in-time 'snapshots' provided by existing studies (de Reuver, Sørensen and Basole, 2017). Data were collected from secondary sources, primarily online blogs with detailed information related to Uber, including various official blogs by Uber, a blog aggregator (Techmeme) and other well-known technology blogs. In addition to blog articles, other types of secondary data were collected, including official video content from Uber (e.g. talks and conferences) and archival data, such as initial public offering (IPO) documents. The collected data provided a huge repository of information that enabled the formation of timelines concerned with the evolution of the payment and map complements of Uber's MSDP and the rationale behind building some of these complements in-house or relying on third-party complementors to provide others.

The data analysis follows a grounded theory-informed approach that leads to new insights into the boundaries of MSDPs. The findings suggest that efficiency and competence factors are still relevant in forming the boundaries of MSDPs; however, the data analysis reveals a demand-side perspective that influences MSDP boundaries as much—if not more than—existing theoretical perspectives based on efficiency and competence. The data analysis uncovers three different demand-side factors influencing the boundaries of MSDPs: (1) complement localisation (the configuration of complements to adapt to macro-level local conditions in markets and to meet business needs), (2) customer heterogeneity realisation (the configuration of complements to address micro-level differences between customers) and (3) supermodular complementarity ignition (integration with third-party complementors in a way that increases demand for or the value of both). The findings indicate that these factors influence the boundary decisions of the MSDP, but the existing literature on firm boundaries ignores them in favour of a focus on supply-side factors. The findings also indicate that existing theories' focus on value capture needs to be complemented by a new focus on value creation to explain MSDP boundary decisions, as value cannot be captured before it is created. Building on these findings, this thesis provides a set of propositions indicating how these demand-

side factors impact MSDP boundary decisions and when a firm is more likely to build in-house or to rely on a third-party complementor.

This thesis makes several theoretical contributions to the literature. The first contribution is to enhance the understanding of MSDPs by connecting the different strands of literature to develop an integrated definition of MSDPs. By doing so, the thesis contributes to the information systems literature by addressing its limited focus on codebase extension. Similarly, the thesis contributes to the strategy and economics literature by providing a better understanding of MSDPs that makes it possible to distinguish between different types beyond the homogenous classification as multisided markets. The second, and the most significant, contribution of this thesis is to the literature on the boundaries of firms from strategy, information systems and business model perspectives. The thesis contributes to this stream of literature by demonstrating the influence of a demand-side perspective on firm boundaries and by highlighting the importance of extending or complementing the existing supply-side firm theories with a demand-side perspective that places creating value for customers at the centre of the boundary decisions of MSDPs. Moreover, this thesis contributes to this literature stream by demonstrating the importance of business model design for capturing value that the MSDPs create for their customers. Finally, the thesis has implications for other streams of literature, such as demand-side strategy and digital entrepreneurship literature, and has practical implications for managers and MSDP owners that can help them set the boundaries of their MSDPs by considering the difference between physical and digital complements as well as the significance of demand-side factors.

1.5 Structure of the thesis

This section describes the structure of this thesis and the content of each chapter. The thesis is divided into eight chapters: introduction, literature review, methodological approach, case study, data analysis, findings, discussion and conclusion.

Chapter 1 (Introduction) presents the phenomenon of interest, the research questions and the gaps in the literature that motivated this research. It also provides an overview of the thesis.

Chapter 2 (Literature Review) provides a critical assessment of the existing literature on MSDPs and synthesises the different strands of literature to create an integrated understanding of MSDPs. The chapter also examines the state-of-the-art in the literature on the boundaries of the firm and identifies the gaps related to its application in the context of MSDPs.

Chapter 3 (Methodological Approach) provides a detailed review of the research design adapted to complete this thesis and the philosophical stance of the researcher. The chapter provides a detailed description of the data collection and analysis procedure as well as justification of the research design decisions.

Chapter 4 (Case Study) describes the embedded case study (Uber) and the associated subcases (payments and maps). The chapter provides a general description of the case and provides timelines showing how the subcases evolved over time.

Chapter 5 (Data Analysis) provides a detailed description of the data analysis process pursued in this thesis. The chapter explains the different rounds of data coding and discusses the assumptions made during the coding process that led to the emergence of different concepts and themes used to address the research questions in this thesis.

Chapter 6 (Findings) presents the findings resulting from the cross-case analysis of the payment and map subcases as well as supporting evidence from the data.

Chapter 7 (Discussion) interprets the findings resulting from the data analysis in more depth and engages with the existing literature to evaluate the findings and to identify the contribution. In addition, the chapter provides a set of propositions that can inform future research.

Chapter 8 (Conclusion) summarises the findings and discusses their implications for theory and practice. The chapter also recognises the different limitations of this thesis and provides suggestions for future research.

1.6 Chapter summary

This chapter follows the conceptual funnel (Marshall and Rossman, 2016) to describe a general phenomenon and to develop specific research questions that existing scholarly work does not adequately address. The phenomenon of interest of this thesis is the emergence of MSDP organising logic and the success of many firms in implementing it. The puzzling observation that this thesis aims to explain is the variation in MSDP decisions regarding whether to build complements in-house or to rely on third-party complementors when configuring their components. Reviewing existing literature indicates that there is conceptual ambiguity regarding what MSDPs are, and existing theories of the firm are limited in their ability to fully explain the boundary decisions of MSDPs. The conceptual ambiguity surrounding MSDPs arises from the concept carrying various meanings in different strands

of literature, whereas the limitations of existing theories of the firm in this digital era stem from the impact of digitalisation on how firms create value and on some of the underlying assumptions of these theories. Therefore, this research aims to clarify this conceptual ambiguity by defining what MSDPs are and then to provide a new theoretical perspective that extends or complements existing theories of the firm to understand the factors that influence the boundary decisions of MSDPs.

2 LITERATURE REVIEW

2.1 Chapter introduction

This chapter provides a concise review of three distinct streams of literature on multisided digital platforms (MSDPs) and the theory of the firm. Understanding the existing literature on this topic is essential to assess the current gaps in the literature, support the significance of this thesis and its potential contribution and lay down the theoretical foundations that will inform the analysis and findings of this thesis. This chapter is divided into five main sections.

Section 2.2 provides an overview of the literature on MSDPs drawn from a broad range of disciplines, including economics, strategic management, engineering design and digital innovation. The main objective of this subsection is to capture the debate in the literature over the exact nature and definition of MSDPs and to demonstrate the need for a more generally accepted understanding of this concept. However, this subsection does not aim to provide a systematic literature review of all published scholarly works on MSDPs, as this has already been done by several recent studies (see Thomas et al., 2014; de Reuver, Sørensen and Basole, 2017; McIntyre and Srinvasan, 2017). Section 2.3 builds on the previous section by synthesising the different perspectives on MSDPs and providing a new, integrated definition that clarifies the MSDP concept and enables a better examination of the boundaries of firms implementing MSDPs. Sections 2.2 and 2.3 collectively answer the first question of this thesis: What is an MSDP?

Section 2.4 provides a review of existing theories concerning firm boundaries. The section describes the two main theoretical approaches (efficiency and competence perspectives) used to examine the boundaries of the firm and justify firm decisions regarding which complements to build in-house and when to rely on third-party complementors. Section 2.5 examines the existing theoretical approaches to studying the boundaries of MSDPs and identifies the main gaps in the literature that this study aims to address. Finally, Section 2.6 provides a summary of this chapter.

2.2 Overview of platforms literature

When scholars discuss phenomena such as Uber, Facebook, the Google search engine and Apple iOS, they often use terms such as ecosystem (Kapoor and Agarwal, 2017), industry platform (Gawer and Cusomano, 2014), multisided platform (Seamans and Zhu, 2014; Pagani, 2013) and digital platform

(Boudreau and Hagiu, 2009; Tiwana, Konsynski and Bush, 2010). These diverse terms reflect the various disciplines that the scholars come from and the different theoretical perspectives that they draw on to understand these complex phenomena. Reviewing the extant research on platforms, Gawer (2014) categorised the literature from the perspectives of economics and engineering design. More recently, de Reuver, Sørensen and Basole (2017) suggested that digital platforms are different from non-digital platforms and require their own unique perspective. Building on this, a review of these three streams of literature is provided, critically analysing the core contributions of these streams and integrating them to create a coherent definition for understanding the complexity of MSDPs.

2.2.1 The economics perspective

The economics perspective on platforms is based on network effects and differential pricing strategy (Rochet and Tirole, 2003; Katz and Shapiro, 1985, 1986; Farrell and Saloner, 1986). The main idea is that an intermediary (i.e. a platform) connects two or more distinct sides of the market (i.e. buyers and suppliers) while implementing a differential pricing strategy in which one side subsidises the other to maximise the direct and indirect network effects (Rochet and Tirole, 2006; Katz and Shapiro, 1985). A multisided platform also reduces the search and shared transaction costs for users (Hagiu, 2007). While direct network effects are important for the growth of a platform, indirect network effects are 'even more powerful' (Gawer and Cusumano, 2014, p. 422). According to Gawer and Cusumano (2014), a direct network effect is usually enforced by technical standards that increase the users' costs of switching to other platforms, while an indirect network effect occurs when growth in the number of users increases the value of complementary products and services. Overall, the economics perspective can be applied to different settings, products and services, including physical settings (e.g. shopping malls) and digital settings (e.g. software platforms such as Airbnb).

While this perspective provides critical insights on digital platforms and the issues of pricing and network effects, this stream of research largely ignores technological components of the digital platform. These components play an essential role in understanding the generativity[4] and other innovation dynamics that are unique in digital platforms (de Reuver, Sørensen and Basole, 2017). While a physical shopping mall, a smartphone platform ecosystem and a ride-sharing platform all produce direct and indirect network effects and leverage a differential pricing strategy, there are

[4] Generativity is defined as the platform's capacity 'to produce unprompted change driven by large, varied, and uncoordinated audiences' (Zittrain, 2006, p. 1980).

substantial differences across these various types of platforms as they leverage a variety of resources to build the platform.

2.2.2 The engineering design perspective

The engineering design perspective draws its theoretical roots from the literature on modularity (Simon, 1962; Baldwin and Clark, 2000) and product development (Clark, 1985). Early works on this topic investigated the design choices of the product architecture that a firm may pursue and their impact on product complexity and innovation (Ulrich, 1995). The general notion highlighted by this stream of literature is the idea of modularity, in which complex systems are decomposed into modular components in such a way that the complexity of each component is abstracted through an interface (Baldwin and Clark, 2000). As a result of this modularity, firms are able to mix and match different components to innovate and provide a variety of product configurations (Garud and Kumaraswamy, 1995). Hence, they can achieve economies of scope (Gawer, 2014) and other economic benefits (Langlois, 2002). Wheelwright and Clark (1992) picked up the early work on product architecture and modularity and introduced the term platform to refer to systems that could be modified through the addition or removal of features. The concept was then further applied in the automotive industry (Cusumano and Nobeoka, 1998) and PC industry (Cusumano and Shelby, 1995; Langlois, 2002). Later, the concept of the platform was used to explain how firms like Intel, Microsoft and Cisco built a competitive advantage by leveraging industry-wide standard interfaces among modules to create positive network effects (Gawer and Cusumano, 2002).

Recently, the concept of a platform in the engineering design literature refers to a system with stable core components and varying peripheral components, resulting from the repeated mixing and matching of the latter (Baldwin and Woodard, 2009; Baldwin et al., 2014; Eppinger et al., 1994; Sanchez and Mahoney, 1996). Overall, any product or system with repeatedly used components can be examined through the lens of modularity, including physical and digital products and services.

2.2.3 The digital innovation perspective

Recently, scholars from different disciplines have begun to incorporate a theoretical understanding of the economics and engineering design perspectives within a digital innovation perspective in order to understand software-based (digital) platforms. According to this perspective, platforms are characterised by an architecture model and a governance model (Parker, Van Alstyne and Jiang,

2017). They are typically defined as 'software-based external platforms consisting of the extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they interoperate' (Ghazawneh and Henfridsson, 2015, p. 199). Digital platforms are different from their physical counterparts because their core modules are software codebase and their subsystem boundaries are loosely defined, leading to a flexible and less expensive decoupling and recoupling of their components (Parker, Van Alstyne and Jiang, 2017).

Digital platforms benefit from three characteristics of digital technology: homogenisation of data, reprogrammability and self-reference (Yoo, Henfridsson and Lyytinen, 2010). Homogenisation, also known as digitising, is the process of converting analogue data into binary zeros and ones (bits) so that different types of digital objects, such as music files and images, can be processed using the same machine (e.g. a computer). Reprogrammability denotes the separation of logical functions from the executing physical components, thus allowing the creation of different kinds of data and functions that are not limited to a particular use (e.g. a smartphone that was initially programmed to make calls might later be reprogrammed to perform additional tasks, such as web browsing and mathematical calculations). Finally, the self-referential nature of digital technology means that digital technology itself can be used to foster innovation. This creates positive network externalities as digital technology becomes more affordable, which, in turn, democratises participation in the innovation process (Yoo, Henfridsson and Lyytinen, 2010).

Figure 2-1: The Layered Modular Architecture of Digital Technology (adapted from Yoo, Henfridsson and Lyytinen, 2010).

According to Yoo et al. (2010), the homogenisation of data and the reprogrammability of digital technology have contributed to the proliferation of generativity in digital artefacts by creating two key separations: between form and function (via reprogrammability) and between content and medium (data homogenisation). In turn, 'these two separations led to the emergence of layered

modular architecture that consists of four independent loosely coupled layers of *physical devices*, *networks*, *services*, and *contents*' (Yoo et al., 2012, p. 10, emphasis added). See Figure 2-1 for an illustration of the layered modular architecture of digital technology. The content layer contains data processed or transferred by a digital technology device (i.e. an iPhone, smart TV or smartwatch). The service layer contains the software used to access and interact with the data of the device. The network layer refers to the connectivity to the device (i.e. communication protocols). Finally, the physical layer refers to the physical components of the device. The emergence of layered modular architecture with four distinct loosely coupled layers, in turn, spurred generativity, whereby complementors derive innovation in ways that were not necessarily intended by the platform owners (Wareham, Fox and Cano Giner, 2014). While generativity is a desirable outcome of digital platforms, platform owners are faced with the paradox of change and control (Tilson, Lyytinen and Sørensen, 2010), which means that they must ensure that the platform is both stable and evolvable (Wareham, Fox and Cano Giner, 2014). Thus, they must still be able to control complementary innovations, as an abundance of low-quality complementary products and services on the platform could negatively affect the customers and the reputation of the platform (Boudreau, 2012).

Overall, the digital innovation perspective extends the economics and engineering design perspectives by providing an understanding of the different features of digital technology that enable generativity. However, most articulations of digital platforms that are based on this perspective adapt the mainstream understanding of digital platforms in the information systems literature, which focuses on codebase extension as the main source of value creation and puts less emphasis on value creation from other sources, such as data (e.g. TripAdvisor and Quora) and underutilised assets (e.g. Uber and Airbnb). As a result, it cannot fully explain the growth of firms such as Google, Facebook, Uber and Airbnb. Table 2-1 summarises these three perspectives on platforms.

	Economics Perspective	Engineering Design Perspective	Digital Innovation Perspective
Core Constructs	Multisided market, network externality	Modularity, core and peripheral components	Extensible software-based codebase, layered modular architecture
Key Outcomes	Positive indirect network effects	Reduction in system complexity, economies of scope in innovation	Generativity
Key Articles	Rochet and Tirole (2003), Katz and Shapiro (1985, 1986), Farrell and Saloner (1986)	Simon (1962), Clark (1985), Ulrich (1995), Wheelwright and Clark (1992), Baldwin and Clark (2000), Gawer and Cusumano (2002), Baldwin and Woodard (2009)	Yoo et al. (2010), Wareham, Fox and Cano Giner (2014), Tiwana, Konsynski and Bush (2010), Henfridsson et al. (2018)
Examples	Shopping mall, credit card market	IBM System/360, Wintel Ecosystem	Apple iOS, Android OS

Table 2-1: The three perspectives on digital platforms.

2.3 An integrated perspective of multisided digital platforms

As discussed in the previous section, there are diverse perspectives on platforms. In order to advance our understanding of how firms like Uber, Airbnb, Google, Apple and Facebook configure their platforms, an integrated and coherent approach is needed. Towards this goal, an MSDP is proposed as a core construct that fuses the three theoretical perspectives to facilitate the understanding of the organising logic of MSDPs. From the economics perspective, this thesis employs the notion of multisided markets that create indirect network effects. From the engineering design perspective, this thesis employs the notion of modularity with core and periphery modules that lead to the reduction of system complexity and the facilitation of innovation. Finally, from the digital innovation perspective, this thesis employs the notion of extensible codebase that creates generativity. The following two subsections discuss the integrated definition of MSDPs and its configuration.

2.3.1 Multisided digital platform definition

A multisided digital platform is defined as *an organising logic powered by an extensible software codebase that forms core digital resources together with physical and digital complementary assets created by third-party complementors to enable the interaction between two or more distinct groups of users in a market with the goal of creating positive network effects*. An MSDP combines a layered modular architecture (LMA) and a governance model (Parker, Van Alstyne and Jiang, 2017; Yoo, Henfridsson and Lyytinen, 2010). MSDP architecture is concerned with how the components of the

system are partitioned into a stable core together with varying complementary modules that belong to different layers of content, service, network and device (Benkler, 2006; Yoo, Henfridsson and Lyytinen, 2010), whereas governance refers to those actors that get to make decisions and enforce control mechanisms (Tiwana, Konsynski and Bush, 2010). Thus, an MSDP entails extensible software-based codebase, standards, interfaces and rules that enable different groups of users and complementors to interact, extend the core and co-create value (Teece, 2018; Yoo, Henfridsson and Lyytinen, 2010).

The articulation of an MSDP in this thesis entails three features. The first feature is multisidedness, in which the MSDP should have at least two distinct groups of users in order to benefit from indirect network effects. The second feature is modularity, in which the MSDP should have core modules and peripheral modules, allowing the inclusion of complementary resources as peripheral modules to extend the performance of the core of the platform. Building on layered modular architecture, the core of the MSDP could be extended in three different ways: content extension (content layer), physical extension (device layer) and software codebase extension (service layer). The third feature is digitality, in which the platform should own and operate an extendible software codebase, allowing generativity to take place.

The definition of an MSDP in this thesis is broad but bounded. It is broad in the sense that it expands the narrow focus on codebase extension that is inherit in the IS literature and allows for the examination of MSDPs like Uber and Airbnb, where the core extension is physical (e.g. cars and apartments). On the other hand, it is bounded because it enforces three conditions that lead to the exclusion of multisided markets that are not digital, such as shopping malls and dating clubs, as well as product platforms that are not multisided and digital, such as car chassis. Figure 2-2 demonstrates the articulation of MSDPs.

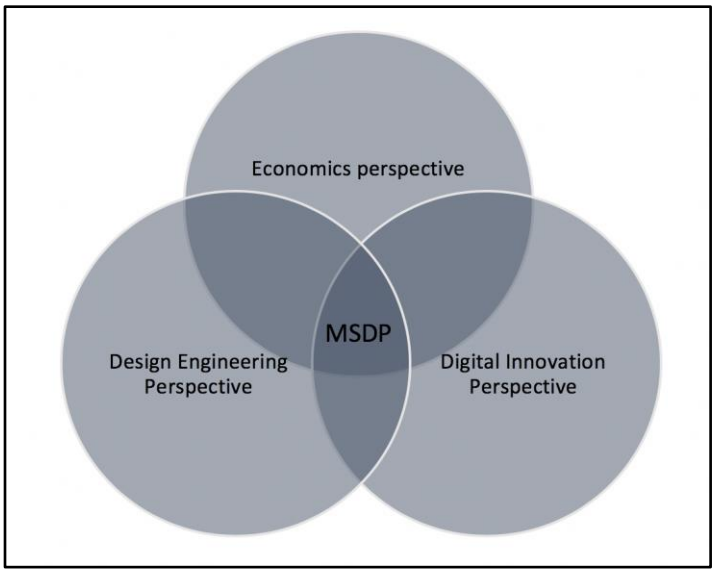


Figure 2-2: An Integrated View of Multisided Digital Platforms.

2.3.2 Multisided digital platform configuration

Since MSDPs have a layered modular architecture, firms can now deliver many products and services in an incomplete form—that is, not all elements are included at the time of production or even at the time of purchase (Garud, Jain and Tuertscher, 2008). Digital innovation scholars refer to this concept as deferred binding (Yoo, Henfridsson and Lyytinen, 2010). A firm that uses the deferred binding approach can add new features and capabilities after a product or service has been delivered to the consumer (Yoo et al., 2012, p. 1399). In the context of MSDP, deferred binding occurs between the platform and complements. Therefore, two key strategic decisions of the owner of an MSDP are: (a) openness of layers and (b) the timing of binding of complements. These two decisions shape the configuration of an MSDP.

The decision on openness of layers refers to which layers will be controlled by the MSDP firm and which layers will be left to complementors, thus it determines the boundary of the firm (Eisenmann, Parker, Van Alstyne, 2009). The openness decision is relevant to the notions of vertical and horizontal complementarity (Teece, 2018). Vertical complementarity occurs when a firm intentionally leaves one or more layers on its MSDP open to harness network effects. Vertical complementarity in the MSDP context is highly associated with achieving economies of scale by enabling users and third-party complementors to bring in their own resources to co-create value. For example, YouTube controls the network and software layers on its MSDP, while leaving the content and device layers open for third-party complementors and customers. By opening the content and device layers, YouTube enables third-party complementors and customers to create content and to

have that content consumed on different kinds of devices (i.e. TVs, smartphones and tablets). Thus, YouTube is able to harness the power of network effects and achieve economies of scale.

Horizontal complementarity, to the contrary, occurs when a firm enables third-party complementors to bring in different kinds of resources on a specific layer and hence increase generativity[5]. For example, Apple enables third-party complementors (developers) to complement the service layer of its MSDP by developing different kinds of mobile applications. Although Apple still participates on the service layer by developing some of the apps internally, enabling third-party complementors to defer the binding of their applications has spurred generativity and increased the variety of offerings on Apple's iOS and hence increased the overall MSDP value.

Since the unique features of digital technology and layered modular architecture enable deferred binding, firms must now consider the timing of binding as another critical strategic decision when configuring the MSDP. The time of binding is defined as the point at which a complementary resource is bound to the MSDP's layers. The binding could be either early or deferred. Early binding is described as the binding of a complementary resource to the MSDP's layers before the product and/or service is delivered to the user. The early binding decision is typically conducted internally by the firm during production time, and usually implies that the firm is more closed at the layer where the resource is bound. A firm usually early binds a resource to increase the quality and efficiency of its product or service in addition to being able to appropriate more value, since it will either own or have more control over the bound resource (Hagiu and Wright, 2019). With early binding, the firm usually captures value at the point of transaction of the product with the buyer. For example, Apple early binds its iOS with all the hardware components it sells to achieve a higher degree of control and appropriate more value from its operating system. As Apple tightly couples iOS with the hardware devices it sells, it is able to achieve greater profit margins when selling hardware than Google can with its Android OS.

Deferred binding, to the contrary, refers to the binding of a complementary resource at or near the time that the product and/or service is used. While early binding is performed by the focal firm (i.e. the MSDP owner), deferred binding can be extended to users, third-party complementors or even competitors. Deferring the binding of a resource usually implies that the firm is more open at the layer where the resource is bound. Deferred binding of MSDPs facilitates generativity, as users can

[5] Vertical and horizontal complementarity ideally lead to the creation of economies of both scale and scope. However, vertical complementarity is more associated with achieving economies of scale than economies of scope, as the firm focuses on increasing the quantity of supply rather than its variety in vertical complementarity. On the other hand, horizontal integration is more associated with economies of scope, as here, the firm focuses on increasing the variety of supply rather than its quantity.

use or enhance the product or service in ways that were unintended by the firm (Garud, Jain and Tuertscher, 2008; Zittrain, 2006). Deferred binding also enables firms to implement a postponement strategy (Pagh and Cooper, 1998; Zinn and Bowersox, 1988), wherein the binding of some elements of a product or service is delayed to respond to unforeseen consumer demand or to reduce risk (Manuj and Mentzer, 2008).

While the time of binding is critical in understanding the configuration of MSDP, only the decision on the openness of layers will be considered in this thesis since it is directly related to the boundary of the firm and the make-or-buy decisions. The following section will discuss the traditional literature on the boundaries of the firm and will connect it with the literature on MSDP and its boundary decisions.

2.4 The boundaries of the firm

There are two theoretical perspectives of firm boundaries that address whether the firm should build a complement in-house or rely on third-party complementors in the market: (1) efficiency and (2) competence (Santos and Eisenhardt, 2005). The following two subsections, 2.4.1 and 2.4.2, provide an overview of these two perspectives and then illustrate the efforts in the literature to combine these two perspectives in order to advance the understanding of firm boundaries. Following this section, Section 2.5 will discuss the applications of these two perspectives in the context of MSDPs and will identify gaps in the literature and problems with using these two perspectives to explain the boundaries of MSDPs.

2.4.1 Efficiency perspective

The efficiency approach to determining firm boundaries is primarily represented by transaction cost economics[6] (Santos and Eisenhardt, 2005), which focuses on minimising governance costs by determining which activities or transactions should be conducted internally within a hierarchical organisation (i.e. a firm) or externally through a market exchange (Coase, 1937; Williamson, 1975). TCE makes two main behavioural assumptions about the agents participating in a transaction (i.e. a firm and a supplier): (1) bounded rationality and (2) opportunism (Williamson, 1985). Bounded rationality indicates that 'human behaviour is intendedly rational, but only limitedly so' (Simon,

[6] The literature contains several extensions to TCE such as property rights theory and agency theory, however, detailed articulation of these theories is outside the scope of this thesis.

1957, p. xxiv). This means that human agents are limited in their ability to predict all future outcomes of a transaction, and hence it would be difficult to generate complete contracts indicating all contingencies between two transacting agents (Foss and Klein, 2010). Opportunism refers to the idea that human agents seek to fulfil their own interests when participating in a transaction, even though fulfilling their own interests might negatively affect those of other transacting agents (Williamson, 1975). As indicated by Hodgson (2004), not all transacting agents will act opportunistically, yet it is still an important assumption to consider in a transaction. In addition to behavioural assumptions, TCE makes transactional assumptions. TCE transactional assumptions begin with the postulation that competition makes markets more efficient for economic exchange than hierarchical organisation does. However, there are transaction attributes that can increase transaction costs and lead to market failure, at which point hierarchical organisation becomes more efficient (Geyskens, Steenkamp and Kumar, 2006). Williamson (1975; 1985) identified three attributes that could impact transaction costs and affect boundary decisions related to whether to build in-house or rely on external complementors: (1) asset specificity, (2) uncertainty and (3) transaction frequency.

The literature indicates that asset specificity is difficult to operationalise because there is no commonly accepted definition of what it stands for (David and Han, 2004; Shelanski and Klein, 1995). Nevertheless, asset specificity generally denotes a relationship between two assets in which the value of one of the assets decreases significantly if redeployed for another use or user (Klein et al., 1978). Williamson (1983) classified asset specificity into four distinct types: (1) site asset specificity, (2) physical asset specificity, (3) human asset specificity and (4) dedicated asset specificity; see De Vita, Tekaya and Wang (2011) for a comprehensive review of the concept of asset specificity. Uncertainty is described as the environmental and behavioural uncertainty resulting in a transaction. Environmental uncertainty refers to the difficulty in predicting and addressing a transacting partner's opportunistic behaviour *ex ante*, whereas behavioural uncertainty refers to the difficulty of evaluating compliance to a contract *ex post* (Geyskens, Steenkamp and Kumar, 2006). Finally, transaction frequency refers to the frequency at which the transaction reoccurs. It reflects the fact that frequently recurring transactions require higher monitoring effort and thus carry higher transaction costs (David and Han, 2004).

TCE suggests that, in the presence of high asset specificity and at least an intermediate degree of uncertainty and/or transaction frequency, hierarchal organisation is recommended to mitigate market inefficiencies and reduce opportunism (Carter and Hodgson, 2006; Williamson 1975; 1985). Out of these three dimensions, asset specificity is considered the most critical determinant of firm

organisational boundaries (Williamson, 1985), and its theoretical importance has been supported by empirical research (Geyskens, Steenkamp and Kumar, 2006; Mahoney, 1992). The literature includes conflicting reports of the impact of uncertainty on organisational boundaries (David and Han, 2004). Santos and Eisenhardt (2005) speculate that the variable influence of uncertainty on firm organisational boundaries stems from the existence of different types of uncertainty. For example, they found that behavioural uncertainty causes firms to favour hierarchical governance over markets in order to mitigate high transaction costs (Sutcliffe and Zaheer, 1998), whereas environmental uncertainty, such as technological uncertainty (Richardson, 1996), leads firms to prefer markets that provide more flexibility to respond to fluctuating demands and avoid technological obsolescence (Dyer, 1996). Finally, there is less empirical support for the importance of transaction frequency in the literature (Rindfleisch and Heide, 1997), hence it has been given the least attention in studies investigating the validity of TCE as a theoretical concept (Geyskens, Steenkamp and Kumar, 2006).

2.4.2 Competence perspective

Despite the popularity of the efficiency perspective of firm boundaries, scholars have identified a major limitation to this approach. Specifically, TCE fails to consider whether the firm possesses the required resources and capabilities to internalise the economic activities in question and what it would cost the firm if it decided to develop these resources and capabilities (Argyres et al., 2012; Jacobides and Hitt, 2005; Barney, 1999). According to Argyres et al. (2012), the first reference to the importance of the competence perspective in explaining firm boundaries can be traced back to Richardson (1972). However, the competence perspective was not popularised until Demsetz (1988) and Winter (1988) demonstrated how the efficiency perspective ignored the impact of firm specific-knowledge. Building on their work, Barney (1999) wrote:

> Transactions cost economics does not focus on the capabilities of a firm or on the capabilities of its potential partners when deciding which economic exchanges to include within a firm's boundary and which to out-source. (p. 138).

To address this oversight, the competence perspective was advanced as another lens through which to understand firm boundaries (Jacobides and Winter, 2005). At the heart of the competence perspective lies the resource-based view (Penrose, 1959; Barney, 1986; 1991; Dierickx and Cool, 1989; Peteraf, 1993). RBV theory was initially established to explain competitive advantage. This theoretical insight into competitive advantage stems from the strategic management literature, which strives to understand the sources of competitive advantage and explain why some firms outperform others (Porter, 1985; Rumelt et al., 1991). According to Barney (1991), a firm enjoys a

competitive advantage if it is 'implementing a value creating strategy not simultaneously being implemented by any current or potential competitors' (p. 102). Thus, a firm gains a competitive advantage when it creates more economic value than its competitors. Barney (2011) defines economic value as 'the difference between the perceived benefits gained by a customer who purchases a firm's products or services and the full economic cost of these products or services' (p. 15).

There are two dominant paradigms in the strategic management field addressing sources of competitive advantage: (1) the traditional industrial organisation (IO) view and (2) the RBV (Spanos and Lioukas, 2001). The IO literature considers a firm to be 'a bundle of strategic activities' aimed at seeking sources of profit within the (external) industry environment. In this sense, a firm is believed to achieve a competitive advantage by positioning itself within an attractive market (Porter, 1985; Spanos and Lioukas, 2001). On the other hand, the RBV of a firm focuses on finding profit sources internally, rather than externally, by appraising a firm's internal resources and capabilities. In so doing, firms are able to determine what makes them different from their competitors and thus design their strategies accordingly (Grant and Jordan, 2015). The main driver behind this paradigm shift was the observation that markets are no longer stable, but are rapidly changing and heavily influenced by technological innovation (Grant and Jordan, 2015). The RBV builds on the Penrosian view of a firm as a bundle of resources (Penrose, 1959). Resources are defined as what a firm owns or that to which it has access (Johnson, 2013). Resources are appraised and accumulated with the aim of achieving above-average returns (profits) and competitive advantage (Dierickx and Cool, 1989). In general, they can be classified as either tangible resources (e.g. physical resources, such as plants and equipment, or financial resources, such as cash) or intangible resources (e.g. reputation, brand and patents) (Grant, 1991). Resources are classified into six categories: technological resources, human resources, reputation, physical resources, organisational resources and financial resources. On their own, these resources do not provide a competitive advantage; they must be joined together in order to create organisational capabilities (Grant, 1991).

The RBV makes two assumptions when analysing sources of a competitive advantage. First, the firm's resources are heterogeneous. The skills, resources and capabilities of the firm differ from those of other firms; if all firms were to have the same resources, then they could all deploy the same strategies and none would have a competitive advantage. Second, the resources are immobile; they do not easily transfer from one firm to another. Intangible resources, such as the brand and organisational culture, are usually immobile. While heterogeneity and immobility provide the basis for competitive advantage, they are not sufficient to sustain it (Barney, 1991). A sustainable

competitive advantage requires four additional attributes, conceptualised in Barney and Clark's (2007) VRIO (value, rarity, inimitability and organisation) framework, as follows:

- Value: The resource must be valuable to customers and be cost-effective (using the resource should either reduce costs or increase revenue).
- Rarity: The resource should be possessed by only one firm (or at most only a few firms).
- Inimitability: The resource should be difficult and costly to imitate and substitute. Three primary factors make it difficult for competitors to imitate a resource: complexity, causal ambiguity, and culture and history.
- Organisation: The organisation should be suitably organised to support its resources and capabilities. A competitive advantage may be lost if the organisation does not have the right mechanisms to make use of its rare and valuable resources.

The RBV was initially used to explain competitive advantage through a firm's possession of a bundle of unique VRIO resources (Barney, 1991). In the years since, it has also been incorporated into the competence perspective to explain firm boundaries (Argyres and Zenger, 2012; Langlois 1992; Barney, 1999; Jacobides and Hitt, 2005). The main idea of this perspective is that firms aim to maximise revenue (Cuervo-Cazurra, Mudambi and Pedersen, 2018) by internalising economic activities when they possess superior capabilities (compared to other firms) and by externalising economic activities when they lack such capabilities (Argyres and Zenger, 2012). Barney (1999) described the tension between the efficiency perspective and the competence perspective. This tension arises when using efficiency as the main determinant of firm boundaries. For example, Barney (1999) notes that in the presence of high transaction costs in the market, the firm is more likely to use hierarchal governance to acquire a complement. However, relying solely on the efficiency perspective ignores the impact of the competence perspective on firm boundaries. In particular, the efficiency perspective overlooks whether the firm has the resources or capabilities to build the complement in-house and whether the production cost of producing the complement in-house would be cheaper than the cost of acquiring it from the market (Barney, 1999).

The above discussion introduces efficiency and competence as two competing perspectives through which to view firm boundary decisions. According to Argyres et al. (2012), this dichotomy can be traced back to the early works of Kogut and Zander (1992), Madhok (1996) and Conner and Prahalad (1996). Based on this view of efficiency and competence as in competition with each other, it is generally assumed that when the two perspectives overlap, the competence perspective dominates the efficiency perspective (Santos and Eisenhardt, 2005). However, recent scholarship has begun to

view these perspectives as complementary and is seeking to integrate them within unified frameworks (Argyres, 2011; Argyres and Zenger, 2012; Jacobides and Winter, 2012). The rationale behind this effort was summarised by Argyres and Zenger (2012), who wrote:

> … capabilities logic alone cannot define firms' boundary choices. Instead, capabilities considerations should be treated as dynamically intertwined with transaction cost considerations and ultimately driven by them. Future research should seek to analyze aspects of this complex interaction. (p. 1653).

In this section, overviews of the efficiency perspective, reflected by TCE, and the competence perspective, reflected by RBV, were provided and their influence on firm boundaries discussed. The following section will discuss the application of these theories in the context of MSDPs and identify limitations specific to their application to MSDPs boundary decisions.

2.5 The boundaries of MSDPs

From a governance and organising perspective, the boundary decisions of an MSDP include decisions about both national boundaries (which geographic markets to enter) and organisational boundaries (whether to build in-house or rely on third-party complementors) (Autio and Zander, 2016). While decisions about national boundaries are essential to the growth of global MSDPs, these decisions are outside the scope of this thesis, which focuses on organisational boundaries and how MSDPs make component configuration decisions. Scholars have rarely applied traditional theories of the firm (i.e. efficiency and competence perspectives) to examinations of the boundary decisions of MSDPs, creating a gap in the literature that this thesis aims to address. Boudreau (2017) urged more research into this topic:

> Despite the conspicuous emergence of platforms in the economy, there is yet little research studying boundaries from the vantage point of organization and governance. Within economic and management research, most existing models proceed with a simplifying assumption that platform boundaries are "given" and one and the same with the platform owner's own economic scope – and then proceed to investigate other questions of interest based on the basis of this simplifying set of assumptions. (p. 228).

Similarly, Helfat and Raubitscheck (2018) argued that even though transaction costs and capabilities influence the boundaries of MSDPs, the literature on MSDPs has granted limited attention to transaction costs, and 'we know little about the capabilities of firms that orchestrate ecosystems in general or digital MS[D]P ecosystems in particular' (p. 3). To the best of the author's knowledge, only two scholarly works have attempted to explicitly examine MSDP boundaries from an organisational perspective and using existing theories of firm boundaries. The first work is a working paper by

Gawer (2015), who attempted to adapt Santos and Eisenhardt's (2005) classification of four distinct conceptions of firm boundaries (cost-efficiency, competence, power and identity) to explain the boundaries of MSDPs. While this paper added to the scholarly understanding of MSDP boundaries, it focused on when firms should shift their boundaries (e.g. expanding to adjacent markets). While this paper includes several interesting insights, it does not address the research question of this thesis, which seeks to identify the factors that influence MSDP firms' decisions to build in-house or rely on third-party complementors, and understand how MSDPs respond to these factors.

The second scholarly work examining MSDP boundaries from an organisational perspective is a book chapter by Boudreau (2017). The main aim of his work was to advance the understanding of MSDP boundaries, as existing literature assumed that MSDP boundaries are 'given' and are identical with the MSDP owner's boundaries. In order to expand the understanding of MSDP boundaries, Boudreau focused on transaction cost economics (Williamson, 1975) and property rights theory (Grossman and Hart, 1986; Hart, 1995; Hart and Moore, 1990) to investigate incentives allocation, coordination problems and critical assets orchestration and control. While useful, Boudreau's work takes a different approach to examining firm boundaries by focusing on incentive allocation, property rights theory and power issues. While these considerations have a meaningful impact on firm boundary decisions, they differ from the factors considered in this thesis, which focuses on the application of efficiency and competence perspectives to MSDP boundary decisions.

Based on the review of the literature, there are two primary reasons for the lack of research adapting existing organisational theories of firm boundaries to MSDPs. The first relates to conceptual ambiguity surrounding the definition of MSDPs, a gap this thesis aims to address. MSDPs have primarily been studied as either multisided markets (economics perspective) or modular systems (engineering design perspective), hindering the application of insights from organisational literature to explain their boundary decisions (Gawer, 2015). However, the conceptualisation of MSDPs as organisations by Gawer (2014) has paved the way for understanding the boundary decisions of MSDPs using organisational perspectives like efficiency and competence (Gawer, 2015). The second reason for the shortage of research on this topic may be an assumption by scholars that MSDPs' boundary decisions can be treated similarly to those of traditional firms. For example, in a book chapter, Eisenmann, Parker, Van Alstyne (2009) stated:

> Firms that sponsor platforms face familiar decisions about vertical strategy. For example, they must decide when to rely on third-party suppliers versus in-house units for platform components. In general, platform sponsors approach such "make-buy" choices in the same way as counterparts in traditional industries. Consequently, we focus here on decisions about vertical strategy that are

> distinctive to platform-mediated networks [i.e. backward compatibility, exclusive access rights and absorbing complements]. (p. 143).

Contrary to the assumption that existing theories of firm boundaries can explain MSDP boundary decisions, the literature suggests that digitalisation may challenge some of the assumptions of the existing theories and that the MSDP context is different from that of traditional firms, especially in terms of value creation and capture dynamics. The following two subsections aim to illustrate how the context of MSDPs may be different from the context of traditional firms by comparing firms in the pre-digital and digital eras and examining how some assumptions underlying existing theories of firm boundaries are challenged in the digital world.

2.5.1 Firms in the pre-digital world

In the pre-digital era, firms sought to optimise their value chain by reducing costs across the stages of value creation in order to increase profits and secure a competitive advantage (Stabell and Fjeldstad, 1998; Porter, 1985). This included making make-or-buy decisions about which activities to bring in-house and which to outsource to other specialised firms in the market. Studies of this optimisation process are commonly based on TCEs (Coase, 1937; Williamson, 1985) and property rights theory (Grossman and Hart, 1986; Hart, 1995; Hart and Moore, 1990). TCE generally recommended vertical integration of firm assets if the cost of transacting in the market was high. TCE made explicit and implicit assumptions that were applicable in the pre-digital world. As demonstrated in subsection 2.4.1, TCE suggests that when a required asset is highly specific and there is a high degree of uncertainty, then vertical integration is recommended to overcome the hold-up problem (Williamson, 1985). These theories also assumed that the distribution of value, or payoffs, was determined by the asset owner. Hence the theories focused on ownership and unification of control rights, in order to overcome inefficiencies resulting from socially-destructive haggling (Gibbons, 2005). In addition, the theories were established by focusing on physical resources with strong complementarity. This has made it difficult to apply these theories to understand how firm boundaries are affected when the complementary resource is digital and/or resembles weak complementarity (Baldwin, 2018). High asset specificity is related to the notion of complementarity, in which the joint value of two assets is larger than their individual sum. In general, complementarity can be classified as strong or weak (Baldwin, 2018). Strong complementarity occurs under two conditions: (1) when there are two complementary assets, A and B, and (2) when the value of B diminishes significantly if it is redeployed for another use. Hence, high asset specificity as considered in TCE is a form of strong complementarity. Weak complementarity

also occurs under two conditions: (1) when there are two complementary assets, A and B, and (2) when they produce more value if they are used together (however, the individual values of A and B do not decline significantly if A or B is redeployed for another use). Weak complementarity has been ignored in existing theories of the firm, despite the fact that many current platforms and ecosystems rely on resources that are developed and contributed by autonomous third-party complementors and, thus, resemble weak complementarity (Baldwin, 2018). This thesis aims to fill this gap by investigating the impact of such resources on MSDP boundary decisions. Finally, existing theories of the firm, especially TCE, ignore the potential role of value creation in integration versus non-integration decisions (Zajac and Olsen, 1993). In particular, existing theories assume that the value generated from a complementary asset is predetermined and thus the production location of the asset does not matter as long as the hold-up problem is solved.

2.5.2 Firms in the digital world

In the digital economy, and more specifically in the context of MSDP ecosystems, three aspects are being affected by digitalisation. First, value creation does not necessarily follow the traditional pipeline model of business, which assumes the firm controls the value chain's sequential stages, from inputting raw material to producing and delivering a final product (Van Alstyne and Parker, 2017). Value is now co-created by a network of actors that includes the firm, its suppliers and its customers (Amit and Han, 2017). Operating in dispersed locations, these actors co-create value through various activities without necessarily being managed by a central authority such as a firm. These actors are heterogeneous and interdependent, with different goals and motives. They bring with them various resources and capabilities that support the firm's innovation and value creation activities (Nambisan et al., 2017). As these activities become dynamic, unpredictable and distributed among heterogeneous actors, it blurs the firm's boundaries and increases the complexity of its business model (Nambisan et al., 2017; Velu, 2017). Having a well-designed business model is essential for a firm's survival and achievement of profitability (Teece and Linden, 2017). Business models have been defined by scholars in a variety of ways (see Zott, Amit and Massa, 2011; Birkinshaw and Ansari, 2015). A business model generally "articulates the logic ... that demonstrates how a business creates and delivers value to customers" (Teece 2010, p. 173). The components of the business model are typically categorised into 4Vs: value proposition, value creation, value capture and value network (Velu, 2019). Value proposition refers to the benefits that the firm pledges to offer to its customers (Adner, 2017). Value creation refers to the value generated through the business activities that contributes to the utility of customers (Bowman and Ambrosini, 2000).

Value capture refers to value appropriation, which is the ability of the firm to capture some, if not all, of the value generated through its business (Teece, 1986; Huang et al., 2013). Finally, value network refers to the economic actors (i.e. customers and complementors) involved in the value creation and delivery process (Pagani, 2013). As these components are interconnected, a business model can be considered a complex system (Velu, 2017). For MSDPs, identifying and implementing a successful business model is often a process that involves experimentation and trial and error (Teece, 2010; Teece and Linden, 2017). Many MSDPs succeeding today co-create value utilising resources owned by members of their network (i.e. customers and complementors). For example, Uber does not own the cars used to deliver its service, YouTube does not own the video content consumed by its users and Apple does not own the apps in its App Store. As a result, MSDP firms can face challenges in capturing value co-created on their networks (Teece and Linden, 2017; Schreieck, Wiesche and Krcmar, 2017). Recently, the literature on MSDPs has provided some insights into how these firms can maximise value capture through mechanisms such as pricing (Hagiu, 2006; Tiwana, 2014; OH, Koh and Raghunathan, 2015) and absorption of complements (Eisenmann, Parker and Van Alstyne, 2009), however, there are still few studies examining the effect of these mechanisms on the interaction between value co-creation and value capture (Schreieck, Wiesche and Krcmar, 2017).

The second aspect disrupted by digitalisation is the degree of asset specificity. Physical resources, on which existing theories of the firm focus, are material, often immobile, costly to reproduce and difficult to share. By contrast, digital resources are malleable (immaterial), reprogrammable, easily recombined and mobile, having low marginal production costs and enabling non-rivalrous consumption (Yoo et al., 2012; Shapiro and Varian, 1998). In particular, being able to recombine and reprogramme digital assets reduces asset specificity, as digital assets' functions can be easily altered to serve different needs. As a result, assets are becoming less specific in the digital world (Autio and Thomas, in press; Autio and Zander, 2016). In the context of MSDP ecosystems, digitalisation further reduces asset specificity through the implementation of a layered modular architecture, supported by standardised interfaces (i.e. APIs) that enable ecosystem partners to connect with the MSDP without necessarily investing heavily in co-specialised assets that might lead to the hold-up problem (Autio and Zander, 2016).

Third, digitalisation makes the value of a complementary asset difficult to determine *ex ante*. The value of digital resources is not fixed for the firm, complementors or customers, as was assumed of physical resources in the pre-digital world. There are two primary reasons for this: (1) how digital resources are valued differs from how physical resources are valued and (2) digitalisation led to the proliferation of supermodular complementarity. Physical resources often have a known, fixed upper

value—that is, the maximum value that can be extracted from the resource is finite. Additionally, the characteristics of physical resources discussed earlier constrain their generativity. In contrast, the reprogrammable and recombinable characteristics of digital resources afford them a broader upper value boundary. The impact of these characteristics is amplified by the availability of generative tools and boundary resources, such as SDKs and APIs, that enable the integration of existing software codes and the creation of new ones. The generative capacity and the unbounded nature of digital technology (Yoo et al., 2012) means that the upper bound of the value produced from digital resources may not be fully determined *ex ante* by the producer. The second reason for digital resources' unpredictable value is the proliferation of supermodular complementarity. Supermodular complementarity occurs when there are two complementary assets, A and B, and more of B makes A more valuable (Baldwin, 2018; Jacobides, Cennamo and Gawer, 2018). Direct and indirect network effects are examples of supermodular complementarity (Jacobides, Cennamo and Gawer, 2018). Supermodular complementarity can contribute to spillover effects, in which assets generate additional value in addition to that created by their main use. For example, the more apps Apple iOS has, the more likely customers will join the platform. At the same time, the more apps Apple iOS has, the more likely software developers are to benefit from each other's apps, through collaboration, integration or imitation. Because the value of digital resources is not fixed, the location of resources (i.e. inside or outside the firm) is becoming an important issue that could affect value creation. In the context of MSDPs, integrating a digital resource may enable the firm to avoid the hold-up problem but lead to a loss of initiative (Gibons, 2005) and reduce value creation potential. For example, bringing certain resources in-house might enable the MSDP firm to reduce opportunism or build internal capabilities, but it might also alienate complementors (Gawer and Henderson, 2007; Gil and Warzynski, 2010) and reduce the variety of complements available to customers (Cennamo, 2018), hence reducing the overall value of the MSDP.

In addition to affecting the three aspects discussed above—value creation, asset specificity and asset value—digitalisation also enables firms to rapidly scale to new markets (Huang et al., 2017; Kelestyn, Henfridsson and Nandhakumar, 2017) by building MSDPs on top of existing infrastructures (Constantinides, Henfridsson and Parker, 2018). When entering new markets, firms face environmental and contextual factors including economic conditions, regulations and culture. According to Santos and Eisenhardt (2005), existing firm boundary theories' focus on the efficiency perspective has hindered understanding of the relationship between the firm boundary and its environment. They called for new theoretical developments that consider the firm-environment relationship and take into account nonefficiency factors that might influence the boundary of the firm:

> … a fruitful research direction is to examine nonefficiency conceptions, either alone or together. This initially would lead to looking at different types of boundary decisions, many of which would be more strategic in character than those in previous work. Given their less atomistic approach, emphasis on nonefficiency conceptions would also naturally lead to examining decisions in the context of other decisions and broader strategic considerations. For example, a decision to acquire would be understood in the strategic context of developing a sphere of influence that might combine ownership and nonownership mechanisms. A decision to develop a resource would be considered in the strategic context of the entire resource portfolio and related expansion into novel product/market domains. (p. 503).

Thus, one of the main objectives of this research is to address this gap by investigating nonefficiency factors influencing the boundaries of MSDPs and to provide a new theoretical understanding that will extend or complement the existing theoretical perspectives on firm boundaries.

2.6 Chapter summary

This chapter examined the different, sometimes contradictory streams of literature on MSDPs and attempted to provide a new, integrated definition of the MSDP concept. Following this conceptualisation, the chapter provided an overview of the two main theoretical perspectives on firm boundaries, efficiency and competence, and questioned the applicability of these theories in the context of MSDPs. To identify some of the shortcomings of these perspectives, the chapter compared firms in the pre-digital world with firms in the digital world. The comparison demonstrated how poorly many of the assumptions underlying existing theories of firm boundaries translate into the digital world in general, and into the context of MSDPs specifically. This exercise demonstrates the need for a new theoretical approach to understanding the boundaries of MSDPs, which can either extend or complement existing theories of firm boundaries. The next chapter will explain the methodological approach followed to collect and analyse data that will inform the results of this thesis.

3 METHODOLOGICAL APPROACH

3.1 Chapter introduction

This chapter provides a detailed description of the methodological approach taken to address the research questions in this thesis: what factors influence the shifts in the boundaries of MSDPs as they configure their complements, and how do MSDP firms respond to these factors? Section 3.2 articulates the philosophical assumptions of the author and the subsequent research design decisions. Section 3.3 provides information about the research context and the case selected for this study. Section 3.4 explains the data collection process and describes in detail the different types of data used to inform this research. The data analysis process and the rationales behind the different stages of the analysis are not part of this chapter but will be discussed in Chapter 5. Finally, a summary of the chapter is provided in Section 3.5.

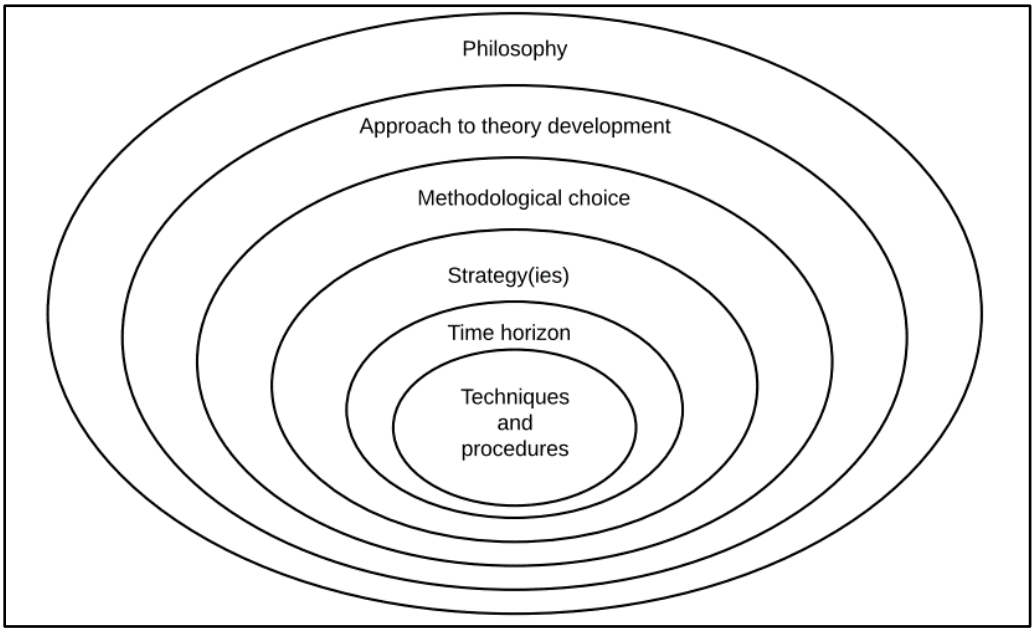


Figure 3-1: The research onion framework (reproduced from Saunders, Lewis and Thornhill, 2019).

3.2 Research philosophy and design

The term 'research philosophy' refers to a researcher's worldviews and his/her beliefs and assumptions about reality (ontological assumptions) and knowledge (epistemological assumptions) (Creswell and Creswell, 2018). The term 'research design' refers to the general plan that the researcher follows to address the research question(s) under investigation, which involves the

means of data collection and analysis used when conducting the research (Saunders, Lewis and Thornhill, 2019). This section follows Saunders, Lewis and Thornhill's (2019) research onion framework to describe the author's research philosophy and the subsequent research design decisions. Figure 3-1 depicts the research onion framework and shows the six different layers that researchers have to consider when conducting their studies: the research philosophy, the approach to theory development, the methodological choice, the research strategy, the time horizon and the data collection and analysis techniques. It is important to note that a researcher cannot treat the research philosophy and design options as a menu of choices for research that can be arranged in a mix-and-match format (Saunders, Lewis and Thornhill, 2019). However, a researcher should be aware of his/her worldviews, as they have a direct influence on the research design and the methods chosen for collecting and analysing data (Crotty, 1998). The research design of this thesis was influenced by the philosophical beliefs of the author. It was also influenced by the need to address existing methodological issues pertaining to studies of MSDPs. The following subsections describe the author's research philosophy and design decisions.

3.2.1 Research philosophy

Given that the worldviews of the researcher and his/her beliefs influence the design of his/her research, identifying how the researcher views the nature of reality and what the researcher perceives as acceptable knowledge is important (Creswell and Creswell, 2018). This research started with the assumption that our knowledge of reality is a social construction, meaning that 'reality is gained only through social constructions such as language, consciousness, shared meanings, documents, tools and other artifacts' (Klein and Myers, 1999, p. 69). Therefore, reality cannot be understood independent of social actors, such as the researcher and the people involved in the studied phenomenon (Orlikowski and Baroudi, 1991). As a general rule of thumb, interpretivist research does not predetermine dependent or independent variables; rather, it emphasises the full complexity of human comprehension during emerging situations (Kaplan and Maxwell, 1994).

3.2.2 Approach to theory development

Academic research typically involves the use of a theory (Saunders, Lewis and Thornhill, 2019). There are two approaches of theory development: deduction and induction (Bryman and Bell, 2011). Deduction is commonly adopted in scientific research; it occurs when a researcher starts with a generalised theory or hypothesis about a research problem and then conducts research to confirm

or reject it. By contrast, induction is more common in the social sciences and occurs when a researcher starts with an observation of a real event or social process and then conducts research to generate a generalised theory or hypothesis (Bryman and Bell, 2011). This thesis followed an inductive approach, given that it was initially influenced by the puzzling observation that many MSDPs seemed to build some of their complements in-house at times whilst relying on third-party complementors at other times, as discussed in Chapter 1. Hence, one of the main objectives of this research was to develop a theory or hypotheses to explain the observed phenomenon.

3.2.3 Methodological choices

The methodological choices made in conducting any research fall within two categories: quantitative and qualitative (Lee and Hubona, 2009; Myers and Avison, 2002). The methodological choice for this thesis was qualitative, following an inductive and interpretive approach. According to Bryman and Bell (2011, p. 386), qualitative research is usually inductive and interpretive and is used to generate a theory. Quantitative research, on the other hand, is usually deductive and positivist and is used to test a theory (see Table 3-1 for a comparison of these two methodological choices). The findings from the literature review supported the use of a qualitative methodology, as the generation of new theories was required to enhance the understanding of MSDPs' organisational logic (Yoo, Henfridsson and Lyytinen, 2010) and there was a shortage of studies explaining the factors influencing the boundaries of MSDPs from an organisational perspective (Boudreau, 2017; Helfat and Raubitscheck, 2018). Because of the current status of the literature on MSDPs, qualitative methods were best suited to provide an in-depth understanding of MSDPs and their boundaries.

	Quantitative	**Qualitative**
Principal orientation to the role of theory in relation to research	Deductive; testing of theory	Inductive; generation of theory
Epistemological orientation	Natural science model, in particular, positivism	Interpretivism
Ontological orientation	Objectivism	Constructionism

Table 3-1: Fundamental differences between the quantitative and qualitative research strategies (reproduced from Bryman and Bell, 2011, p. 27).

3.2.4 Research strategy

Saunders, Lewis and Thornhill (2019) define a research strategy as the general plan that connects the researcher's philosophical assumptions with the methods adopted to collect and analyse data. This research implemented a case study research strategy. Yin (2018, p. 15) defines a case study as 'an empirical method that investigates a contemporary phenomenon (the "case") in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident'. In addition, Yin (2018) provides three conditions as determinants for choosing a research strategy: (1) the form of the research question, (2) the degree of control the researcher has over the phenomenon of interest and (3) the degree of how contemporary the phenomenon of interest is. The first condition relates to the type of research question, which can be categorised as either a 'what', 'how', 'why', 'who' or 'where' question. A case study research strategy is recommended when the research question is either a 'what' descriptive question or a 'how' or 'why' exploratory question. The second condition relates to the amount of control the researcher can exert over the phenomenon of interest. When a researcher has limited or no control over the phenomenon (i.e. the researcher cannot control or manipulate the observed phenomenon), a case study research strategy is recommended; however, when the researcher can control the observed phenomenon, such as in scientific experiments in labs in which the researcher can manipulate some of the variables, a case study is not recommended. The third condition indicates whether the phenomenon of interest is contemporary or historic, and a case study is recommended when the phenomenon of interest is contemporary. This thesis aligned with the stipulations for the three conditions suggested by Yin (2018) to pursue a case study research strategy. First, the research questions that this thesis aims to address are as follows: *What factors influence the shifts in the boundaries of MSDPs as they configure their complements, and how do MSDP firms respond to these factors?* These questions satisfied the first condition, as they are both a 'what' question, concerned with the factors influencing the boundaries of MSDPs, and a 'how' question, concerned with how MSDP firms react to these factors. This thesis also satisfied the second condition, as the researcher had no control over the observed phenomenon of interest (i.e. MSDP firms taking different decisions to either build a complement in-house or rely on third-party complementors). Finally, this thesis satisfied the third condition, as it examines the contemporary phenomenon of MSDPs that has led scholars to call for new theorising efforts to advance our understanding of this phenomenon (Gawer, 2009; Yoo et al., 2012). Yin (2018) suggests other research strategies, such as experiments, survey archival analyses and history. Each of these research strategies is applicable based on how the research is evaluated against the three conditions. Table 3-2 provides a summary of the different research strategies and their applicability to this research.

Research strategy	Form of research questions	Requires control over behavioural events?	Focuses on contemporary events?	Is it suitable for this research?
Experiment	How, why	Yes	Yes	No; it requires control over events.
Survey	Who, what, where, how many, how much	No	Yes	No; it lacks in-depth insights, and it is usually quantitative.
Archival analyses	Who, what, where, how many, how much	No	Yes/no	No; it is quantitative and focuses mostly on 'who' and 'how much' research questions.
History	How, why	No	No	No; it looks at historic events, whereas this research is interested in a contemporary phenomenon.
Case study	How, why , what	No	Yes	Yes; this research asks 'what' and 'how' questions, has no control over the phenomenon of interest and focuses on a contemporary phenomenon.

Table 3-2: Different research strategies and their applicability to this research (adapted from Yin, 2012; 2018).

A case study can be conducted in various ways, as indicated by Cavaye (1996):

> Case research can be carried out taking a positivist or an interpretive stance, can take a deductive or an inductive approach, can use qualitative and quantitative methods, can investigate one or multiple cases. Case research can be a highly structured, positivist, deductive investigation of multiple cases; it can also be an unstructured, interpretive, inductive investigation of one case; lastly, it can be anything in between these two extremes in almost any combination. (pp. 227-228)

Based on the philosophical stance of the researcher, this thesis took an interpretive stance and an inductive approach to conduct a case study. Yin (2018) identifies four possible case study designs: single case (holistic), single case (embedded), multiple case (holistic) and multiple case (embedded). Figure 3-2 illustrates the differences amongst these four types.

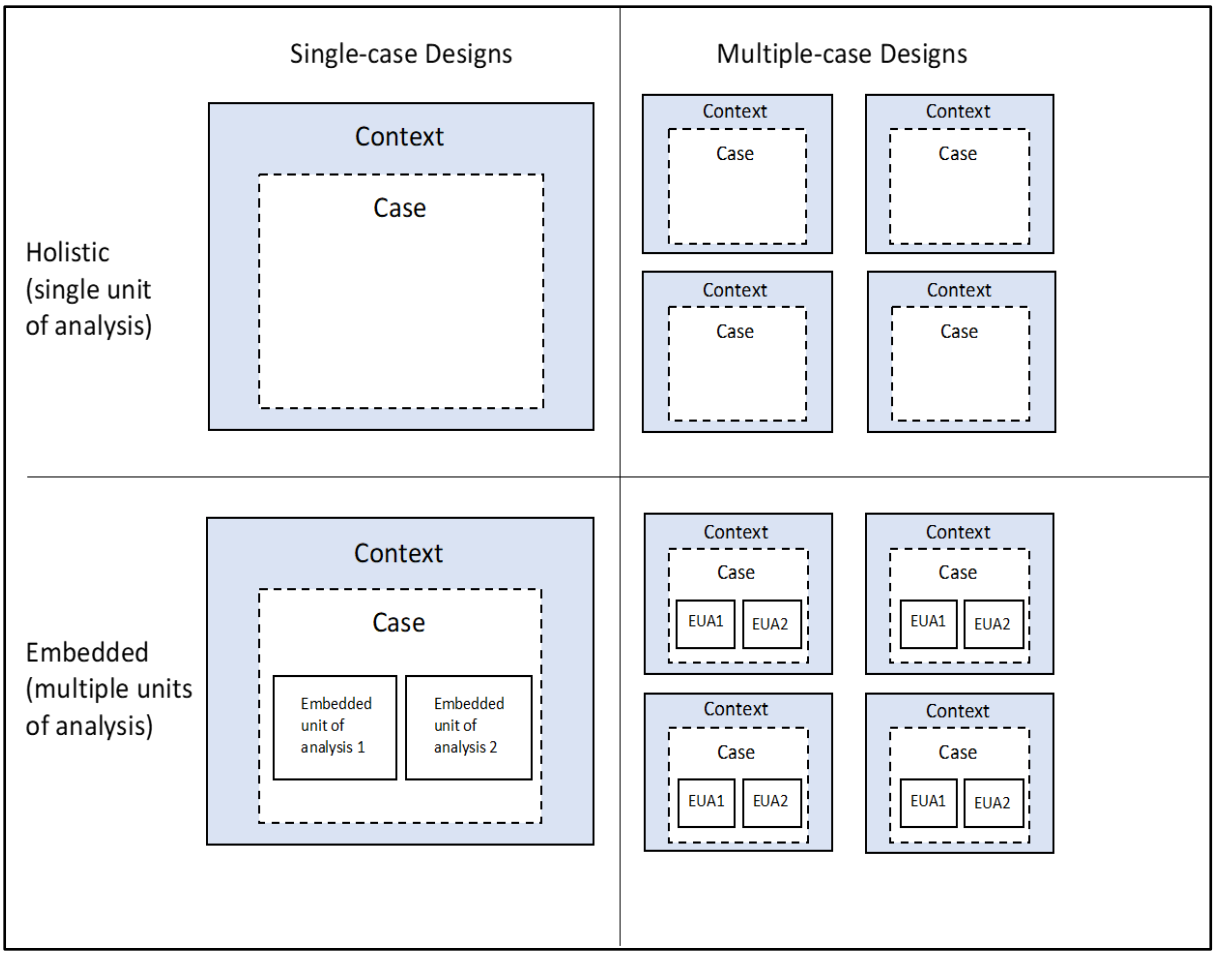


Figure 3-2: Basic types of designs for case studies (reproduced from Yin, 2018, p. 48).

This study implemented a single case (embedded) study design to examine the factors influencing the boundary decisions of MSDPs. Examining a single case study allows the researcher to gain a more in-depth understanding of the phenomenon of interest; this approach allows the study to focus on the primary phenomenon of interest and makes it possible to learn from an extreme or unusual case (Yin, 2018). As Ozcan, Han and Graebner (2017) suggest, a single case study enables the researcher to develop a fine-grained understanding of a complex phenomenon and to observe it from different perspectives and over time. It is difficult to develop such a detailed understanding of a phenomenon by studying multiple cases or conducting large statistical studies, they add. As few studies have thus far sought to understand the boundaries of MSDPs, this thesis aims to generate new understanding rather than test existing theories, so a single case study is an appropriate design[7] (Mills, Durepos and Wiebe, 2010). Another motive for using a single case study was to make theoretical sampling and identifying the unit of analysis easier than they would have been in a

[7] This is not to suggest that single case studies are superior to multiple case studies in all applications, simply that a single case study fits the purpose of this research, given the current status of the literature on the boundaries of MSDPs. Conducting additional comparative case studies is worthwhile task that nevertheless is not within the scope of this thesis and thus must be left for future research.

multiple case study (Eisenhardt and Graebner, 2007). This is particularly important in the context of studying MSDPs, because the comparability of research units across different MSDPs is difficult due to the complexity of these enterprises (de Reuver, Sørensen and Basole, 2017). Section 3.3 will describe the context of the case study, the main unit of analysis and the subunits of analysis. It will also discuss the rationale for choosing the single case that informed this research.

3.2.5 Time horizon

The time horizon refers to whether the design of a study is cross-sectional or longitudinal. A cross-sectional study is a kind of snapshot in which data are collected at a single point in time; a longitudinal study is like a series of snapshots, as data are collected at several points in time (Saunders, Lewis and Thornhill, 2019). A longitudinal time horizon makes it possible to observe changes and developments in the examined case. A longitudinal time horizon was selected for this study to mitigate the main methodological problem with existing studies on MSDPs, most of which are cross-sectional (de Reuver, Sørensen and Basole, 2017). According to Tilson, Lyytinen and Sørensen (2010), the dynamics of MSDPs can only be understood through an examination over a long period of time. Therefore, this study is longitudinal. The collected data illustrated different MSDP boundary decisions (i.e. to build in-house or to rely on a third-party complementor) that the MSDP firm took over time.

3.2.6 Data collection and analysis techniques

As the philosophical stance of this study is interpretivist and the chosen research design is qualitative and inductive, data collection and analysis were informed by the techniques used in a grounded theory approach (Corbin and Strauss, 2014; Gioia, Corley and Hamilton, 2013; Suddaby, 2006). An approach informed by grounded theory was an appropriate way to collect and analyse data in this study because the main aim of this study matches the aim of the grounded theory approach, which is to construct a theory from the data and enhance the understanding of a phenomenon, rather than to test an existing theory (Suddaby, 2006). A detailed discussion of how grounded theory was used to inform data collection will be presented in Section 3.4 whereas data analysis will be discussed in chapter 5.

In summary, this section has presented the research philosophy and design decisions that informed this study. Table 3-3 summarises the main research approach and design decisions taken in this

study, following the order presented in the research onion framework. The following two sections discuss the context of the case study and provide a detailed discussion of how the data were collected.

Research layer	**Research philosophy and design decision**
Research philosophy	Interpretivist
Approach to theory development	Inductive
Methodological choice	Qualitative
Research strategy	Single case study (embedded)
Time horizon	Longitudinal
Data collection and analysis techniques	Informed by grounded theory approach

Table 3-3: A summary of the research philosophy and design decisions taken in this research.

3.3 Research context and case selection

Yin (2018, p. 31) indicates the importance of 'bounding the case' by identifying its context, the unit of analysis, the unit of observation and its temporal and spatial boundaries. This step is essential to determine the scope of the research project and what data are required to complete it. The context of this research is the growing ecosystem of MSDPs, which are scaling rapidly and serving many heterogeneous groups of users and markets. As Yin notes, the unit of analysis is determined by the case under investigation (i.e. individuals, organisations, projects and communities). In this thesis, the main unit of analysis is Uber, a ridesharing MSDP based in San Francisco in the US. Uber is believed to present an ideal case for studying the factors that influence the boundaries of MSDPs and how MSDP firms respond to these factors. Detailed information about Uber will be provided in Chapter 4. Uber was chosen as the main unit of analysis for several reasons. First, Uber represents an extreme case (Yin, 2018)—an unusual manifestation of the examined phenomenon—in that it achieved unprecedented success by rapidly expanding into different markets, raising a staggering amount of funds and achieving an outstanding valuation despite being unprofitable after several years of operation (Levy, 2019). It was successful in expanding rapidly and dominating multiple markets, but its persistent unprofitability presented a challenge. The existing literature on MSDPs has focused on very successful MSDPs while ignoring those that faced challenges, so Uber's case holds valuable new

lessons (de Reuver, Sørensen and Basole, 2017). Second, Uber is a contemporary phenomenon, which is a critical condition for choosing a case study research strategy (Yin, 2018). Third, as a result of the huge amount of funds it has raised, Uber has been able to build some of its complements in-house, but it also relies on third-party complementors. Therefore, Uber has made a variety of different boundary decisions, which can be examined to address the research questions motivating this study, namely, what factors influence the boundaries of MSDPs and how MSDP firms respond to them. Fourth, Uber is considered a role model for many MSDPs which have sought to replicate its business model and become the 'Uber for X' in different industries (Madrigal, 2019). This may make the findings more transferable to other MSDPs. Fifth, Uber's MSDP involves a variety of physical and digital complements. Unlike MSDPs such as eBay, YouTube and the Apple App store that are similar across geographical areas, Uber's complements and business model have a variety of configurations based on location, as explained in subsection 1.1 of chapter 1. This variation makes Uber an interesting case to study, as it may contribute to the discovery of new strategic and contextual factors influencing boundary decisions, beyond the efficiency and competence factors identified by Santos and Eisenhardt (2005).

As Uber is made up of several components and complements, this thesis identified two subunits of analysis (the payment and maps complements) to limit the research scope and provide a consistent level of comparison. The payment complements refer to the products or services used in Uber's MSDP for customers to pay for the service. The maps complements are the products or services used in Uber's MSDP to provide mapping services, such as navigating from point A to point B, searching for pickup or drop-off destinations and tracking a ride on a map. Chapter 4 will discuss these components in greater detail. The payment and maps complements were chosen for three main reasons. First, these complements are core to Uber's MSDP; without them, Uber's value would decline significantly, and it might even become non-operational. Second, these complements are digital and hence reprogrammable (Yoo et al., 2012). The reprogrammable nature of these complements reduces the relevance of asset specificity and thus undermines the assumptions underlying traditional theories of firm boundaries, as described in Chapter 2. Examining these complements thus yields new insights into the boundaries of MSDPs. Third, payment and maps complements are common to many MSDPs. Moreover, Uber made multiple different decisions about how to configure these complements over time and geography, so focusing on these complements provides many boundary decisions for analysis. Therefore, choosing these subunits increased the potential transferability of the findings of this thesis, mitigating one of the downsides of the single case study design (Yin, 2018).

In addition to the unit of analysis, the unit of observation was determined to guide the data collection process (Marschan-Piekkari and Welch, 2011). The unit of observation in this thesis was Uber's boundary decisions regarding whether to build the payment and maps complements in-house or to rely on third-party complementors to provide them. As Yin (2018) indicates, identifying the temporal and spatial boundaries of the case to determine the scope of the research project is also important. In this case, the temporal boundaries were set to a long span of time, beginning with Uber's establishment in June 2010 until the end of December 2018. Within this wide timeframe, the researcher examined multiple individual boundary decisions, allowing for a thorough exploration of the phenomena in different contexts over time, which increased the validity of the findings. The spatial boundaries were also set to include all countries into which Uber has expanded, allowing more insights to emerge into how contextual factors influence MSDPs' boundaries. Figure 3-3 depicts the main and subunits of analysis, the unit of observation and the boundaries of the case study.

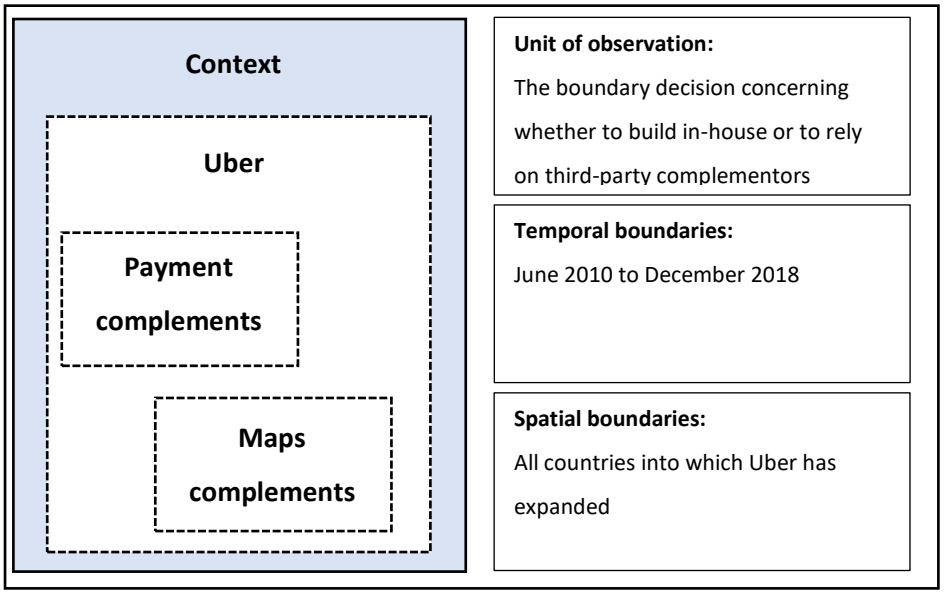


Figure 3-3: Unit of analysis, subunits of analysis, unit of observation and boundaries of the case study.

3.4 Data collection

The data collection process was guided by the research questions: what factors influence the shifts in the boundaries of MSDPs as they configure their complements, and how do MSDP firms respond to these factors? The data collection process was also influenced by the need to mitigate the methodological problems in existing studies on MSDPs (see de Reuver, Sørensen and Basole, 2017) and to adhere to the time constraints of the author's PhD project. This section is divided into two

subsections. Subsection 3.4.1 discusses and justifies the data sources used to conduct this research, and subsection 3.4.2 describes the data collection process, indicating how the author searched for and prepared the data for analysis.

3.4.1 Data sources

This research relied on secondary sources—technology blogs, archival data and supplementary data—to address the research questions. Table 3-4 lists the data sources used. The main aim of the study was to understand the factors influencing the boundaries of MSDPs and how MSDP firms respond to these factors by examining the extreme case of Uber. However, the main problems with examining extreme cases are limited access to primary data and the complexity of MSDPs themselves, which require diverse sets of data points. This was explained by de Reuver, Sørensen and Basole (2017):

> The secrecy of all the major platform-owners makes reliable first-hand data on governance and design decisions almost impossible to ascertain. Furthermore, due to the distributed nature of digital platforms and ecosystems, such access would likely be insufficient to fully understand the phenomenon. (p. 6)

Therefore, researchers, in general, and PhD students, in particular, have usually chosen their case studies based on practical considerations concerning primary data accessibility. Cases were generally chosen because the researcher was granted access to primary data rather than because the case itself was the best option to advance the understanding of MSDPs. This thesis viewed Uber as an extreme case (Yin, 2018) to understand MSDPs' boundary decisions, but it still faced the problem of a lack of access to primary data. To address this issue, this thesis followed the recommendation of de Reuver, Sørensen and Basole (2017) and relied on publicly available blogs to conduct the research. Using such publicly available blogs as a source of rich data was also inspired by recent studies on MSDPs and ecosystems, such as those of Constantiou, Eaton, and Tuunainen (2016), Eaton (2012), Eaton et al. (2014), Eaton et al. (2015), Ghazawneh and Henfridsson (2013), Liu, Nandhakumar and Henfridsson (2019), and Skog, Wimelius and Sandberg (2018).

Data Source	Description of the Source	Web Address
Blog Aggregator	Techmeme	https://www.techmeme.com
Technology Blogs	Mashable	https://mashable.com
	TechCrunch	https://techcrunch.com
	The Verge	https://www.theverge.com
	Medium	https://medium.com
	Wired	https://www.wired.com
Official Uber Blogs	Newsroom Blog	https://www.uber.com/newsroom
	Engineering Blog	https://eng.uber.com
	Medium Blog	https://medium.com/@UberPubPolicy
Archival Data	Quarterly reports and IPO filing documents	https://investor.uber.com/financials
Supplementary Data	Talks and conferences (Uber's YouTube channel)	https://www.youtube.com/UberWorldwid

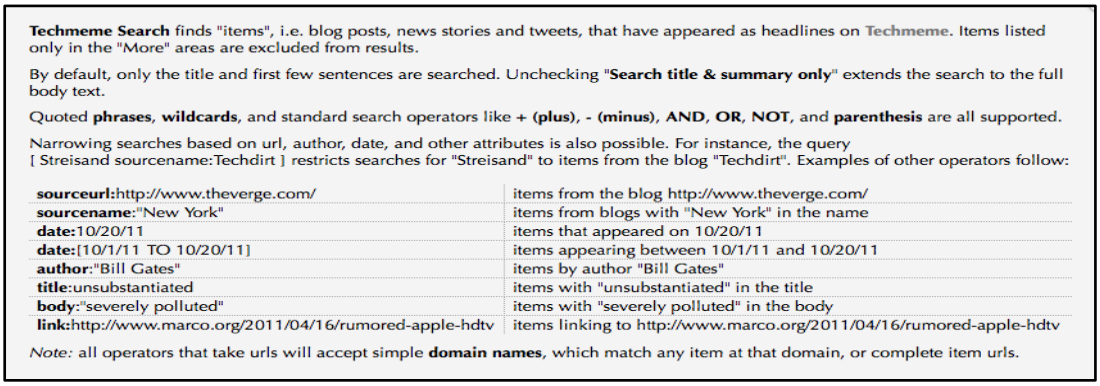
Table 3-4: List of data sources used in this research.

A blog is defined as 'a web-based publication with reverse chronological order of dated entries, usually maintained and published with a blog-authoring tool' (Davidson and Vaast, 2009, p. 40). According to Puri (2007), blogs are becoming important sources of rich data and are being increasingly used in the social sciences. The universe of blogs on the Internet is called the blogosphere, and it involves different kinds of bloggers, such as corporate bloggers, who post information about their firms, online news bloggers, who cover news about daily events and stories, and individual bloggers, who share their own experiences and narratives (Eaton, 2012; Mattson and Davidson, 2009).

This research was interested in blogs covering technical details and stories about Uber that could be analysed to understand the boundary decisions the company has taken since its establishment in 2010. Such information is typically found in technology blogs and is covered by tech bloggers, who are defined as 'bloggers whose postings focus on developments and innovation with new technologies, particularly information technologies, and with high-tech business' (Davidson and Vaast, 2009, p. 40). These bloggers have knowledge in various technological areas and can provide

invaluable information about Uber's implementation of new technology (related to the payment and maps components) and its boundary decisions. The technology blogs explored in this research contained opinions from the tech bloggers themselves and from industry experts, as well as interviews with Uber's executives and engineers, and other information directly from Uber, such as the company's comments on breaking stories. As indicated by Eaton et al. (2015), technology blogs provide adequate secondary and tertiary data because they are (1) relevant (provide information necessary for studies), (2) flexible (provide convenient data search, filtering and accessing options) and (3) of good quality (provide content that is cross-checked with different sources).

In this thesis, information about Uber was mainly retrieved from the Techmeme blog aggregator, replicating the data collection process used by Eaton et. al (2015). According to Vaast, Davidson and Matteson (2013, p. 1073), blog aggregators are 'algorithms that scan a list of indexed blogs or news sites using custom logic in order to publish links to the most current news and information from around the web on a single website'. These blog aggregators can retrieve articles from indexed blogs, newspapers and websites, such as *The Verge*, TechCrunch, *Wired*, the *Financial Times* and *The Wall Street Journal*. Some blog aggregators, such as Techmeme, offer advanced search features, enabling more customised search results. Figure 3-4 depicts Techmeme's advanced features, such as the ability to search within certain blogs, specify search dates, look for a specific author and search by keywords in the title or body of an article.



Techmeme Search finds "items", i.e. blog posts, news stories and tweets, that have appeared as headlines on Techmeme. Items listed only in the "More" areas are excluded from results.

By default, only the title and first few sentences are searched. Unchecking "**Search title & summary only**" extends the search to the full body text.

Quoted **phrases**, **wildcards**, and standard search operators like **+ (plus)**, **- (minus)**, **AND**, **OR**, **NOT**, and **parenthesis** are all supported.

Narrowing searches based on url, author, date, and other attributes is also possible. For instance, the query
[Streisand sourcename:Techdirt] restricts searches for "Streisand" to items from the blog "Techdirt". Examples of other operators follow:

sourceurl:http://www.theverge.com/	items from the blog http://www.theverge.com/
sourcename:"New York"	items from blogs with "New York" in the name
date:10/20/11	items that appeared on 10/20/11
date:[10/1/11 TO 10/20/11]	items appearing between 10/1/11 and 10/20/11
author:"Bill Gates"	items by author "Bill Gates"
title:unsubstantiated	items with "unsubstantiated" in the title
body:"severely polluted"	items with "severely polluted" in the body
link:http://www.marco.org/2011/04/16/rumored-apple-hdtv	items linking to http://www.marco.org/2011/04/16/rumored-apple-hdtv

Note: all operators that take urls will accept simple **domain names**, which match any item at that domain, or complete item urls.

Figure 3-4: A screenshot of the advanced search features of the Techmeme blog aggregator.

Collecting data from Techmeme provided blogs and news articles about Uber from various sources, which contained general information about Uber, as well as information about MSDPs' boundary decisions related to the payment and maps complements. Whilst Techmeme provided a huge set of data from different sources, the researcher could not solely rely on it because its indexing is influenced by human editors. This meant that Techmeme's human editors could affect the retrieved

blogs and articles about Uber, leading to the possibility of bias or missing important information. Therefore, the researcher collected data about Uber directly from five other technology blogs: Mashable, *The Verge*, Medium, TechCrunch and *Wired*. Doing so decreased the probability of missing critical information about Uber and its boundary decisions.

In addition to Techmeme and the five other technology blogs, the researcher collected data from Uber's official blogs: the Newsroom, Engineering and Medium Blogs. The Newsroom Blog contained information about new products or services being introduced in Uber's MSDP, as well as information about expansion to new markets. The Engineering Blog contained technical information about Uber's MSDP, such as how Uber integrates payment or maps systems and develops its own solutions in-house. The Medium Blog contained self-reflections from Uber employees and executives on different aspects of Uber's business, technology and solutions. It also offered some private reflections and information that could not be found in other sources. For example, one entry was a self-reflection from Uber's co-founder, who shared Uber's initial pitch in PowerPoint slides[8]. Data were collected from Uber's official blogs to ensure that the MSDPs' boundary decisions were understood mainly from the perspective of Uber's executives and employees. The data collected from Techmeme and other technology blogs contained not only the viewpoints of Uber's executives and engineers but also the opinions of blog writers, industry experts and competitors.

Archival data were also collected from Uber's website, presenting financial and technical information about Uber's MSDP and targeted investors. Despite the significance of this data source, the number of documents was limited, as Uber only began releasing them close to its IPO in April 2019. Finally, supplementary data were collected from Uber's YouTube channel, highlighting historic information about Uber, as well as technical information about Uber's MSDP, usually presented by Uber's engineers.

Using these various data sources increased the validity and reliability of the data analysis in this thesis by enabling triangulation and providing multiple views and accounts of the case under study (Patton, 2002; Yin, 2018). Table 3-5 describes the data collected from each source, the viewpoints found in each source and how the data were recorded for analysis.

[8] See (https://medium.com/@gc/the-beginning-of-uber-7fb17e544851)

Data Source	Description of the Data	Point of View	Data Recording
Blog Aggregator **Technology Blogs**	Data collected from these blogs contained general news and information about Uber, as well as information about boundary decisions related to the payment and maps complements. This was a main source of data in the analysis process.	Tech Bloggers Industry Experts Competitors Uber Executives Uber Engineers	Structured Excel Spreadsheet
Official Uber Blogs	Data collected from Uber's official blogs contained general news and information about Uber, as well as information about boundary decisions related to the payment and maps complements. Quite often, these blogs had more technical details, but they only reflected Uber's viewpoints. This was a main source of data used in the analysis process.	Uber Executives Uber Engineers	Structured Excel Spreadsheet
Archival Data	Archival data included documents produced by Uber for its investors, related to its initial public offerings. It included internal and private information Uber produced for the first time. These documents were limited in number, as Uber began producing them only close to its initial public offering in April 2019. This source supported the data retrieved from technology blogs.	Uber Executives	Unstructured Notes
Supplementary Data	Supplementary data included news and information about Uber, as well as technical details about the payment and maps complements. Videos of talks and conferences included information supporting the analysis of the main data source (technology blogs).	Uber Executives Uber Engineers	Unstructured Notes

Table 3-5: Description of the collected data, the viewpoints in the data sources and the method of data recording.

3.4.2 Data collection process

The previous subsection described the data sources used to collect data. This subsection describes the data collection process, beginning with how the author searched for the required data and ending with how he prepared the data for analysis. Moreover, this subsection also provides statistics illustrating the breadth and usefulness of the data for this research. Figure 3-5 depicts the data collection process for blog posts from the five technology blogs and the official Uber blogs that were chosen for this research.

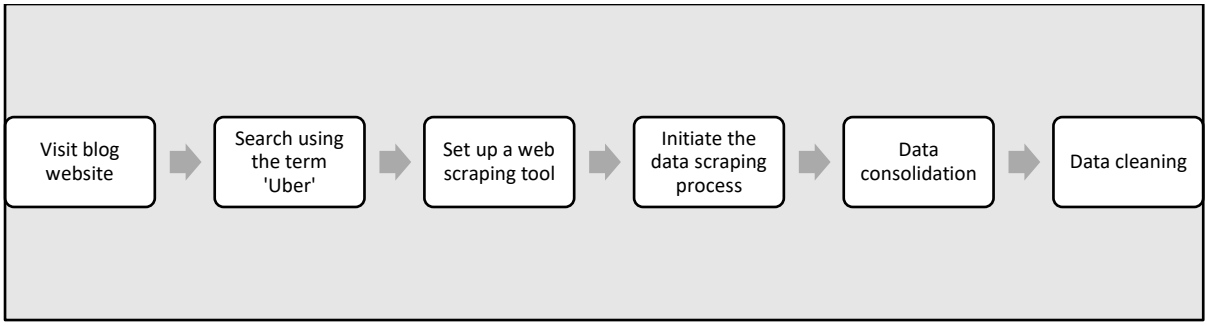


Figure 3-5: Data collection process.

Data collection from blogs began by visiting the technology blog website. The next step was to search for the term 'Uber'; this retrieved all the blog articles that were either about Uber or contained the word 'Uber'. Usually, this step resulted in a display of the blog articles in reverse order, followed by either numeric pagination (i.e. page 1, page 2, page 3, etc.) or automatic pagination (i.e. more links to blog articles were loaded on the screen as the user scrolled down). Figure 3-6 illustrates the search results from The Verge blog using the term 'Uber'. Once the search yielded results, a data scraping tool was configured to automatically extract data about all of the resulting blog articles. A data scraping tool 'accesses web pages, finds specified data elements [using Hypertext Markup Language (HTML) tags] on the page, extracts them, transforms them if necessary, and finally saves these data as a structured data set' (Boeing and Waddell, 2016, p. 3).

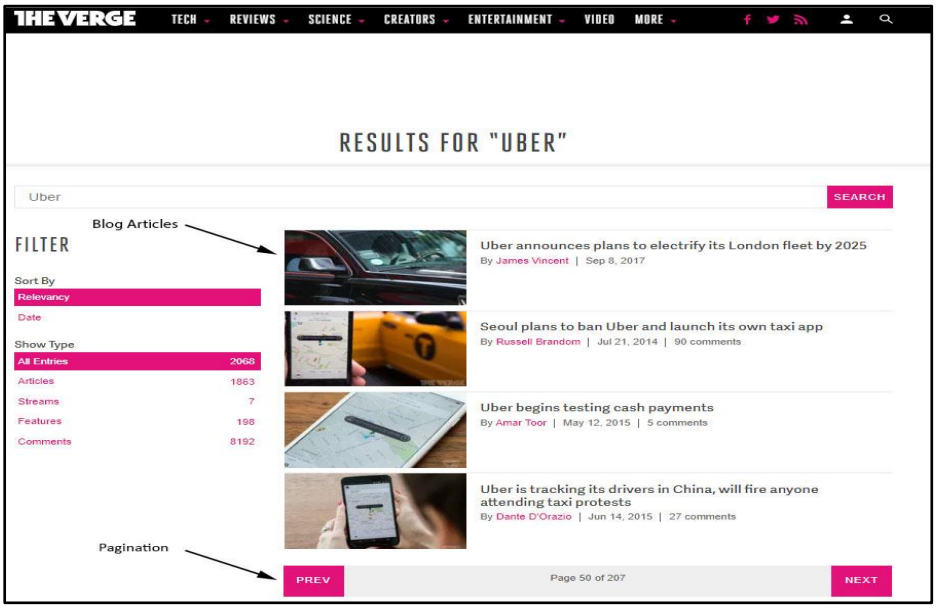


Figure 3-6: Search results from The Verge showing blog articles and numeric pagination.

In this thesis, the author used a Google Chrome web browser data scraping plugin called Web Scraper[9], which was relatively easy to configure and did not require writing extensive programming codes. The data scraping tool allowed identifying fields of data that were required to be scraped (extracted). For the purpose of this thesis, the data fields that were identified for scraping were the weblink to the blog article, the date of publication, the name of the author, the name of the blog, the blog article title, the summary of the blog article (provided by some blogs only) and the full content of the blog article. Once the data fields were identified and the data scraping tool was configured accordingly, the tool started extracting the data by automatically going through each blog article that was populated from the search. Once the data scraping tool finished processing all of the articles and extracting all of the required data, the data were then saved into a structured format either as comma-separated values (CSVs) or in Extensible Markup Language (XML) format. Figure 3-7 depicts an example of a blog article extracted from the Verge and saved into a structured format.

	SOURCE URL	ARTICLE	AUTHOR	BLOG NAME	ARTICLE TITLE	SUMMERY	ARTICLE CONTENT
2	https://www.theverge.com/2015/5/12/8590339/uber-cash-payments-hyderabad-india	12/05/2015	Amar Toor	The Verge	Uber begins testing cash payments	Null	Uber today announced that it will begin testing a cash payments system in Hyderabad, India, marking a global first for the credit card-based mobile app. In a blog post published today, the company described the initiative as an "experiment" in a part

Figure 3-7: A screenshot demonstrating an example of a blog article extracted from The Verge.

This data collection process was replicated across all of the technology blogs and official Uber blogs identified for this research. However, the process was not straightforward for Techmeme. As Techmeme is a blog aggregator, it collates blog articles from different online blogs and web sources. This means that the HTML tags of the fields (i.e. author or date) differ from one website to another. The Web Scraper tool that was used to extract data from individual technology blogs was not able to dynamically address the different HTML tags of the fields required for extraction. Therefore, the author had to write a data scraping script, using Python programming language, in order to overcome this problem and enable the dynamic extraction of blog content from the various websites that Techmeme generates its data from.

Once all of the blog articles were collected from Techmeme, the five technology blogs and Uber's official blogs, the data had to be consolidated by combining all of the blog articles from the different sources into a single Excel spreadsheet. This data consolidation process involved unifying the headers of the data (column name), standardising the date format (as different websites had various date and time formats) and sorting the blog articles chronologically.

[9] https://webscraper.io

The final step of the data collection process was to clean the data after they were consolidated into a single Excel spreadsheet. The data cleaning process involved filling in missing information, deleting irrelevant data and preparing the data to be imported into NVivo 12, the qualitative data analysis software (QDAS) used during the data analysis process.

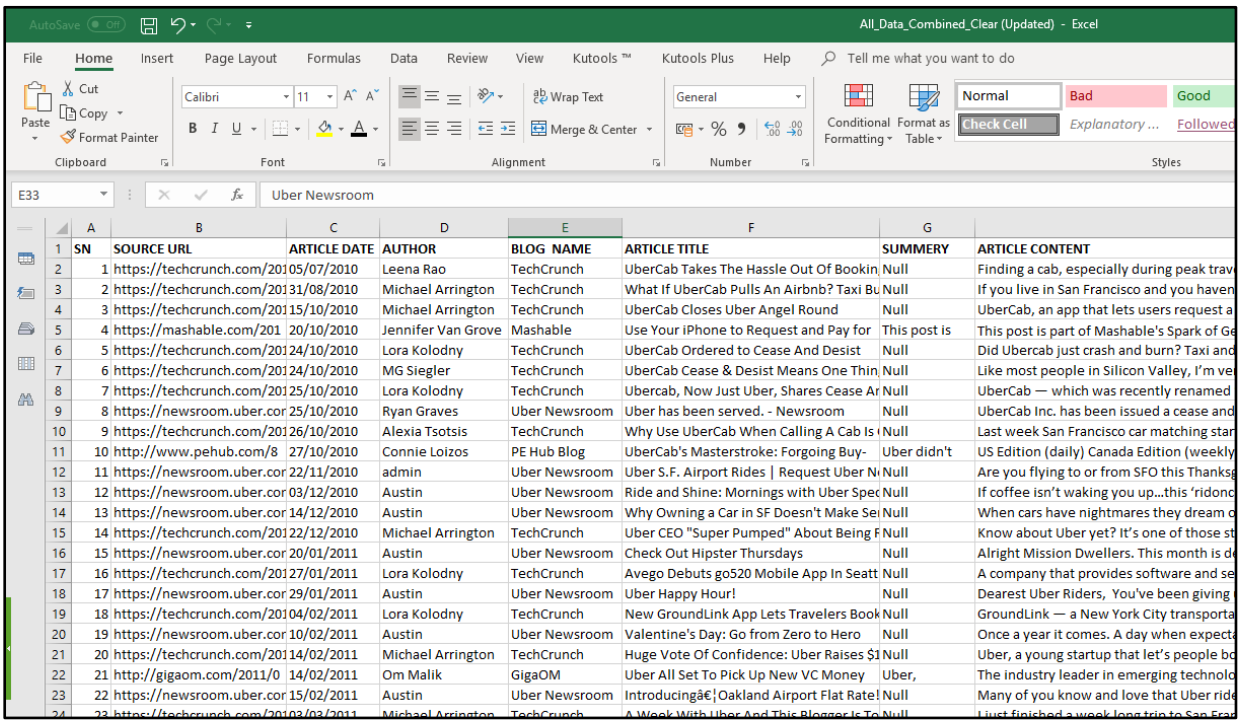
Although data scraping tools enable automatic and fast data extraction, data can still go missing. The consolidated data had some missing information, such as the date, the author's name and, sometimes, the full content of the blog. This usually occurs because of technical issues related to the way some HTML tags are defined differently, so they are not recognised by the data scraping tool. In order to solve this issue, the author had to search for the missing information and add it manually. The process was cumbersome, but the scraping of the weblink for each blog article sped up the process, as the author was able to quickly access the blog article and manually extract and add the missing information to the Excel spreadsheet.

Once all the missing data were added, the author skimmed the content of each blog article to remove the irrelevant blog articles. The author used two conditions to determine which articles were irrelevant. First, the blog article was removed from the data set if it contained the word 'Uber' but was not relevant to Uber, the firm. For example, some articles contained the term 'uber' used as an English word that means something extreme or excessive[10]. Second, a blog article was removed from the list if it contained a reference to Uber but did not contain any information about the firm. For example, some blog articles covered stories about the sharing economy and listed Uber as one of many examples. The removal of these blog articles was a part of the data reduction that should be conducted in qualitative research to manage the huge amount of collected data and enable a more focused data analysis (Miles and Huberman, 1994).

After adding the missing information and removing the irrelevant blog articles, the author had to prepare the data set in the Excel spreadsheet to be imported to NVivo 12. First, the author had to issue a unique identifier for each blog article (i.e. assigning a unique number to each blog article); data could not be imported to NVivo 12 if every single blog article was not uniquely identified. Second, the author had to remove any HTML tags (i.e. <!DOCTYPE> and <title>) in the data set, as they caused problems when attempting to import the data set to NVivo 12. Removing the HTML tags was easy, as many Excel macro scripts that can be used to automatically remove all HTML tags from the data set in Excel are available online. Finally, the author had to remove all line breaks (i.e. empty lines that separate two different paragraphs), as these also caused problems when attempting to

[10] https://www.merriam-webster.com/dictionary/%C3%BCber-

import the data set to NVivo 12. Figure 3-8 depicts a screenshot of the final data set imported to NVivo 12. The following subsection will provide a statistical description of the data set to illustrate the breadth of the data and of the sources used in the data analysis; this helps illustrate how the validity and reliability of this thesis were increased by performing data triangulation using multiple sources (Yin, 2018; Patton, 2002).



SN	SOURCE URL	ARTICLE DATE	AUTHOR	BLOG NAME	ARTICLE TITLE	SUMMERY	ARTICLE CONTENT
1	https://techcrunch.com/201	05/07/2010	Leena Rao	TechCrunch	UberCab Takes The Hassle Out Of Bookin	Null	Finding a cab, especially during peak trav
2	https://techcrunch.com/201	31/08/2010	Michael Arrington	TechCrunch	What If UberCab Pulls An Airbnb? Taxi Bu	Null	If you live in San Francisco and you haven
3	https://techcrunch.com/201	15/10/2010	Michael Arrington	TechCrunch	UberCab Closes Uber Angel Round	Null	UberCab, an app that lets users request a
4	https://mashable.com/201	20/10/2010	Jennifer Van Grove	Mashable	Use Your iPhone to Request and Pay for	This post is	This post is part of Mashable's Spark of Ge
5	https://techcrunch.com/201	24/10/2010	Lora Kolodny	TechCrunch	UberCab Ordered to Cease And Desist	Null	Did Ubercab just crash and burn? Taxi and
6	https://techcrunch.com/201	24/10/2010	MG Siegler	TechCrunch	UberCab Cease & Desist Means One Thin	Null	Like most people in Silicon Valley, I'm ve
7	https://techcrunch.com/201	25/10/2010	Lora Kolodny	TechCrunch	Ubercab, Now Just Uber, Shares Cease Ar	Null	UberCab — which was recently renamed
8	https://newsroom.uber.cor	25/10/2010	Ryan Graves	Uber Newsroom	Uber has been served. - Newsroom	Null	UberCab Inc. has been issued a cease and
9	https://techcrunch.com/201	26/10/2010	Alexia Tsotsis	TechCrunch	Why Use UberCab When Calling A Cab Is	Null	Last week San Francisco car matching star
10	http://www.pehub.com/8	27/10/2010	Connie Loizos	PE Hub Blog	UberCab's Masterstroke: Forgoing Buy-	Uber didn't	US Edition (daily) Canada Edition (weekly
11	https://newsroom.uber.cor	22/11/2010	admin	Uber Newsroom	Uber S.F. Airport Rides | Request Uber N	Null	Are you flying to or from SFO this Thanksg
12	https://newsroom.uber.cor	03/12/2010	Austin	Uber Newsroom	Ride and Shine: Mornings with Uber Spe	Null	If coffee isn't waking you up...this 'ridonc
13	https://newsroom.uber.cor	14/12/2010	Austin	Uber Newsroom	Why Owning a Car in SF Doesn't Make Se	Null	When cars have nightmares they dream o
14	https://techcrunch.com/201	22/12/2010	Michael Arrington	TechCrunch	Uber CEO "Super Pumped" About Being F	Null	Know about Uber yet? It's one of those st
15	https://newsroom.uber.cor	20/01/2011	Austin	Uber Newsroom	Check Out Hipster Thursdays	Null	Alright Mission Dwellers. This month is d
16	https://techcrunch.com/201	27/01/2011	Lora Kolodny	TechCrunch	Avego Debuts go520 Mobile App In Seatt	Null	A company that provides software and se
17	https://newsroom.uber.cor	29/01/2011	Austin	Uber Newsroom	Uber Happy Hour!	Null	Dearest Uber Riders, You've been giving
18	https://techcrunch.com/201	04/02/2011	Lora Kolodny	TechCrunch	New GroundLink App Lets Travelers Book	Null	GroundLink — a New York City transporta
19	https://newsroom.uber.cor	10/02/2011	Austin	Uber Newsroom	Valentine's Day: Go from Zero to Hero	Null	Once a year it comes. A day when expecta
20	https://techcrunch.com/201	14/02/2011	Michael Arrington	TechCrunch	Huge Vote Of Confidence: Uber Raises $1	Null	Uber, a young startup that let's people bo
21	http://gigaom.com/2011/0	14/02/2011	Om Malik	GigaOM	Uber All Set To Pick Up New VC Money	Uber,	The industry leader in emerging technolo
22	https://newsroom.uber.cor	15/02/2011	Austin	Uber Newsroom	Introducingâ€¦Oakland Airport Flat Rate!	Null	Many of you know and love that Uber ride

Figure 3-8: A screenshot of the cleaned-up data set imported to NVivo 12.

3.4.3 Statistical description of the data

This section provides a brief description of the blog data collected to conduct this research. The main goal of data collection from different blogs was to address the research questions, which were concerned with the factors that influence the boundary decisions of MSDPs and how MSDP firms respond to these factors. The collected data about Uber were from June 2010 until the end of December 2018. The data were collected in June 2017 and in December 2018. When the author first collected data in June 2017, he believed that the data were rich enough to conduct the analysis for this research. However, the author realised that Uber's MSDP was evolving rapidly after June 2017. At that time, a month would not pass without a major story breaking about Uber, including boundary decisions relevant to the payment and maps components. Moreover, Uber was becoming more open to sharing private data publicly during 2018, as it was planning for an IPO. Hence, more

financial data were available about Uber after June 2018 than in all the previous years since its establishment.

When the data were consolidated in a single Excel spreadsheet, the total number of distinct blog posts about Uber or containing the word 'Uber' was 14,127. However, as explained in subsection 3.4.2, the data were cleaned up to remove the blog articles that were not relevant to this research; hence, the final number of blog articles that were imported to NVivo 12 was 7,475. Table 3-6 shows the number of blog articles per blog before and after data cleaning.

Blog name	Number of extracted blog articles	Number of relevant blog articles
Techmeme	3,281	1,628
Mashable	2,572	994
Uber Newsroom Blog	2,193	1,954
TechCrunch	1,935	864
The Verge	1,452	847
Wired	1,352	387
Medium	973	432
Uber Engineering Blog	258	258
Uber Medium Blog	111	111
Total	**14,127**	**7,475**

Table 3-6: Number of blog articles per blog before and after data cleaning.

As described in subsection 3.4.2, the consolidated data set in the Excel spreadsheet had unified column names. These column names were the serial number, source URL, article date, author, blog name, article title, summary and article content. Table 3-7 provides a description of the columns of the data set consolidated for this research.

Column name	Description
Serial number	This is a unique identifier for each blog article. This is required for importing the file into NVivo 12.
Source URL	This contains the link to the blog article.
Article date	This is the date when the blog was written.
Author	This includes the name of the author of the blog article. Only the name of the first author was extracted when there were multiple authors to reduce the complexity of data extraction.
Blog name	This is the name of the site where the blog article was originally posted.
Article title	This is the title of the blog article.
Summary	This is a summary of the blog article, as provided by the blog website. Some of the blog websites provide a brief summary of each blog article. Not all blogs provide such a summary, so some of the fields are assigned to null.
Article content	This field contains the full content of the blog article.

Table 3-7: Description of the columns of the data set consolidated for this research.

As the data about Uber span from its establishment in June 2010 until December 2018, the number of blog articles varies per year. Figure 3-9 shows the distribution of blog articles per year. In general, it can be observed that the number of blog articles on Uber increased per year. This is plausible because Uber was gaining more popularity, and it was expanding into new markets rapidly. However, Figure 3-9 shows that the number of blog articles decreased in 2018. The reason behind this decline is that the researcher was stricter in cleaning the data when they were collected in December 2018 than in June 2017. The author had already started the data analysis and was more familiar with the requirements of the newly extracted data in December 2018. Hence, the author removed all blog articles that were not directly relevant to the payment and maps complements prior to importing the new data to NVivo 12.

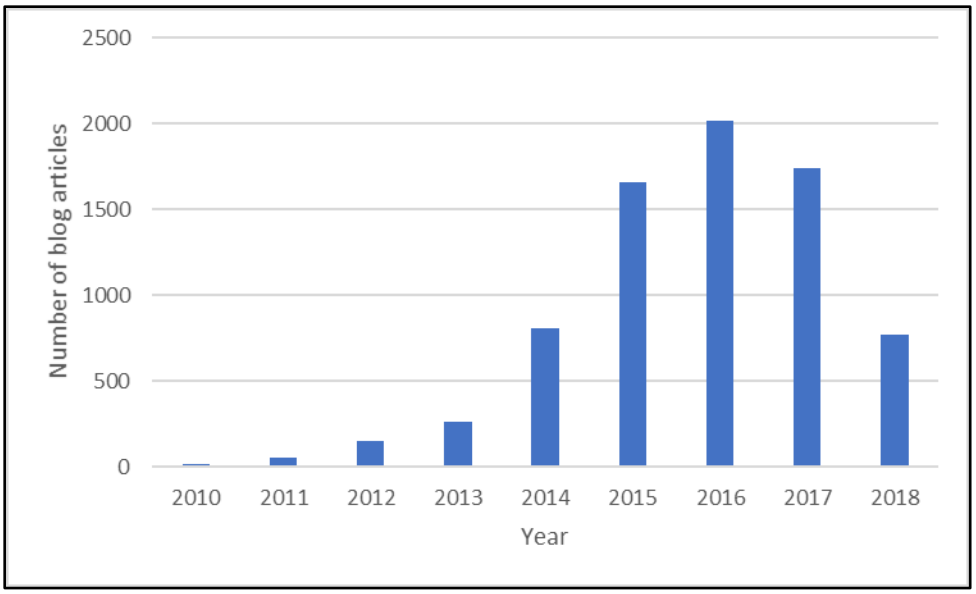


Figure 3-9: Distribution of the number of blog articles per year.

To illustrate the diversity of the data, Figure 3-10 depicts three screenshots showing the first 10 blog articles in the data set, 10 blog articles from the middle of the data set and the last 10 blog articles in the data set. Figure 3-10 shows that the blog articles were written on various dates and by various authors and that they come from a variety of blogs. This diversity adds strength to the study and ensures that any information could be cross-checked in different sources; this occurred because stories about Uber are usually reported by multiple blog sites, including Uber's official blogs. Hence, this enabled the data analysis to provide a deeper understanding of the factors influencing the boundary decisions of Uber's MSDP, as well as to investigate how Uber responded to these factors. It is worth mentioning that some blog sites have better coverage in different geographical areas. For example, the author found that Mashable is better at covering Uber's stories in Europe, whereas TechCrunch is better at covering Uber's stories in the US.

SN	SOURCE URL	ARTICLE DATE	AUTHOR	BLOG NAME	ARTICLE TITLE	SUMMERY	ARTICLE CONTENT
1	https://techcrunch.com/201	05/07/2010	Leena Rao	TechCrunch	UberCab Takes The Hassle Out Of Bookin	Null	Finding a cab, especially dur
2	https://techcrunch.com/201	31/08/2010	Michael Arrington	TechCrunch	What If UberCab Pulls An Airbnb? Taxi Bu	Null	If you live in San Francisco ar
3	https://techcrunch.com/201	15/10/2010	Michael Arrington	TechCrunch	UberCab Closes Uber Angel Round	Null	UberCab, an app that lets use
4	https://mashable.com/201	20/10/2010	Jennifer Van Grove	Mashable	Use Your iPhone to Request and Pay for	This post is	This post is part of Mashable
5	https://techcrunch.com/201	24/10/2010	Lora Kolodny	TechCrunch	UberCab Ordered to Cease And Desist	Null	Did Ubercab just crash and b
6	https://techcrunch.com/201	24/10/2010	MG Siegler	TechCrunch	UberCab Cease & Desist Means One Thin	Null	Like most people in Silicon V
7	https://techcrunch.com/201	25/10/2010	Lora Kolodny	TechCrunch	Ubercab, Now Just Uber, Shares Cease Ar	Null	UberCab — which was recen
8	https://newsroom.uber.cor	25/10/2010	Ryan Graves	Uber Newsroom	Uber has been served. - Newsroom	Null	UberCab Inc. has been issue
9	https://techcrunch.com/201	26/10/2010	Alexia Tsotsis	TechCrunch	Why Use UberCab When Calling A Cab Is	Null	Last week San Francisco car r
10	http://www.pehub.com/8	27/10/2010	Connie Loizos	PE Hub Blog	UberCab's Masterstroke: Forgoing Buy-	Uber didn't	US Edition (daily) Canada Edi
• • • •							
4527	https://medium.com/uber-	07/10/2016	Uber Under the Hoo	Uber Medium Blo	London's new late night alternative: The	Null	London's new late night alt
4528	https://www.uber.com/nev	08/10/2016	Stephanie Rose	Uber Newsroom	AT&T Delivers on Game Day	Null	Football is back in Atlanta a
4529	https://www.uber.com/nev	08/10/2016	Tommy Pierucki	Uber Newsroom	Celebrating Transportation Options	Null	Uber's mission is to connect
4530	https://mashable.com/201	10/10/2016	Ariel Bogle	Mashable	Uber shares data to show how the	Uber partners	Uber drivers are on the roa
4531	https://medium.com/sitepo	10/10/2016	Theo Miller	Medium	4 Ways Uber Wins UX by Killing Friction	Null	4 Ways Uber Wins UX by Kil
4532	http://motherboard.vice.c	10/10/2016	Greg Sandoval	Motherboard	France's transportation department	France's	Anti-Uber grafitti in Paris. Ir
4533	https://www.uber.com/nev	10/10/2016	Laura Flatley	Uber Newsroom	Ride Into Winter with Uber and Warren M	Null	Ski and snowboard season i
4534	https://www.theverge.co	10/10/2016	Andrew J. Hawkins	The Verge	Images of Google's first self-driving	Null	Last May, Google and Fiat Cl
4535	https://www.theverge.co	10/10/2016	Andrew J. Hawkins	The Verge	Digital mapping firm Here wants to	Null	Here, the mapping business
4536	https://mashable.com/201	11/10/2016	Maria Gallucci	Mashable	Driverless cars, electric vehicles and	Getting	Three early transportation t
4537	http://www.bloomberg.co	11/10/2016	Eric Newcomer	Bloomberg	Sources: Square discussed selling Caviar	Price of about	Connecting decision maker
• • • •							
7465	http://techcrunch.com/2018	20/12/2018	Zack Whittaker	TechCrunch	At Blind, a security lapse revealed privat	Blind, an anon	housands of people trusted
7466	http://www.sfchronicle.cor	20/12/2018	Roland Li	San Francisco Chr	Square leases Oakland's Uptown Station	Square says it h	Payments processor Square
7467	http://techcrunch.com/2018	20/12/2018	Romain Dillet	TechCrunch	French data protection watchdog fines Ul	Uber fined €40	French data protection wat
7468	http://techcrunch.com/2018	20/12/2018	Ingrid Lunden	TechCrunch	Uber partner Fair gets $385M led by Softb	Flexible car ow	California startup Fair.com i
7469	http://www.cnet.com/new	20/12/2018	Dara Kerr	CNET	Uber's self-driving cars return to public r	Uber says it wil	Uber took its self-driving ca
7470	http://techcrunch.com/2018	21/12/2018	Ingrid Lunden	TechCrunch	Delivery Hero sells its German business t	Delivery Hero s	One more big consolidation
7471	http://techcrunch.com/2018	23/12/2018	Ingrid Lunden	TechCrunch	Uber reaches tentative settlement with c	Sources: Uber h	years and covers nine state
7472	http://techcrunch.com/2018	28/12/2018	Jon Russell	TechCrunch	Grab raises fundraising target to $5B as So	Source: Grab h	Southeast Asian ride-hailing
7473	http://www.ft.com/conten	30/12/2018	Shannon Bond	Financial Times	When things go wrong at Uber: inside its	Inside Uber's U	Please use the sharing tool
7474	http://arstechnica.com/cars	30/12/2018	Timothy B. Lee	Ars Technica	The hype around driverless cars came cra	Big players in a	As 2018 dawned, expectatic
7475	http://en.globes.co.il/en/ar	31/12/2018	Null	Globes Online	Volkswagen to write off Gett investment	Der Spiegel: Vo	German carmaker Volkswag

Figure 3-10: Screenshots of different examples of blog articles captured from the top, middle and bottom of the data set.

As the blog articles come from different sites, demonstrating the contribution of each blog to the data set is important. Table 3-8 lists the top contributing blogs to the data set of this research by calculating the number of articles from each blog and their percentage of the 7,475 blog articles. The table shows that the blog that contributed the most articles was Uber Newsroom, which accounted for 26% of the total blog articles in the data set. The table also shows that TechCrunch, Mashable, The Verge and Medium are amongst the top five contributing blogs. This is plausible because the author collected blog articles about Uber directly from these blogs and added the results to the various blog articles collected from the blog aggregator Techmeme.

#	Blog	Count	Percentage
1	Uber Newsroom Blog	1,945	26.0%
2	Mashable	994	13.3%
3	TechCrunch	864	11.6%
4	The Verge	847	11.3%
5	Medium	446	6.0%
6	Wired	387	5.2%
7	Uber Engineering Blog	258	3.5%
8	Bloomberg	140	1.9%
9	New York Times	134	1.8%
10	Reuters	105	1.4%
11	Wall Street Journal	92	1.2%
12	Recode	91	1.2%
13	Uber Medium Blog	84	1.1%
14	BuzzFeed	63	0.8%
15	VentureBeat	45	0.6%
16	Business Insider	45	0.6%
17	Re/code	30	0.4%
18	Bloomberg Business	28	0.4%
19	The Next Web	26	0.3%
20	Axios	24	0.3%

Table 3-8: Top sites contributing to the data set.

This subsection provided a statistical description of the different blog articles and sources that were collected to conduct the data analysis for this research. The different tables and figures illustrated the breadth of the data and the variety of sources.

3.5 Chapter summary

This chapter described and justified the research philosophy and design that informed this research. It also provided a detailed description of the data collection process. The chapter discussed the choice to conduct an embedded case study of Uber and provided statistical descriptions of the 7,475 blog articles that were the main source of data used in this research. The next chapter will describe the main case study, Uber, and its embedded subunits, the payment and maps complements.

4 CASE STUDY

4.1 Chapter introduction

This chapter provides a detailed description of Uber, the main case, and its payment and maps complements, the embedded cases. Section 4.2 offers general background information about Uber, including information about its establishment, its business model and its market and adjacent businesses expansion. Section 4.3 provides an overview of the main components of Uber's MSDP. Section 4.4 offers a detailed description of the embedded cases, the payment and maps complements, that have been examined in this thesis in order to address the research questions related to identifying the factors that influence the boundary decisions of MSDPs and how MSDP firms respond to them. Section 4.4 also provides a timeline of the evolution of Uber's payment and maps complements. Finally, Section 4.5 summarises the chapter.

4.2 Case study background

This section provides background information about Uber, and it is divided into three subsections. Subsection 4.2.1 offers background information about the inception of Uber, its business model and its disruption of the taxi industry. Subsection 4.2.2 discusses how Uber's MSDP works. Subsection 4.2.3 discusses Uber's market expansion as well as its expansion into adjacent businesses.

4.2.1 Uber's inception and disruption of the taxi industry

In 2009, Travis Kalanick and Garrett Camp established Uber in San Francisco to offer taxis, private cars and ridesharing services. The founders came up with the idea for Uber as a result of their difficulty finding a cab on a snowy night in Paris; they decided to create a 'push a button get a ride' mobile application (Mishkin, 2015). The most prominent feature of Uber is that it runs a taxi service without owning any cars and without employing drivers. Uber considers its drivers independent contractors and hence does not incur costs related to car insurance, repairs, gas, paid time off or health insurance (Nova, 2019).

Uber launched its first operations in San Francisco in June 2010 and then expanded to different cities in the United States, followed by global expansion to Europe, Asia, Africa and South America

between 2011 and 2018 (Hartmans and Leskin, 2019). Uber was initially branded as UberCab but later removed 'Cab' from its brand name to avoid labelling it as a taxi company, thereby circumventing legislations associated with the taxi industry (Kolodny, 2010). This was indicated by the head of Uber's operations in Indonesia, who claimed that 'Uber is only a smartphone application ... We don't need a transportation license, as all we make is a smartphone app that connects riders to drivers' (Yuniar, 2015).

Uber is regarded as the first mover in the ridesharing business, followed by competitors such as Didi Dache, GrabTaxi, Lyft, Ola, Hailo and Sidecar (Financial Times, 2015). It allows its customers to request a taxi ride from points A to B using an application on their smartphones, and the Uber app enables customers to track their allocated taxi's location on a map using GPS technology. Moreover, it allows online payment of ride fees and grants customers and drivers the ability to rate each other. It currently offers a range of taxi services, ranging from low-cost to premium rides. As of December 2018, it operated in more than 63 countries and 700 cities and has 91 million consumers[11] and 3.9 million drivers (Uber Technologies, Inc., 2019). As of August 2018, Uber was valuated at $76 billion (Trefis Team and Great Speculations, 2018), surpassing major automobile manufacturers such as General Motors ($55 billion) and Honda ($60 billion) (La Monica, 2015). The firm's revenue model is based on charging drivers a small commission for each journey, allowing it to generate substantial revenue, especially since the firm does not incur costs such those arising from as car maintenance or insurance. Drivers keep most of the ride fees, allowing them to earn a good income; according to Uber's IPO filing document, the commission rate varies from 12 to 24 percent based on geographical region (Uber Technologies, Inc., 2019).

Uber is considered a disruptor of the taxi industry. It disrupted the taxi industry by using an MSDP that allowed the utilisation of excess capacity. Robin Chase, cofounder of Zipcar, defines excess capacity as 'downtime from your other means of earning income and making use of the car you already owned' (Chase, 2016). Uber allowed people to take advantage of assets they already own and have already paid for to create new value (Chase, 2016). Moreover, it changed the way riders book cabs and drivers find hires. Uber achieved a competitive advantage over traditional taxi firms by eliminating many of the expensive costs incurred in the traditional taxi industry, such as those related to maintenance, insurance and fuel costs (Wanetick, 2015). This in turn allowed Uber to offer cheaper prices than those offered by traditional taxis. For instance, Uber's fare for a trip from

[11] In its IPO filing document, Uber provided the total number of consumers, including UberEATS users; it did not provide separate consumer counts for its ridesharing and food delivery MSDPs.

Shepherd's Bush to Wapping in London costs £24, versus the £44 cost of using a traditional black cab in London (Thring, 2014).

Another example of Uber's disruption is the set of benefits it provides to its customers compared to traditional taxis. Uber's service is more reliable than traditional taxis, because riders can get accurate estimations of times of arrival and fares before starting the ride. Further, the rider is able to view detailed information about his or her allocated car and driver, such as the car's plate number and colour and the driver's name, photo and rating (Wanetick, 2015). These features are not typically available using traditional taxi services. In addition, Uber allows riders to rate and evaluate their drivers, which contributes to increasing the quality of the service and eliminating poor drivers. Because its system predetermines the fare and route of the trip and allows passengers to pay the fare electronically, passengers are not expected to tip drivers, and disputes are thereby reduced. The consistency and reliability of the service changed the way passengers book rides, because Uber passengers book rides by pushing a button on their smartphones instead of waiting in queues or underserved areas.

Uber offers advantages to its drivers that are not available to taxi drivers. Joining Uber allows drivers to bypass many of the rigidities of the traditional taxi industry. For instance, new taxi drivers in London can simply join Uber without investing effort and time in passing The Knowledge test, because Uber operates using navigational systems instead of depending on the experience and knowledge of the drivers. Similarly, new Uber drivers in New York City do not need to invest tremendous amounts of money to acquire new taxi medallions (Wanetick, 2015). Moreover, through matching algorithms and sophisticated systems, Uber allows drivers to reduce their waiting time and maximise their capacity, thereby increasing their income. In addition, Uber drivers can rate passengers, giving them the opportunity to eliminate passengers with bad behaviours. Finally, Uber allows flexible working hours for their drivers, which encourages people to join the network. The aforementioned advantages have urged many traditional taxi drivers to shift to Uber and other similar ridesharing companies (Salmon, 2013). The movement of traditional taxi drivers to Uber had a severe impact on traditional taxi businesses. For example, Yellow Cab Co-operative, once the biggest taxi company in San Francisco, filed for bankruptcy in 2016 as a result of the disruption caused by Uber (Buckley, 2016). Table 4-1 provides a comparison between the business models of Uber and the traditional taxi industry.

Feature/Aspect	Traditional Taxi	Uber
GPS driver guidance	Optional	Mandatory
Know exact location and arrival time of vehicle	No	Yes
Easy choice of vehicle	No	Yes
Type of drivers	Employees and independent contractors	Independent contractors
Ability to provide feedback/rating	No	Yes
Payment type	Cash or credit	Cashless (credit cards, digital wallets and mobile payment) and cash
Spend time on payment while in vehicle	Yes	No (except for cash payment)
Can be hailed on the street	Yes	No
Driver owns or leases car	Mixed	Yes
Computer dispatching	Mixed	Yes
How company is paid	Mixed (revenue split, plus per diems)	Revenue split with driver

Table 4-1: Comparison between the business models of Uber and the traditional taxi industry (adapted from Teece, 2017).

4.2.2 How Uber works

Uber is an MSDP, which means that it connects at least two distinct groups of users. In Uber's case, the main two groups of users are drivers and riders. The main idea of Uber is to establish strong network effects by attracting more drivers to its MSDP. When more drivers join Uber, more riders are likely to join Uber, because as the number of drivers increases, the waiting times for riders decrease (this happens because riders will be matched with drivers more quickly). As more riders join Uber, additional drivers will join, because the probability of receiving new ride requests increases. This creates a positive feedback loop that reinforces the growth of the MSDP and helps it achieve competitive advantage. Figure 4-1 depicts the dynamics of the positive feedback loop that Uber attempts to achieve.

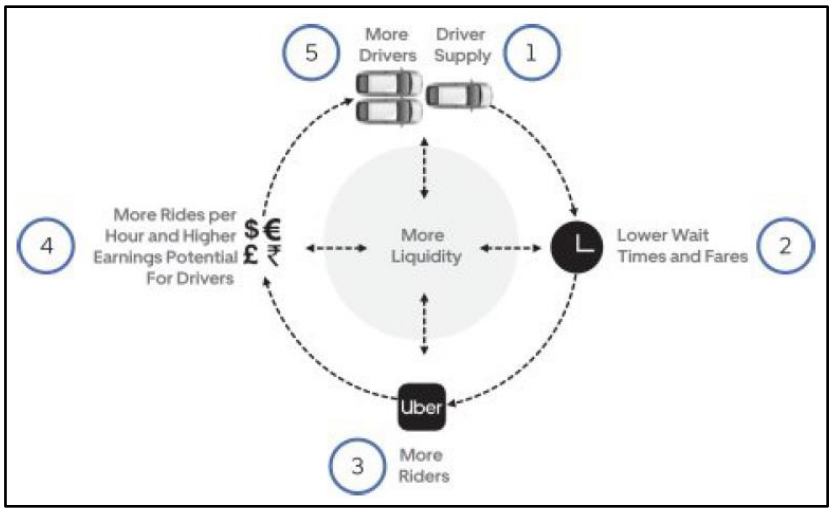


Figure 4-1: The dynamics of Uber's positive feedback loop (reproduced from Uber Technologies, Inc., 2019, p. 14).

In MSDPs, the convention is to treat users (such as riders) as customers and workers (such as drivers) as suppliers. However, Uber considers its drivers customers as well as suppliers of the service. As a senior executive at Uber stated, 'I am making sure that the Uber team knows drivers are our customers ... our job is to make driving with Uber feel rewarding and worth [the drivers'] time' (Statt, 2017). Hence, in this thesis, Uber drivers are also considered customers.

Riders can access Uber's MSDP through a mobile application that can be downloaded on either Apple iOS or Android OS. Drivers use a different mobile application than riders, and this app is also available on Apple iOS and Android OS. Figure 4-2 depicts a screenshot of Uber's app interface on Apple iOS. The process of requesting a ride is consistent across the geographical areas in which Uber operates. The rider first creates an Uber account using a personal email address and phone number. The rider then enters the destination, confirms the pickup location and selects one of the available ride options (i.e. low-cost or premium ride). The user is then presented with an estimated fare and estimated time of arrival. Once the rider confirms the ride request, Uber matches the rider with a nearby driver and displays ride information, such as the name of the driver and the car's colour, make and plate number. The rider then waits for the driver to arrive at the specified location; Uber enables the rider to track the location of the driver on a map in real time. Once the driver arrives, the rider checks that the car and the driver match the details displayed on the app and enters the car. The rider is then transported to the specified destination. When the rider arrives at the destination, payment is usually deducted in the background, without any interaction from the rider or driver; this assumes that the driver has already set up a digital payment method. Finally, the rider and driver get to rate each other; accumulating a low average rating could lead to the suspension of a driver or rider from Uber's MSDP.

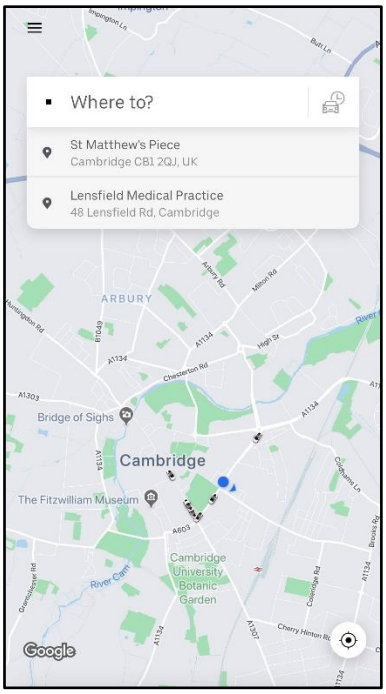


Figure 4-2: A screenshot of Uber's app interface on Apple iOS.

4.2.3 Market expansion and expansion into adjacent businesses

Uber believed that achieving rapid scaling of its business would grant it competitive advantage over its competitors (Uber Technologies, Inc., 2019). Hence, Uber's expansion strategy was aggressive in terms of both expanding to new markets and expanding to various adjacent businesses. Figure 4-3 depicts Uber's yearly expansion to new cities. In 2010, Uber was operating only in San Francisco (Travis, 2011). By the end of 2014, Uber had expanded to over 250 cities globally (Wasserman, 2014). By the end of 2018, this number had tripled, and Uber was serving more than 700 hundred cities (Uber Technologies, Inc., 2019). As an indication of Uber's aggressive expansion, the data show that at one point in 2014, the pace of expansion reached one city per day, as reported by Forbes:

> Uber's head of global expansion told *Businessweek* that Uber was launching in a new city every other day, but those now seem obsolete just a few weeks later. Depending on how you slice the numbers that FORBES gathered, Uber's growth rate is closer to one new city a day. It launched in around 30 cities in the last 30 days, though some launches are for regions that include multiple cities (Huet, 2014).

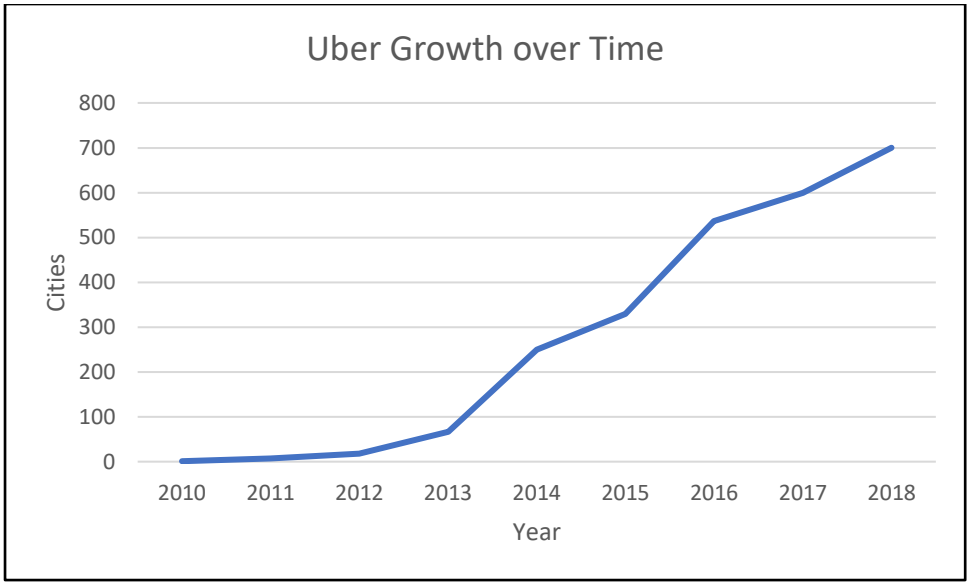


Figure 4-3: Uber's yearly expansion to new cities.

Uber's first international expansion was in 2011, when it expanded to Paris; this also marked Uber's first expansion to Europe. In 2012, Uber continued its European expansion by entering other major markets, such as Amsterdam and London, and continued its North American expansion by launching in Toronto. In 2013, Uber expanded to Asia, launching in Taiwan and India. At the same year, Uber also expanded to Africa, launching first in Johannesburg, South Africa. In 2014, Uber expanded to the Middle East, launching in the United Arab Emirates. In the same year, Uber continued expanding to major Asian markets, such as China and Malaysia, as well as to more African countries, including Nigeria (Hartmans and Leskin, 2019). By the end of 2018, Uber was operating across five continents.

Besides market expansion, Uber diversified its services and expanded to adjacent businesses. For example, when Uber was launched in 2010, it offered only a premium service called UberBlack, provided by a chauffeur with a luxury car. In 2012, Uber added a new option called UberX, offering a low-cost ride using hybrid cars such as the Toyota Prius (Chen, 2012). In the same year, Uber launched UberPool, a ridesharing option that enables different people who are likely going in the same direction to share the ride, thereby reducing the fare cost for each passenger (Jen, 2012). Besides diversifying its business, Uber expanded to adjacent businesses, such as food and supply delivery (MacMillan, 2015) and helicopter, e-bikes, e-scooter and boat rides[12] (Uber Technologies, Inc. 2019; Hawkins, 2017; Flynn, 2014).

[12] This thesis is concerned only with Uber as a ridesharing service, moving people from point A to point B.

4.3 The main components of Uber's MSDP

Uber's MSDP is very complex, being composed of thousands of different microservices[13] (Uber Engineering, 2018). In this section, the main components of Uber's MSDP are discussed in a simple, abstract format. There are three main components of Uber's MSDP: marketplace technologies, payment technologies and maps and routing technologies (Uber Technologies, Inc., 2019). These components are supported by both in-house technologies and technologies provided by third-party complementors. The following briefly explains these main components of Uber's MSDP.

4.3.1 Marketplace technologies

Uber identifies marketplace technology as real-time algorithmic engines responsible for matching the supply of and demand for its ridesharing services (Uber Engineering, 2017). These engines are responsible for demand prediction, intelligent dispatch and pricing. A core objective of Uber is to increase earnings for its drivers while reducing waiting times for its riders. One of the ways Uber is achieving this is by guiding its drivers to areas with the highest demand potential, hence potentially serving more customers and increasing its drivers' earnings. Uber guides its drivers to areas with the highest demand using heatmaps, which predict the locations that are likely to have a spike in demand, using algorithms, machine learning and historic data. Figure 4-4 depicts an example of a heatmap displayed on a driver's app, whereby the areas marked in red hexagons are expected to have increasing demand, and, hence, the drivers are encouraged to move to those areas.

Another type of technology implemented by Uber to increase the efficiency of supply and demand matching are algorithmic engines that dynamically determine ride prices. Uber implements what is known as surge pricing, whereby prices fluctuate based on changes in demand. Surge pricing typically occurs when demand exceeds supply in a specific area. To maintain an efficient service, Uber dynamically raises prices for rides originating from areas with spikes in demand; surge prices typically vary from 1.5 to 2.5 times the normal price. By doing this, Uber encourages more drivers to move to areas where the prices have been increased; this creates more supply. At the same time, riders who are not willing to pay the higher prices have to wait until the prices return to normal; this

[13] Microservices, also known as a microservice architecture, is the architectural configuration of a software system as a collection of modules (services) that are loosely coupled and independent. Microservice architecture is the opposite of monolithic architecture and is usually preferred over the latter. For more information, see (https://medium.com/edureka/microservice-architecture-5e7f056b90f1).

leads to a reduction in demand and, hence, balances supply and demand. Once supply and demand are balanced, Uber ends surge pricing and prices return normal[14].

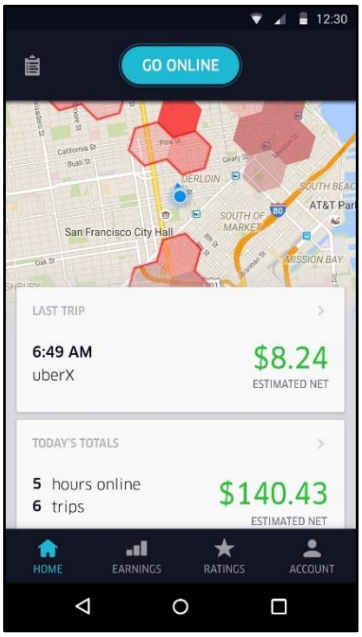


Figure 4-4: Example of a heatmap displayed on a driver's app (adapted from Hempel, 2015).

4.3.2 Payment technologies

As previously indicated in this chapter, one of the advantages of Uber's business model compared with traditional taxi companies is the enabling of a frictionless payment experience. Payment happens electronically in the background as a rider enters and exits a ride: the rider does not need to wait in the car to pay for the ride or dispute the payment with the driver. To provide a frictionless payment experience, Uber relies on both third-party payment complementors and in-house payment technologies. Section 4.4 provides a detailed discussion of the payment components of Uber's MSDP; they represent the first embedded case in this thesis, as indicated in chapter 3.

4.3.3 Maps and routing technologies

A core element of Uber's service is to both determine the location of riders and drivers and enable accurate routing (i.e. accurate directions from point A to point B and accurate estimated time of arrival). To do this, Uber relies on both in-house technology and technology provided by third-party

[14] The practice of surge pricing is highly controversial. For more information, see (https://money.cnn.com/2017/06/04/technology/uber-london-attack-surge-pricing/index.html).

complementors. This includes the use of global positioning system (GPS), routing engines, navigation systems, mapping systems and location data. By utilising a combination of these technologies, Uber is able to efficiently determine the best route a driver should follow to reach a rider's pickup location and transport them to their destination. This takes into consideration location and time as well as other factors, such as traffic conditions and local events (Uber Technologies, Inc., 2019). Section 4.4 provides a detailed discussion of the maps components of Uber's MSDP; they represent the second embedded case in this thesis, as indicated in chapter 3.

4.4 The embedded cases

As indicated in subsection 3.3 of chapter 3, Uber's payment and maps complements were selected as the two embedded cases to be investigated in this thesis because these components are both digital and core to Uber's MSDP. This section is divided into two main subsections. Subsection 4.4.1 discusses the embedded case of Uber's payment complements and subsection 4.4.2 discusses the embedded case of Uber's maps complements. Both subsections examine how these complements were configured over time; they examine Uber's boundary decisions regarding when to build complements in-house and when to rely on third-party complementors. At the end of each subsection, a timeline showing the evolution of these complements is provided.

4.4.1 Embedded case 1: Payment complements

Payment complements are an important part of Uber's MSDP. A seamless payment experience is one feature that distinguishes Uber from traditional taxi companies. Since its launch in June 2010, Uber has configured the payment component of its MSDP in a variety of ways, both by relying on third-party complementors and by developing payment solutions in-house. Investigating the history of how Uber configured its payment components reveals three phases: (1) accepting cashless payment through credit cards only, (2) adding new complements for global cashless payment and (3) localising payment complements and accepting cash payments.

Accepting cashless payment, through credit cards only (2010-2013)

From its founding, Uber believed that cashless payments would give it a competitive advantage over traditional taxi companies and help it attract new customers. This tenet was outlined in their IPO filing document:

> We remain committed to providing a convenient, frictionless experience for consumers. We introduced the convenience of on-demand transportation—tap a button, get a ride—which allowed us to rapidly attract new consumers. We were forward thinking in developing cashless transactions, which enables riders to pay using flexible payment options stored on their mobile device. We continue to find new ways to make the Ridesharing experience seamless for riders (Uber Technologies, Inc., 2019).

In accordance with this belief, Uber only accepted payment through credit cards between 2010 and 2013. When Uber first started its operations in the United States it relied on Authorize.net[15], a payment processor that enables businesses to accept credit card and e-check payments online, for payment processing. When Uber expanded to Paris in 2011 it was faced with a challenge, because at that time Authorize.net was only processing payments in US dollars. This was inconvenient and confusing to riders in France: Uber's app displayed ride fares in Euros but the payments were processed in US dollars. To address this problem, in 2011 Uber began relying on Braintree, a global payment gateway that was able to process payments in local currency in several markets that Uber was expanding to. In 2012, as Uber continued expanding into new markets in different regions, it added Ayden[16], another global payment gateway, to ensure that its riders could pay in their local currency in all the markets that it served.

Between 2010 and 2013, Uber strived to enhance the customer's payment experience. For example, Uber integrated Card.io[17], a credit card scanning toolkit owned by Braintree, in 2012 to enable its riders to easily enter the details of their credit cards by simply holding the card in front of their phone's camera. In 2013, Uber further enhanced the payment experience for riders by introducing a fare splitting feature that allowed co-riders to easily split the ride fare.

Adding new complements for global cashless payment (2013 – 2014)

In 2013 and 2014, Uber continued aggressively expanding into new markets, expanding from serving 66 cities in 2013 to 250 cities in 2014. In this period, Uber was keen to make its service accessible to as many customers as possible, while still maintaining a frictionless cashless experience. In some of the new markets that Uber entered, many customers did not have credit cards or did not feel comfortable using them with a new service. In a 2017 blog post, Uber acknowledged this, writing that '[their] mission is to provide access to reliable transportation everywhere for everyone. Not everyone has a credit card or feels OK handing one over to a service they've never used' (Laura,

[15] https://www.authorize.net/en-gb/
[16] https://www.adyen.com/
[17] https://techcrunch.com/2012/01/19/no-more-swiping-card-io-launches-new-consumer-app-developer-tools-which-see-your-credit-card/

2017). To address this issue, Uber began integrating third-party payment complements. For example, Uber integrated Google Wallet[18], a digital wallet provided only on Android OS, in 2013 as an option for users who did not feel comfortable entering their credit card details directly into Uber's app. In same year, Uber also integrated PayPal[19], an online payment gateway and digital wallet, to enable users pay using their debit and credit cards through PayPal. In 2014, Uber integrated Apple Pay[20], the equivalent of Google Pay but for Apple iOS, to attract more users to the service *and* make it easier for existing users to pay.

Localising payment complements and accepting cash payments (2014-2018)

As Uber expanded into new regions and markets, such as developing countries in Asia, Africa and South America, it encountered heterogenous customer demands and local market conditions that made acquiring new users challenging. Relying on global payment providers and a cashless payment business model was no longer sufficient to continue growing the user base. China was the first market where Uber localised payment complements in order to address the heterogenous demands of its customers. In 2014, Uber added Alipay[21], a digital wallet based in China, in response to demand from Chinese users; many customers were using other ridesharing services in China because they accepted Alipay, while Uber did not.

India was the first market where Uber localised payment complements to adapt to local market conditions, also in 2014. Uber added Paytm[22], a digital wallet based in India, as a payment option for users in India in response to regulations on credit card transactions imposed by the Reserve Bank of India that negatively affected the seamless payment experience that Uber strove to provide to its customers.

Uber also realised that it was missing out on access to a large segment of customers in India because credit card penetration there was low. In 2015, Uber developed a cash payment system in-house to enable Uber drivers to accept cash payments for the first time in its history. Accepting cash payments marked a major change to Uber's business model, which had always included exclusive use of cashless payments to provide a seamless customer experience. The decision to adapt to local conditions in India was explained by a software engineer at Uber:

[18] Google wallet was later rebranded Google Pay. See (https://pay.google.com/)
[19] https://www.paypal.com/
[20] https://www.apple.com/uk/apple-pay/
[21] https://intl.Alipay.com/
[22] https://paytm.com/

> Credit card usage is not as common in India and other Southeast Asian countries, so Uber built a cash payment system in 2015 to make our services more accessible to these markets. Enabling cash payments presents new challenges, from ensuring that riders have cash on hand to processing and collecting driver commissions (Liu and Natarajan, 2017).

From 2015 to 2018, Uber rolled out its cash payment system to new regions. For example, in 2016, Uber began accepting cash payments in the Middle East, Africa and East Asia. The period from 2014 to 2018 also saw Uber continue to localise payment complements in different markets. For example, Uber added Airtel[23], a payment provider based in India, in 2015 to offer new payment options to customers in India. In the same year, Uber added M-PESA[24], a local mobile payment service in Kenya, to provide Kenyan customers an alternative payment option to credit cards and cash. In 2016, Uber integrated Paga[25], a Nigerian mobile payment service, to attract new Nigerian customers, many of whom were concerned about using the other payment options offered by Uber because of security or currency exchange issues. In 2017, Uber added Momo[26], a digital payment service in Vietnam, because the majority of Vietnamese customers preferred it when transacting online. Uber's efforts to localise payment methods continued in 2018, when Uber introduced Venmo, a digital wallet based in the United States and owned by PayPal, to enable American customers to split and share their ride fare. In the same year, Uber added iDEAL[27], a digital payment provider in the Netherlands, because the majority of online transactions there were processed through it. Adding iDEAL as a payment option gave Uber access to a larger pool of potential Dutch users. Figure 4-5 depicts a timeline of Uber's main boundary decisions related to payment complements. Appendix B provides a more detailed timeline, including information about events and boundary decisions related to payment complements.

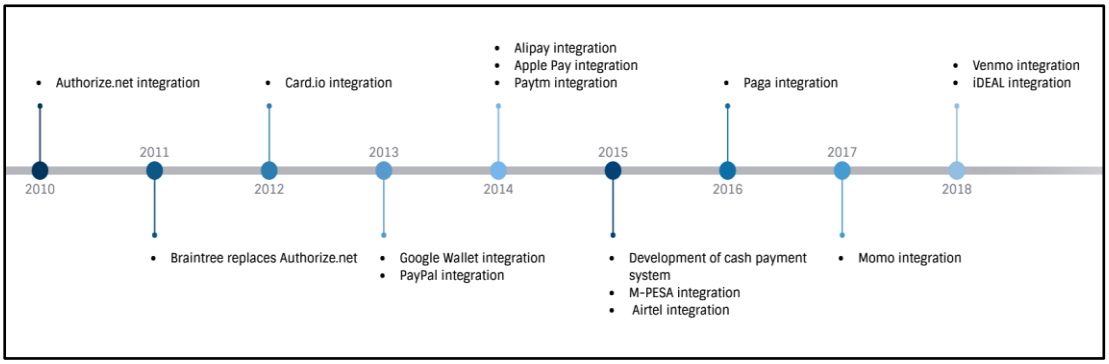


Figure 4-5: A timeline of the main boundary decisions of the payment complements.

[23] https://www.airtel.in/bank/
[24] https://www.safaricom.co.ke/personal/m-pesa
[25] https://www.mypaga.com/
[26] https://momo.vn/
[27] https://www.ideal.nl/en/

4.4.2 Embedded case 2: Maps complements

Maps complements are essential to the delivery of services on Uber's MSDP. The maps complements that Uber has implemented to deliver its services are a mixture of complements developed in-house and complements developed by third-party complementors. An Uber spokesperson summed up the company's attitude in a 2015 statement, saying, 'Mapping is at the heart of what makes Uber great. So we'll continue to work with partners, as well as invest in our own technology, to build the best possible experience for riders and drivers' (Bell, 2015). Investigating the history of how Uber configured its maps components reveals two phases: (1) heavy reliance on Google and third-party complementors followed by (2) building in-house maps capabilities.

Heavy reliance on Google and third-party complementors (2010-2014)

From its founding, Uber relied heavily on Google and other third-party complementors to support its maps technologies. For example, Uber relied heavily on Google Maps to support all map services when it began operations in 2010. The heavy reliance on Google Maps reflected its status as the best available solution on the market, as indicated in a Bloomberg report:

> Uber's smartphone applications for drivers and riders are based on Google Maps, which gives Google a fire hose of data about transportation patterns within cities. Uber would be crippled if it lost access to the industry-leading mapping application, and alternatives—such as AOL's MapQuest, Apple Maps, and a host of regional players—are widely seen as inferior (Stone, 2015a).

In addition to Google Maps, Uber relied on Open Source Routing Machine (OSRM) engines to support routing and determine estimated arrival times. In 2012, Uber released the second (2.0) version of its ridesharing app with improved maps and location services. The improvement relied on the integration of location data from Foursquare[28], an independent location data and technology provider. Integrating Foursquare data into Uber allowed users to select locations by name without entering the full address. The second version of Uber's app on Apple iOS also had more accurate location data and an improved navigation system, thanks to the integration of Apple Maps services.

[28] https://foursquare.com/

Building in-house maps capabilities (2014-2018)

As it matured, Uber continued to rely heavily on third-party complementors, but the company also started building its own maps technology that better served its needs. For example, Uber built its own routing engine early in 2014 because existing routing engines were not capable of providing real-time traffic calculations that matched the speed at which Uber was expanding to new markets. In the same year, Uber poached a senior maps engineer from Apple to build an internal mapping solution. In 2015, Uber established a research centre in Pittsburgh, in collaboration with Carnegie Mellon University, to develop mapping and autonomy technology. In the same year, Uber acquired deCarta, a platform for location and mapping services, to build customisable mapping solutions and increase the accuracy of estimated arrival times for the new services it was launching, such as UberPool. Uber also bid to acquire Nokia's Here mapping technology in 2015 but lost the bid to a consortium of German automakers. Shortly after, Uber acquired mapping technology from Microsoft Bing, including a data centre, cameras, intellectual property and a team of 100 engineers. To further improve its maps capabilities, in 2015 Uber poached the head of Google Maps and another executive from Google to lead the development of mapping and autonomy technology at Uber. By the end of 2015, Uber started rolling out mapping cars in the United States to collect mapping data and images and to improve existing mapping technology and estimated arrival times.

In 2016, Uber ramped up its investments in building internal maps capabilities. It established a research centre in Bangalore to work on mapping technology and invested $500 million in building its own worldwide maps. In the same year, Uber acquired Geometric Intelligence, a start-up specialising in artificial intelligence (AI), and established its own AI lab in San Francisco to solve autonomous driving issues and improve search and mapping capabilities.

Uber continued capability building throughout 2017. It started generating its own mapping data globally (i.e. in Australia and Singapore) by installing cameras on some drivers' cars to collect imagery and mapping data. In March 2017, Uber crowned its effort to build internal maps capabilities by introducing its own in-app navigation system, which provided Uber drivers with turn-by-turn navigation instructions in the Uber app, so they no longer needed to switch to third-party navigation systems (i.e. Google Maps or Waze).

Two main reasons are usually cited for Uber's effort to build internal maps capabilities. The first is to reduce the company's heavy reliance on Google Maps. A 2016 Financial Times report summarised Uber's efforts to reduce reliance on Google Maps:

> The company has decided to invest $500m in mapping, according to a person familiar with Uber's plans, as it doubles down its efforts in this challenging space. … Uber's initial growth was largely enabled by pre-existing hardware and software, such as smartphones and cars, but as the company looks to secure its long-term growth it is spending more on original research. … By developing its own maps Uber could eventually reduce its reliance on Google Maps, which currently power the Uber app in most of the world. Although Google was an earlier investor in Uber, the two companies have avoided working closely together and are now developing rival technologies for driverless cars … Google has started to increase the fees that it charges for the use of Google Maps, presenting concerns about whether it might raise prices further in future (Hook, 2016).

The second reason indicated for building maps capabilities in-house is the importance of maps to Uber's current operations and to future autonomous vehicle technology, which Uber is developing. This motivation was described in a report by The Verge covering Uber's bid for Nokia's Here mapping technology:

> Uber's interest in the company [Nokia's Here] is obvious. Maps and mapping are a core part of its business today, and are set to become an even greater part of its future. Right now it has deals with other companies for some of those maps and some location information, but a purchase of Here could bring some of that technology in-house. The company's already taken steps in that direction with the acquisition of mapping company deCarta earlier this year. Looking ahead to Uber's self-driving car project, ownership of that data could both help it develop cars that run without humans, and keep from worrying that competitors have some of the same data (Lowensohn, 2015).

Even though the period between 2014 and 2018 is defined by Uber's efforts to build in-house maps capabilities, Uber was still relying on third-party complementors to improve its service and solve issues it faced when expanding to new markets. For example, Uber integrated Baidu Maps, a Chinese maps service provider, in 2014 because Google Maps was not running effectively in China. In 2015, Uber started using location data from TomTom, an independent location, navigation and map technology provider, to improve Uber's own maps and reduce its heavy reliance on Google Maps. In 2016, Uber started using location data from OKHi, a Kenyan direction start-up, to overcome the lack of standard addresses in Africa. In the same year, Uber started using mapping data from DigitalGlobal, a provider of space imagery and geospatial content, to improve the quality of its own maps.

In a nutshell, Uber initially relied heavily on Google and other third-party complementors for its maps complements. Then, it invested heavily in building its own maps capabilities, but did not stop relying on third-party complementors. The maps technologies that Uber has implemented are a mixture of third-party and in-house complements. Figure 4-6 depicts a timeline of Uber's main boundary decisions related to maps complements. Appendix C provides a more detailed timeline, including information about events and boundary decisions related to maps complements.

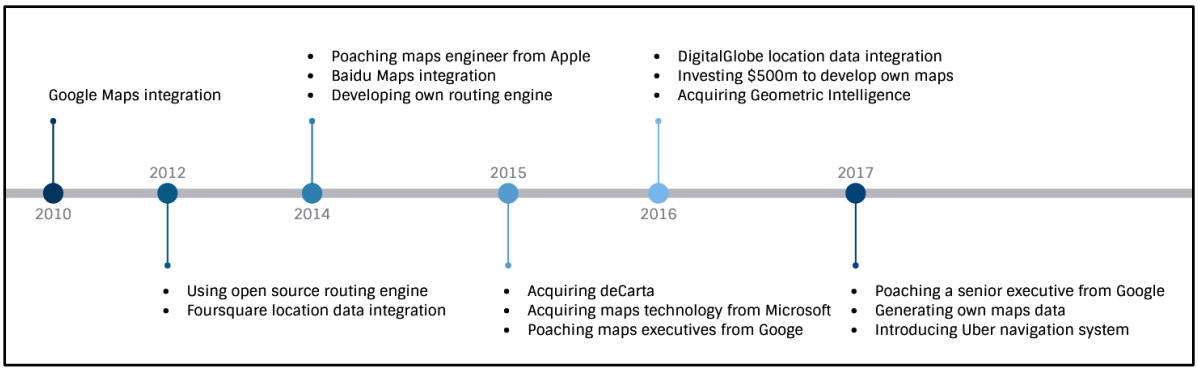


Figure 4-6: A timeline of the main boundary decisions of the maps complements.

4.5 Chapter summary

This section provided a description of the main case study used in this thesis: Uber's two embedded cases, the payment and maps complements. This chapter started by presenting background information on Uber, including a discussion of its business model and how it has disrupted the taxi industry. This chapter then presented the aggressive expansion of Uber into new markets and adjacent businesses. Following this, this chapter deliberated on how Uber works and provides its service. This chapter then briefly described the main components of Uber's MSDP. Finally, this chapter presented the two embedded cases used in this thesis, the payment and maps complements, and provided a detailed account of how these complements were configured in Uber's MSDP over time.

5 DATA ANALYSIS

5.1 Chapter introduction

This chapter picks up where chapter 3 left off and details the data collection process. It provides a detailed description of the process followed to analyse the large data set populated to address the research questions of this thesis: what factors influence the boundary decisions of MSDPs as they configure their complements, and how do MSDP firms respond to these factors? Section 5.2 describes in detail the process followed to analyse the data. Section 5.3 demonstrates the coding process, describing the decisions and assumptions made during the coding process that led to the emergence of the different concepts and themes used to generate a new understanding of the boundaries of MSDPs. Finally, a summary of the chapter is provided in Section 5.4.

5.2 Data analysis process

The data analysis process began once the collected blog data was compiled into a single Excel spreadsheet, as described in subsection 3.4 of chapter 3. The first step of data analysis was importation of the data set into NVivo 12, which allowed the large set of data to be more easily managed and simplified the data coding process. Once the data was imported into NVivo 12, five rounds of coding were performed to address the research questions of this thesis, which focus on the factors influencing the boundary decisions of MSDPs and how MSDP firms respond to these factors. Reporting, the final step of the data analysis process, will be presented in chapter 6. Figure 5-1 depicts the complete data analysis process. The data analysis process used in this thesis was informed by the grounded theory approach and followed its main procedural components, including memoing, theoretical sampling, constant comparison, open coding, axial coding and selective coding (Corbin and Strauss, 2014; Gioia, Corley and Hamilton, 2013; Suddaby, 2006; Glasser and Strauss, 1967). It is important to note, though, that the nature of the collected data and the lack of access to primary data required creative adaptation of certain elements of the grounded theory approach; these adaptations will be discussed where appropriate in this chapter. Corbin and Strauss (1990) discussed the need, when implementing the grounded theory approach, to be creative and to take into consideration the data collected and the researcher's theoretical purpose:

> If the researcher simply follows the grounded theory procedures/canons without imagination or insight into what the data are reflecting—because he or she fails to see what they really indicate

except in terms of trivial or well known phenomena—then the published findings fail on this criterion. Because there is an interplay between researcher and data, no method, certainly not grounded theory, can ensure that the interplay will be creative. Creativity depends on the researcher's analytic ability, theoretical sensitivity, and sensitivity to the subtleties of the action/interaction (plus the ability to convey the findings in writing). A creative interplay also depends on the other pole of the researcher-data equation, the quality of the data collected or analyzed. An unimaginative analysis may in a technical sense be adequately grounded in the data, yet be insufficiently grounded for the researcher's theoretical purpose. This occurs if the researcher does not draw on the complete resources of data or fails to push data collection far enough. (p. 19).

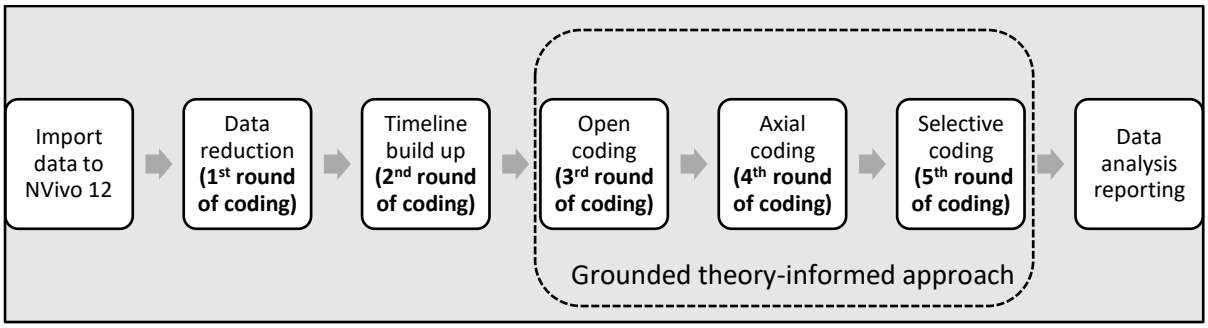


Figure 5-1: Data analysis process.

The rest of this section is divided into four subsections based on the data analysis process depicted in Figure 5-1. Subsection 5.2.1 discusses how the data was imported into NVivo 12 to initiate the data analysis process. Subsection 5.2.2 describes the first round of coding where the aim was to reduce the data required for analysis. Subsection 5.2.3 describes the second round of coding, in which a timeline of events related to the payment and maps complements of Uber's MSDP was created. Finally, subsection 5.2.4 discusses the grounded theory-informed approach that was pursued in this thesis and involves the third, fourth and fifth rounds of coding.

5.2.1 Import data into NVivo 12

The first step in the data analysis process was importing the data set into NVivo 12, which enabled the vast amount of data to be managed efficiently (Woods et al., 2016). Importing the data into NVivo 12 was not a straightforward task; fitting a huge amount of qualitative data into the cells of an Excel spreadsheet posed some challenges. Most of the problems faced were technical and related to the format of the data (i.e. the need to remove line breaks and HTML code) and were dealt with as explained in the previous section. Since the data set was in Excel spreadsheet format, it had to be imported into NVivo 12 using the survey import wizard, which automatically sets the data set up for analysis. When importing the data, the survey import wizard treated each blog article as a case node with a unique identifier number. (The convention in NVivo 12 is to treat each row of the data set as a unique case node. This, though, does not mean that this research treats each blog article as a case;

the case in this research is Uber and the two subunits of analysis are payment and map complements.) The columns in the data set were then classified as either codable data or data attributes. Codable data included the qualitative data in the form of long text. In the data set used in this research, the article content and summary columns were treated as codable data in NVivo 12. Data attributes are the columns that contain attributes assigned to the case nodes (i.e. each individual blog article). In the data set used in this research, the article date, author and blog name columns were treated as attributes in NVivo 12. Once the columns of the data set were classified as either codable data or data attributes, the data set was then imported into NVivo 12 and became a relational database, which enabled different kinds of searches and coding to be performed (e.g. a search for all blog articles written by a specific author or in a particular date or year). Figure 5-2 shows the NVivo 12 project after successful importation of the data set.

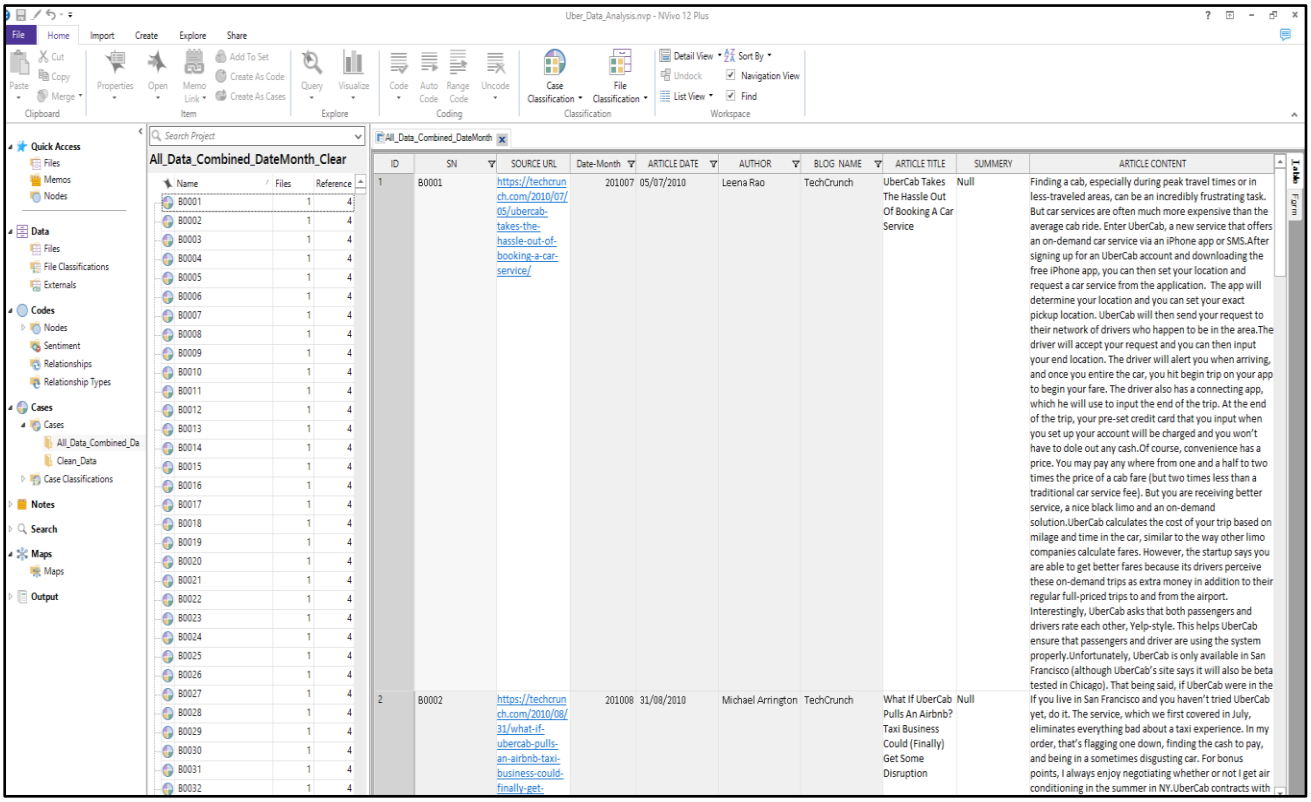
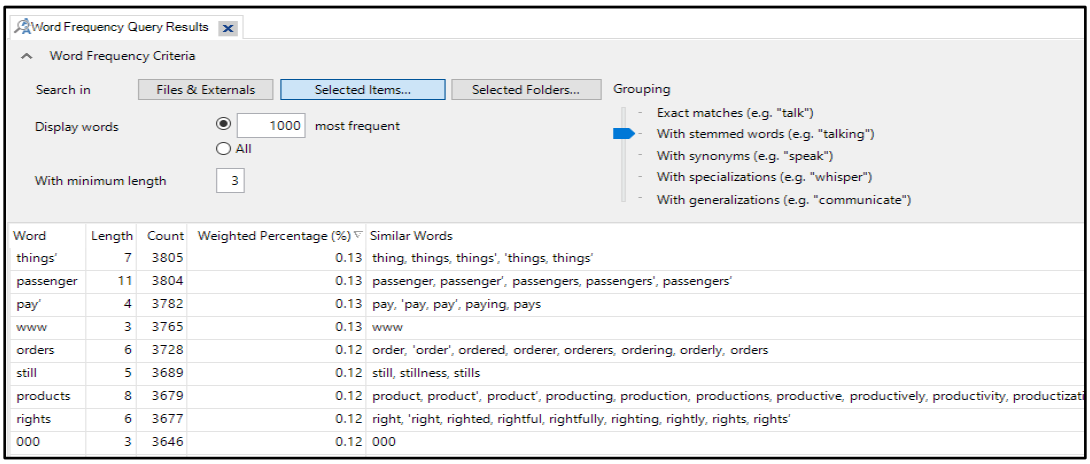


Figure 5-2: The NVivo 12 project after importing the data set.

5.2.2 Data reduction (first round of coding)

Once the data set was successfully imported into NVivo 12, the next task was to analyse the data. However, the data set contained 7475 different blog articles. These blog articles differed in length and did not all necessarily focus on the two subunits of analysis of this thesis: the payment and maps

complements. It was impractical to go through the blog articles one by one and start the coding process, especially given that, in line with grounded theory, the data analysis and the coding process were iterative, which meant that the author had to go through the data over and over again. Hence, to manage the huge data set and help focus the data on events, issues or boundary decisions related to the payment and maps components, the first round of coding aimed to reduce the amount of data, as recommended by Miles and Huberman (1994). To reduce the amount of data and discard irrelevant information, the author used the 'text search query' function in NVivo 12. The aim of using this search function was to extract paragraphs related to boundary decisions regarding the payment or maps complements from all the blog articles. The challenge was to determine which paragraphs out of the vast set of data were related to the payment and maps complements. Potentially relevant paragraphs were ultimately identified based on the use of keywords related to the payment and maps complements. In order to identify these keywords, when the author was cleaning the data during the data collection process, he took note of frequently used words related to the payment and maps complements. For example, paragraphs that talked about the payment complements typically contained terms like pay, cash and credit card. Paragraphs that talked about the map complements typically included terms like map, direction and navigation. In addition to taking notes during the data cleaning process, the author used the 'word frequency query' function in NVivo 12, which shows the 1000 most-used words across the data set, to check for additional keywords related to payment and maps complements. Figure 5-3 shows a partial screenshot of the results of the word frequency query in NVivo 12.



Word	Length	Count	Weighted Percentage (%)	Similar Words
things'	7	3805	0.13	thing, things, things', 'things, things'
passenger	11	3804	0.13	passenger, passenger', passengers, passengers', passengers'
pay'	4	3782	0.13	pay, 'pay, pay', paying, pays
www	3	3765	0.13	www
orders	6	3728	0.12	order, 'order', ordered, orderer, orderers, ordering, orderly, orders
still	5	3689	0.12	still, stillness, stills
products	8	3679	0.12	product, product', product', producting, production, productions, productive, productively, productivity, productizati
rights	6	3677	0.12	right, 'right, righted, rightful, rightfully, righting, rightly, rights, rights'
000	3	3646	0.12	000

Figure 5-3: A screenshot of the word frequency query.

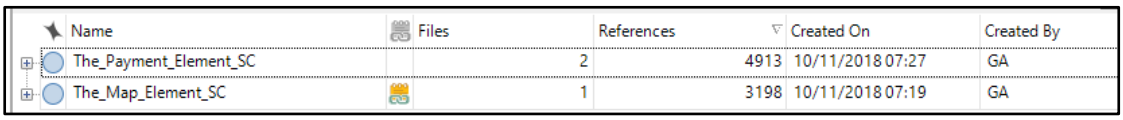
By reviewing the list of the 1000 words used most frequently in the data set, the author identified additional keywords that could be found in paragraphs related to the payment and maps

complements. Table 5-1 shows the keywords identified and used in subsequent search queries to find paragraphs about the payment and map complements.

Complement	Keywords
Payment	Pay, pays, payment, payments, paid, cash, cashless, card, cards and credit.
Maps	Destination, destinations, map, maps, mapping, mapped, navigate, navigates, navigation, navigations, navigated, route and routes.

Table 5-1: Keywords identified for payment and map complements.

Once the keywords were identified, the text search query function was used to search for the keywords identified in Table 5-1[29]. Since the goal was to search for paragraphs that contained the payment and map complements keywords, the text search query function was set to extract the keywords in addition to fifty words before and after the keywords. The search hence produced a list of paragraphs composed of 100 words each. The results were 4913 paragraphs containing the identified keywords related to the payment complements and 3198 paragraphs containing the identified keywords related to the map complements. Figure 5-4 shows a screenshot of the total number of paragraphs generated by the keyword search and potentially related to boundary decisions concerning the payment and map complements. Figure 5-5 shows examples of the extracted paragraphs for the payment complements.



Name	Files	References	Created On	Created By
The_Payment_Element_SC	2	4913	10/11/2018 07:27	GA
The_Map_Element_SC	1	3198	10/11/2018 07:19	GA

Figure 5-4: A screenshot of the total number of paragraphs related to payment and map complements.

[29] To ensure potential keywords were not missed, the author used a search option within the text search query function called 'with stemmed words'. Ticking this option while searching for keywords allowed NVivo 12 to search for all variants of the keywords identified for the payment and map complements (e.g. stemmed words for pay could be 'pays' and 'paying').

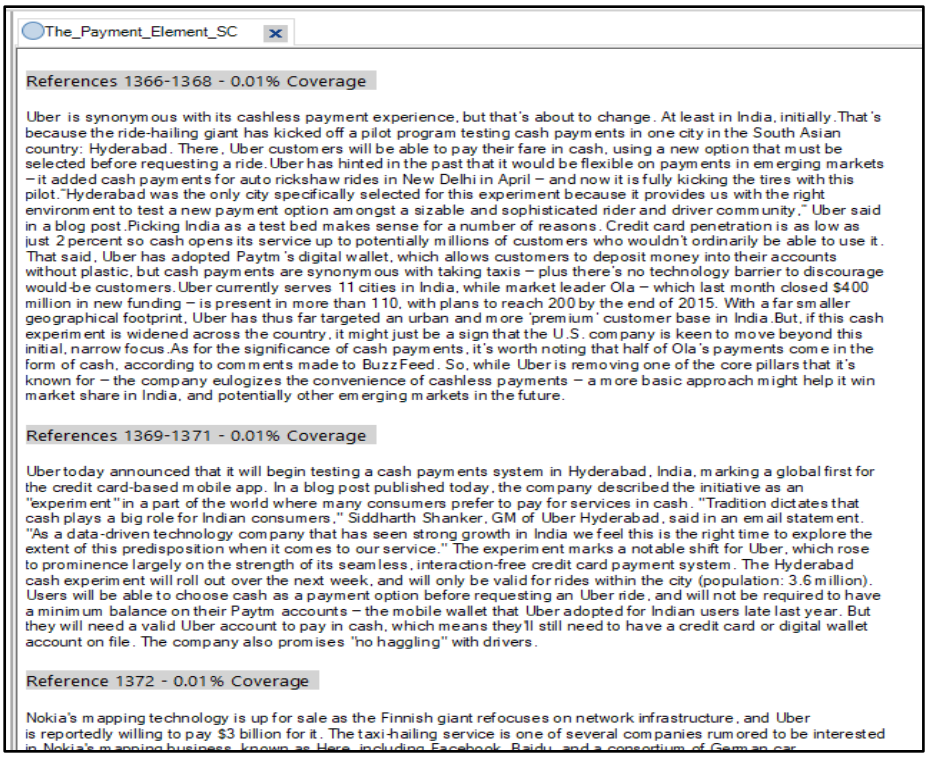


Figure 5-5: Examples of paragraphs related to the payment complements.

Once paragraphs potentially related to the boundary decisions concerning the payment and maps complements were identified, the next step was to go through these paragraphs one by one to discard irrelevant information[30] and identify those directly related to a boundary decision regarding payment or maps complements (i.e. paragraphs containing an announcement by Uber of partnership with a payment service provider or an announcement about building or acquiring mapping technology). This exercise reduced the number of paragraphs about the payment elements from 4913 to 635 and the number of paragraphs about the maps complements from 3198 to 523. The final outcomes of the first round of coding were 635 paragraphs about the payment complements and 523 paragraphs about the maps complements that were directly related to boundary decisions and could be analysed further to address the research questions. Figure 5-6 summarises the data reduction process.

The data reduction process, identified as the first round of coding, is one of the reasons the data analysis approach of this thesis is described as a grounded theory-informed approach rather than a classic grounded theory approach. In a classic grounded theory approach, the researcher does not start with a research question; he/she must start by collecting data, usually through interviews, to

[30] Not all paragraphs were related to the payment and maps complements. For example, there were paragraphs that contained the word 'pay' but had nothing to do with Uber making a boundary decision concerned with the payment complement. These paragraphs were filtered out as they were not related to the research questions.

identify the concerns of the participants and how they resolve them (Glaser, 1992). The process of the classic grounded theory approach is purely inductive. However, this research began with the author's curiosity about what factors influence how MSDPs' boundaries shift as they configure their complements and how MSDP firms respond to these factors. The data reduction process was deductive and designed to discard irrelevant data that was not related to payment and maps complements-related boundary decisions and to enhance the focus of the data analysis (Miles and Huberman, 1994).

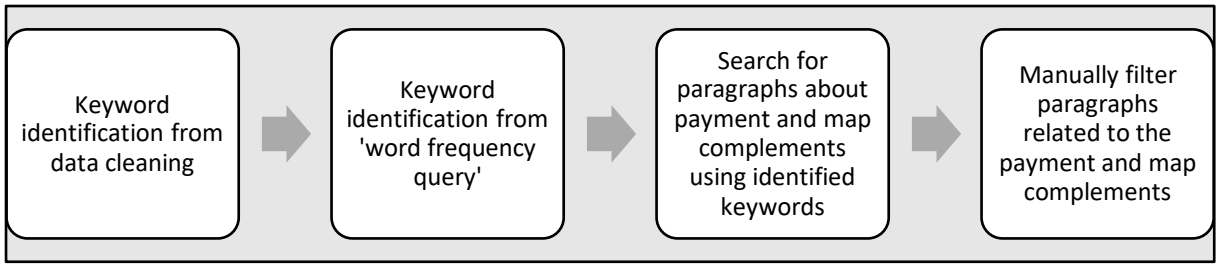


Figure 5-6: A summary of the data reduction process.

5.2.3 Timeline build-up (second round of coding)

Once the data was reduced from thousands of blog articles to a few hundred paragraphs about boundary decisions related to the payment and maps complements, the next step was to create timeline tables for each of these complements showing how Uber configured its payment and maps complements over time. This step followed the recommendation of Miles and Huberman (1994), who suggested displaying data in the form of charts, tables or graphs to clarify a large amount of data and facilitate the data analysis process. To build the timeline tables for the payment and map complements, the author had to go through all the extracted paragraphs one by one to identify what boundary decision was covered by each paragraph and the date of that decision; at this stage the timeline represented descriptive data rather than theoretical concepts (Charmaz, 1996). To determine the date associated with each boundary decision described, the author instructed NVivo 12 to open the original blog article from which the paragraph was extracted. Since the date of each blog article was recorded in the data set, the author was able to determine the date of the boundary decision[31]. Table 5-2 shows a sample of the timeline table created for the payment complements;

[31] It is important to note that the date of the blog article does not necessarily always refer to the date of the boundary decision covered in the article. Sometimes the author had to extract the date of the boundary decision by reading the whole article, especially when the blog article was reporting on a past boundary decision.

the timeline was presented in chapter 4, where the payment and maps complements were described in detail.

Date	Event	Description
06/2010	Payment accepted only by credit cards	Uber started its operation by accepting only cashless payment through credit cards
06/2010	Cashless payment processed through AuthNet API	Uber initially relied on AuthNet API to process cashless payments
02/2011	Braintree replaces AuthNet for payment processing	Uber switched to Braintree to handle its local and international payments
04/2012	Integration of Card.io	Uber integrated Card.io to enable users to enter their credit card details by scanning the card rather than through manual input

Table 5-2: A sample of the timeline table of the payment complements.

5.2.4 Grounded theory-informed approach (third, fourth and fifth rounds of coding)

Once the big picture was painted by creating timelines of boundary decisions related to the payment and maps complements, the next step was to scrutinise the data and analyse it to understand what factors influenced Uber's boundary decisions related to the payment and maps complements. The analysis followed the three typical stages of the grounded theory approach: open coding, axial coding and selective coding (Glaser and Strauss, 1967). As discussed earlier in the chapter, the grounded theory-informed approach was suitable for this research because this research examined a complex phenomenon and aimed to generate theory from data rather than to test existing theory (Charmaz, 2014; Corbin and Strauss, 1990, 2014). While this subsection explains the different rounds of coding sequentially, it is important to note that the coding process was iterative, meaning that the author went back and forth between the rounds of coding to refine the emerging concepts and theoretical dimensions (Corbin and Strauss, 2014; Gioia, Corley and Hamilton, 2013).

Open coding was the third coding round of the data analysis performed in this thesis, and it refers to the process of analysing textual data to identify concepts that might be related to the phenomenon of interest (Corbin and Strauss, 2014; Gioia, Corley and Hamilton, 2013). In this thesis, the concepts were identified by splitting and lumping the data (Saldaña, 2016). Splitting the data refers to

breaking the paragraphs (those that emerged from the data reduction process, as explained in subsection 5.2.2) up into meaningful concepts through line-by-line coding (Charmaz, 1996). The author examined the different paragraphs related to the boundary decisions to identify concepts related to the factors influencing these decisions and understand how Uber responded to them. The results of the line-by-line coding were typically in vivo codes, which are labels composed of a few words quoted directly from the data and refer to an emerging concept. In many cases, line-by-line coding was not sufficient to understand the whole context of a boundary decision. Hence, the author performed 'lumper' coding on top of line-by-line coding (Saldaña, 2016), in which a concept was formed by coding a huge chunk of data (instead of a few words). Figure 5-7 depicts an example of lumper coding and in vivo coding by showing the coding stripes[32] and highlighting the coded segment referring to the 'Seamless customer experience' concept.

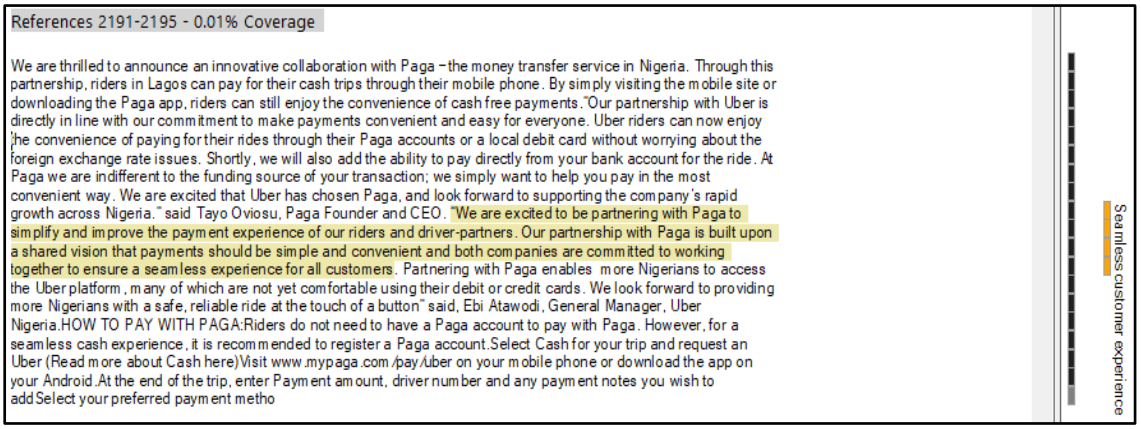


Figure 5-7: A screenshot demonstrating lumper coding and in vivo coding for the 'Seamless customer experience' concept.

Once open coding (third round of coding) generated several concepts concerned with the payment and maps boundary decisions, the next step was to establish relationships between the different concepts and group similar concepts into themes[33]. This process is defined as axial coding (fourth round of coding), and it involves using inductive and deductive reasoning to arrange the different concepts under common themes (Corbin and Strauss, 2014; Gioia, Corley and Hamilton, 2013; Charmaz, 1996). When conducting axial coding, the concepts that emerged from open coding can be refined.

Once several concepts were identified and arranged around common themes, the fifth and final round of coding was performed to group all emerging themes under aggregate theoretical

[32] Coding stripes are the coloured bars showing the nodes that are related to coded content in NVivo QDAS.
[33] Some scholars refer to themes as categories.

dimensions[34] (Corbin and Strauss, 2014). This process is known as selective coding, whereby the researcher revisits the data and selectively (deductively) codes it based on the aggregate theoretical dimensions that emerged (Holton, 2007). Selective coding is considered similar to axial coding, however, it involves more abstraction as it focuses on the different concepts and themes around core theoretical dimensions which set the storyline of the research (Vollstedt and Rezat, 2019). Section 5.3 will demonstrate the coding process that lead to the emergence of different first-order concepts, second-order themes and aggregate dimensions in addition to highlighting assumptions and strategic decisions made during the coding process.

As noted earlier in this chapter, the data analysis process was iterative and informed by the grounded theory approach, yet some adaptation was required to take into consideration the type of data collected and the theoretical purpose of the researcher. Three main procedural components were adapted from the grounded theory approach: memoing, constant comparison and theoretical sampling (Corbin and Strauss, 2014; Charmaz, 2015; Glasser and Strauss, 1967); these were applied across the open coding, axial coding and selective coding rounds (Holton, 2007). Memoing is the process of writing down ideas about emerging concepts or themes as the researcher carries out the coding process. Memoing is important in supporting theory building from data because it allows the researcher to keep track of ideas as they develop and to make relationships between the emerging concepts or themes (Glaser, 1988). The author wrote brief memos in NVivo 12 as he was conducting the coding process. Figure 5-8 shows a sample of memos written in NVivo 12. The advantage of using a QDAS is that the text in a memo can be linked to the original data (e.g. the memos in Figure 5-8 each link to a relevant paragraph in the data set, making it easy to track what each memo is referring to).

[34] Scholars who refer to themes as categories refer to aggregate dimensions as core categories.

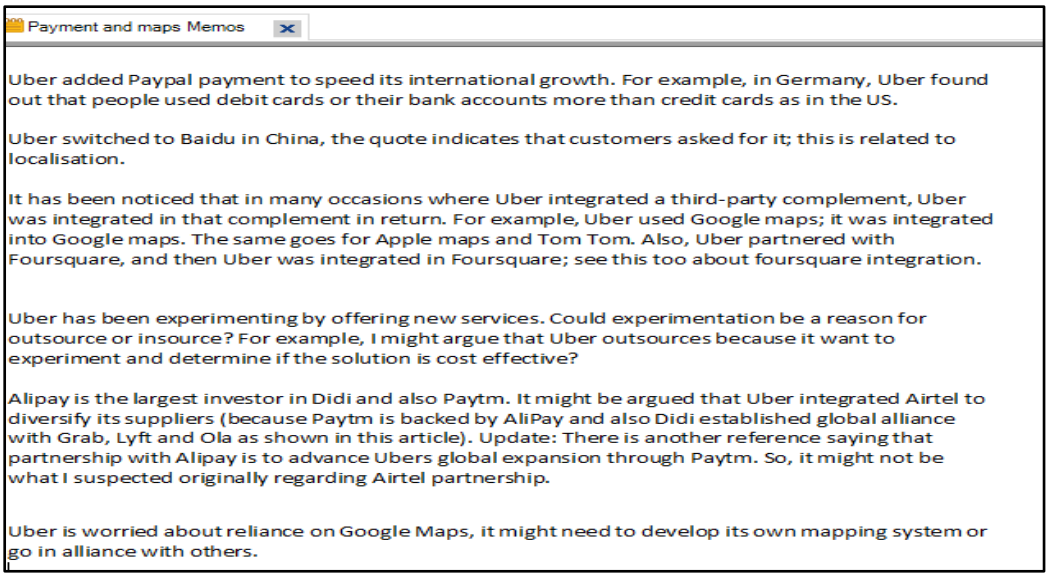


Figure 5-8: A sample of memos written during the data coding process.

In addition to memoing, constant comparison and theoretical sampling were also adapted from the grounded theory approach. Constant comparison refers to the process of continuously comparing data with previously collected and analysed data to determine similarities and differences; this ensures that theorisation is grounded in data (Corbin and Strauss, 2014; Glaser, 1967). The author continuously compared the data with the emerging concepts and themes to refine the emerging concepts and guide the data analysis process; this was supported by memoing as comparisons were typically recorded in memos, as depicted in Figure 5-8. Relevant to constant comparison is theoretical sampling, which refers to decisions regarding what data to collect next to continue building the emerging theory (Glaser, 1978). In a classical grounded theory approach, data collection and analysis happen simultaneously; the data collection process typically starts by conducting a few interviews. As concepts or themes emerge, the researcher theoretically samples additional participants to collect data that can support further theorisation; this is a deductive process, and the researcher typically selects additional participants that he/she thinks will help in building the emerging theory further. Theoretical sampling needed to be adapted to the research design in this thesis because the author had already collected the blog data before starting the data analysis process. Theoretical sampling in this thesis instead guided what blog article the author would analyse next; this adaptation is consistent with the use of grounded theory to analyse secondary data (Whiteside, Mills and McCalman, 2012; Andrews et al., 2012). Constant comparison and theoretical sampling were applied until the author believed that the data analysis process had reached theoretical saturation, at which point further data collection or analysis would not generate additional concepts or themes (Glaser and Strauss, 1967). Having a large data set spanning from June 2010 to December 2018 helped in achieving theoretical saturation. When the data analysis was

finalised, the outcome was presented in a tabulated data structure, adapted from Corely and Gioia (2004), and consisting of first-order concepts, second-order themes and aggregate dimensions; the data structure will be presented at the end of the next section.

5.3 Coding process demonstration

This section demonstrates the coding process, starting with the third round of coding (open coding) and followed by the fourth (axial coding) and fifth (selective coding) rounds of coding, as depicted in Figure 5-1. In addition, this section explains the assumptions and decisions taken by the author during the coding process. The section follows the convention of reporting the coding process in a linear way and retrospectively. Moreover, this section provides snapshots of the coding process over different points of time; however, it is important to emphasise that the process was iterative and involved moving back and forth between the different rounds of coding (Gioia, Corley and Hamilton, 2013).

Open coding started without a priori codes or a theory in mind. This allowed many new concepts to emerge from the data, as prescribed in grounded theory-informed approach, rather than limiting the analysis to 'prefigured' coding schemes (Creswell, 2013). The decision whether to use a priori codes or not is influenced by the research questions, the status of the literature and the epistemology of the research design (Punch, 2014). Considering that the main question of this thesis is concerned with identifying the factors influencing MSDP boundaries and there is a shortage of studies identifying them, the goal then was to generate a new understanding of MSDP boundaries rather than test existing theories. Therefore, it was decided not to start the coding process with predefined codes based on existing theories and to allow concepts to emerge freely.

During the open coding process, the author conducted active reading of the data generated through the first round of coding and relevant to the payment and maps complements. The author was looking for boundary decisions taken by Uber and statements containing reference to the motivations or factors influencing them. These statements were then assigned descriptive labels (codes) reflecting the concepts identified in the text segment. Figure 5-9 shows the screenshot of a sample of coded text for the 'attract new users' concept that emerged from the open coding process.

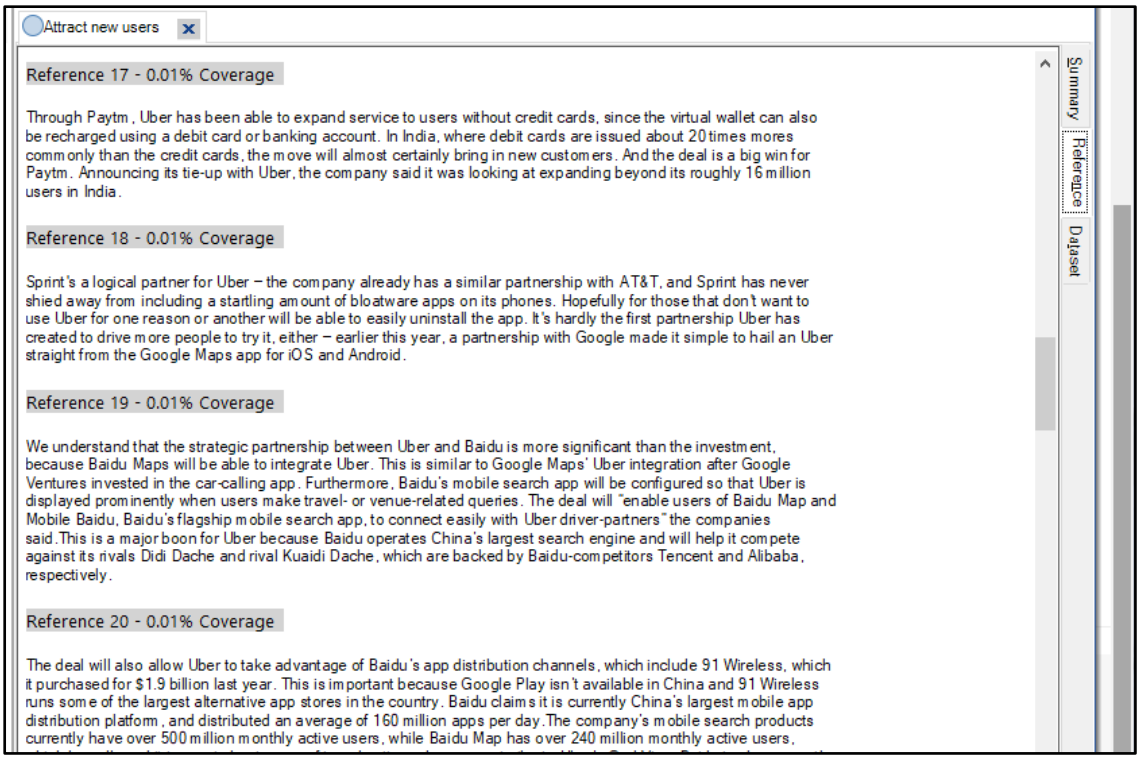


Figure 5-9: A screenshot of a sample of coded text for the 'attract new users' concept that emerged from the open coding process.

The process of open coding resulted in 83 first-order concepts related to the factors influencing the boundaries of MSDPs; see Appendix D for the full list of first-order concepts that emerged from open coding. Figure 5-10 shows a screenshot of first-order concepts with high frequency that emerged from open coding; the final column in the figure labelled 'Reference' refers to the frequency with which a code was used and the same column is also included in the table of first-order concepts in Appendix D. Figure 5-11 shows a screenshot of first-order concepts with low frequency that emerged from open coding.

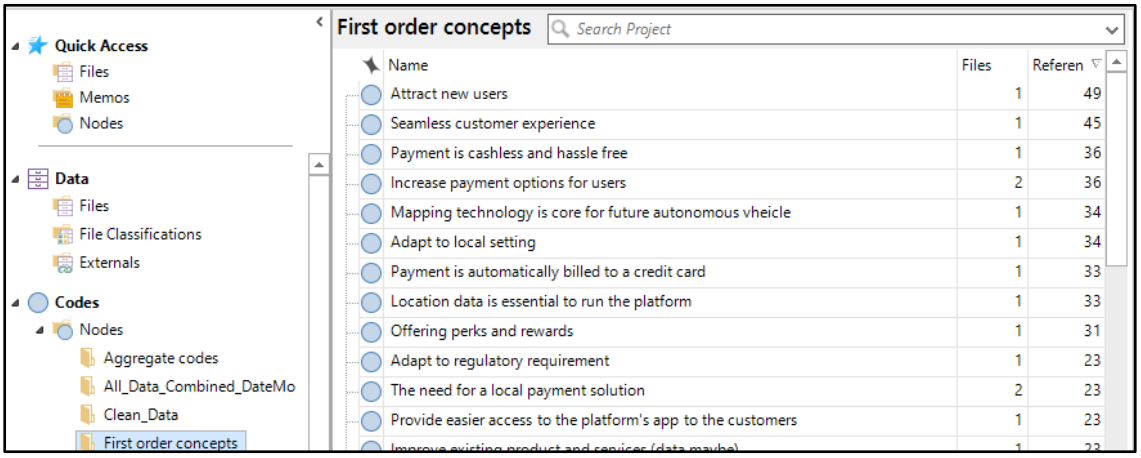


Figure 5-10: A screenshot of some of the first-order concepts with high frequency that emerged from open coding.

Name	Files	Reference
Take advantage of the features of another firm's product	1	1
Provide consistent experience	1	1
Centeralize payment	1	1
Reduce payment processing fee	1	1
A complementor's product is more affordable	1	1
Uber cannot customize payment solution in each market it enters	1	1
Benefit from potnetial marketing and promotional opportunities with a complementor	1	1
The more technology leveraged to make payment easy, the better	1	1
Complementor product meets platform development needs	1	1
Make it easier for passengers and riders (customers) to find each other	1	1
Difficult to generate data offered by a complementor	1	1
Location and mapping technology is commodotized or not profitable	1	1
ability to rapidly test a solution	1	1

Figure 5-11: A screenshot of some of the first-order concepts with low frequency that emerged from open coding.

Once the concepts emerged from open coding, the next step was to conduct axial coding, in which the concepts were reviewed to determine the similarities and differences among them and subsequently grouped into higher second-order themes (Corbin and Strauss, 2014). Axial coding brought an additional layer of abstraction to open coding and required the researcher to ask the question 'What's going on here?' (Gioia, Corley and Hamilton, 2013, p. 20). As open coding resulted in 83 first-order concepts, the author ran into the risk of 'data asphyxiation' described by Pettigrew (1990), wherein a researcher becomes overwhelmed by the large amount of data. However, both bewilderment and confusion are parts of the data analysis process that is influenced by grounded theory-informed approach. Gioia, Corley and Hamilton (2013, p. 20) state that 'You gotta get lost before you can get found'. To reduce the risk of data asphyxiation, the author pursued two strategies. First, the author started memoing early in the data analysis process to take note of similarities and differences among the emerging concepts. Secondly, the author followed the recommendation of Saldaña (2016, p. 25) who stated that 'the final number of major themes or concepts should be held to a minimum … but there is no standardized or magic number to achieve'. The author reduced the number of concepts as he started conducting the axial coding in two ways. First, the author focused on reducing the number of concepts with low frequency. The majority of these concepts usually emerged either because the author was unable to identify the most frequently used concepts that were relevant to the text segment being coded or because the concept could be based on a single blog post. Therefore, dealing with such concepts that were not too frequent was important to ensure that the results were not biased. Where appropriate, the concepts with low frequency were merged with concepts with higher frequency. A few were removed after deciding that they did not bring greater understanding of the phenomenon of

interest. For example, the concept with low frequency labelled 'Provide consistent experience' was merged with the concept with high frequency labelled 'Seamless customer experience' because they were relevant. On the other hand, a concept such as 'Ability to rapidly test a solution' was removed because it could not be merged with another concept. It is important to note that while the frequency of a code might give assurance that the concept is based on a pattern rather than on a one-off event, some qualitative researchers have reservations about the principle of counting in qualitative research. For example, Creswell (2013, p. 185) states that 'counting conveys a quantitative orientation of magnitude and frequency contrary to qualitative research'. Similarly, Saldaña (2016, p. 41) indicates that the 'frequency of occurrence is not necessarily an indicator of significance'. Therefore, the author did not automatically remove all concepts with low frequency and had to carefully revise them. The second step in reducing the number of concepts was to merge the similar concepts among the whole list of first-order concepts throughout the different iterations of axial coding. For example, the concepts labelled 'The need for a local payment solution' and 'The need for a local map provider' were merged at later iterations with the concept labelled 'The need for a local solution'. After a few iterations of axial coding, new second-order themes emerged with the first-order concepts becoming further condensed. Table 5-3, depicting a snapshot of second-order themes that emerged after several iterations of data coding, shows the 12 second-order themes that emerged at one point of time while conducting axial coding. The table also indicates that the number of first-order concepts were reduced from 83 to 49 after several similar concepts were merged; it is important to note that at that point of the analysis, these concepts emerged in an inductive manner and not driven by existing theories in literature.

First-Order Concepts	**Second-Order Themes**
• Adapt to regulatory requirements • Provide solutions to problems in developing countries	Regulatory Adaptation
• Adapt to the local setting • The need for a local payment solution • The need for a local solution • The complementor understands the local environment better than Uber • The need for a local map provider	Local Adaptation
• Respond to the interest of users • Users prefer a complementor over others • Address the needs of heterogeneous customers	Customer Preference Adaptation
• Enhance existing product and services • The need to customise technology (payment or mapping) • Third-party solutions cannot be customised • Uber cannot customise the payment solution for each market it enters	Complement Customisation
• Existing solutions are not reliable • Existing solutions in the market are not accurate • An existing complementor is not available elsewhere • Third-party service or product does not perfectly fit the needs of the firm	Complement Reliability

• Seamless customer experience • Payment is cashless and hassle free • Increase payment options for users • Payment is automatically billed to a credit card • Increase map options for users • Provide a complete experience • Make payment easier for overseas customers • Enhancing customer experience • Provide consistent experiences	Seamless Customer Experience
• Users do not fully trust Uber • Increase users' trust in using Uber	User Trust
• Attract new users • Enabling faster scaling to different markets • Increase the number of users • Collaborate with a complementor to retain existing customers • Attract frequent travellers or customers • Grow customer base	MSDP Growth
• Provide easier access to the platform's app to customers • Offer customers integration with other frequently used apps • Making it easier for new users to sign up on the platform	MSDP Accessibility
• Offering perks and rewards • Benefit from potential marketing and promotional opportunities with a complementor • Bundling features or offers	Rewards
• Buy from a complementor to encourage future investment in the firm • Build on the network of users of a complementor • Build on the existing relationship with a complementor • A complementor is an investor in Uber	Relational Investment
• Mapping technology is the core of future autonomous vehicles • Location data are essential to run the platform • Mapping is very important to Uber • Technology (mapping or payment) is the core of the platform	Core Technology

Table 5-3: A snapshot of second-order themes that emerged after several iterations of data coding.

Subsequent iterations of data analysis looked deeper into the relationship between the emerging themes, as the data analysis was entering the selective coding stage, while at the same time attempting to further condense the themes and concepts (Corbin and Strauss, 2014; Gioia, Corley and Hamilton, 2013). At this point, the author started to engage with the existing literature to revise the themes and concepts, following the recommendation of Gioia, Corley and Hamilton (2013, p. 20) who suggested focusing on 'nascent concepts that don't seem to have adequate theoretical referents in the existing literature … or existing concepts that ''leap out'' because of their relevance to a new domain'. Table 5-4 demonstrates the second-order themes at an advanced stage of data analysis. A comparison of Table 5-4 with Table 5-3 indicates that the first-order concepts have been reduced to 12 while the second-order themes have been reduced to 6. Some themes such as 'Core Technology' were removed because the author realised that the subunits of analysis – the payment and map components – had already been chosen because they were core to Uber's MSDP.

Moreover, it is already known in the literature that core assets influence boundary decisions as indicated in the literature on RBV and firm boundaries (Santos and Eisenhardt, 2005; Jacobides and Winter, 2005). Other themes were merged because they shared the same general idea. For example, the themes 'Regulatory Adaptation' and 'Local Adaptation' were merged into 'Market Adaptation' theme as they were both concerned with the MSDP making a boundary decision to adapt to the different characteristics and regulations in the markets the MSDP serves. Similarly, 'Complement Reliability' was merged with 'Complement Customisation' as they were both concerned with the MSDP making a boundary decision to be able to customise a complement. Moreover, 'User Trust' theme was merged with 'Seamless Customer Experience' because they were both concerned with the MSDP making a boundary decision to ensure that the users receive a seamless experience while using the MSDP. Finally, 'MSDP Growth', 'MSDP Accessibility' and 'Rewards' themes were all merged into 'User Base Boosting' as they were all concerned with the MSDP making a boundary decision to grow the number of users. Table 5-4 also indicates that many first-order concepts were condensed using more abstract and inclusive labels. This was a decision taken by the author to simplify the data structure table and present the general themes and concepts in an easy-to-read format. A detailed explanation of the concepts and themes will be presented in chapter 6. For example, all of the first order concepts under the 'Local Adaptation' theme in Table 5-3 were merged into 'Need to adapt to local characteristics'. Similarly, all the first-order concepts under the 'Regulatory Adaptation' theme were merged into 'Need to adapt to local regulations'.

First-Order Concepts	**Second-Order Themes**
• Need to adapt to local characteristics • Need to adapt to local regulations	Market Adaptation
• Need to customise a complement • Existing complement not reliable everywhere	Complement Customisation
• Users preferring a specific complementor • Users preferring a specific solution	Customer Preference Adaptation
• Providing more options and choices to users • Increasing user trust	Seamless Customer Experience
• Integrating a complementor within the MSDP • Integrating the MSDP within a complementor	User Base Boosting
• Getting investment from a complementor • Building on an existing relationship with a complementor	Relational Investment

Table 5-4: Second-order themes at an advanced stage of data analysis.

Once the themes and concepts were simplified, the final step was to group the second-order themes into aggregate dimensions to set the storyline for the research that was derived from the data (Vollstedt and Rezat, 2019; Corbin and Strauss, 2014; Gioia, Corley and Hamilton, 2013). As noted earlier, the literature was engaged in the late stages of data analysis and it influenced the final grouping of the themes. The two streams of literature that seemed relevant to the emerging concepts and themes were demand-side strategy (Priem, 2007; Rietveld, 2018) and the literature on complementarity (Jacobides, Cennamo and Gawer, 2018; Teece, 2018). The final round of coding resulted in three aggregate dimensions that offers new insights into the factors influencing the boundary decisions of MSDPs and how MSDP firms respond to them. The first aggregate dimension was 'Complement Localisation'. It emerged by grouping the 'Market Adaptation' and 'Complement Customisation' themes, and it is concerned with the MSDP making a boundary decision to localise the complement to fit its business needs and adapt to the conditions in the markets that the MSDP serves. The second aggregate dimension was 'Customer Heterogeneity Realisation'. It emerged by grouping the 'Customer Preference Adaptation' and 'Seamless Customer Experience' themes, and it is concerned with addressing the heterogeneous needs of customers[35]. The third aggregate dimension was 'Supermodular Complementarity Ignition'. It emerged by grouping the 'User Base Boosting' and 'Relational Investment' themes, and it concerned with increasing the user base and investment in the MSDP through supermodular complementarity. Table 5-5 depicts the final coding structure with the three aggregate dimensions, and it will be discussed in greater detail in the findings chapter.

First-Order Concepts	**Second-Order Themes**	**Aggregate Dimensions**
• Need to adapt to local characteristics • Need to adapt to local regulations	Market Adaptation	**Complement Localisation**
• Need to customise a complement • Existing complement not reliable everywhere	Complement Customisation	
• Users preferring a specific complementor • Users preferring a specific solution	Customer Preference Adaptation	**Customer Heterogeneity Realisation**
• Providing more options and choices to users • Increasing user trust	Seamless Customer Experience	
• Integrating a complementor within the MSDP • Integrating the MSDP within a complementor	User Base Boosting	

[35] There is a difference between the themes 'Market Adaptation' and 'Customer Preference Adaptation'. The former is concerned with the macro conditions in the market, while the latter is concerned with the micro-differences between the customers. This difference will be explained further in the findings chapter.

• Getting investment from a complementor • Building on an existing relationship with a complementor	Relational Investment	**Supermodular Complementarity Ignition**

Table 5-5: Data coding structure.

5.4 Chapter summary

This chapter discussed the data analysis process that was pursued in this research. It provided a detailed description of five different rounds of coding – data reduction (1st round), timeline build up (2nd round), open coding (3rd round), axial coding (4th round) and selective coding (5th round). Following the description of the different rounds of coding, a discussion of the coding process was provided, highlighting the decisions and assumptions that led to the emergence of different concepts, themes and aggregate dimensions. The next chapter will provide more details about the findings that resulted from data analysis.

6 FINDINGS

6.1 Chapter introduction

The previous two chapters presented the embedded case study of Uber and provided a detailed description of the data analysis process that led to the emergence of new concepts and themes addressing the following research questions: *What factors influence the shifts in the boundaries of MSDPs as they configure their complements, and how do MSDP firms respond to these factors?* This chapter is divided into five sections. Section 6.2 provides an overview of all the concepts, themes and aggregate dimensions resulting from the open coding, axial coding and selective coding analysis described in Chapter 5. Sections 6.3 to 6.5 provide supporting evidence and a detailed articulation of the first-order concepts, second-order themes and three aggregate dimensions that emerged from the data and that are believed to influence the boundary decisions of MSDPs. Finally, Section 6.6 provides a summary of the chapter.

6.2 The three factors influencing MSDP boundary decisions

The identification of factors influencing the MSDP's decision to build complements in-house or rely on third-party complementors was informed by the analysis of the data via open coding, axial coding and selective coding, as described in Chapter 5. Table 5-5, presented near the end of Chapter 5, depicted the coding structure resulting from the data analysis. The analysis shows that the traditional determinants of firm boundary decisions, such as competency and transaction cost economics, are still relevant in the context of MSDPs. However, the findings also suggest three new factors affecting the boundary decisions of MSDPs that have not been considered in the existing literature: complement localisation, customer heterogeneity realisation and supermodular complementarity ignition. In the same order as the aggregate dimensions of the coding structure in Table 5-5, the following three sections describe the factors that influenced Uber's decisions to build complements in-house or to rely on third-party complementors. Each section begins by explaining the aggregate dimensions that represent the factors and then proceeds to expound the second-order themes and first-order concepts associated with each, while providing key representative quotes as supporting evidence. At the end of each of these sections, a table containing additional representative quotes supporting the dimensions discussed in the section is provided.

6.3 Complement localisation

The data show that as Uber expanded to new markets, it became clear that its MSDP was not one size fits all. Uber had to adapt to the unique characteristics and regulations of each market, while ensuring that it provided a consistent level of experience. As Uber's general manger in Nigeria told Wired, 'Uber may be a global brand, but it is a local business' (Hempel, 2016). This point was reinforced by a Bloomberg report describing the localisation issue for Uber when it expanded to Singapore and Malaysia in 2013:

> For users already accustomed to the service, the experience was seamless. But for locals, especially in Malaysia, it suffered from three problems. First, it was noticeably more expensive than traditional taxi alternatives. And second, payment could be made via credit card only, despite the fact that consumers strongly preferred using cash. Finally, Uber—like other car services in Malaysia—suffered from perceptions that it was unsafe, especially for female riders (Minter, 2017).

To adapt its platform to the local setting, Uber relied on third parties that offered localised complements and customised localised complements in-house. These complement localisations can be categorised into two themes: (1) market adaptation and (2) complement customisation. The former refers to the localisation required to adapt the platform to local market characteristics and to local regulations. The latter refers to the technical customisation of complements undertaken to make the complements that worked for local markets work for Uber's needs. Table 6-1 presents the data structure for the aggregate dimension of complement localisation.

First-Order Concepts	**Second-Order Themes**	**Aggregate Dimension**
• Need to adapt to local characteristics • Need to adapt to local regulations	Market Adaptation	**Complement Localisation** *(The need to configure a complement to adapt to the macro-level local setting where the MSDP operates and to meet business needs)*
• Need to customise a complement • Existing complement not reliable everywhere	Complement Customisation	

Table 6-1: Data structure for the aggregate dimension of complement localisation.

6.3.1 Market adaptation

Expanding to new markets was not a straightforward task for Uber. Although digitalisation facilitates the standardisation and replication of a product or a service, Uber could not simply copy its MSDP from one market to another; it had to adapt to distinctive local contextual characteristics and

regulations. In this subsection, examples are provided across cases to illustrate situations in which market adaptation influenced whether Uber built in-house complements or relied on third-party complementors.

As markets are heterogeneous, Uber had to adapt its service in order to adapt to the local characteristics of the markets it expanded to. Map solutions are essential to delivering the services of Uber's MSDP, as they're used to enter pick-up and drop-off locations, track rides and more. In the course of its expansion, Uber faced an address identification problem that affected its operations in several markets. In India (one of Uber's top three markets besides the US and Latin America), for example, Uber faced a problem in delivering its service because of the lack of proper addresses in many areas where it operated. Hence, the Uber research team in Bangalore investigated solutions to overcome this problem, as communicated by Uber's director of product design:

> In cities like Mumbai, Uber will also have to adapt to [the] local infrastructure, such as the frequent lack of street addresses. We're thinking about ways to allow riders to take photos of the location where they're at and share that with the driver (Bogle, 2016).

Similarly, Uber had to adapt to the lack of street addresses in several African countries where drivers were not able to reach pick-up or drop-off locations for riders. In Kenya, for example, Uber partnered with a local directions startup, OkHi, to mitigate the problem, which was described by Uber's general manager for Sub-Saharan Africa as follows:

> Streets are not as well mapped across the continent as many of our other markets, which poses challenges for our driver-partners. … In Kenya, Uber is testing a pilot program with local directions startup OkHi, which uses smartphones and digital images to overcome inaccurate or non-existent postal codes, street names, or physical addresses. Rather than the Uber driver aiming for number, say, 7 Mombasa Road—which may not be mapped—he or she can aim for the white fence or green gates of the exact location as seen on a mobile device (Bright, 2016).

Payment solutions are also essential to delivering the services of Uber's MSDP. Uber's initial business model envisioned digital payments through credit cards as a crucial feature for providing a smooth experience to users. This model worked very well in the US, Uber's initial market, because the country's credit card penetration rate is high. However, Uber's business model was challenged when it expanded internationally and realised that it could not provide the same smooth payment experience by only relying on credit card payments. Uber faced two problems with accepting digital payments when expanding internationally: (1) currency exchange issues and (2) low credit card penetration in some locations.

With regard to the first problem, Uber's original payment processor, Authorize.Net, was only able to process payments in US dollars. Consequently, when Uber expanded to Europe, riders could not pay in their local currencies and had to pay in US dollars. Uber then partnered with payment processors Ayden and Braintree to allow riders to pay in their local currency without requiring currency exchange. A case study report by Braintree on its integration with Uber elaborated on the issue further:

> As Uber expanded internationally, it needed a payment gateway provider that could simplify the complexities of taking an mCommerce business international and efficiently process payments in foreign currencies. During its initial expansion into Paris, and before Braintree, Uber had to charge Parisian passengers in U.S. dollars and display Euros on-screen. This discrepancy was a large source of confusion and customer complaints, making passengers slow to adopt the new service. … Uber switched to Braintree in February 2011 for all of its international and U.S. based payments. … Braintree processes payments in over 130 currencies around the world, so Uber's international passengers were able to begin making payments in their local currencies from day one. … Braintree's ability to process payments in foreign currencies was the most important aspect of Uber's selection, but Braintree was also the payments provider with which Uber's fleet of engineers wanted to work (Braintree, 2018).

The low credit card penetration in some locations was the second problem that Uber faced when it was expanding to new markets. Many countries or cities had a low number of users who owned credit cards, which prevented them from using Uber's service. The following excerpt from a TechCrunch report illustrates the variation in credit card penetration rates between Uber's markets:

> Credit card penetration varies widely throughout Southeast Asia and is relatively low in several of the countries where Uber has launched or is planning to rollout. For example, 39% of Malaysians surveyed by Nielsen use credit cards frequently, but the Philippines has a credit card penetration rate of just 3% (Shu, 2014b).

To solve the problem of low credit card penetration, Uber relied on a variety of solutions, which differed depending on the market. These solutions included partnering with local third-party digital wallets (e.g. Momo and Paytm) and mobile payment services (e.g. Airtel and Paga) and introducing Uber-branded credit and debit cards in collaboration with banks. For example, in Vietnam, where credit card penetration was 4.1%, Uber struck a deal with Momo, a Vietnamese digital wallet, to enable local riders to pay for their rides without credit cards. As Tech in Asia reported, 'Uber has partnered with Vietnam-based payments startup Momo to enable cashless transactions on the Uber app' (Tegos, 2017). As a different solution to the problem of low credit card penetration, Uber introduced a branded debit card in Mexico in collaboration with MasterCard and Bankaaol, a Mexican bank. Unlike many other debit cards in Mexico that restrict e-commerce purchases, Uber's branded debit cards allow riders to make online purchases and use the card to book rides on Uber.

Relying on third-party digital wallets and mobile payment services allowed Uber to solve the credit card penetration problem in many markets while maintaining its business model of cashless payment. However, sticking to this business model crippled Uber's competitive stance in other markets, including some in East Asia and Africa. As an Uber executive explained in a TechCrunch report:

> We recognize that not everyone uses a credit card and there are different payment mechanisms in different places. We want to be able to serve everyone so, fundamentally, everyone needs to accommodate our system or we need to accommodate how riders in other markets pay (Tegos, 2017).

To accommodate riders without digital payment accounts, Uber experimented with accepting cash payments in Hyderabad and then gradually rolled the option out to other Indian cities. The initial experiment was successful, and Uber expanded cash payments to other markets as well, including Latin America, Africa, the Middle East and East Asia.

In addition to adapting to the mapping and payment technology available in different markets, Uber also had to adapt to different regulations in different markets. Uber's expansion strategy is aggressive, meaning that it begins operating in a market before dealing with regulators. As a result, Uber faced regulatory struggles around the world, and often opted to lobby governments or go to court to maintain its operations. In some cases Uber was unable to adapt to and comply with regulations and ended up withdrawing from a few markets, such as Denmark and Hungary. However, in many other markets, Uber was able to influence regulations or find solutions to work within them.

India is one example of a market where Uber adapted to comply with local regulations—after initially trying to circumvent them. Legislation was passed by the Reserve Bank of India requiring all e-commerce transactions to be processed via two-factor authentication systems. This meant that customers making online transactions received a validation code via SMS, which they used to complete the transaction. Uber initially worked around this regulation by routing transactions through a foreign bank (e.g. a Dutch bank), making it exempt from the two-factor authentication process. This manoeuvre worked initially, but the Reserve Bank of India eventually closed the loophole by requiring such transactions to be processed through a bank in India and only in Indian currency. This meant that Uber was no longer able to work around the implementation of a two-factor authentication system, which the company feared would disrupt its value proposition of providing a seamless experience, as riders would have to authenticate payments at the end of every single ride. Since Uber could not afford to exit one of its biggest markets, it chose instead to

integrate a third-party complementor, Paytm digital wallet, into its MSDP. Quartz India reported on the decision:

> Due to a long-running dispute with the Reserve Bank of India (RBI) about Uber's use of customers' stored credit card details—which was triggered by complaints from India's old-school taxi operators—Uber has been forced to set up a new system with local payments firm Paytm that allows users to load cash onto a virtual wallet that can then be used to make transactions (Walia, 2014).

Integrating Paytm allowed Uber to adapt to local regulations and to continue offering a seamless customer experience; two-factor authentication was only used when riders needed to fill their Paytm digital wallets.

Another example of Uber partnering with a third-party complementor in order to adapt to local regulations comes from China, where regulations were stiff. When Uber was entering the Chinese market, providing the same level of experience that it could offer in other places was not easy. Chinese users not only had to have credit cards, but were also required to validate their credit card information prior to opening an Uber account. As stated in an HBR article, 'This presented a major obstacle for many potential Chinese users' (Kirby, 2016). This prompted Uber to look for another payments solution for the Chinese market, which led to the firm's decision to partner with Alipay as a third-party payment option.

Uber also had to adapt its maps component to comply with local regulations in China, after initially relying on Google Maps as the embedded map in users' apps. However, in China Google Maps provided inaccurate information that negatively affected riders' experience. In a blog post on Medium, a technology expert summarised the problem:

> China has a security/protectionist rule in place governing map data; effectively map providers are required to obfuscate map coordinates. While Google Maps renders my own location correctly (due to a license they have with a government approved mapping company), Uber's entities are shifted by China's GCJ-02 offset. The result is confusion [regarding] where both I and the driver are (Staley, 2016).

In order to solve this problem, Uber had to find a map provider in China that would enable it to provide a consistent level of experience for its users. As a result, Uber switched from using Google Maps in China to using Baidu Maps, which enabled it to gain a 'technological edge, some drivers say, including more accurate maps' (Dou and Carew, 2015).

6.3.2 Complement customisation

In contrast to market adaptations, in which Uber's platform needed to be tailored to work for local markets (either in-house or by partnering with a third party), complement customisation refers to situations in which complements worked in local markets but needed to be customised to Uber's business needs. MSDPs, by definition, have some of their components provided by third-party complementors. However, many of the maps and payment complements used by Uber are general-purpose technology, meaning they can be used in different ways and are not necessarily customised for Uber's business needs. In this subsection, examples are provided that illustrate how the need to customise these complements impacted Uber's decisions regarding building complements in-house or relying on third-party options.

As illustrated in the previous sections, Uber always strives to find and use the maps and payment solutions that will provide a seamless experience for its users, wherever they are. The firm has partnered with a variety of complementors (e.g. Google Maps and TomTom) to power the maps embedded in the riders' and drivers' apps (in addition to the turn-by-turn navigation options for the drivers). While these complements met the basic functional needs of Uber's MSDP, they were not always optimised to Uber's needs; some had irrelevant information, for example, or were unreliable in certain parts of the world. Faced with this need for a more customised map complement, Uber invested in developing its own map solution by making acquisitions, poaching engineers from complementors and collecting its own map imagery. Uber's Vice President of the maps and business platform explained why the company decided to double down on developing its in-house mapping technology on the company blog:

> I lead Uber's mapping efforts to ensure we can provide a safe, reliable ride—no matter where you are. To do that, Uber uses a mix of mapping technologies (including our own) to provide the underlying infrastructure for our apps. Existing maps are a good starting point, but some information isn't that relevant to Uber, like ocean topography. There are other things we need to know a lot more about, like traffic patterns and precise pickup and drop-off locations. Moreover, we need to be able to provide a seamless experience in parts of the world where there aren't detailed maps—or street signs. The ongoing need for maps tailored to the Uber experience is why we're doubling down on our investment in mapping (McClendon, 2016).

Launching new services sometimes increased the necessity of being able to customise complements. For example, the launch of UberPool enabled users to share rides with others, reducing the cost of their trip. Existing navigation complements that worked fine for traditional Uber services, such as UberX, were not fit for UberPool, which required drivers to make multiple stops and change pick-up and drop-off locations on the go. This point was elaborated on in a blog post on Uber's company blog:

> For most drivers in most situations, your trip is a simple one: you've got a starting point, a destination, and the best route between the two. The end. … If you are a driver on an UberPool trip, your route might have several overlapping pickups and dropoffs. Throw deliveries into the mix—where you might need to park and walk inside for a pickup—and navigation can get incredibly complicated. … Unlike traditional navigation apps, Uber Navigation has to help its users answer the question 'What's next?' … Uber Navigation is custom tailored for drivers, and we're not done yet (Wachsman, 2017).

In addition to maps components, sometimes payment complements also needed to be customised to meet Uber's business needs. As discussed previously, Uber eventually started accepting cash payments in order to adapt to markets where credit card penetration was low. For Uber, collecting digital payments was a clear, linear process. A user enters a car, is dropped off at his/her destination, a fare is produced and, finally, a transaction is automatically triggered and charged to the user's preferred digital payment method. Uber then collects its share from the ride's fare (i.e. 20% of the total fare) and transfers the rest to the driver's bank account. However, the process became more complicated with the introduction of cash payments. When a user pays a driver in cash, Uber needs to physically collect its share of the trip fare from the driver. As more users started paying in cash, Uber ended up being owed millions of dollars by its drivers and thus needed to find a convenient way to collect its share. To solve this problem, Uber introduced its own cash payment system that was customised to its needs and solved the issues related to cash payments. The customised cash payment solution was described in a blog post by an Uber software engineer:

> In cities where we support cash payments for our ridesharing service, driver-partners keep the money paid to them in cash and pay Uber's fees for those trips automatically from the proceeds of digitally-paid trips. In these circumstances, our intelligent dispatch system guarantees that driver-partners receive enough trips paid with a digital payment type to cover fees owed to Uber from previous cash trips. Drivers benefit from an immediate payment while Uber enables riders to pay with physical cash, an important feature in regions where some people do not have access to credit cards (Austin, 2018).

This section presented several examples of boundary decisions (in which Uber either decided to build in-house complements or rely on a third-party complementor) that were influenced by complement localisation factors. These factors were further broken down by theme into market adaptation situations—in which Uber had to adapt its platform to local conditions or regulations—and complement customisation situations—in which Uber had to customise complements to its needs. Table 6-2 provides additional quotes that map to the second-order themes in this section.

Theme	Representative Quotes
Market adaptation	*'We build globally, we live locally.* We harness the power and scale of our global operations to deeply connect with the cities, communities, drivers, and riders that we serve every day.' (Uber Technologies, Inc., 2019, p. 12). 'Uber wants its app to be global, of course, but also to become irreplaceable in each city where it operates -- a goal that requires local adaptation.' (Bogle, 2016). 'Beyond this, the relative lack of smartphone and credit card penetration in India means Uber must find a way to scale without relying on the fundamental "click a button, get a ride" mechanism that's made it so successful in the U.S.' (Bhuiyan, 2015a). 'Building a local operation in Los Angeles is radically different from building one in Nairobi. To scale a company that operates in hyper-diverse environments requires juggling local regulation, payment infrastructure and operations. Uber's customer-facing app is coherent despite these localizations. A glimpse over my 'select payment' screen paints a microcosm. In the US, the default payment method is obviously a credit card. (There are more than 2 credit cards per person). If you take an Uber in India, the preferred way to pay is a popular prepaid wallet called 'PayTM'. (25 million users). And if you hail an Uber in Nairobi, Kenya, you may also pay with cash, a tactic Uber needs to apply in developing and frontier markets.' (Pal, 2015). 'Uber is working very closely with Baidu to develop the company's local presence, local staffing and integration with local maps and other services' (Lunden, 2015c). 'To date, Uber has allowed passengers to pay for their rides only through its app — via credit card or a digital wallet. But in emerging markets like India and Colombia where credit card penetration is low, Uber's cashless system has limited the company's growth. The company moved to address this issue with digital wallets, which can be used with Uber's mobile app and are easily replenished by purchasing ride credits at a local convenience store.' (Bhuiyan, 2015b). 'For PayPal, though, working with Uber is an opportunity to tap into its vast (and now very global) network of users to spur more new sign-ups or re-engage less active users. Interestingly, China and India — two of Uber's fastest growing markets and two of the world's biggest countries, to boot — are absent from this list. That's for good reason. Legal issues forced Uber to adopt an in-app payment wallet in India last year — it partnered with Alibaba-backed Paytm — so PayPal's service is a little redundant there.' (Russell, 2015b). 'Making payment straightforward is clearly a major hurdle to capturing a large slice of overseas travelers. While Uber is a global brand present in over 300 cities worldwide, the Chinese branch of its service previously required a dual-currency credit card to take rides overseas, with all billings made in U.S. dollars. With fewer dual-currency cards in circulation, that stipulation limits its potential user base. Adding Alipay, which boats over 400 million active users, is sure to ease things for Uber customers headed overseas.' (Russell, 2016b). 'Uber's engineers will have to work within parameters unique to India—particularly, phone and network limitations. Not everyone has a top-shelf iPhone in the country, and the data-hungry plans we're used to in the US are prohibitively costly for many in India. At the same time, the constraints created by these limitations lend themselves to creative thinking. In the US, for example, riders compulsively stare at the Uber app to watch a miniaturized car crawl on a map until it reaches them. But for riders in India, that process would consume a horrifying amount of data over slower connections.' (Alba, 2016). 'The impetus for testing cash connects to the lower e-finance penetration in Nigeria, and a 'distrust of e-commerce' in both countries. Lits [Uber's general manager for Sub-

	Saharan Africa] likened it to the U.S. in the late 90s, when consumers were still wary of giving up personal information for online transactions. “Cash seems to allow many to give Uber a try, see how it works, and then load their payment information at a later stage.”’ (Bright, 2016). ‘When accepting card payments, there are certain requirements that companies must comply with. In the US, these are known as PCI requirements. The Payment Card Industry Data Security Standards (PCI DSS) is a set of requirements designed to ensure that all companies that process, store, or transmit credit card information maintain a secure environment. In effect, this applies to any merchant that has a Merchant ID (MID). Uber chose to partner with Braintree, one of the leaders in the mobile payment market, to accept card payments.’ (Abrosimova, 2014). ‘As a global company, Uber strives to make its services accessible everywhere it operates. That effort involves understanding regional customs and adapting our technology to them.’ (Austin, 2018).
Complement customisation	‘Travis Kalanick's beleaguered startup officially launched a new navigation system for its drivers … According to Maya Choksi, a senior product manager at Uber, the aim is to provide drivers with an optimal navigation experience. One of the main complaints from drivers on Uber's iOS app was small font size, she said, but in the past, Uber had little say in how street labels appeared. That was because the company used a number of different mapping APIs ‘to kind of cobble together’. ‘There were a number of things that were really suboptimal about this,’ she explained. ‘We had no control over the size of [street] labels or which labels show or don't show. We couldn't control necessarily the name of the street where the driver is supposed to make a right turn.’ Now the team controls more of the mapping stack, and they're able to customise it specifically for the needs of Uber, UberX, UberPool and UberEats drivers -- a far more complicated set of directions than your average commuter trip.’ (Bogle, 2017). ‘According to Brian McClendon [Vice President of maps and business platform at Uber], relying entirely on existing maps has been ‘a good starting point,’ but which don’t provide the granular level of detail that the company could use, such as traffic patterns, locations of doors or other potential pickup locations. This new investment will allow the company to build up tailor-made maps that would provide this level of detail.’ (Liptak, 2016). ‘Uber will begin mapping Singapore's streets soon, as it expands its large-scale mapping project to Asia. The company said in a blog post that it is hoping to improve Uber's underlying technology by refining how it handles traffic, and where drivers can pick up and drop off users. Uber explained that third party map data often isn't relevant to its needs as a ride-sharing app, since they include additional information such as oceanic topography. The effort follows Uber's mapping efforts in Canada, the U.S., Mexico, the U.K., South Africa and Australia, and is expected to take around two or three months for Singapore.’ (Ng, 2017). ‘As with Uber, the advantage of having maps that you can customise to your needs could not only improve the logistics of the business today, but could help them plan for what they would like to deliver tomorrow.’ (Lunden, 2015a). ‘The ride hailing company has inked a new deal with Foursquare to use its location information to make Uber's app better at finding the addresses of specific locations.’ (Bell, 2016). ‘With the three-sided marketplace of Uber Eats, the majority of cash received by a delivery-partner from an eater is owed to the restaurant-partner. Moreover, in markets with low credit or debit card usage, it is not possible to dispatch enough digitally-paid deliveries to offset the outstanding cash collected. Rather than asking our delivery-

	partners to go back to the restaurants they just came from to drop off cash paid for an order, we needed a sustainable means of transferring cash payments between the eater and the restaurant-partner. We first tried using third-party cash collection services that leverage participating locations, such as convenience stores, as well as traditional bank deposits and transfers. The problem we found with this approach was that these services were not available in all Uber Eats cities, limiting where we could support cash payments, and required our delivery-partners to make stops that were not part of the traditional delivery trip experience.' (Austin, 2018). 'The ride hailing company has inked a new deal with Foursquare to use its location information to make Uber's app better at finding the addresses of specific locations ... Under the new deal, Uber's app will incorporate Foursquare's Places data so that riders can find the addresses for exact locations by only typing in the restaurant or venue name. Foursquare will enable Uber to customize, improve and increase the breadth of our non-personal POI [points of interest] location data to enhance Uber's rider and driver experience.' (Bell, 2016). 'Anyone who frequently uses ride-sharing services like Uber or Lyft knows the frustration that can come from a driver and rider trying to find each other. Sometimes the driver is on the wrong side of the street, or misses their turn — and sometimes the rider gives terrible directions over the phone. Uber wants to fix that and has reworked the navigation system it builds into the Uber Driver app in a bid to get everyone to where they're going more quickly … Uber It's all about customizing the software to the unique needs of Uber's drivers.' (Golson, 2017).

Table 6-2: Additional selected quotes for the second-order themes of the aggregate dimension of complement localisation.

6.4 Customer heterogeneity realisation

In the course of scaling its operations, Uber realised that users are heterogeneous and have different needs. While the market adaptation theme looked at heterogeneity of markets at a macro level, this discussion of customer heterogeneity reflects Uber's efforts to cater to micro-level differences between users. For example, even in markets characterised by low credit card penetration, some users may have credit cards and prefer to pay with them. Uber made an effort to cater to these types of individual user preferences as well as the preferences of different user groups, such as students, adults, seniors and business people. Users were also differentiated by their use of different kinds of devices powered by different operating systems, such as Apple iOS and Android OS. The analysis shows that in addition to macro-level contextual factors in markets, Uber considered these micro-level customer-related factors when making decisions about whether to build complements in-house or rely on third-party complementors. Two main themes related to customer heterogeneity were identified: 1) customer preference adaptation and 2) providing a seamless customer experience. The former is concerned with situations in which Uber's decisions were informed by customers' heterogeneous preferences, while the latter refers to situations in which Uber's decisions were motivated by a desire to provide the same level of experience to all customers

despite their differences. Table 6-3 presents the data structure for the aggregate dimension of customer heterogeneity realisation.

First-Order Concepts	Second-Order Themes	Aggregate Dimension
• Users preferring a specific complementor • Users preferring a specific solution	Customer Preference Adaptation	**Customer Heterogeneity Realisation** (*The need to configure a complement in order to address the micro-level differences between customers*)
• Providing more options and choices to users • Increasing user trust	Seamless Customer Experience	

Table 6-3: Data structure for the aggregate dimension of customer heterogeneity realisation.

6.4.1 Customer preference adaptation

Although Uber's main service was moving riders from point A to point B, addressing the specific needs and preferences of riders and drivers was also important, and influenced decisions about when to build map and payment complements in-house and when to rely on third-party complementors. The data analysis shows that on many occasions, Uber integrated complements in response to user preference for either a specific complementor or a specific solution. In this subsection, a variety of examples are provided across cases to illustrate the impact of customer preference adaptation on in-house vs. third-party complement decisions.

The previous section demonstrated the importance of payment methods for completing a ride with Uber. The data analysis reveals that users had heterogeneous preferences which Uber attempted to address when it came to payment methods. In many cases, users preferred to pay using a specific complementor, which in turn influenced Uber's boundary decisions. For example, Uber integrated iDEAL, A Dutch e-commerce payment service, because users in the Netherlands preferred it for conducting online transactions. As stated by the head of UberEats in the Europe, Middle East and Africa region, Uber integrated iDEAL in the Netherlands because '90 percent of electronic payments are made with iDEAL' (Turner, 2018). Another example of customer preference adaptation driven by customer preference for a specific complementor can be found in the case of China. Although PayPal was available in China, Uber integrated Alipay because Chinese customers preferred it to PayPal. As noted in the previous section, Uber considered alternative payment options in China because of the hurdles involved in paying by credit card there. Faced with this macro constraint (created by regulations), Uber looked to customer preferences in deciding what solution to offer, making this an

example of a boundary decision based on both market adaptation and customer preference adaptation. As stated in a Forbes report, 'Uber started out in China with a credit card system but added Alipay when its customers asked for it' (Huet, 2015). Indeed, addressing the preference of users enabled Uber to expand its growth in China:

> Processing Alipay payments has been a crucial component of Uber's explosive growth in China, where the ride-sharing company went from just one percent of the market in early 2015 to roughly 33 percent by the end of that year (Conger, 2016).

Recognising the importance of addressing users' preferences, Uber took an extra step by adapting to Chinese users' preferences globally, demonstrating the difference between user preference adaptation and market adaptation. Chinese users travelling overseas were unable to use their preferred payment complementor, Alipay, to pay through the Uber app, because it was not a payment option in other markets. To serve these customers' unique needs, Uber expanded its partnership with Alipay and enabled Chinese users to order and pay for Uber rides directly from the Alipay app when they were abroad:

> With Uber's global expansion of its Alipay partnership, Chinese riders can continue to pay through Alipay wherever they are instead of obtaining a dual-currency credit card. … Chinese travelers abroad will automatically see the Uber icon inside their Alipay wallet and will be able to hail and pay for rides directly from Alipay. When they return home, this option will vanish and users will need to return to the Uber app to order a car (Huet, 2015).

Uber also adapted to users' preferences regarding map components. For example, Uber developed its own customised navigation system that met its business needs and helped drivers complete their jobs efficiently. However, drivers still had their own preferences when it came to which navigation system to use. For example, in a blog post on the UberPeople.Net forum, drivers indicated different navigation system preferences. One driver expressed a preference for Uber navigation: 'I like the Uber navigation. Many here do not. I don't like Waze or Google. I have not had many problems with the Uber nav'. Another driver favoured Google Maps: 'I use Google [Maps] during the drive but switch back to Uber as I get close to the drop off'. A third driver preferred Waze: '[I] switch to Waze if there's a major traffic delay. Gave me options to get out of [the] traffic mess the other day that Google didn't' (Uberpeople.net, 2017). In recognition of drivers' varying preferences for specific complementors, Uber enabled drivers to select their preferred navigation system during an Uber ride, as confirmed by a report by The Verge:

> Uber says it doesn't currently have plans to offer the program [the Uber navigation system] outside the company, and, though it wants its mapping program to be the preferred one for its drivers, Uber says drivers may continue to use whichever mapping solution they prefer (Golson, 2017).

Sometimes, customers expressed preferences not for a specific complementor but for a specific solution. Some users preferred to pay using credit cards, others preferred debit cards and others favoured traditional cash payment. For example, despite the prevalence of cash payments in Germany (Schutz, 2019), Uber enabled payment through PayPal as well, because it realised that many customers in Germany preferred to use their debit cards rather than credit cards for online transactions. The decision was explained by Uber's CEO in a Mashable report covering Uber's integration of PayPal:

> Customers in Germany prefer paying through their bank accounts rather than with credit cards. … Are we then going to get intimately familiar with how banks work in Germany and how to interface with them?... We have to go mass market and we need a payments partner that can do that with us (Fiegerman, 2013).

The inverse situation developed in Singapore and Malaysia. In Singapore, Uber began accepting cash payments, despite the widespread use of credit cards there, to cater to the preferences of a minority of customers. As reported by Mashable, the acceptance of cash payments in Singapore was an unusual move 'given that on average, most individuals in Singapore hold about two cards in their wallets' (Ho, 2016b). Similarly, in Malaysia, despite the common use of credit cards, some Malaysians still prefer to pay for their rides in cash. Uber chose to cater to the preferences of these users as well as broader market demands and started accepting cash payments, enabled by the cash payment system it had developed earlier for India. The Uber blog described the decision as follows:

> Over the last few weeks we've introduced cash as a payment experiment in Johor Bahru, Penang and Ipoh and we've seen a very clear trend from your feedback—Malaysian riders and driver-partners love the flexibility of cash and credit options combined—so today, we're bringing cash payments to the capital—Kuala Lumpur! Credit cards are a common way to pay but many Malaysians still prefer transacting in cash (Khera, 2016).

Customers' preference for a specific solution also affected decisions about how to offer or develop map components. Prior to Uber's development of its own navigation system, Uber drivers were mostly using Google Maps and Waze for turn-by-turn navigation. However, this required them to switch between Uber's app and their chosen navigation app. Many drivers preferred an integrated solution within Uber's app that would not require them to switch back and forth. Therefore, one of the main reasons for the development of the Uber navigation system was to adapt to the preference of their drivers. This was announced in a blog post by Uber:

> Today, we're excited to introduce a redesigned navigation experience built around drivers' needs. We've completely revamped navigation on iOS and are introducing in-app navigation on Android for the first time. Now, with one-tap, turn-by-turn directions start right away, saving time and eliminating

> the need to juggle multiple apps. … Reducing the need to toggle multiple apps ties to our efforts around safety and distracted driving (Choksi, 2017).

6.4.2 Seamless customer experience

While catering to customers' heterogeneous preferences and needs, Uber also wanted to ensure that it offered a seamless customer experience regardless of user preference. As Uber wrote in a post on its corporate blog: 'Building frictionless payment experiences for riders and drivers regardless of device or payment preference is the primary objective of [Uber]' (Pancholi, 2017). The data analysis indicates that Uber balanced catering to heterogeneous customer preferences with maintaining a seamless experience in two ways: (1) by providing more options or choices to users and (2) by increasing users' trust. In this subsection, a variety of examples are provided from across cases to illustrate how Uber's prioritisation of maintaining a seamless customer experience impacted its decisions regarding building complements in-house or relying on third-party complementors.

Providing a seamless payment experience is a key element of Uber's value proposition. Uber frequently used terms such as 'seamless', 'frictionless', 'simple' and 'hassle free' to describe how it envisioned its service. Uber always visualised a service in which a user could request a ride with the press of a button, get to his or her destination and exit the car without ever needing to worry about whether he or she was carrying enough cash, whether the driver had change or whether the driver accepted credit cards. This experience was part of the value proposition that distinguished Uber from existing taxi service providers. As Uber noted on its corporate blog, 'An elegant and hassle-free exit has always been core to the Uber experience' (Moore, 2015). To create a seamless customer experience for as many users as possible, Uber attempted to provide a wide variety of payment options for users. These options enabled riders to pay for their rides by using credit cards, digital wallets (e.g. Paytm, Airtel and Alipay), mobile payment systems (e.g. iDEAL, Android Pay and Apple Pay) or cash. Uber explained the rationale behind this decision on its corporate blog:

> Uber offers riders around the world several ways to set up billing for their Uber account, including credit card, PayPal, Google Wallet, Alipay and many more. Reliability and accountability are paramount to us at Uber, as is our commitment to serving all riders, no exceptions. Effortless trip requests that ensure the highest quality and broadest possible service are just the beginning—every feature in the app is designed from the ground up to make your transportation experience simple, affordable and transparent (Arielle, 2014).

Offering a seamless customer experience to all Uber customers meant both making and buying complements. For example, Uber worked persistently to create a convenient cash payment system

that could be used across the different cities that Uber served around the world, as emphasised in a TechCrunch report:

> Accepting cash might seem like a piece of cake for Uber, but Rathod [general manager of Uber Bangalore] explained that it required significant 'innovation on the backend' of the company's platform. 'Drivers and riders have always been carrying cash, so we had to understand their behavior and assess which tech could support this,' he explained. That was done using a combination of Uber's India-focused team, based in the South Asian country, and its centralized tech team in San Francisco (Russell, 2015c).

By developing its own cash payment system, Uber was able to provide an additional payment choice for its users around the world. For example, in one of its promotional blogs about introducing cash payments in Qatar, Uber wrote:

> Doha, you asked and we listened. Choice is a beautiful thing and soon many of you will be able to pay for Uber rides using cash, credit or debit card. That's right—all the convenience of Uber, with even more payment options to cover your rides. Simply choose the 'cash' option in the payments menu, take a ride and pay your driver directly in cash at the end of the trip. This is an experiment and one of the few places in the world where cash payment is available across the 400+ cities where Uber is present. We have worked hard to create a seamless option that is truly Uber, and your feedback is crucial to making it a success (Berkani, 2016a).

Uber also relied on third-party complementors to offer seamless payment solutions. In India, Uber initially integrated Paytm digital wallet in response to local regulations, as indicated earlier in this chapter. However, it later integrated Airtel digital wallet as well, in order to provide users with another payment option and a seamless customer experience. The decision was announced on Uber's blog:

> We are thrilled to announce an innovative collaboration with Bharti Airtel – the largest wireless carrier in India and [the] third largest wireless carrier in the world. Through this partnership, riders in India can pay for their trips with Airtel's mobile wallet, Airtel Money. … This integration with Airtel Money will provide riders with another hassle-free payment option and make Uber the first technology platform to officially launch Airtel Money (Ari, 2015).

Uber also worked to ensure its map solutions offered a seamless experience to all users, through a combination of in-house development and use of third-party complements. As discussed above, Uber let drivers choose between using its own in-app integrated navigation system and third-party systems. Uber also expanded the ways riders could search for destinations. Originally, users had to enter the street address of the location they were going to. To provide a more seamless customer experience, Uber collaborated with Foursquare to enable users to search for points of interest by name within Uber's app instead of having to enter the full address (which often required looking it up in another app). The change was publicised in a TechCrunch report:

> Foursquare and Uber have today announced a global partnership that would use Foursquare's location data to let users type in a venue name (instead of address) when setting their destination. Uber currently partners with Google Maps for points of interest, with TomTom Navigation hooked into the driver apps for directions and transit information. With the addition of Foursquare's data, Uber users will be able to type in the name of their location, whether it's a restaurant or [a] movie theater or [a] bar, without having to insert the exact address. This has been a frustrating pain point for most Uber users, as some places like airports and various restaurants are easily listed on the app, whereas other places require an address. Foursquare will enable Uber to … enhance Uber's rider and driver experience (Crook, 2016).

In addition to supporting or integrating a wide variety of payment and map options to increase user choice, improving user trust in the platform was an important consideration with regard to offering a seamless customer experience to all Uber users. Increasing trust demanded that Uber realise and recognise the heterogeneity of their users, including their differing levels of trust in the platform. For example, one of the reasons for introducing cash payments in Singapore was Uber's realisation that some users were not comfortable with using credit cards to pay for Uber rides. The realisation was mentioned in a Mashable report:

> 'This move (in Singapore) is about reaching new users who might be afraid of credit card fraud', said Tseng [Uber's general manager for Singapore]. Uber is also keen to touch segments of the populace like students who may not have credit cards yet, or senior citizens who feel nervous about putting their credit card information into the app (Ho, 2016b).

Developing a cash payment system was one way by which Uber gained some users' trust. In other cases, it chose to rely on third-party complementors that users already trusted—decisions that in many cases also allowed the company to provide a seamless customer experience and encouraged the adoption of its service. For example, Uber integrated Paga payment in Nigeria because many Nigerians were wary of inputting their credit card information into the Uber app. The general manager of Uber Nigeria described the decision as follows:

> Our partnership with Paga is built upon a shared vision that payments should be simple and convenient and both companies are committed to working together to ensure a seamless experience for all customers. Partnering with Paga enables more Nigerians to access the Uber platform, many of which are not yet comfortable using their debit or credit cards. We look forward to providing more Nigerians with a safe, reliable ride at the touch of a button (margaret, 2016).

In this section, the impact of realising customer heterogeneity on Uber's decisions to build complements in-house or rely on third-party complementors was demonstrated using a variety of examples. Table 6-4 provides additional quotes that map to the second-order themes in this section.

Theme	Representative Quotes
Customer Preference Adaptation	'He [Uber general manager of Singapore] said that despite Singapore's 90% credit card penetration rate, cash is still favoured in an estimated 30% of day-to-day transactions.' (Ho, 2016a). 'A few major players have started tackling the e-payments problem but a mass market solution is still a few years off. For now, [Indians] prefer to book over the phone and pay via cash' (Sharma, 2013). 'Tap the arrow next to your driver's information Select 'Change Payment' Please note that available credit in your account will automatically be applied to your next trip. If you'd prefer not to use credit for your trip, you can use the credits toggle to disable their use.' (Berkani, 2014). 'Uber has added several features catering to businesses in the last year. The company teamed up with American Express, a credit-card favorite among corporate finance departments, in June 2014 to book rides using reward points.' (Stone, 2015). 'Allowing passengers to ride without a credit card potentially enables the Uber service up to new demographics, but Uber also believes that it works two ways. 'By offering cash as an alternative mode of payment, we are opening up Uber to a much larger base of potential users who prefer transacting in cash. By using Uber, they in turn are also introduced to a new, smart technology that enables them to move around their city easily, and potentially electronic payments which is something they may not have been familiar with or comfortable using previously,' the company [Uber] spokesperson said.' (Russell, 2016a). 'Nearly one year ago, with the aim to better fit the needs and preferences of our riders, we began our cash payments pilot in Beirut. Today, we're excited to announce that cash payments are now available to all riders in Egypt, Lebanon, Saudi Arabia, Jordan, Morocco, and Qatar. We continue to roll out cash payments in the UAE and hope to extend it to all riders in the near future.' (Berkani, 2016b). 'Riders will always be able to pay by credit or debit card if they prefer, and change will be handled in the form of credits directly through the app.' (Laura, 2017). 'Uber has adopted Paytm's digital wallet, which allows customers to deposit money into their accounts without plastic, but cash payments are synonymous with taking taxis — plus there's no technology barrier to discourage would-be customers.' (Russell, 2015d).
Seamless Customer Experience	'Uber has partnered with Vietnam-based payments startup Momo … The partnership with Uber will open a seamless and cashless transport experience for the many Vietnamese without credit cards.' (Tegos, 2017). 'One of Uber's biggest selling points is its seamless payment system. By binding a card to your account, your fare is debited as you close the door of your ride and get on with the rest of your day. That means convenience to most people: no hassle finding small money to pay the fare, no issue if a driver doesn't have change for your large bank note, no need for jingling coins to fill your pockets when you do get your change, and no weirdness over tipping/not tipping. Yet, despite all that, cash is becoming an important facet of Uber's service in some parts of the world. Last week that initial cash payment trial was expanded to a range of new markets that took it to 10 countries across three continents.' (Russell, 2016a). 'Our goal is to be drivers' first choice when driving with Uber. This update [Uber Navigation] is just the first step and we have a lot of work ahead of us. We will continue to seek feedback from drivers towards creating a more seamless experience that enables more reliable trips for everyone, everywhere.' (Choksi, 2017).

	'We are customer obsessed. We work tirelessly to earn our customers' trust and business by solving their problems, maximizing their earnings, or lowering their costs. We surprise and delight them.' (Uber Technologies, Inc., 2019, p. 216). '"With this platform, TomTom is the trusted partner for innovative and future proof location technology for the global automotive and consumer technology industry. We look forward to working with TomTom, a leader in the mapping and navigation space," said Matt Wyndowe, Head of Product Partnerships at Uber. "Their mapping and traffic data will help ensure we continue to provide a great experience for drivers everywhere.'" (Lunden, 2015b). 'Users will be able to choose cash as a payment option before requesting an Uber ride, and will not be required to have a minimum balance on their Paytm accounts — the mobile wallet that Uber adopted for Indian users late last year. But they will need a valid Uber account to pay in cash, which means they'll still need to have a credit card or digital wallet account on file. The company also promises 'no haggling' with drivers.' (Toor, 2015). 'Our business depends on the trust of the millions of riders and drivers who use Uber' (Uber Team, 2014). 'While credit cards remain the most popular payment method used on the Uber app, we hope cash as an additional payment option will provide riders across the Middle East with the ability to pay for their Uber rides in the way that best suits their needs. Why we're introducing cash? Removing the fear factor for first time riders. Not everyone is comfortable using their credit card for online or mobile transactions – we listened to these concerns and introduced an alternative so that you have the freedom to choose the way you move around your city, and cash is a truly inclusive way to empower everyone to do so. No credit card? No problem. Cash opens doors for more people to sign up, take their first ride, and have a quality experience on Uber.' (Berkani, 2016b). 'local players have typically used available, accepted methods to gain the trust of consumers and later introduced innovative technologies to improve the experience.' (Sharma, 2013). 'Future failures of the payment processing infrastructure underlying our platform could cause Drivers to lose trust in our payment operations and could cause them to instead use our competitors' platforms.' (Uber Technologies, Inc., 2019, p. 54). 'The company said two weeks ago that it hopes cash will open the service to riders like students, who might not have credit cards. Since then, cash payments have been made in 5% of Uber's rides in Singapore, and this figure is expected to go up, he said. A third of first-time riders are also using cash, showing a possible reluctance to put in credit card data into the app at the beginning.' (Ho, 2016a). 'By testing out cash payments in KL, we're hoping to provide all Malaysians, no matter which city you call home, more choice and a payment option that suits your needs. So whether you're a grandmother looking to visit her grandchildren more often, a student that needs to get to class on time or a busy young professional that need to get to and from the train station every day, we want Uber to be a reliable and convenient option for you. Why we're introducing cash? Removing the fear factor for first time riders. Not everyone is comfortable using their credit for online or mobile transactions – we listened to these concerns and introduced an alternative so that every Malaysian can have the freedom to choose the way they travel.' (Khera, 2016). 'Our mission is to provide access to reliable transportation everywhere for everyone. Innovations that make transportation more affordable and accessible like uberPOOL have helped us make progress toward that mission; but to serve more people, we have to meet them where they are in ways that meet their needs. One way we've done that is by giving folks in over 150 cities across the globe the option to pay for rides with cash. Not everyone has a credit card or feels OK handing one over to a service they've never used.

	We get that, so we developed a solution using technology to enable people who want to pay with cash to do so with our app.' (Laura, 2017).

Table 6-4: Additional selected quotes for the second-order themes of the customer heterogeneity aggregate dimension.

6.5 Supermodular complementarity ignition

The third and final overarching factor Uber considered when configuring the map and payment components of its MSDP was supermodular complementarity. Supermodular complementarity exists when an increase in one input (e.g. user, asset, activity or investment) increases the value of another input and vice versa. The data analysis indicates that igniting this type of complementarity and benefiting from the virtuous cycle of value creation that resulted was a recurring theme of Uber's boundary decisions across the different cases. Across these cases, increasing the number of users and investment from a complementor were observed to be critical for Uber. Therefore, decisions regarding building in-house complements or relying on third-party complementors were influenced by supermodular complementarity in two ways: 1) user base boosting and 2) relational investment. Table 6-5 presents the data structure for the aggregate dimension of supermodular complementarity ignition.

First-Order Concepts	**Second-Order Themes**	**Aggregate Dimension**
• Integrating a complementor within the MSDP • Integrating the MSDP within a complementor	User Base Boosting	**Supermodular Complementarity Ignition** *(A type of complementarity in which more of an input makes another input more valuable; it refers to decisions regarding building in-house complements or relying on third-party complementors to increase the number of users or investment from a complementor)*
• Getting investment from a complementor • Building on the existing relationship with a complementor	Relational Investment	

Table 6-5: Data structure for the aggregate dimension of supermodular complementarity.

6.5.1 User base boosting

The data analysis indicates that Uber was always striving to scale by increasing its user base, as Uber considers this to be its main competitive advantage in different markets. This was evident in Uber's Form S-1 filing:

> We believe that our scale and platform provide us with important advantages. Generally, for a given geographic market, we believe that the operator with the larger network will have a higher margin than the operator with the smaller network, as a result of lower costs due to greater scale (Uber Technologies, Inc., 2019, p. 100).

Adding payment solutions to the platform did not just make it easier for more riders to pay for their rides, and supporting a variety of map solutions was not just about making it easier for drivers to navigate or for users to enter their destinations. Decisions about both complements were also related to boosting the number of Uber users by integrating complementors who already had their own large networks of users. Partnering with a complementor with a large user base created a reciprocal effect in which Uber got access to the complementor's users and the complementor also benefited from access to Uber's users. Thus, user base boosting influenced Uber's boundary decisions in two ways: 1) by integrating a complementor within the MSDP and 2) by integrating the MSDP within a complementor.

Integrating third-party complementors within the MSDP was the first method through which Uber increased its user base. The data analysis shows that whenever Uber was scaling its business, it integrated payment methods that would enable it to access the largest numbers of users. For example, Uber integrated Apple Pay and Android Pay in order to access the large networks of users who have these payment methods installed on their iOS- and Android-powered devices. On many occasions, the integration of a third-party complementor (e.g. Alipay, iDEAL and PayPal) yielded reciprocal benefits for both Uber and the complementor, usually in the form of an increased number of users as well as perks and promotions. For example, Uber integrated PayPal in order to benefit from the large network of users already using PayPal:

> Uber now allows you to add your PayPal account as a payments option. … Enabling PayPal was the simplest way to allow a universal payments method that is used across the globe by 140 million users. … There are other potential marketing and promotional opportunities that Uber (and PayPal) can benefit from (Rao, 2013).

After integrating PayPal, Uber offered perks and promotions for users who paid using PayPal, a move that helped both Uber and PayPal access more users and hence achieve reciprocal benefits. For example, Uber offered users in Australia the following promotion:

> You can now pay for your Australian Uber rides with PayPal! Love PayPal, new to Uber? Download the Uber app now for iPhone or Android. Signup and add PayPal as your payment method. Select 'Promotions' from the top left menu icon in your Uber app. Enter the promo code 20PP for up to $20 off your first trip paying with PayPal (James, 2014).

More examples of achieving reciprocal benefits were Uber's partnerships with credit card companies such as Visa, MasterCard and American Express. For example, Uber started accepting American Express as a payment method in the US in order to grow its user base. In return, American Express benefited by being exposed to new users from Uber and by increasing the customer loyalty of its existing users. The partnership was described in a Mashable report:

> Uber and American Express announced a new partnership on Monday that will let card holders earn and use loyalty rewards points for the ride-sharing service. … 'Our customers really do overlap in a significant way,' Leslie Berland, SVP of digital partnerships and development at American Express, told Mashable. … Emil Michael, SVP of business at Uber, says that the goal is to bring in new users to Uber and improve the payment experience for existing customers (Fiegerman, 2014).

The second method of increasing the user base was to integrate Uber into a complementor. On many occasions, a complementor was first integrated into Uber, followed by the integration of Uber into the complementor, which benefitted both Uber and the complementor (see Table 6-6 for a list of representative examples of reciprocal integration). For example, Uber integrated Alipay in its MSDP in February 2014 in order to have access to more Chinese users. In May 2016, Uber was then integrated in the Alipay app, enabling Uber to potentially access its over 400 million active users (Russell, 2016b).

Uber's partnership with Baidu Maps is another example of reciprocal integration. Uber integrated Baidu Maps in China in December 2014 in order to adapt to the local conditions of the Chinese market. Shortly thereafter, Uber was integrated into Baidu Maps, enabling Chinese users to book Uber rides directly from Baidu Maps. The reciprocal integration enabled Uber to boost its user base in China, as noted in a TechCrunch report:

> We understand that the strategic partnership between Uber and Baidu is more significant than the investment, because Baidu Maps will be able to integrate Uber. … Baidu's mobile search app will be configured so that Uber is displayed prominently when users make travel- or venue-related queries. The deal will 'enable users of Baidu Map and Mobile Baidu, Baidu's flagship mobile search app, to connect easily with Uber driver-partners', the companies said. This is a major boon for Uber because Baidu operates China's largest search engine and will help it compete against its rivals Didi Dache and rival Kuaidi Dache, which are backed by Baidu-competitors Tencent and Alibaba (Shu, 2014a).

Complementor	Date of complementor integration into Uber	Date of Uber integration into the complementor
Alipay	February 2014	May 2016
Google Maps	July 2010 (approximate date)	May 2016
Paytm	November 2014	February 2017
Baidu Maps	December 2014	December 2014

Table 6-6: Examples of reciprocal integration between Uber and its complementors.

The data analysis shows that despite the high transaction costs involved in dealing with third-party complementors, Uber found relying on these complementors to be a reliable way to increase its user base. As stated in its Form S-1 filing, '[Uber] make[s] short-term sacrifices for a lifetime of loyalty' (Uber Technologies, Inc., 2019, p. 208). However, at the same time, Uber did indicate that such short-term sacrifices could severely affect its business if the transaction costs of dealing with complementors increased significantly, reflecting a risk involved in choosing to push boundaries outward. Uber discussed the trade-off in its Form S-1 filing, in the section discussing risk factors affecting its business:

> The convenient payment mechanisms provided by our platform are key factors contributing to the development of our business. … We rely on third parties for elements of our payment-processing infrastructure to remit payments to drivers, restaurants, and carriers using our platform. …. For certain payment methods, including credit and debit cards, we generally pay interchange fees and other processing and gateway fees, and such fees result in significant costs. In addition, online payment providers are under continued pressure to pay increased fees to banks to process funds, and there is no assurance that such online payment providers will not pass any increased costs on to merchant partners, including us. If these fees increase over time, our operating costs will increase, which could adversely affect our business, financial condition, and operating results (Uber Technologies, Inc., 2019, p. 46).

6.5.2 Relational investment

Finally, as a startup, Uber considered raising funds to be crucial for scaling its business and expanding internationally. Funds were especially important because Uber's expansion strategy depended on providing subsidies to users, in the form of incentives to drivers and discounts to riders. This was made clear in its Form S-1 filing:

> To remain competitive in certain markets, we have in the past lowered, and may continue to lower, fares or service fees, and we have in the past offered, and may continue to offer, significant driver incentives and consumer discounts and promotions (Uber Technologies, Inc., 2019, p. 12).

The data analysis indicates that the boundary decisions regarding the configuration of complements on Uber's MSDP were influenced by Uber's desire to build relational investments with many of its complementors. These relational investments took the form of financial investments from complementors or building on an existing relationship with a complementor. The data analysis shows that in many cases, a complementor invested in Uber before or after its complement was integrated into Uber. For example, Uber acquired some mapping technology, including a data centre, cameras, intellectual property and a team of engineers, from Microsoft in June 2015. The following month, in July 2015, Uber received an investment from Microsoft estimated at $100 million (Bass, 2015). Another example of investment followed by integration was Uber's partnership with Baidu in China. In December 2014, Baidu invested $600 million in Uber (Chen, 2014). During the same month, Baidu Maps was integrated into Uber as an alternative to Google Maps in China. Another example of a relational investment can be seen in Figure 6-1, which depicts the investment relationship between Uber and Google Maps. Google Maps was integrated into Uber early on, when Uber was first launched in the second half of 2010 in San Francisco. As Uber continued using Google Maps, it received a huge investment ($258 million) from Google in 2013. Following this investment, Uber was integrated into Google Maps, which made it the first ridesharing option to be integrated into the mapping service. The Verge reported on this integration as follows:

> [Google] Maps is also building Uber into its options for getting around. In certain cities—presumably those where Uber operates—anyone who has Uber's app installed will see a 'Get an Uber' option along with an estimated transportation time when searching for public transit or walking directions. It's an interesting integration, especially given Google Ventures' sizeable investment in Uber (Kastrenakes, 2014).

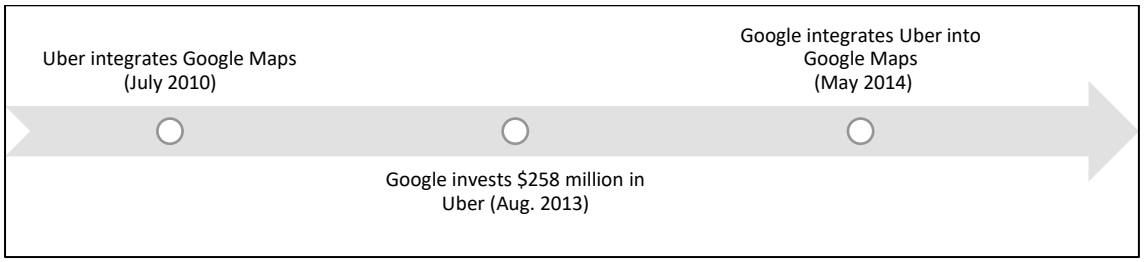


Figure 6-1: A timeline of Uber and Google's investment relationship.

In addition to financial investments from complementors, the data analysis indicates that existing relationships with complementors also influenced Uber's decisions about when to build complements in-house and when to rely on third-party complementors. For example, when Uber wanted to allow Indian users to pay in their local currency when travelling overseas, it partnered with Paytm, capitalising on its existing relationship with Alipay, which was a major investor in and partner of Paytm. A Mashable report summarised the move as follows:

> The American company [Uber] will also introduce a similar feature [paying in local currency] for Indian travellers on Paytm, a digital payment wallet backed by Alibaba and with which Alipay has been sharing its technology. … Alibaba is also the larger investor in Paytm, and had announced the integration of the Paytm and Alipay platforms this January (Joshi, 2016).

Uber's partnership with PayPal provides another example of the impact of an existing relationship on Uber's boundary decisions. Figure 6-2 depicts the business relationship between Uber and PayPal. Uber integrated Braintree early in 2011 to allow users in the markets it expanded to outside the US to pay in their local currency. In April 2012, Uber integrated Card.io to let customers conveniently enter their payment details into Uber by scanning their credit cards with their phone's camera. PayPal then acquired Card.io in July 2012 and Braintree in September 2013. Following the integration of both firms by PayPal, Uber integrated PayPal as a payment method in November 2013, capitalising on its existing relationship with Braintree and Card.io. An article by The Next Web covered the decision:

> Uber and PayPal have teamed up to integrate the payment system into the private car service's mobile apps. … Interestingly, Uber currently uses Braintree to manage its credit card processing—a service that was recently acquired by PayPal for $800 million. … Uber is also one of the first companies to utilize PayPal's new mobile SDK which was unveiled in March. This offering includes a cleaner interface and simpler integration, along with support for Card.io, another PayPal acquisition (Yeung, 2013).

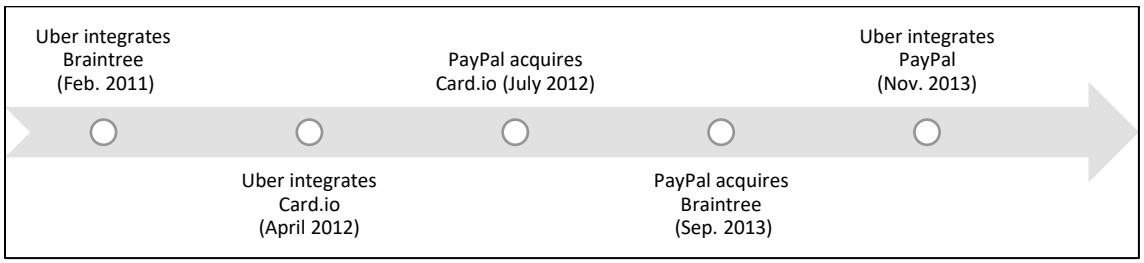


Figure 6-2: A timeline of Uber and PayPal's business relationship.

In this section, the influence of supermodular complementarity on Uber's decisions regarding when to build in-house complements and when to rely on third-party complementors was demonstrated by a variety of examples. Table 6-7 provides additional quotes that map to the second-order themes in this section.

Theme	Representative Quotes
User Base Boosting	'We are excited to extend our partnership with Paytm – Uber and Paytm are joining hands to make your daily outings easier than ever before. Starting today, you'll be able to book an Uber ride through the Paytm app, in just a few taps … Paytm users will now be able to book a ride instantly from their current location, powered by Uber. New to Uber? Enter promo code PAYTM17 and get ₹50 off your first three Uber rides!' (Aviral, 2017). 'The ride-hailing company is launching a debit card available to Uber Mexico customers … The card represents an effort by Uber to attract more customers in Mexico, where some debit providers don't allow e-commerce purchases like Uber rides.' (Hinchliffe, 2016b). 'Uber and American Express announced a new partnership on Monday that will let card holders earn and use loyalty rewards points for the ride-sharing service. To take advantage of the program, customers who have enrolled in the American Express rewards program and registered an eligible card with Uber just need to download the latest version of Uber's app and tap the "enroll me" button. After that, they will see options in the Uber app to either "Earn 2x Points" or "Use Points."' (Fiegerman, 2014). "The ride-hailing app announced that it is teaming with the bank to offer discounts to Uber riders who pay with a Capital One Quicksilver card. Starting Tuesday, Quicksilver cardholders will get 20% of the value of each Uber transaction back as statement credit through April of next year -- effectively a 20% discount off all rides. Any cardholder who uses Uber for the first time will also get up to $30 on each of their first two rides, as long as those rides are within the United States." (Kulp, 2015). 'Uber today expanded its partnership with Alipay, a Chinese payment app owned by Alibaba that boasts 450 million active users. The partnership will allow Chinese travelers to pay their Uber fares using Alipay in any of the 68 countries where Uber does business, and allow riders to hail Uber cars directly from the Alipay app. Uber China's collaboration with Alipay has grown steadily over the past few years, with plans for this global expansion first announced in January.' (Conger, 2016). 'There are other economies of scale that come with being the market leader. When you consider that Uber is partnering with smartphone vendors, credit card companies, car manufacturing companies, leasing companies, and insurance companies, you can imagine that being larger is a distinct advantage. As an example, on May 28th Uber announced a partnership with AT&T to embed Uber on all its Android phones. Then on June 9th, they announced a partnership where American Express users will get 2X loyalty points on all Uber rides. Additionally, Membership Rewards users can use those points to pay for rides directly in the application. It is also easy to imagine a future where Uber drivers receive discounts on things like leases, gasoline and car repair. Scale clearly matters for these types of opportunities.' (Gurley, 2014). 'Since working together on bringing Uber to Foursquare's users, the two companies are finding other ways to work together. In May, Foursquare announced that Uber would start using Foursquare's database of Points of Interest to improve the accuracy and ease of pickups and drop-offs in the Uber app.' (Uber Developers, 2016). 'For the past six months, we've been delighted to work with our partner Baidu to give riders across China access to Uber through an integration of Baidu Maps and Uber's API. Beginning today, we're making that same functionality available to developers across China so that they too can connect their users to safe, reliable, and affordable rides from within their apps.' (Uber Developers, 2015b). 'Ordering a ride has never been easier. We're excited to announce that iPhone users will soon be able to use Siri, Apple's voice-activated personal assistant, to request a ride and receive real-time updates. You can also book a car right within the Maps app. When you request a ride through Siri, you'll see the fare and driver information and be able to quickly

	confirm your request. When you look up a destination in Maps, you'll have the option to book an Uber to get there.' (Sarah, 2016). 'Uber has partnered with Chinese online payment platform Alipay and its Indian equivalent Paytm to enable Uber users from both countries to seamlessly hail and pay for a cab ride in all the cities where Uber operates. While Uber's global integration with Alipay started from today, it will soon be introduced for Paytm as well. With the new integration, Alipay's 450 million users can also pay for their rides in their own currency using the app.' (Joshi, 2016). 'It's a new year and you've got new places to be. When you're on the go and looking at transportation options in Google Maps, you can now request an Uber ride directly from the Google Maps app. It's already been easy to compare wait times and the pricing of available Uber options, including POOL, uberX, and uberXL, in Google Maps. With the latest integration update powered by Uber's API, you can now request a ride, see your driver en route, contact your driver, and follow your trip status — all without having to switch over to the Uber app. Plus, you can pay with your options on file with either Uber or Google. To get started, all you have to do is open the ride services tab on Google Maps and tap on "REQUEST" to take a ride. For a limited time, all new riders in the U.S. will receive $15 off their first ride.' (Rahematpura, 2017). 'The best part about the integration is that it only took a few lines of code! Now Foursquare users can get to their favorite venue by choosing from a range of products including everything from uberX to UberSUV'. (Uber Developers, 2015a). 'Uber has something in common with credit card companies: both businesses face a lot of competition from nearly identical services when it comes to attracting and keeping customers using them. In a bid to kill two birds with one stone, Uber is launching a new feature called Payment Rewards. The transportation giant will team up with specific credit card companies — starting first with Capital One and its Quicksilver brand — to pay for rides, and if you pay for enough of them — nine, to be exact — you get one ride worth up to $15 free. Uber says the service will be live for U.S. cardholders first. It will also include more payments companies over time … The Payment Rewards service is interesting in that it opens the door a little wider to how Uber ties itself in with card companies. And, depending on how many card partners Uber decides to sign up, this could also potentially be a useful sales channel for those card companies.' (Lunden, 2016). 'When you Uber, chances are you don't think about your payment method very often. After all, you can hop in and hop out without ever having to pull out your wallet. But sometimes how you pay for your Uber rides can make a difference — and today that's certainly the case. We're excited to announce that we've partnered with Capital One to bring a new, rewarding experience to riders. Now, every 10th ride is free (up to $15) when you pay with a Capital One Quicksilver or QuicksilverOne card through March 2017… We're always looking for ways to make riding with Uber even more rewarding.' (Quinn, 2016). 'Uber is already an integral part of many people's commutes, but now the ride-hailing giant wants to buy loyalty from its users via purchases made during the rest of the day. It has partnered with Visa on a new program called Uber Local Offers, the companies announced Tuesday. Uber riders who have a Visa credit card registered in the app will be able to earn points at hundreds of participating merchants. For every dollar spent, Uber riders earn one point, where 100 points translates to $10 off a ride … The program is Uber's latest effort to incentivize riders to take Uber, amid the constantly growing number of ride-hailing competitors, and keep the experience at top of mind even when you are not in a car.' (Flynn, 2016). 'Uber is getting into pre-tax money. Customers can now use their commuter dollars (which aren't subject to taxes) to pay for certain Uber rides. Uber announced the policy in an email to New York users Tuesday morning. The move into commuter benefits is through a partnership with WageWorks, a popular national employee benefits platform. It's a small but important step as Uber looks to make itself more than a ride-hailing service by

	engraining itself in everyday life. The company has been slowly introducing various new features to attract commuters.' (Hinchliffe, 2016a). 'In an effort to catch up, earlier this week Android Pay announced it's partnering with Chase Bank as well as Uber, which is offering 50 percent off 10 rides for customers who check out with Android Pay.' (Glaser, 2016). 'Today we're sharing some great news. We've agreed an exclusive loyalty programme with the UK's leading payments business, Barclaycard, to bring you rewards for your rides … 'We're constantly looking for new ways to give our 10 million customers additional value on their everyday spend and make their lives easier with new innovation. Working with Uber will see us offer great value to Barclaycard holders, and builds on our heritage of innovation in the transport space as we work together to drive forward exciting new ways of rewarding customer loyalty.' Brian Cole, CEO of Barclaycard.' (Karen, 2017).
Relational Investment	'Microsoft's investment in Uber follows a high-profile deal in June in which Uber acquired Microsoft's Bing Maps technology. Additionally, Uber's new investment tie-up with the largest software company on the planet greatly expands the possibilities for Uber to leverage its service on Microsoft's platform in the future, as well as tap into Microsoft's technology research and enterprise expertise'. (Strange, 2015). 'Uber has its own power relationship in China, courtesy of search giant Baidu which made a strategic investment in the U.S. firm in early 2015.One of the fruits of that coming-together is that Uber is the taxi-app of choice in Baidu Maps, China's largest consumer maps app, while Uber enjoys prime positioning within other Baidu services, which include China's top search engine'. (Russell, 2015a). 'This is arguably the most interesting part of the update [integrating Uber into Google Maps], since it represents Google essentially blessing one tech-focused transportation startup over all others. Uber is also a Google Ventures portfolio company, so it begs the question of whether or not this is some kind of sweetheart deal, though Google always maintains its venture arm operates independently from the rest of the organization.' (Etherington, 2014). 'One of PayPal's biggest businesses is Braintree, a white label mobile payments solution that powers transactions on everything from Uber to Airbnb. When a customer takes an Uber, PayPal makes money by taking a cut of the transaction. Braintree has developed a substantial client list and has become a force in the mobile payments space.' (Roof, 2016). 'Google brought Uber into its mobile family Tuesday with an update to its iOS and Android Maps applications, integrating the transportation and ride-sharing app as one of its various travel options. If you have Uber installed and are in a city with Uber service, it will show up alongside walking, driving, and public transportation options to let users see estimated travel times using the car service. The update will also allow you to jump directly into Uber with one tap on the icon within Maps. This comes as no surprise. After all, Google has had a longstanding relationship with Uber, an app at the forefront of the on-demand and sharing economy movements that has turned urban travel and various metropolitan taxi industries on their heads. In 2013, Google's investment arm, Google Ventures, sunk $258 million into Uber's last mammoth funding round of $361.2 million.' (Statt, 2014). 'Uber chose to partner with Braintree, one of the leaders in the mobile payment market, to accept card payments. Just for the record, we should mention another great payment system ... Uber also uses PayPal's Card.io service for credit card scanning on iOS. Card.io allows you to input credit card information by simply holding up your credit card in front of your phone's camera.' (Abrosimova, 2014). 'You can already pay for Uber trips using your PayPal balance, so it shouldn't come as a surprise that Uber is now adding the same option for Venmo, which is owned by PayPal. Both Uber and Uber Eats customers will be able to cover their rides (or food deliveries)

	through Venmo. Like PayPal, everything is handled directly in the Uber app — unless you want to split a trip with friends, in which case you'll have to hop out to the Venmo app.' (Welch, 2018). 'The deepening of the Uber partnership is particularly interesting – it will admittedly help anyone who uses the transport service to get around, but it also means Google is getting even cosier with a company that is also a portfolio member in its investment arm, Google Ventures. Building Uber time and price right into the Maps app gives it a considerable advantage over other means of private transit, including standard taxi services. We'll keep you updated on Google's progress as it continues to put material design on everything within its considerable realm of software and apps – and of course we'll be watching the Uber connection closely, as the next stage would presumably be offering Uber booking direct, without requiring a user to even leave the app.' (Etherington, 2014b). 'Braintree powers the payment transactions for Uber, Airbnb, Pinterest and more. This means that every time someone takes an Uber, PayPal makes money.' (Roof, 2016a). 'That round could be closed as soon as next week, the person familiar with the situation said. Not all of Uber's deals have gone smoothly. Google invested more than $250 million in 2013 and has helped Uber add new users by promoting ride-sharing in Google's popular mobile maps.' (MacMillan and Demos, 2015).

Table 6-7: Additional selected quotes demonstrating the second-order themes of the aggregate dimension of supermodular complementarity.

6.6 Chapter summary

This chapter provided the findings resulting from the open coding, axial coding and selective coding analysis conducted on the data gathered to conduct this research. The findings indicated that there are three new factors affecting the boundary decisions of MSDPs that are not considered by the efficiency and competence perspectives: complement localisation, customer heterogeneity realisation and supermodular complementarity ignition. As a result of these factors, different decisions regarding building complements in-house or relying on third-party complementor were observed. The section presented evidence from the data and provided a table of additional supporting evidence at the end of each subsection.

7 DISCUSSION

7.1 Chapter introduction

This chapter provides an in-depth interpretation of the results detailed in the case description chapter (Chapter 4) and the findings chapter (Chapter 6). Section 7.2 broadly answers the research questions motivating this thesis and then delves into the three factors, *complement localisation, customer heterogeneity realisation* and *supermodular complementarity ignition*, that influence the boundaries of MSDP firms and have not been adequately investigated in the literature. Following the introduction of these three factors, Sections 7.3, 7.4 and 7.5 examine in detail each of the three factors and provide a set of propositions derived from the data analysis that may open new avenues for future research. Across these three sections, the findings are critically examined, as well as compared and contrasted with findings from the existing literature. Finally, Section 7.7 provides a summary of the chapter.

7.2 The three customer-side factors affecting the boundary of MSDP firms

The aim of this research was to understand the factors that influence the shifts in the boundaries of MSDPs as they configure their complements and how the MSDP firm responds to these factors. The existing literature on complement configuration recommends that when the transaction costs of accessing a complement on the market are high, and the complement is a core competency for the firm, the firm should internalise the competency, both to reduce coordination problems resulting from the high transaction costs and to create a source of competitive advantage. However, in some situations, research does recommend that firms rely on third-party complementors that have superior competencies and are better equipped to deliver the complement, even if this results in higher transaction costs (Barney, 1999). Relying on a third-party complementor may be the best choice if the firm does not have the resources to build the competency in-house, if the cost of building the competency is too high or if relying on a third-party complementor allows more resources to be allocated to improve the core competencies the firm possesses in order to maximize revenue and achieve competitive advantage (Barney, 1999; Jacobides, 2005; Santos and Eisenhardt, 2005). The tables of chronologically listed events related to Uber's payment and map complements resulting from the first round of coding, introduced in Chapter 4, show Uber's decisions in various situations. In a minority of these situations, Uber was urged to build a complement in-house because

it was a core competency and the cost of transacting for it on the market was high. Specifically, Uber made some attempts to bring the maps and payment complements in-house in order to avoid coordination problems and because they were considered core to Uber's MSDP. For example, the data show Uber making several attempts to build its own maps solution: poaching engineers from Google, acquiring mapping firms and solutions (e.g. deCarta and Microsoft Bing) and rolling out imagery collection cars in different cities around the world. Because maps solutions are core to Uber's current and future business operations, these actions were generally assumed to be efforts by Uber to reduce its reliance on Google Maps and prepare for the introduction of autonomous vehicles. For similar reasons, Uber also attempted to bring some payment complements in-house, developing its own cash payment system and introducing its own digital wallet. The tables of chronologically listed events likewise show numerous situations in which Uber chose to rely on third-party complementors (i.e. Braintree, Alipay, Paytm, Apple Pay and Paga) to provide the payment and maps complements, representing a majority of the situations in the tables. The descriptive tables paint a picture of Uber's boundary decisions that resemble the theoretical recommendations in the literature: Uber tried to build the competencies for providing payment and maps services in-house, but it mostly relied on third-party complementors that had better capabilities and resources and thus were equipped to provide better payment and maps complements.

However, the findings in Chapter 6 indicate that supply-side factors (i.e. efficiency and competence) were not the only determinants of the boundaries of Uber's MSDP. Demand-side factors also played a role. The findings in Chapter 6 offer a novel explanation for the outward shift of the firm boundary towards the market that goes beyond efficiency and competence factors. Specifically, *complement localisation, customer heterogeneity realisation* and *supermodular complementarity ignition* influenced Uber to shift its boundaries towards the market with the aim of generating more value for users. These three factors are demand side oriented, putting the customer at the heart of the firm's boundary decision process. Complement localisation reflects the platform's efforts to adapt to local market conditions and contextual factors whilst meeting its business needs, putting local customers at the heart of the boundary decision-making process. Similarly, customer heterogeneity realisation orients firm boundary decisions towards customers by prioritising the recognition and fulfilment of their heterogeneous needs and the provision of a consistent level of experience to these customers, ensuring that all customer segments receive high-quality service no matter their preferences. Finally, supermodular complementarity ignition also puts the customer at the heart of the firm boundary decision by prioritising user habits, such as the other platforms and services they use. The findings indicate that whilst the efficiency and competence perspectives influenced Uber's boundary decisions, these demand-side perspectives were equally, if not more, important.

Whilst the existing literature on firm boundaries emphasises supply-side influences on boundary decisions, represented by the efficiency and competence perspectives, and seeks to maximise the value captured by the firm (Cuervo-Cazurra, Mudambi and Pedersen, 2018), this thesis offers a complementary perspective; it introduces a demand-side perspective that puts the customer at the heart of the MSDP boundary decision-making process and shifts the focus of the boundary decision from value capture by the MSDP to value creation for customers. In this sense, the thesis builds on the work of Priem, Wenzel and Kosh (2017, p. 3) that 'value is not simply 'out there' waiting to be captured'; it first needs to be created by the firm.

Whilst this new perspective represents a marked departure from existing theories of firm boundaries, it responds to Santos and Eisenhardt's (2005) call for a new theoretical understanding of firm boundaries that goes beyond efficiency explanations and examines nonefficiency concepts that are more strategy oriented. It is also in line with recent trends in various streams of literature, focusing on the customer and on value creation as important factors motivating the strategic decisions of firms and how they create value and achieve competitive advantage. In particular, the new perspective in this thesis is in line with calls and efforts to integrate a demand-side perspective in the management literature (Adner and Zemsky, 2006; Levitas, 2013; Priem, 2007; Priem, Li and Carr, 2012), business model literature (Priem, Wenzel and Kosh, 2017; Zhu, Zhang and Lin, 2017), entrepreneurship literature (Rietveld, 2018) and internationalisation literature (Jones and Pitelis, 2015; Pitelis and Teece, 2018). To date, these streams of literature have been dominated by supply-side theoretical perspectives, such as TCE, RBV and the dynamic capabilities view, but have started to incorporate demand-side perspectives, either to address the limitations of supply-side perspectives or to provide complementary theoretical understanding. Surprisingly, though, the literature on firm boundaries has lagged behind other disciplines in incorporating a demand-side perspective, despite the many limitations of supply-side perspectives in explaining firm boundary decisions, especially in the digital world. Even though the literature on ecosystems and MSDPs recognises the importance of customers in co-creating value (Amit and Han, 2017), a demand-side perspective has not been taken to examine the boundary decisions of MSDP firms. The major contribution of this thesis to the literature is to offer such a demand-side perspective in order to advance the understanding of the boundary decisions of MSDPs and hence the business model design. The three factors identified in the data analysis illuminate the importance of demand-side factors in decisions about building in-house versus relying on third-party complementors, and thus in determining whether MSDP boundaries shift inwards or outwards towards the market.

The following three sections provide detailed interpretations of the three demand-side factors by pointing out the similarities and differences between the findings and the existing literature and by providing propositions derived from the data analysis.

7.3 Complement localisation

The findings indicate that whilst Uber is a global MSDP, it is a local business. Uber's layered modular architecture enabled the platform to configure the maps and payment complements in order to suit local markets' macro conditions as it expanded, whilst satisfying its business needs. It was important for Uber to adapt to the markets it expanded into in order to establish its presence and be able to compete against local competitors, which were often better suited to the local environment. The literature shows that firms that are unable to adapt to local market conditions are more likely to be outcompeted and fail when they internationalise their businesses. Uber wanted to make sure that when it entered a new market, it was not hindered by local macro conditions in the market or by local regulations, so it adapted, as shown in the data analysis. The analysis shows Uber extending its MSDP boundaries outward by relying on third-party complementors that could help the firm adapt to the local characteristics of the market and overcome regulatory problems. As a result of these efforts to adapt, Uber was able to compete against local competitors and dominate in some markets.

The maps and payment components of Uber's MSDP are essential to its value creation and delivery process. Failure to provide an adequate map solution that enables riders and drivers to locate pickup locations and that helps drivers navigate to the drop-off location would have significantly reduced the quality and value of Uber's MSDP and thus affected customer adoption. Similarly, failing to provide an adequate payment mechanism that makes it simple for the rider to pay for his/her ride and for the driver to receive his/her sum would have also affected Uber's competitive position in the markets it was expanding to. Local market conditions, such as low credit card penetration, an informal address system or strict government regulations (e.g. requiring two-factor authentication payment systems or restrictions on the use of GPS and location data), induced Uber to shift its boundary outward and rely on local complementors. By relying on these local complementors, Uber ensured that it could continue to create and deliver value for its customers in each of the different markets in which it operated. However, relying on third-party complementors arguably increased Uber's transaction costs, as indicated in Chapter 4. In addition, such reliance increases the likelihood of coordination problems related to rising transaction costs and the transfer of core competencies outside the firm. Theories of firm boundaries based on RBV and TCE recommend bringing a

complement in-house when it is a core asset and the cost of transacting in the market is high (Santos and Eisenhardt, 2005; Barney, 1991; Williamson, 1985). However, the findings presented in Section 6.3 in Chapter 6 imply that, faced with a need to adapt to diverse macro market conditions, an MSDP firm might give more weight to the value it can create by relying on third-party complementors than to the efficiency-related savings or competence building offered by in-house development. Based on this discussion, this thesis suggests the following proposition:

P1: The more diverse the local characteristics and regulations in the markets an MSDP firm expands to, the more likely it is to shift its boundaries outward and rely on third-party complementors, even when this entails higher transaction costs than in-house development.

Whilst complement localisation generally incentivised Uber to rely on third-party complements, there is an exception visible in the data analysis. On some occasions, Uber was not able to customise these complements in order to fit its business needs and thus provide value to customers. The examples of the in-house development of a navigation system for drivers and a cash payment system demonstrate this point. The development of a navigation system was motivated by Uber's idiosyncratic business needs. Existing navigation systems provided by third-party complementors were not customisable, did not include some features required by various Uber services and often included information that was not needed by Uber users. These drawbacks limited the value Uber was able to provide its customers and sometimes even negatively affected the value generated for customers. For example, some existing navigation complements contained unnecessary information, such as ocean topography, that did not benefit drivers. This extraneous information could even be a hindrance, for example, to drivers with limited mobile data plans, who had to download large amounts of unneeded data. In addition, these systems were not customised for multi-stop trips with dynamic pickup and drop-off locations, negatively affecting the value delivered to users. In order to meet its business needs, Uber had to build its own navigation system in-house.

Uber's decision to develop its own cash payment system in-house provides another example of business needs justifying the development of a complement in-house. Existing third-party payment complements were not designed to collect cash payments, so Uber had to take a variety of steps and develop innovative solutions to make paying with cash as seamless as using cashless payment methods. As existing third-party complements did not meet Uber's business needs, and since Uber had to accept cash payments to adapt to local conditions in markets where credit card penetration was low, Uber chose to build a cash payment system in-house. The decisions to develop the

navigation and payment systems in-house align with the efficiency perspective and TCE (Santos and Eisenhardt, 2005; Williamson, 1985), which recommend the integration of assets that are core and would incur high transaction costs to access through the market. However, the findings suggest that there is an additional justification for the in-house development of these systems beyond efficiency considerations. The findings further suggest that building in-house can be the optimal choice when existing complements in the market cannot be customised to fit the needs of the MSDP firm. In other words, even when a complement can be purchased from the market at a transaction cost that is lower than the cost of in-house development, if the complement is not sufficiently customisable, it may negatively affect the value created for customers, as indicated in subsection 6.3.2 in Chapter 6, thus reducing the firm's ability to capture value. Based on the above discussion, the following is proposed:

P2: An MSDP firm is more likely to shift its boundaries inward and build complements in-house as the amount of customisation required to adapt third-party complements to the MSDP's business needs increases, even when building in-house may involve higher transaction costs than transacting in the market.

7.4 Customer heterogeneity realisation

The data analysis indicated that Uber's customers have heterogeneous needs. The proponents of demand-side perspectives attribute the heterogeneity of customer demand to the heterogeneity of the markets that the firm serves (Adner, 2002; Priem, 2007). However, this thesis makes a sharper distinction between the two. Whilst complement localisation considers market-wide factors arising from serving different (heterogeneous) markets, customer heterogeneity realisation investigates customer-specific needs and preferences. The data analysis indicated that boundary decisions regarding complements were influenced by customer preference adaptation and the desire to provide a seamless customer experience.

In this thesis, customer preference adaptation refers to the firm's efforts to configure its complements in order to address varying customer needs and preferences, in recognition of customers' non-homogenous needs (Cennamo and Santalo, 2019). Addressing the needs of customers is important to create value and ultimately capture it (Priem, Li and Carr, 2012). The findings indicated that Uber had to adapt to two kinds of customer preferences: preference for a

specific complementor and preference for a specific solution. As indicated in the findings, some Uber customers had a preference for one complementor over another, as when Chinese users preferred Alipay over PayPal or when some drivers preferred Uber's navigation system over Waze and Google Maps (and vice versa). This finding parallels extensive research that shows customers may have varying preferences for complementors and may prefer some over others (Binken and Stremerch, 2009; Cennamo, 2018; Corts and Lederman, 2009; Panico and Cennamo, 2015). Uber addressed these preferences by choosing to rely on the third-party complementors that were preferred by Uber customers. Rather than the efficiency and competence factors predicted by TCE and RBV (Santos and Eisenhardt, 2005; Barney, 1991; Williamson, 1985), the most important factors influencing Uber's boundary decisions were customer preferences for specific complementors.

Uber also had to address customer preferences for a specific solution. The findings demonstrated that Uber customers varied in their preferred way of using the service. For example, some users preferred transacting using cash, whereas others preferred cashless payment methods. Even within the segment of customers who preferred cashless payment, some users preferred to use credit cards, whereas others preferred to use debit cards. Similarly, some drivers preferred using the integrated navigation system within Uber's app, whereas others did not mind switching to third-party navigation systems. In both cases, Uber had its own perceptions of what was best for users. For example, Uber always considered cashless payment the distinctive feature of its MSDP, giving it a competitive edge over traditional taxi companies and the associated problems arising from cash payment, such as haggling between riders and drivers. Similarly, Uber considered its integrated navigation system better for drivers to use during service delivery, as it is more customised to the various services offered by Uber. However, the findings indicated that Uber made the radical decision to cater to some users' preference for cash payment, despite the fact that accepting cash payments was in direct opposition to its original value proposition based on a frictionless, cashless payment experience. Similarly, despite developing its own navigation system, Uber still enabled drivers to use third-party navigation systems. Such findings, which were detailed in subsection 6.4.1 in Chapter 6, support the conceptualisation of the demand-side strategy by Siqueira, Priem and Parente (2015), who indicated that prior to the acquisition of a resource, a firm should identify explicit and latent customer needs. To address the preferences of customers, whether for a specific complementor or a specific solution, Uber primarily relied on third-party complementors[36]. Based on this discussion, this thesis proposes the following:

[36] The findings showed two exceptions: the development of a cash payment system and the development of Uber's navigation system. It is argued that these exceptions exist because these systems were developed in response to Uber's inability to sufficiently customise third-party complements to meet its needs, as indicated in Proposition 2.

P3: The more heterogeneous customer preferences are, the more likely an MSDP firm is to shift its boundaries outward and rely on third-party complementors, even when this entails higher transaction costs than in-house development.

The second influence on MSDP boundary decisions identified in the findings is the need to provide a seamless customer experience that caters to all customer preferences. Existing research has shown that a seamless customer experience yields positive outcomes, such as increased customer satisfaction and loyalty, and generates greater customer lifetime value (Nash, Armstrong and Robertson, 2013). In order to provide a seamless customer experience, Uber worked to provide more options to its customers and to increase customer trust in using the MSDP.

The findings indicate that customers have heterogeneous needs, often explicitly expressed. Whilst Uber addressed these needs, it also went beyond that, offering a wider variety of complements in order to address their latent needs, as recommended by Siqueira, Priem and Parente (2015). For example, when customers required alternative payment methods to credit cards, Uber provided multiple payment options of the same and different kinds by relying on third-party complementors. For example, Uber added multiple payment options of the same kind, such as PayPal, Alipay, Paytm and MoMo payment, which are all variations of digital wallets. Uber also provided payment options of different kinds, such as digital wallets, operating system-specific payment methods (i.e. Apple Pay and Android Pay), payment rails (i.e. Venmo) and mobile payment options (i.e. Paga). Similarly, Uber offered drivers a variety of map solutions: drivers could choose from alternative navigation systems (i.e. Google Maps and Waze) and opt to enter pickup/drop-off addresses manually or by point of interest using Foursquare's database. Increasing the options for users meant adding more complements (payment and maps) to increase the probability that the customer would adopt the MSDP by satisfying his/her needs, which will ultimately lead the customer to have a seamless experience. This finding builds on observations in the existing literature showing that the layered modular architecture of MSDPs enables generativity (Yoo, Henfridsson and Lyytinen, 2010) and that more generativity and a wider variety of complements generate more value for users (Cennamo and Santalo, 2019). The findings also support the arguments of Cennamo and Santalo (2019) that increasing the complement options for customers increases value of use and value in use. Increasing the value of use attracts more users to the MSDP, as the probability of addressing the needs and preferences of a new customer increases (because of the increased number of options). For example, when Uber introduced cash payments in East Asia, the platform witnessed a significant

increase in the number of users. Value in use relates to the variation of utility that a customer receives from using the different complementors on the MSDP; Uber drivers' preference for different navigation systems is an example, as each different navigation system provides them with a different utility. These findings contribute to the demand-side perspective by identifying how the firm uses the boundary decision to maximise customer use value (Priem, 2007), which ultimately increases customer willingness to pay for the service and can thus 'increase the size of the pie' (Gulati and Wang, 2003) that the firm can capture value from.

Whilst increasing generativity and the variety of complements is generally deemed to increase the value generated by the MSDP, the literature indicates that the uncontrolled growth of these elements can lead to negative consequences. Low-quality complements affect the customer experience and the reputation of the MSDP, reducing the overall value of the MSDP (Boudreau, 2012; Cennamo and Santalo, 2019; Tiwana, 2015). The findings suggest that the MSDP can mitigate these negative effects by being selective about which third-party complements will be integrated within the MSDP. Uber's selection of complementors for the payment and map complements of its MSDP reflects this strategy. These findings contribute novel evidence to the literature, indicating that a firm can still induce generative outcomes by shifting its boundaries outward whilst maintaining very tight control over the complementors that may integrate with the MSDP. This was demonstrated on several occasions, such as when Uber's complementors Google, Paytm and Baidu integrated Uber within their apps, giving customers a new way to book Uber rides, and when drivers indicated that they switch between navigation systems to solve problems, such as traffic congestion (a behaviour that was not anticipated or designed by Uber).

Increasing options for customers is one way to provide a seamless customer experience. The findings suggest that increasing customer trust in the service is another important factor in providing a seamless customer experience and improving adoption and retention. Research has shown that trust is an essential element of commercial interactions, and its significance in e-commerce settings is more prominent than in traditional settings (Gefen and Straub, 2004). Transacting in e-commerce settings usually involves uncertainty and risk, thus increasing the complexity of the transaction. Increasing trust is an effective mechanism to reduce such complexities (Luhmann, 1979; Mittendorf, 2017). The findings presented in subsection 6.4.2 in Chapter 6 suggest that trust plays a role in the boundary decisions of MSDP firms. The findings indicate that Uber repeatedly chose to shift its boundaries outward[37] and rely on third-party payment complementors that customers already

[37] There is one notable exception: when users in East Asia did not trust the platform enough to use their credit cards for e-commerce, Uber instead shifted the boundary of the MSDP inward by developing an in-house cash payment system. However, this system was initially developed because Uber could not customise third-party complements to meet its needs, as indicated in Proposition 2.

trusted in order to enhance customer trust in their own platform, despite the fact that the payment component is core and even though relying on third-party complementors exposed Uber to high transaction costs. As mentioned previously in the chapter, RBV (Barney, 1991) and TCE (Williamson, 1985) dictate that Uber should have brought the development of the map and payment components in-house to avoid paying the high transaction costs of the market. In reality, Uber chose to rely on third-party complementors that customers trusted in order to increase adoption and retention rates. For example, subsection 6.4.2 in Chapter 6 shows that Uber integrated the Paga payment system in Nigeria and the Momo digital wallet in Vietnam because users felt using their credit cards through Uber's system was risky. Increasing trust in the platform can increase use, as confirmed by Mittendorf (2017) in a study that found a positive correlation between trust and customer intention to request an Uber ride. Based on the aforementioned discussion, this thesis proposes the following:

P4: The greater the customers' perceived risk in using an MSDP, the more likely the MSDP firm is to shift its boundaries outward and rely on third-party complementors that customers trust, even when this entails higher transaction costs than in-house development.

7.5 Supermodular complementarity ignition

The findings indicate that igniting supermodular complementarity was an influential factor in the boundary decisions of the MSDP. Whilst supermodular complementarity, also known as Edgeworth complementarity[38] (Milgrom and Roberts, 1990; Topkis, 1978; 1988), is a well-established concept in economics, it has only recently been adapted to generate theories in the context of MSDPs and business ecosystems (Baldwin, 2018; Jacobides, Cennamo and Gawer, 2018; Teece, 2018). This research is ongoing, and no effort has yet been made to consider supermodular complementarity as a factor in the boundary decisions of firms, in general, and of MSDPs, in particular. This thesis fills such a gap and adds to the literature by describing the impact of supermodular complementarity as a demand-side factor on the boundary decisions of an MSDP. In particular, the thesis extends TCE by suggesting that supermodular complementarity is another form of complementarity that should be considered alongside strong complementarity (e.g. asset specificity) when analysing the boundary decisions of MSDP firms. Generally, the findings suggest that the MSDP firm is more likely to rely on third-party complementors if doing so will boost its customer base or attract investment from the

[38] Direct and indirect network effects are forms of supermodular complementarity (Jacobides, Cennamo and Gawer, 2018).

complementors (which can then be used to fund customer acquisition and ultimately increase the value generated by the MSDP). The findings indicate that the MSDP may choose to rely on third-party complementors even when it is less cost efficient and the complement resembles a core competency that the firm must also develop in-house. These findings contribute important insights to the literature, as they show that the goal of user base growth has an impact on the boundary decisions of the MSDP, which may even outweigh supply-side considerations, such as the efficiency and competence perspectives (Santos and Eisenhardt, 2005; Williamson, 1985).

The findings regarding user base growth suggest that Uber strove to increase its potential customer base by relying on third-party complementors with large user networks. The literature on MSDPs identifies user numbers as an essential element in securing a competitive advantage; in some cases, the MSDP with the highest number of users dominates a single market in a *winner-take-all* outcome (Eisenmann et al., 2006). The findings indicate that, as described in the literature, Uber believed that the MSDP with the highest number of users in a single market would have a competitive advantage, and so Uber endeavoured to increase its number of customers. One strategy for increasing its potential user base was to integrate third-party complements with their own large networks of users. This was demonstrated by many examples in the findings chapter, such as the integration of PayPal to gain access to its large international user base and the decision to accept American Express as a payment method. Shifting its boundaries outward to rely on third-party complementors enabled Uber to ignite supermodular complementarity, in which the value of an asset or activity increases as usage of a complementary asset or activity increases, and vice versa. As Uber integrated third-party complementors in its MSDP, it gained potential access to all the users of these complementors. If these users became Uber users, value was generated on Uber's platform, and more value could ultimately be captured, as indicated in the demand-side strategy literature (Priem, 2007; Rietveld, 2018). The complementors also benefit from being integrated into Uber because the use of their own services increases, and, thus, they can capture more value. The findings likewise indicate that Uber sought not only to gain access to new potential customers but also to ignite supermodular complementarity, encouraging complementors' users to become Uber customers by providing perks and promotions in collaboration with the complementors. This ultimately increases the use of both Uber's platform and the complementor's service, generating more value for all parties and increasing *the size of the pie* from which value can be captured. The findings chapter provided several examples of this behaviour, such as offering ride discounts for using PayPal or offering loyalty rewards to customers who use American Express to pay for their Uber rides.

Uber also sought to increase user numbers, and ultimately its MSDP's value, by integrating Uber into complementors' apps and platforms. The findings chapter includes several examples of Uber being integrated into a complementor's app or MSDP, increasing Uber's exposure and potential to attract new users. For example, Uber was integrated into the Paytm and Alipay digital wallets, as well as into Google and Baidu Maps. Integrating Uber directly into these platforms made all their users potential Uber users.

The previous discussion demonstrates the influence of supermodular complementarity as a demand-side factor affecting the boundary decisions of the firm. The findings suggest that increasing the number of customers was important to secure a competitive advantage and motivated the MSDP to rely on third-party complementors with large user networks. By attracting more users, the firm created more value and increased its potential value capture. Based on the aforementioned discussion, this thesis proposes the following:

P5: The greater the supermodular complementarity effect (i.e. reciprocal user base increases) of relying on a complementor, the more likely the MSDP firm is to shift its boundaries outward and rely on third-party complementors.

The findings also show that in addition to increasing its user base, the MSDP's boundary decisions were influenced by the prospect of relational investment: Uber shifted its boundaries outward in exchange for investment from third-party complementors, which it used to attract more customers. The findings indicate that on many occasions, Uber's reliance on a third-party complementor was associated with receiving investment from that complementor. For example, Google and Baidu were both investors in Uber and complementors at the same time. The findings also show that reliance on a third-party complementor was often associated with an existing relationship with that complementor, exemplified by Uber's integration of PayPal and its subsidiary services. Both examples demonstrate supermodular complementarity: the more Uber used a complementor, the more likely the complementor was to invest in the MSDP, either financially or in the form of commitment. These findings provide an interesting addition to the existing literature on this topic, which is largely focused on strategic sponsorship by MSDP owners, in which they invest in third-party complementors to attract participation from third-party complementors, ultimately increasing value creation and capture opportunities for the MSDP (Boudreau, 2017; Katz and Shapiro, 1986; Shapiro and Varian, 1998). These findings illustrate the inverse situation, in which the complementor becomes a stakeholder in the MSDP. Investing in the MSDP may align the interests of the

complementor more closely with those of the MSDP owner, as well as incentivise the overall success of the MSDP for both, even though MSDPs can sometimes become competitors of their complementors. This finding raises questions about the long-term impact of the complementor becoming a stakeholder of the MSDP and how the arrangement might affect MSDP boundary decisions. Building on the discussion in this section, this thesis proposes the following:

P6: An MSDP firm is more likely to shift its boundaries outward by relying on a third-party complementor if the third-party complementor becomes a stakeholder in the MSDP.

The findings discussed in this section demonstrate how supermodular complementarity helped Uber attract new users and investment from third-party complementors. The findings also show that Uber shifted its boundaries outward and relied on third-party complementors in pursuit of these goals. The identification of supermodular complementarity as a demand-side factor influencing the boundary decision of the firm offers an important contribution to the literature. Existing supply-side perspectives view asset specificity as an important transaction factor that determines the boundaries of the firm. Baldwin (2018) refers to asset specificity as the strong complementarity between two assets. This thesis shows that MSDPs making boundary decisions should also consider supermodular complementarity. This finding is particularly significant because supermodular complementarity, which takes forms including direct and indirect network effects (Jacobides, Cennamo and Gawer, 2018), is an integral part of the definition and composition of MSDPs.

7.6 Alternative perspectives

Although all factors identified as a result of the data analysis are considered demand side oriented, the first round of data analysis was conducted using open coding, without the use of prior coding templates generated from the literature review. This means that the factors identified might not necessarily be demand side oriented. In the literature on MSDPs, several studies have examined the interaction between the MSDP owner and its complementors as a potential determinant of the boundary of the firm (Zhu and Liu, 2018). The literature is primarily oriented towards defining the ideal scope of the firm, i.e. whether an MSDP should enter the market of a complementor via a process known as envelopment (Eisenmann, Parker and Van Alstyne, 2011). Despite the relevance of the complementor–MSDP relationship, such an outcome did not appear in the data. For example, the data did not show any sign of conflict when Uber developed its own cash payment system or

digital wallet. Such actions were not described as invading the space of complementors, such as PayPal, Paytm, Alipay and MoMo. Similarly, developing the Uber navigation system did not trigger any negative response from maps complementors, such as Google and Baidu. None of the examples revealed that the complementors perceived Uber as a competitor to their payment or maps systems. The literature suggests that entering the business of a complementor usually results in direct competition and creates tension between the MSDP and its complementor, and in some cases, the complementor ends up exiting the market (Zhu and Liu, 2018). However, the data in this case did not reveal any of such outcomes. There are two likely reasons for this. First, the classification of MSDPs might affect the likelihood of such outcomes. Recently, scholars, including Teece and Linden (2017) and Cusumano, Gawer and Yoffie (2019), have begun to classify MSDPs as transaction, innovation or hybrid platforms. Uber is primarily seen as a transaction platform (although it could also be argued that it is a hybrid platform, as Uber is innovating on different levels and considers itself a technology company rather than a taxi company). The tension between complementors and platform owners and the threat of envelopment are noticeably higher for innovation MSDPs, such as app ecosystems with heterogeneous complementors (i.e. app developers). Being a transactional platform might have concealed the significance of such an interaction and its effect on the boundary of the firm. Competition between the MSDP owner and complementors may also have been absent in this case because of the nature of the map and payment complements. Quite often, these complements are themselves MSDPs and are owned by resourceful firms rather than individuals or small firms, as is the case for many developers in app ecosystems. For example, PayPal and Google Maps are themselves MSDPs, and their values increase with multihoming, i.e. being integrated in many different services. Therefore, it might not have made sense for these complements to react negatively to Uber's entrance into their business domains. Based on this discussion, the classification of MSDPs and the nature of the complements may both be important to the factors influencing the boundary of the firm.

7.7 Chapter summary

This chapter provided a critical interpretation of the findings of this thesis. The chapter discussed the findings in relation to the following research questions: what factors influence the shifts in the boundaries of MSDPs as they configure their complements, and how does the MSDP firm respond to these factors? The findings indicate that MSDP boundaries are influenced not only by supply-side factors, such as efficiency and competence, but also by the demand-side factors of *customer localisation*, *customer heterogeneity realisation* and *supermodular complementarity*. The findings

generally indicate that the MSDP firm may shift its boundaries outward to meet idiosyncratic business needs, adapt to local market macro conditions, boost the number of users and receive investment from complementors. The main aim of the findings is to demonstrate the impact of demand-side factors on MSDP boundary decisions and show how this perspective can extend the supply-side perspective, leading to a more comprehensive understanding of when and why MSDPs shift their boundaries. The thesis explicates the role of demand-side factors at influencing the boundary decision of the MSDP and offers a set of propositions that can inform future research. The next chapter will discuss the implications of the findings for theory and practice and discuss the limitations of this thesis.

8 CONCLUSION

8.1 Chapter introduction

This chapter provides a summary of this thesis. Section 8.2 provides a brief overview of the research, including the research questions, the research gaps and the methodology chosen to address the research questions. Section 8.3 provides a summary of the main findings of this research. Section 8.4 discusses the theoretical and practical implications of the research findings and discusses the limitations of the research and avenues for future research.

8.2 Research overview

This research focused on the phenomenon of Uber, a digital ridesharing platform that achieved rapid success in market expansion and, in some regions, industry domination. Upon careful examination of Uber, it was observed that, despite being an MSDP, which enables the centralisation and standardisation of components and services, Uber's MSDP was configured differently in the different markets in which it expanded. On some occasions, Uber offered products or services that were built in-house, while on other occasions, it relied on third-party complementors. These observations suggested the need for research to examine the following questions:

1. What is an MSDP?
2. What factors influence shifts in MSDP boundaries as they configure their complements, and how do MSDP firms respond to these factors?

The literature on platforms was found to be scattered across three different disciplines: strategy/economics, engineering design and digital innovation. While these disciplines offered different perspectives and understandings of MSDPs, they also defined MSDPs in various ways. Hence, the first goal of this thesis was to create an integrated definition of MSDPs that took into account the different perspectives in the literature, thereby reducing the confusion and ambiguity around MSDPs. Based on a critical review and synthesis of the literature, this definition enabled the examination of different MSDPs by firms such as Uber, Airbnb, Facebook and Google. This thesis defined MSDP as *an organizing logic powered by an extensible software codebase that forms core digital resources, together with physical and digital complementary assets created by third-party complementors, to enable the interaction between two or more distinct groups of users in a market*

with the goal of creating positive network effects. This integrated definition links the different literature streams by articulating the requirement that an MSDP satisfies three distinct conditions: (1) multisidedness (serving at least two distinct groups of users), (2) modularity (having core and peripheral components) and (3) digitality (operating an extensible software codebase).

Addressing the first question of this thesis enabled the progression to subsequent questions related to MSDP boundaries. Because of MSDP ambiguity, scholars had been previously unable to treat them as organisations and, hence, to examine them through the theoretical lens of organisational boundaries. Defining an MSDP as an organising logic built on the work of Gawer (2014; 2015) and enabled the examination of MSDPs as organisations. While defining MSDPs reduced ambiguity, the literature review revealed another gap in relation to their boundaries. In particular, the literature review indicated that existing theories of firm boundaries (i.e. efficiency and competence perspectives) might not apply directly to the context of MSDPs (Boudreau, 2017) because digitalisation challenged three main assumptions of existing theories. First, value creation does not necessarily follow a pipeline model of business (Van Alstyne and Parker, 2017), a dominant model in the pre-digital world; value is now co-created by heterogeneous groups of actors, such as suppliers, users and competitors (Amit and Han, 2017). Second, the reprogrammable nature of digital technology reduced asset specificity in the digital world (Autio and Thomas, in press; Autio and Zander, 2016), hence challenging existing theories' predictions based on asset specificity. Third, due to the reprogrammable nature of digital technology, the full value of digital assets become difficult to determine *ex ante*. This also challenged the existing theories of firm boundaries, which typically assumed asset value to be predetermined.

Taking into consideration the shortage of studies applying theories of firm boundaries to the context of MSDPs, and the impact of digitalisation on the assumptions of existing theories of firm boundaries, the subsequent research questions aimed to investigate whether existing theories of firm boundaries, such as efficiency and competence perspectives, were still applicable in the context of MSDPs. Moreover, the questions responded to Santos and Eisenhardt's (2005) call for new theoretical understanding of firm boundaries that are influenced by strategic factors over efficiency factors (i.e. TCE), and that take the MSDP's environment and context into consideration. Finally, the questions aimed to understand how an MSDP firm responded to these factors and shifted its boundaries accordingly.

To address the research questions, this research implemented a qualitative research design for an embedded case study of Uber. The main unit of analysis was Uber, and the subunits of analysis were

the payment and maps complements, which were core complements of Uber's MSDP. Data were collected about Uber from its establishment in 2010 to December 2018. The data included information about the payment and maps complements, and were gathered using online blogs and other secondary sources. The online blogs included a blog aggregator, official Uber blogs and five other technology blogs. Other secondary sources included archival documents published by Uber and videos of conferences and talks presented by Uber executives and engineers. By utilising this diverse set of data, this thesis was able to identify factors influencing Uber's boundary decisions related to whether to build in-house or rely on third-party complementors to provide payment and maps complements. The following section summarises the main findings of this research.

8.3 Summary of key findings

The findings indicated that considerations of existing theories of firm boundaries, such as the need to mitigate transactional hazards and the need to build capabilities in-house to achieve competitive advantage, were still relevant in the context of MSDPs. The descriptive analysis in Chapter 4 indicated that some of the decisions taken by Uber were partially explained by existing theories of firm boundaries. For example, the findings indicated that Uber acquired several companies that provided maps solutions, in addition to poaching maps engineers from complementors and competitors to build its own maps solutions. These efforts were generally described as an effort by Uber to reduce its reliance on Google, which is a main complementor of Uber's MSDP. Moreover, these efforts were described as building a core competency internally because the maps complement was core to Uber's MSDP and was also important for the future introduction of autonomous vehicles.

However, the findings in Chapter 6 indicated the presence of demand-side factors, other than efficiency and competence factors, that influenced Uber's MSDP boundary decisions. These factors were complement localisation, customer heterogeneity realisation and supermodular complementarity ignition. The findings indicated that the need to localise a complement, either to adapt to local market conditions or to meet Uber's business needs, influenced Uber's MSDP boundary decisions. In particular, as Uber expanded into new markets, it was subject to new local market conditions, such as low credit card penetration and lack of proper location addresses. The findings also indicated that the need to address heterogeneous customer preferences influenced Uber's MSDP boundary decisions. For example, users had different preferences, such as preferring ecommerce transactions over cash or preferring a specific complementor over others (e.g. Chinese users preferring Alipay over PayPal). Finally, the findings indicated that supermodular

complementarity ignition also influenced Uber's MSDP boundary decisions. In particular, Uber made boundary decisions that would lead to reciprocal benefits for itself and its complementors, such as increasing the number of users and amount of investment. The findings suggested that Uber was more likely to rely on third-party complementors to address demand-side factors, such as the need to adapt to local market characteristics, the need to address the heterogeneous preferences of customers and the need to increase the number of users and amount of investment in the MSDP. However, the exception was that Uber was more likely to build in-house when the complement provided by a complementor could not be customised for Uber's business needs.

The findings suggested that these demand-side factors were equally, if not more, important to the efficiency and competence factors identified by the existing theories of firm boundaries. The findings also indicated that demand-side factors required shifting the focus of boundary decisions from value capture (the primary focus of efficiency and competence perspectives) to value creation. By creating more value, MSDPs attract more users and, ultimately, capture more value. However, capturing value requires implementing innovative business models.

8.4 Implications, limitations and areas for future research

The findings of this thesis had several theoretical contributions and practical implications. Subsections 8.4.1 and 8.4.2 discuss them in detail. In addition, subsection 8.4.3 discusses the limitations faced in this research and the mitigation strategies used to reduce their impact. subsection 8.4.4 discusses avenues for future research identified as a result of this thesis. Finally, subsection 8.4.5 includes the author's concluding remarks and the main takeaway points.

8.4.1 Theoretical contributions

The conceptualisation of MSDPs in this research, as well as its findings, have contributed directly to theories of firm boundaries, digital platforms, demand-side strategy and business model innovation. This subsection explains the theoretical contributions of this research and its implications for these literature streams. The literature on firm boundaries has emphasised the importance of avoiding transactional hazards and building capabilities in-house to achieve a competitive advantage (Williamson, 1975; 1985; Argyres and Zenger, 2012; Barney, 1999; Santos and Eisenhardt, 2005). Existing theories on organisational boundaries have seldom been applied to the context of MSDPs; as such, it has been unclear whether these theories were sufficient to explain MSDP boundaries

(Boudreau, 2017; Gawer, 2015). This thesis has added to the literature on digital platforms by defining an MSDP as an organising logic, building on the work of Gawer (2014; 2015). This enabled the examination of MSDP boundaries from an organisational perspective. The literature review in Chapter 2 indicated that the boundaries of a firm are typically explained by supply-side perspectives such as efficiency and competence perspectives (Santos and Eisenhardt, 2005). These perspectives have been led by TCE (Coase, 1937, Williamson, 1975, 1985) and RBV (Penrose, 1959; Barney, 1986, 1991), which are two distinct yet complementary theories of firm boundaries (Argyres and Zenger, 2012). These theories recommend that when a complement is a core asset and accessing/acquiring it from the market entails high transaction costs, a firm should shift its boundaries inward and bring the asset in-house to mitigate transactional hazards (Argyres and Zenger, 2012). However, the findings presented in Chapter 6 and discussed in Chapter 7 clearly showed that Uber, on many occasions, did the opposite. That is, it shifted its boundaries outward by relying on third-party complementors, even though the complement was a core asset and transacting in the market entailed a high transaction cost.

This thesis offered a novel explanation for this shift, showing that complement localisation, customer heterogeneity realisation and supermodular complementarity ignition (three demand-side factors derived from the data analysis and explicated in Sections 7.3, 7.4 and 7.5 of Chapter 7) affect the boundaries of MSDPs. The timeline of events of payment and maps components, presented in Chapter 4, indicated that supply-side considerations, such as the need to mitigate transactional hazards and build core competencies in-house, are relevant in the context of MSDPs. However, existing theories of firm boundaries seem to have overlooked demand-side factors and implicitly assumed the customer value proposition is fixed. This thesis proposed that by relying only on existing theories of firm boundaries (that is, TCE and RBV), an MSDP firm might make suboptimal decisions that could affect its overall value creation and, consequently, customer adoption. For example, an MSDP firm expanding into a new market might decide to develop a complement in-house when transacting in the market involves transactional hazards, and the complement is a core asset. However, as explained in Section 7.5 of Chapter 7, such a decision may affect user adoption, which is a main source of competitive advantage for MSDPs. As shown in Section 7.3 of Chapter 7, bringing a complement in-house may allow an MSDP firm to mitigate transactional hazards, but it will remain unable to adapt to the various contextual factors and conditions of the markets into which it expands. Moreover, as indicated in Section 7.4 of Chapter 7, it might be unable to address the heterogeneous needs and preferences of its customers.

Overall, this thesis has contributed to the literature on the boundaries of firms and digital platforms by providing longitudinal research findings on MSDP boundaries, of which there is a shortage (Boudreau, 2017; Helfat and Raubitscheck, 2018; de Reuver, Sørensen and Basole, 2017). It has also addressed shortcomings with existing theories, which have focused on firm boundaries on supply-side factors while overlooking nonefficiency factors (Santos and Eisenhardt, 2005). In this thesis, the longitudinal analysis of Uber and the identification of demand-side factors have extended TCE and RBV, enabling scholars to explain shifts in MSDP boundaries more accurately. It also enables MSDP firms to make optimal decisions that ensure the growth of its user base and ultimately, create more value, which firms can then capture.

The findings of this thesis also have theoretical implications for the literature on concurrent sourcing and tapered integration (Parmigiani, 2007; Harrigan, 1985), which examine why a firm might build an in-house complement and rely on third-party complementors simultaneously for the same component. To date, the efficiency perspective on its own has been unable to predict why firms might do this (David and Han, 2004). Parmigiani (2007) suggested that additional theories should complement the efficiency perspective to have a better understanding of concurrent sourcing. The findings of the present research have potentially offered a new theoretical perspective, based on demand-side factors, to explain concurrent sourcing. While the timeline of events related to payment and map components in Chapter 4 indicated that efficiency and competence perspectives are important for MSDP boundary decisions, the demand-side perspective is equally important, if not more so. The findings discussed in Sections 7.3, 7.4 and 7.5 of Chapter 7 indicated that an MSDP is likely to make boundary decisions to address demand-side factors even if this seems contradictory to the efficiency and competence perspectives. For example, a firm may rely on third-party complementors despite the consequent high transaction costs. The tension between demand-side perspectives and efficiency and competence perspectives is a plausible explanation for concurrent sourcing. An MSDP might build a complement in-house to develop core capabilities while simultaneously relying on third-party complementors to address demand-side factors. This may be inferred, for example, from Uber's decision to acquire several maps companies and poach maps engineers to build its own mapping system while relying on third-party complementors at the same time.

In addition, this thesis has contributed to the literature on demand-side strategy (Priem, 2007; Rietveld, 2018; Siqueira, Priem and Parente, 2015). Demand-side strategy has been applied to different contexts, such as competitive advantage (Adner and Zemsky, 2006), business model innovation (Priem, Wenzel and Kosh, 2017) and entrepreneurship (Rietveld, 2018). However, its

relevence to firm boundaries and MSDPs has not been addressed previously. This study has shown the importance of demand-side strategy in determining firms' boundaries by shifting the theoretical emphasis from value capture to value creation and from the supply side to the demand side. This has created predictions of MSDP boundary decisions (presented in the six propositions in Chapter 7) that vary from those provided by existing theories of firm boundaries such as TCE and RBV. The findings indicated that addressing demand-side factors allows an MSDP firm to attract additional users, which creates a competitive advantage. The more value an MSDP creates, the more users it attracts and the more value it can capture. This is the essence of demand-side strategy, whereby a firm can achieve a competitive advantage by addressing the heterogenous needs and preferences of its customers without necessarily owning valuable, rare and inimitable resources (Priem, Li and Carr, 2012).

This thesis has also contributed to the literature on demand-side strategy (Priem, 2007; Rietveld, 2018; Siqueira, Priem and Parente, 2015) by making a sharper distinction between market heterogeneity and customer heterogeneity. The findings discussed in Sections 7.3 and 7.4 of Chapter 7 indicated that an MSDP firm should adapt to both macro market conditions and customer-specific needs and preferences to create value. For example, many markets into which Uber has expanded have a low credit card penetration rate. Therefore, Uber was unable to create value for its customers in those markets when it only accepted electronic payments. Uber began accepting cash payments to address this problem. However, addressing this market condition was insufficient, as Uber also had to address the heterogenous needs of its customers, such as their preferences for electronic payment varying from direct credit card payments to digital wallets (such as PayPal) and operating system-specific payment methods (such as Apple Pay). Explicating these distinctions between market heterogeneity and customer heterogeneity has enabled a better understanding of how firms can create value.

This thesis has also contributed to business model innovation literature by emphasising the interaction between an MSDP firm's boundary decisions and its business model design. A business model is the logic that underlies a firm's value creation and value capture activities (Teece, 2010; Zott and Amit, 2010). The findings discussed in Sections 7.3, 7.4 and 7.5 of this thesis indicated that demand-side factors shift the focus of a firm's boundary decisions from value capture to value creation. The goal is always to create as much value as possible to increase the pie from which value can be captured (Gulati and Wang, 2003). The findings showed that having an appropriate business model design is important for the creation and capture of value. This was evident when Uber made the radical decision to change its business model to accept cash payments instead of relying solely

on seamless digital payments. This affected Uber's value creation and value capture activities and had an impact on its stakeholders, such as riders, drivers and complementors. Moreover, it required the alteration of activities related to service delivery and payment collection. For example, Uber can take its share for cash and digital payments from digital payments alone by assigning drivers both fare types, eliminating the need for drivers to transfer Uber's share of cash fares. These findings have contributed to the recent conceptualisation of business models as complex systems (Velu, 2017) by emphasising the relationship between the boundary decisions and business model activities an organisation pursues to create and capture value. Boundary decisions by MSDPs have far-reaching effects, as they affect more than a single transaction and more than a handful of transacting agents. Moving forward, deeper research into MSDPs will need to adapt systems thinking to reflect and build on the modularity of MSDPs and the dynamic business models that enable them to create and capture value.

8.4.2 Practical Implications

The findings of this thesis have three practical implications for managers and MSDP owners. First, managers should be aware that a boundary decision in the context of MSDP is strategic rather than tactical. A manager might be inclined, for example, to bring a complement in-house to reduce transaction costs. However, making such boundary decisions while ignoring demand-side factors, such as the heterogeneity of markets and customer demands, might affect the firm's competitiveness and profitability in the long run. It is not always enough to have the most advanced technology or solution. Uber, for example, could have the most sophisticated payment and maps systems. However, customers might simply prefer other complementors and might not be willing to switch from the complementors they are already comfortable with. This occurs especially when the complement itself is an MSDP (e.g. a payment service provider, such as PayPal, or a map service provider, such as Google Maps). The main goal of an MSDP is to increase its network effects by increasing the number of users. By so doing, the MSDP can enjoy competitive advantage over its complementors. Growing this network effect usually requires shifting the MSDP firm boundaries outward by relying on third-party complementors who are likely to attract more users, despite potentially increasing transactional hazards. Therefore, managers should think strategically about the boundary decisions and consider the cost and benefit of building in-house or relying on third-party complementors over a long period of time.

Secondly, managers should also be aware of the limitations of digital technology. It is usually assumed that digital technology is global, meaning that it works anytime and anywhere because it

transcends geographical borders. However, managers should be aware that it is not easy to redeploy digital technology in different markets. Different markets have different local conditions and regulations, what might work in the United States might not work in China. The findings in this thesis illustrated several examples of this, such as when Uber could not rely on Google maps or PayPal in China due to local regulations and preferences. Moreover, in many occasions, managers might still have to have a physical presence in some of the markets that the MSDP firm expands to in order to have a better understanding of the local regulations and characteristics. This is particularly true for markets that are large and involve a high degree of customer heterogeneity. For example, Uber was able to identify the need for accepting cash payment and the subsequent design of the system in India only when it set up a research and development centre in Bangalore. Hence, managers should be aware that digital technology is a tool for achieving global expansion and not an end in itself.

Third, managers should realise that building capabilities to connect with third-party complementors is as important as building internal production capabilities and competences. MSDPs have layered modular architecture and are composed of core and periphery modules. It is not possible for a single firm to develop and maintain all the complements by itself. It is not only the MSDPs that have layered modular architecture, even the complements are typically digital technology and, hence, have layered modular architecture. Relying on third-party complementors in the digital age is a necessity; managers should build capabilities that enable seamless integration with third-party complementors. Managers should also generally view collaborating with third-party complementors as a win-win situation, even if the complementor might turn into a competitor. For example, Uber still relies on Google Maps despite the reports that Google is working on its own autonomous vehicles which would be used in the future as a substitute for Uber's service. The integration of Google Maps in Uber's MSDP is a win-win for both firms. Google benefits from the large volume of rides that Uber delivers each day (i.e. access to more data and revenue per ride) while Uber benefits from a reliable complementor whose services are unmatched. Managers should also be aware that having a good relationship with complementors increases the probability of investment in the MSDP. This was evident in the examples of Baidu Maps, Google Maps and Bing Maps. Understanding the concept and power of supermodular complementarity and how to take advantage of it is critical in the context of MSDPs and business ecosystems. Managers at MSDPs who recognize the potential of supermodular complementarity will base boundary decisions not just on considerations of strong complementarity (i.e. asset specificity) but will make boundary decisions in way that harnesses the positive outcomes of supermodular complementarity.

8.4.3 Research limitations

This thesis implemented a single case research design with a qualitative inductive approach. As a result of the design choices, it had some limitations. This subsection discusses the limitations and mitigation strategies pursued to minimise their effects.

Limited generalisability of findings

In general, case study designs are criticised for lacking generalisable results that can be applied in different contexts. This criticism is even more relevant to the single case study design than the multiple case study design (Eisenhardt and Graebner, 2007). While such a limitation cannot be fully eliminated, this thesis mitigated it by implementing an embedded design and selecting subunits of analysis that were likely to be found in other contexts. In particular, the subunits of analysis were the payment and maps complements. These complements were not unique to Uber; many of the MSDPs implemented at least one of them. For example, most of the MSDPs required at least one method of payment before allowing customers to use their services. Choosing the payment and maps complements as subunits of analysis enhanced the generalisability of the findings.

Lack of primary data

A significant limitation of this research was the lack of primary data due to Uber's limited accessibility. Hence, this research followed de Reuver, Sørensen and Basole's (2017) recommendation to use secondary sources, such as online blogs. To further mitigate this limitation, this thesis collected data from different blogs, including three official blogs published by Uber, and also accessed publicly available video conferences and talks by Uber executives and employees. Finally, the data collection was extended from June 2017 to December 2018, which enabled more Uber-related data to be gathered because, in late 2018, the firm began publishing more private data for its approaching IPO.

Despite efforts to mitigate the limitation created by the lack of primary data, some areas could not be fully mitigated. For example, a major purpose of this research was to identify the point at which an MSDP should build a complement in-house rather than rely on third-party complementors. The literature indicated that when the cost of transacting in the market is high, the complement should be developed in-house. The author had to rely on qualitative data and descriptions to identify whether the cost of transacting in the market was high; for example, Uber's S-1 filing form indicated

that Uber incurred high costs when relying on third-party payment complementors. While this is a good indication, no numerical data were available to support this claim. Hence, the researcher could not determine, based on the numbers, if developing a payment system in-house would have been cheaper than relying on third-party complementors. Such data were not publicly available or could not be induced from Uber's financial statements because Uber was not a publicly traded company during the time horizon of the study. Uber started publishing financial records only as its April 2019 IPO approached; however, granular information, such as how much it costs Uber to use PayPal or Apple Pay services, could not be fully extracted or deduced from financial statements.

Researcher bias

A common criticism of the interpretivist and inductive approach is the high probability of researcher bias caused by subjectivity. To overcome this problem, this thesis implemented several mitigation strategies. First, the scope of the data collection included diverse data sources. This was achieved by collecting data from Uber official blogs, five other technology blogs, archival data and other publicly available data, such as video conferences and talks. As such, the data contained the points of view of different actors, such as Uber executives and engineers, industry experts, tech bloggers and, sometimes, even drivers and riders. Having diverse sources of data and points of view enabled triangulation, thereby reducing the impact of researcher bias. Moreover, this thesis adapted the constant comparison technique from the grounded theory approach, which enabled the comparison between different incidents from the data. Hence, the findings and discussions reviewed the general patterns in the data as well as alternatives or exceptions, which reduced the impact of researcher subjectivity on the findings.

8.4.4 Recommendation for future research

This thesis opened several avenues for future research. This subsection discusses several areas in which additional research would enhance the understanding of MSDP boundaries.

Testing the six propositions in this thesis

Based on the findings, this thesis offered six propositions in Chapter 7 related to an MSDP firm's likely response to the three demand-side factors identified in this research. Validating these propositions requires a quantitative research design based on a large sample of MSDPs. By validating

these propositions, we would have a better understanding of how MSDPs can optimally address demand-side factors when making boundary decisions.

Scrutinising market characteristics

One of the main findings in this thesis is the importance for MSDP firms to adapt to local market characteristics. In this thesis, examples of local market conditions were low credit card penetration and lack of proper location addresses (e.g. in developing countries). While this thesis identified the importance of adapting to local market conditions, it did not explicate the differences between market conditions and their relative importance for MSDP boundaries. Future research could explicate the differences among market characteristics by categorising them as economic, political and environmental factors, and then examining the relative impact of each of these factors on MSDP boundaries. It may be found, for example, that in some geographical areas, political factors play a more important role than others (e.g. this might apply in China, where foreign firms strive to establish good relationships with the government to successfully operate in the Chinese market).

A different kind of embedded case study design

This research implemented a single case (embedded) study, following the recommendation of de Reuver, Sørensen and Basole (2017) to adapt embedded case studies to overcome the difficulty of comparing two different MSDPs; MSDPs are very complex, and each is unique. Future studies could improve on the design of this research by implementing an embedded case study by region rather than by complement, as was done in this thesis. For example, a future study on Uber could examine the different boundary decisions that Uber has taken by examining Uber's MSDP in different countries as subunits of analysis. By making Uber's MSDPs in different countries the subunits of analysis, a greater understanding could be achieved on the architectural level, because such design would enable the understanding of how the layered modular architecture of Uber's MSDP changes from one country to another. It was not possible to achieve architectural-level understanding in this research because the data did not provide sufficient granularity of MSDP architecture configuration. Thus, this research focused only on payment and maps complements as subunits of analysis.

Building capabilities to connect with third-party complementors

The findings indicated the importance of relying on third-party complementors to increase investment in the MSDP and the potential number of users, and to adapt to local market conditions and customers' heterogeneous needs. The existing literature on firm competencies focused on how firms should develop internal production capabilities to develop core competencies and achieve competitive advantage. However, the existing literature did not closely examine the capabilities required to connect with third-party complementors and integrate their complements. Hence, future research could investigate the capabilities required to connect with different third-party complementors and how such capabilities could lead to competitive advantage in the context of an MSDP.

The nature of the complements

This thesis focused on the payment and maps complements on Uber's MSDP. These complements were purely digital, meaning that they were software complements that could easily be transferred from one location to another. In many cases, the complement could also be digital but contain physical elements (e.g. autonomous vehicles). This research did not examine the impact of the nature of the complements on boundary decisions. In general, digital complements were assumed to be global. For example, when Uber integrated PayPal as a payment option, PayPal became available to Uber customers around the world. However, when the complement involves physical components, transferring such a complement from one place to another might be difficult. Hence, future research could investigate the impact of the nature of the complement on MSDP boundary decisions.

Examining payment business models

The findings of this thesis reveal multiple attempts by Uber to enter the fintech industry, both by making partnerships and relying on third-party complementors (i.e. offering branded debit cards) and by developing in-house complements (i.e. cash payment system and digital wallet). Other MSDPs have shown a similar tendency to move into the fintech industry. For example, Apple recently introduced its own credit card and Grab, a ridesharing competitor to Uber, introduced its own digital wallet. While some researchers have recently made an effort to understand mobile payments and their implications for business model innovation (i.e. Velu, Smart and Phillips, 2016), much remains to be understood. One potentially fruitful area for future research will be examining

why MSDPs are inclined to offer their own mobile payment services. Another illuminating research direction could be examining how MSDPs can leverage their in-house mobile payment services to achieve customer lock-in; for example, reports are indicating that Uber is building its own digital wallet that can be used to book rides and to order food through UberEATS. It is still unclear if Uber will make its digital wallet open- or closed-loop (i.e. whether customers will be able to use Uber's wallet to make purchases outside Uber's MSDP). A third promising area of research is examining how different payment business models (i.e. cash, pre-paid mobile credit and mobile payments) influence customer adoption and what sort of capabilities are needed to adopt these different models.

An alternative and comprehensive perspective

The main finding of this thesis was that demand-side factors played an important role in determining MSDP boundaries. A demand-side perspective puts customers and value creation at the heart of boundary decisions. However, the analysis hinted that other actors might also play a role in affecting boundary decisions. For example, the findings indicated that an MSDP firm was more likely to integrate a complement if the complementor was a stakeholder. This thesis viewed this issue from a demand-side perspective by pointing out the importance of investments from complementors to attract new users (by allocating these investments to efforts to meet the demands of heterogeneous MSDP users). Nevertheless, this issue could be viewed from a perspective that considers the demands and needs of different stakeholders, such as investors and shareholders. Hence, one potential area of future research is to apply the recently developed stakeholder perspective of the resource-based view (Barney, 2018) to the examination of MSDP boundaries.

8.4.5 Concluding remarks

This thesis is considered to have served its purpose if the reader takes away the following three points. First, the literature on MSDPs is scattered across different disciplines, which created conceptual ambiguity for MSDPs overall. This thesis contributed to the existing knowledge by reducing this ambiguity and providing an integrated definition of MSDPs as an organising logic entailing three conditions: (1) multisidedness, (2) modularity and (3) enabling codebase extension. Second, while existing theoretical understandings of firm boundaries, such as efficiency and competence perspectives, still play a role in influencing MSDP boundary decisions, the findings in this thesis suggested that demand-side factors, such as the need to address heterogeneous market

conditions and user preferences, and the need to rapidly increase the number of users and amount of investment in the MSDP, are equally, if not more, important. Hence, this thesis contributed to existing knowledge by demonstrating that, in the context of MSDPs, making boundary decisions relying only on existing theoretical perspectives such as efficiency and competence, may lead to suboptimal decisions and, ultimately, reduce customer adoption of the MSDP. To achieve competitive advantage, increasing the number of users is an MSDP's primary goal; hence, an MSDP may need to rely on third-party complementors to address demand-side factors even if such a decision might not seem optimal from efficiency or competence perspectives. Third, addressing demand-side factors means that firms should shift their focus from value capture to value creation when making boundary decisions in the context of MSDPs. Value should be created first so that the MSDP may capture it. Focusing on demand-side factors helps to increase overall MSDP value and, ultimately, the potential to capture that value. As such, business model innovation is vitally important for an MSDP firm to capture the value it creates, if it is to survive and compete in a volatile digital economy.

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Appendix A: The preliminary exploratory research

In early 2016, the author conducted preliminary exploratory research to gain a better understanding of Uber's MSDP and to construct a timeline of the evolution of Uber from its launch in June 2010 to the first quarter of 2016. Preliminary data on Uber were collected from news articles using the Factiva database and retrieved from four mainstream newspapers and magazines: *The Wall Street Journal* (*WSJ*), *The Financial Times* (*FT*), *Forbes* and *The Economist*. These sources were selected to provide diversity in terms of the types of resources (magazines and newspapers) and their publication locations. The *WSJ*, the *FT* and *Forbes* are based in the United States and focus more on Uber's operation there, while *The Economist* is based in the United Kingdom and has better coverage on Uber in Europe, which was the first market that Uber has expanded to after its launch in the United States.

Search Summary	
Text	Uber
Source	Financial Times - All sources Or The Economist - All sources Or The Wall Street Journal - All sources Or Forbes - All sources
Author	All Authors
Company	Uber Technologies Inc.
Subject	All Subjects
Industry	All Industries
Region	All Regions
Language	English
Results Found	2095

Table 1: Search criteria used in Factiva.

To retrieve all news articles about Uber, two actions were taken: using 'Uber' as a search term and using Factiva's 'search by company' feature, which allows retrieving all news articles related to a specified firm. Using Uber as a search term ensured the retrieval of all articles containing the term 'uber', which reduced the chance of missing articles due to errors in Factiva's 'search by company' indexing (see Table 1 for the search criteria). The search in Factiva using the criteria described in Table 1 yielded 2095 articles about Uber. The author manually traversed through these articles and started recording data in a tabular and non-structured fashion using the Microsoft Excel spreadsheet. The

Excel spreadsheet contained distinct headers for the rows and time intervals (yearly quarters) for the columns (see Table 2 for data extract from the Excel spreadsheet).

Yearly quarter	**Q2-2014**	**Q3-2014**
Company	Uber rallies customers to respond to taxi union complaints. Uber uses pricing strategy and incentives to respond to competition.	Uber temporarily decreases prices in NY to counter complaints about decreased earnings and defections to rivals.
Products/Services	UberPop launches in Berlin. UberRush launches in Manhattan.	UberX grows faster than other Uber premium services. Uber offers new services for businesses.
Recruitment	Uber organises monthly sessions for its new recruits to inform/educate them about the company. Uber hires Cameron Poetzscher of Goldman Sachs as head of corporate development.	Uber incentivises employees to poach drivers from Lyft Uber hires Obama's campaign mastermind as senior vice president of policy and strategy.
Funding	Uber initiates another funding round that could value the company at more than $12b. Uber successfully raises $1.2b in capital. Its CEO claims its logistics business was not part of the pitch for this fundraising.	Null
Geographic Expansion	Uber operates in about 100 cities in 35 countries (update: 128 cities, 37 countries by the end of May).	Uber launches in Hong Kong, increasing the number of cities to 150.
Acquisitions/Partnerships		Uber partners with Concur to appeal to business travellers.
Competition	Alibaba invests $250m in Lyft.	BlaBlaCar receives $100m in funding. Lyft launches its services in New York City, leading to a price war with Uber.
Legal	Brussels bans Uber (update: Miami and Las Vegas too) Berlin temporarily bans Uber.	Uber agrees to abide by New York's price-gouging statute, which caps prices during emergencies.
Controversies	Black cab drivers threaten to cause gridlock in London. London's minicabs join Black Cabs in questioning the legality of Uber in the UK. Taxi drivers in various EU countries protest.	Uber and Lyft accuse each other of sabotage involving fake ride requests.
Customers	Null	Null

Table 2: *A sample of Microsoft Excel spreadsheet data-recording format.*

The categories to which the collected data were assigned include the following:

- Company: General information about the company, such as office moves or plans for a new business strategy.
- Products/services: Information about the launch of any new product or service; for instance, in the third quarter of 2013, Uber introduced the UberChopper service in New York, which allows customers to travel by helicopter.
- Recruitment: Information about the company's hiring of personnel and associated statistics; for instance, the majority of Uber hires in the first quarter of 2013 were from the finance and banking industry.
- Funding: Funding and venture information that helps explain how Uber is able to fuel its expansion; for example, Uber raised $1b in the first quarter of 2015 to back its expansion into the Chinese market.
- Geographic expansion: Information about Uber expansion, which includes a study of the pace at which Uber is able to enter new markets; for example, between the second and third quarters of 2014, Uber increased the number of cities it serves from 100 to 150.
- Acquisitions and partnerships: Information about partnerships and companies, services and assets acquired by Uber; for example, Uber established a partnership with Carnegie Mellon University in the first quarter of 2015 to work on autonomous cars.
- Competition: Information about Uber's competitors in the sharing economy and how they respond to Uber's threats; for example, Hailo, a British taxi-matching company, retreated from North America in 2014 due to aggressive pricing competition from Uber.
- Legal: Legal issues that Uber has faced locally and internationally; for instance, in 2014, Uber battled several European bans on its ridesharing services.
- Controversies: Information about controversial issues involving Uber and its operations; for instance, Uber's surge pricing has faced criticism and controversy on the grounds that it is an unfair trade practice.
- Customers: Information about customer habits and behaviour when using Uber services.

The exploratory data collection and analysis from Factiva provided six main findings. First, Uber was expanding rapidly into various geographic markets in a short period of time. Second, Uber was also expanding into adjacent businesses, such as grocery delivery, helicopter travel, bike rentals and restaurant delivery service. Moreover, Uber was experimenting with what it calls stunts, such as delivering kittens, ice-cream and Christmas trees; these were called stunts because these delivery

experiments usually lasted for only a short period of time; they did not become permeant business offerings. Third, Uber was relying on external partners as well as building its own technology to provide its services. Noted was Uber's increased interest in developing payment systems, maps systems and autonomous vehicles. Fourth, Uber was relying heavily on algorithms and artificial intelligence to efficiently match drivers with riders, dynamically set prices and accurately predict future demand. Fifth, Uber was facing many regulatory and ethical issues concerned with its business practices. For example, many taxi companies protested Uber because they thought that Uber operated as a taxi company without having the appropriate licence. Moreover, Uber faced many ethics criticisms concerned with its practices, such as offering incentives to poach drivers from competitors and raising prices during natural disasters and unfortunate events. Sixth, Uber had always marketed itself as a technology company rather than as a taxi company in the effort to overcome the regulatory pressures from governments and legislators.

Overall, the preliminary exploratory study helped the author gain a greater understanding of Uber and narrow the focus of his research. However, the data collected from this exploratory study was not incorporated into the main data analysis of this thesis because the data was collected in an unstructured format, hence it was difficult to trace back the sources of information. Nevertheless, this exploratory research was sufficient to enable the author to gain a greater understanding of Uber and the potential research areas that could be pursued for his PhD.

Appendix B: Payment timeline

Date	Event	Description	Motivation
06/2010	Payment only by credit card	Uber started their operation accepting only cashless payments	Uber believed cashless payment provided a seamless experience for users and reduced haggling between riders and drivers
06/2010	Cashless payment processed through AuthNet API	Uber initially relied on AuthNet API to process cashless payments	Not available
02/2011	Braintree replace AuthNet for payment processing	Uber switched to Braintree to handle their local and international payments	AuthNet was only able to process payments in USD, inconveniencing users outside the US; Braintree could process different currencies
04/2012	Integration of Card.io	Uber integrated Card.io to enable users to enter their credit card details through scanning, without the need for manual input	Made it easier for users to join Uber and use the service
07/2012	PayPal acquire Card.io	PayPal acquired Card.io, and integrated into Uber	Made it easier for customers to use PayPal services
12/2012	Uber use TLC payment systems in NYC	Payment for Uber rides in New York City had to be processed through the Taxi and Limousine Commission's (TLC) payment system, instead of Uber's own payment processors, due to a ban on payments through ridesharing apps	Responded to local regulations, to continue operating in New York City
12/2012	Adyen become another payment processor	Adyen an additional payment processor for Uber alongside Braintree	With Uber expanding internationally, they needed providers who enabled payments in local currencies
07/2013	Fare splitting feature added	Co-riders were able to split the ride fare	Made it easier for users to pay for their rides
05/2013	Users can pay using Google Wallet	Uber enabled users to pay for rides using Google Wallet	Increased user payment options

Date	Event	Description	Motivation
09/2013	PayPal acquire Braintree	PayPal acquired Braintree, becoming the owner of two services used by Uber	Accelerated PayPal's global leadership in mobile payments
11/2013	Users in some countries can pay using PayPal	Users were able to pay for their rides using PayPal within the Uber app	Increased payment options for users, the need for a universal payment provider and enabled users without credit cards to use Uber's service
02/2014	Users in China can pay using Alipay	Chinese users could pay for rides using Alipay within Uber's app	Localised payment methods by enabling Chinese users to pay in Chinese yuan, rather than USD
06/2014	US users can pay using AmEx	US users could use American Express credit cards to pay for their rides	Increased payment options and attracted new users
09/2014	Users can pay using Apple Pay	iOS users could pay for their rides using Apple Pay, without the need to enter payment information	Increased payment options, simplified the payment experience and attracted new users
11/2014	Users in India can pay using Paytm digital wallets	Users in India could pay for their rides, by charging their Paytm digital wallets with their debit cards or net banking accounts	Responded to local regulations in India requiring all digital payments to apply two-factor authentication (2FA); paying for rides using digital wallets eliminated the need for 2FA, hence ensuring a seamless payment experience for users
04/2015	Users paying with Capital One cards receive perks	Uber partnered with Capital One, to provide perks and discounts for users paying for rides using Capital One credit cards	Attracted new users for both firms
04/2015	Development of in-house payment system for cash payments in India	Users in India could pay for their rides in cash using a system developed in-house by Uber. This marked a departure from Uber's initial business model, which disabled cash payments	As Uber was expanding internationally, they realised that not all users could pay digitally, thus losing customers to competitors; accepting cash payments enabled Uber to increase payment options and attract new users
06/2015	Users in Kenya can pay using M-PESA	Uber enabled Kenyan users to pay using the mobile payment service M-PESA. Payment works by depositing cash at Safaricom (M-PESA provider) stores and spending it by sending SMS messages	Provided more payment options to Kenyan users , as many do not carry cash or use credit cards for security reasons
06/2015	Drivers can receive a gas credit card powered by FleetCor and MasterCard	Uber partnered with FleetCor and MasterCard to provide a Partner Fuel Card, granting drivers fuel discounts	Attracted and retained drivers
06/2015	Users can pay using PayPal in more countries	Uber expanded their support for PayPal payments to nine new countries: Greece, Hong Kong, Israel, Mexico, New Zealand, Singapore, Sweden and Switzerland.	Supported international expansion and provided users more payment options

Date	Event	Description	Motivation
		These joined the following countries that already accepted PayPal payments: Australia, Austria, Belgium, France, Germany, Ireland, Italy, the Netherlands, the UK and the US	
07/2015	Adyen payment processing for Uber expands to more countries	Adyen processed payments for Uber in about 50 countries, including those in Europe and Africa	Enabled users to pay in their local currencies instead of USD
08/2015	Users in India can pay using Airtel payment service	Users in India could pay for their rides using Airtel mobile wallet. Uber's partnership with Airtel granted users perks such as free mobile Wi-Fi during rides and discounts	Increased payment options, offered perks and attracted users
01/2016	Users in Nigeria can pay using Paga	Users in Nigeria could pay for their rides with Paga payment service, which automatically charges the rider's registered debit card in local currency	Provided more payment options, attracted more users and saved Nigerian users from worrying about currency exchanges
02/2016	Chinese users can now pay using Alipay globally	Uber enabled Chinese users to pay via Alipay globally, after previously enabling it only in China	Responded to the demand of Chinese users, by enabling them to pay in their preferred app and currency while using Uber abroad
03/2016	Establishment of a research centre in Bangalore	Uber established a research centre in Bangalore, to solve payment system challenges in the Indian market such as low credit card penetration and cash payment preferences	Understood local settings and developed solutions for local payment preferences
04/2016	Users in Singapore, Malaysia and the Philippines can pay in cash	After the experience with India, Uber enabled users to pay for rides in cash in Singapore, Malaysia and the Philippines. Unlike India, these countries have higher credit card penetration rates	Attracted new users who feared credit card fraud and targeted people who do not have credit cards, such as students
05/2016	Users in India can pay using Paytm globally	Indian users using Uber abroad could pay with Paytm	Responded to the needs of Indian users; many Indian users using Uber abroad were unable to use their credit cards or were worried about currency exchanges; Paytm solved these problems
05/2016	Uber are integrated into the Alipay app	Following Alipay's integration in February, Uber integrated into Alipay's wallet app, enabling Chinese users abroad to pay for an Uber ride directly from Alipay. This option only appears when Chinese users	Attracted new users and encouraged Chinese users to use Uber abroad

Date	Event	Description	Motivation
		travel abroad; the users must book rides directly from the Uber app when they are in China	
05/2016	Uber collaborate with Visa to provide offers to their users	Uber users could receive Uber credit or discounts on their next ride if they purchased from different shops using the Visa card linked to their accounts	Attracted new users to Uber and achieved customer lock-in
05/2016	Users can now pay using Android Pay instead of Google Wallet	Users could pay for rides using Android Pay, an Apple Pay rival from Google that replaced Google Wallet	Increased payment options and attract new users
06/2016	Users in some African countries can pay with cash	After introducing cash payments in India and East Asia, Uber enabled users in South Africa, Nigeria, Uganda, Kenya, Morocco and Egypt to pay in cash	Increased payment options and adapted to local settings, by attract new users who do not have debit or credit cards
06/2016	Uber launch Payment Rewards, in collaboration with Capital One's Quicksilver card	Uber teamed up with Capital One to offer payment rewards for users, if they use a specific credit card to pay for rides	Mutually benefited Uber and Capital One, by attracting new users and achieving customer loyalty
08/2016	US users can pay using commuter dollars, enabled by WageWorks	Uber enabled US users to use untaxable commuter dollars to pay for UberPool on Uber, in collaboration with WageWorks	Provided users more payment options and enabled them to save money
08/2016	Uber launch local rewards in collaboration with Visa	Uber collaborated with Visa to provide perks, such as free rides, to US users who use the Visa credit card linked to their Uber account at partnering stores	Attracted Visa users to Uber and achieved customer loyalty
10/2016	Uber launch debit cards in Mexico, powered by Bankaool and MasterCard	Uber launched debit cards for users in Mexico, collaborating with Bankaool bank and MasterCard. The card works as a regular debit for in-store purchases, e-commerce and ATM withdrawal	Attracted new customers, as many existing debit providers prevented e-commerce purchases like Uber rides
01/2017	Uber expand commuter dollar payment, collaborating with Edenred, Ameriflex, Benefit Resource and Navia	Uber expanded commuter dollar payment options to new cities in the US, by collaborating with Edenred, Ameriflex, Benefit Resource and Navia	Increased payment options for users and helped them save money
02/2017	Uber are integrated into Paytm app in India	Uber integrated into the Paytm app, enabling users to book Uber rides directly from Paytm without switching to Uber's app	Benefited Paytm app users

Date	Event	Description	Motivation
03/2017	Users paying for rides with a Barclaycard in the UK receive rewards	Uber partnered with Barclays in the UK, to offer rewards to users who pay for rides using a Barclaycard	Attract new users by building on the network of Barclaycard users, and provided additional value to existing users
10/2017	Uber launch credit card in the UK powered by Barclays and Visa	Uber partnered with Barclays and Visa to launch a credit card for users in the UK. The card can by used as a regular credit card, and users can receive rewards such as money back and free Uber rides. Uber received access to user spending data in return	Attracted new customers, achieved customer lock-in and made use of consumer data, to provide new services
11/2017	Users in Vietnam can pay using Momo	Uber enabled users to pay using the Momo digital wallet service within Uber's app. Momo is considered Vietnam's most used digital payment service	Provided more payment options and attracted more users, by building on Momo's user network
07/2018	Users in the US can pay using Venmo	Uber enabled users to pay via PayPal's Venmo, ideal for sharing and splitting ride fees	Increased payment options for users
08/2018	Users in the Netherlands can now pay using iDEAL	Uber enabled users in the Netherlands to pay using the iDEAL payment service within Uber's app. 90% of Dutch e-commerce transactions are made with IDEAL	Provided more payment options and attracted new users by building on iDEAL's user network

Appendix C: Maps timeline

Date	Event	Description	Motivation
07/2010	Users can track their ride on a map	Uber enabled users to track their ride on a map embedded within their app	Provided a more seamless experience, compared to a traditional taxi
07/2010	Uber use Google Maps API in their app	Uber's first app relied on mapping services from Google	Not available
09/2011	Uber use location data from Zillow in the US	Uber used data from Zillow, to determine the boundaries of the neighbourhoods they serve in the US. Data from Zillow enabled Uber to break the US cities they serve into distinct places	Reduced pickup time
03/2012	Uber use an Open Source Routing Machine to produce ETAs	Previously Uber relied on an Open Source Routing Machine which helped determine the shortest path between two points, to provide an estimated time of arrival (ETA). Data from different sources used together, increased ETA accuracy	Solved the expanding Uber's cold start problem, meaning Uber did not have data about new cities to provide accurate ETAs
07/2012	US Uber app pulls location data from Foursquare	Uber used pickup location data provided by Foursquare	Enabled users to easily identify a pickup location
12/2012	Uber integrate Apple Maps into their iOS version	In their 2.0 iOS rider app, Uber started using Apple Maps	Not available
03/2014	Uber develop their own routing engine Gurafu	Uber developed their own routing engine, Gurafu, after relying on external engines	Existing external routing engines were incapable of providing real-time traffic calculations that matched the speed at which Uber expanded in terms of services and geography
05/2014	Google integrate Uber into their Maps app	Google Maps users could see Uber as a transportation option inside the app with the "Get an Uber" option, alongside an ETA; if users selected the option, they were redirected to the Uber app, to request a ride	Attracted new users and increased Uber's exposure

Date	Event	Description	Motivation
12/2014	Uber poach maps engineer from Apple	Uber hired Chris Blumenberg, a senior engineering manager who worked on Apple Maps	Built Uber's internal mapping solutions
12/2014	Uber use Baidu Maps instead of Google Maps in China	Uber replaced Google Maps with Baidu Maps in China after forming a strategic partnership with Baidu	Provided more accurate maps in China
12/2014	Baidu integrate Uber into their Maps app	Baidu integrated Uber into their Maps app, so users searching for transportation information on Baidu Maps saw Uber as an option	Enabled more exposure for Uber and attracted new users by building on the existing Baidu Maps user network
02/2015	Research centre launches in Pittsburgh to work on mapping and autonomy technology	Uber established a research centre in Pittsburgh in collaboration with Carnegie Mellon University, to work on mapping and autonomy technology	Mapping technology is essential to Uber's platform and future autonomous vehicles
03/2015	Acquisition of deCarta, a platform for location and mapping services	Uber acquired deCarta, a platform offering local search and turn-by-turn navigation services	Gained customisable mapping solutions to increase ETA accuracy and fit new services such as Uber pool; existing third-party mapping solutions were unreliable for these new services
05/2015	Uber bid to acquire Nokia's Here	Uber bid to acquire Nokia's Here mapping technology	Mapping technology is central to Uber and to future autonomous vehicles
06/2015	Uber acquire mapping technology from Microsoft Bing	Uber acquired mapping technology from Microsoft, including a data centre, cameras, intellectual property and about 100 engineers	Uber could control some mapping in-house, to reduce their reliance on external providers
06/2015	Foursquare integrate Uber service into their app	Foursquare integrated Uber into their app, enabling Foursquare users to instantly book a ride while browsing Foursquare's recommendations	Made it easier for Foursquare users to book a ride and to benefit from Uber's user network
07/2015	Uber poach the head of Google Maps	Uber hired Brian McClendon, former head of Google's mapping division, to lead the development of mapping and autonomy technology	Helped Uber build in-house mapping solutions and reduced reliance on external partners
08/2015	Uber introduce Suggested Pickup Points feature	Uber introduced "Suggested Pickup Points" in the US, which suggests convenient pickup points for users to meet drivers	Helped drivers reduce wasted time by increasing the efficiency of rider pickup, and helped riders find a convenient pickup point
10/2015	Uber roll out mapping cars in the US to collect mapping data	Uber unveiled cars with installed cameras to collect mapping data and images	Improved existing mapping technology and ETAs; self-collected data built up mapping capabilities

Date	Event	Description	Motivation
11/2015	Uber begin using mapping data from TomTom	Uber announced a deal with TomTom to use their mapping and traffic data, to improve the navigation service on their driver app. TomTom's data was used alongside other mapping technology, such as Google Maps and Bing	Reduced reliance on a single complementor (Google Maps) and benefitted from TomTom data that other third-party providers could not match
12/2015	Uber poach a second executive from Google Maps	Uber poached Manik Gupta from Google Maps, to work on mapping and autonomy technology	Built internal capabilities, to reduce reliance on third-party complementors (Google Maps in particular)
03/2016	Uber establish research centre in Bangalore to work on mapping solutions	Uber established a research centre in Bangalore, to work on mapping technology	Improved rider and driver experiences across India and emerging markets, offering solutions to local problems
05/2016	Uber use Foursquare POI location data globally	Uber announced a global partnership with Foursquare, enabling user searches for locations without entering exact addresses	Provided a seamless experience for users to book a ride, and benefitted from Foursquare's POI data
06/2016	Uber use OKHi's location data in Kenya	Uber partnered with Kenyan direction start-up OKHi, to overcome inaccurate locations and addresses in Kenya. OkHi uses smartphones and digital images for easier address detection	Solved a local problem in Kenya where addresses were not easily identified
07/2016	Uber use mapping data from DigitalGlobe	Uber partnered with DigitalGlobe, to use their satellite imagery, helping Uber identify and improve pickup and drop-off locations	Improved existing Uber mapping technology, and provided a seamless user experience
07/2016	Uber invest $500m to develop their own mapping system	Uber invested $500m into a global mapping project, to build their own worldwide maps	Reduced reliance on external providers, enabled customisable external mapping solutions to meet Uber's needs and enhanced mapping technology for future autonomous vehicles
08/2016	Google integrate other ride-sharing options into their Maps app	Google expanded their support for ridesharing transportation options to include other ridesharing businesses (e.g. Lyft, Grab and Go-Jek), redirecting users to the respective app if selected. Uber was no longer the only ridesharing option in Google Maps	Increased Google's userbase by building on the networks of other ridesharing businesses
09/2016	Uber partner with Yext to provide business addresses	Uber partnered with Yext, specialised in location data for businesses, to help online shoppers book rides to their favourite stores. As part of this partnership, stores in Yext's directory could add a "Call me an Uber" button	Increased the accuracy of location data and built on Yext's user network

Date	Event	Description	Motivation
		to their homepages or marketing email, and users would get ride requests loaded with an accurate drop-off point at the store	
12/2016	Uber acquire Geometric Intelligence and establish AI lab	Uber acquired Geometric Intelligence and established their own artificial intelligence lab in San Francisco, to solve autonomous driving issues. One of the lab's tasks was to improve search and mapping capabilities	Developed and improved mapping capabilities for future autonomous vehicles
01/2017	Uber roll out users' calendar integration	Uber introduced Calendar Shortcuts, so users could link their personal calendars with an Uber account. Once linked, events from users' calendars appeared as shortcuts in Uber's app and their location was loaded into the app	Made it easier for users to book a ride, and enabled Uber to access users' data, to optimise the service
01/2017	Uber launch Uber Movement	Uber launched a new tool for mapping travel times. The tool enabled users to measure travel times between different parts of a city, aimed at city governments and urban planners. The tool used data gathered from Uber rides	Owning and sharing such data enabled Uber to build a better relationship with cities and governments
01/2017	Uber hire ex-vice president of Search from Google	Uber hired Amit Singhal, to lead their Maps and Marketplace departments	Built internal capabilities for map development, core to Uber's business and future autonomous vehicles
01/2017	Google enable users to hail Uber rides instantly in Google Maps	Google enabled users to book Uber rides directly from Google Maps, without switching to Uber's app (a feature unavailable to other rideshare businesses)	Google benefitted by keeping users and allowed more data collection; Uber benefitted from faster ride bookings, compared to their competitors
01/2017	Uber generate their own mapping data in Australia	Uber installed cameras on several drivers' cars, collecting imagery and data for routes in various Australian cities	Provided Uber's seamless experience in areas with no detailed maps or street signs; existing mapping solutions previously contained irrelevant information such as ocean topography
02/2017	Uber generate their own mapping data in Singapore	Uber installed cameras on some drivers' cars, to collect imagery and mapping data in Singapore	Improved existing mapping solutions, increased pickup and drop-off location accuracy and built mapping capabilities for future autonomous vehicles
03/2017	Uber introduce their own navigation system	Uber introduced their own navigation system into their driver app (Uber still let drivers choose their preferred navigation app)	Navigation solutions did not fit well with Uber's different services, creating overlapping trips and alternating passenger pickup and drop-off locations

Date	Event	Description	Motivation
05/2017	Uber establish research centre in Toronto	Uber established a new Advanced Technology Group (ATG) branch in Toronto, to work on mapping technology related to autonomous vehicles	Built up mapping capabilities important for future autonomous vehicles
05/2017	Uber integrate and are integrated into Transit	Uber partnered with Transit, to provide public transportation information inside their app. Uber was also integrated into Transit's app, enabling Transit users to get wait times for Uber ride requests without leaving the app	Uber appeared as a complement to public transportation, not a competitor; at the same time, they benefitted from Transit's user network
06/2018	Instant Uber ride booking removed from Google Maps	Google removed the possibility of booking an Uber ride directly from Google Maps; users were once again switched to Uber's app to complete a booking	Not available

Appendix D: First-order concepts

First-Order Concept	References
Attract new users	49
Seamless customer experience	45
Payment is cashless and hassle free	36
Increase payment options for users	36
Mapping technology is the core of future autonomous vehicles	34
Adapt to the local setting	34
Payment is automatically billed to a credit card	33
Location data are essential to run the platform	33
Offering perks and rewards	31
The need for a local payment solution	23
Provide easier access to the platform's app to customers	23
Enhance existing product and services	23
Adapt to regulatory requirements	23
The need for a local solution	21
Respond to the interest of users	20
Buy from a complementor to encourage future investment in the firm	19
Users prefer a complementor over others	19
Address the needs of heterogeneous customers	18

First-Order Concept	References
Bundling features or offers	17
The need to customise technology (payment or mapping)	16
Enabling faster scaling to different markets	14
Build on the network of users of a complementor	14
Build on the existing relationship with a complementor	13
Users do not fully trust Uber	12
Mapping is very important to Uber	12
Third-party solutions cannot be customised	11
A complementor is an investor in Uber	11
Track the car live on the map	10
Existing solutions are not reliable	10
Historic data are important in improving customer experience	9
Increase users' trust in using Uber	7
Existing solutions in the market are not accurate	7
The complementor understands the local environment better than Uber	7
A single complementor may be strong in one area but has weaknesses in others	7
To have a global complementor for payment or mapping service	6
Technology (mapping or payment) is the core of the platform	6
Increase map options for users	6
To have a global payment complementor	5
Reduce the need to switch to other apps	5
Provide a complete experience	5

First-Order Concept	References
Offer new payment features to reduce the price for passengers	5
Make payment easier for overseas customers	5
Building our own solution increases efficiency	5
Reduce fare cost borne by consumers	4
Experiment with a new solution	4
Use mixed resources to customise an element	3
The need for a local map provider	3
Offer customers integration with other frequently used apps	3
Making it easier for new users to sign up on the platform	3
Provide solutions to problems in developing countries	3
Enhancing customer experience	3
Change in the business model	3
Build internal capability (for developing mapping or payment solutions)	3
Supermodular complementarity	2
The performance of the map element affects users' experience greatly	2
Increase the number of users	2
Imitate a competitor	2
Increase in complementor fees	2
Collaborate with a complementor to retain existing customers	2
Buying a solution (mapping or payment) is easier than building from scratch	2
Automate payments for business travellers under one account	2
Attract frequent travellers or customers	2

First-Order Concept	References
An existing complementor is not available elsewhere	2
A complementor becomes a potential competitor	2
Uber needed data for new cities because it did not have historic data (cold start problem)	1
Uber cannot customise the payment solution for each market it enters	1
Third-party service or product does not perfectly fit the needs of the firm	1
The more technology is leveraged to make payments easier, the better	1
Take advantage of the features of another firm's product	1
Reduce payment processing fee	1
Provide consistent experiences	1
Make it easier for passengers and riders (customers) to find each other	1
Hire people in order to refine and study the existing product	1
Growing competition with a complementor	1
Grow customer base	1
Entering payment details just once	1
Difficulty in generating data offered by a complementor	1
Complementor product meets platform development needs	1
Complementor offered a reasonable price for the complementary product or service	1
Centralise payment	1
Benefit from potential marketing and promotional opportunities with a complementor	1
Ability to rapidly test a solution	1
A complementor's product is more affordable	1