The London School of Economics and Political Science

Mobile Payment System: Theory and Cases of Services Modularity

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Declaration

I certify that the thesis I have presented for examination for the MPhil/PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

I declare that my thesis consists of 55,608 words.

Contents

List of Figures

List of Tables

Abstract

This thesis applies modularity theory to services using the case of mobile payment systems. We compare three mobile payment projects—Oi Paggo in Brazil, TCASH in Indonesia, and M-PESA in Kenya—as case studies. The study of modularity is influenced by literature from the field of production and manufacturing sciences and the present work modifies and extends the theory. It also demonstrates the potential of modularity theory in managing complexity, increasing flexibility, and achieving efficiency in the service context.

Modularity is a principle that shows how a system can be designed with subsystems while reducing complex interdependencies via standardised interfaces in order to retain efficiency. Modularity offers greater flexibility through recombination and efficiency through economies of scale from reusability. We sought to find how a service provision can be dissolved into coarse-grained service modules that minimise interdependencies and make the whole system more comprehensible.

We argue that, first, the application of modular thinking in services will be likely affected by three key attributes which differentiate services from products: customer involvement, intertwined elements in the final service offerings, and modular packages that incorporate technical and human attributes. These analytical approaches are likely to be valid in those industries that are particularly technology-intensive and incorporate network effects. Second, contrary to what has been proposed by literature on product modularity, we find empirical evidence in the case of mobile payments that transactions between participants such as customers and regulators were mainly conducted at thick crossing points.

This thesis contributes to the emerging literature on modularity in services. First, we test and validate the theory of modularity in services using the case of mobile payment services. Second, we propose a redefinition of modularity in services that emphasises the peculiar characteristics of service provision. Finally,

we propose an indicative proposition for service modularity that can be used to help better develop modular services.

This thesis also contributes to literature on mobile payments. We posit that technology-intensive services such as mobile payments should be developed and managed in such a modular way. Not only is it associated with flexibility and agility, modular thinking in services allows companies to maximise compatibility in fulfilling customers' needs as well as complying with regulators.

Keywords*: services, modularity, mobile payment, developing countries*

Chapter 1

Introduction

This is a period of increasing changes in heterogeneity of customer demands and shorter technological life cycles. In the context of management of innovation, the main challenge is to improve flexibility and organisational agility without sacrificing operational efficiency.

The power of modularity in manufacturing is widely accepted (i.e. Baldwin, 2015; Baldwin and Clark, 2000; Schilling, 2000), but to what extent can modularity theory explains the dynamics of services sector innovation? Most literature on modularity addresses the manufacturing context and little attention has been given to the concept of modularity in services. This study extends the research agenda by focusing on the concept of modularity in new service development and assessing the empirical evidence from the case of mobile payment systems in developing nations.

This study is both timely and relevant. The mobile payment industries are currently in a transition period where hundreds of tried-but-failed mobile payment solutions appeared, along with some future promising-but-uncertain innovative mobile payment solutions being introduced in the market (Dahlberg et al., 2008; Dahlberg et al., 2015; Dermish et al., 2012; Evans and Pirchio, 2015). This research challenges the generalisability of 'modularisation' in product manufacturing into service development and highlights other findings that are of interest and contribute toward service provision.

1.1 Positioning the work in the literature

Modularity is much discussed in the literature of production, organisational, and supply chain management, but relatively little attention is paid to service modularity (Bask et al., 2010a). Modularity, as core idea in the domain of general systems theory, can be defined as "a very general set of principles for managing complexity. By breaking up a complex system into discrete pieces—which can then communicate with one another only through standardized interfaces within a standardized architecture—one can eliminate what would otherwise be an unmanageable spaghetti tangle of systemic interconnections" (Langlois, 2002, p19). This concept of modularity can be both an organisational characteristic and a technical characteristic, and has implications for both the performance and organisational structure of firms and industries (see Langlois, 2002).

The study of modularity has a long tradition in the context of production and manufacturing, but recently there is increasing attention to the organisational features of modularity. A few scholars take steps toward adopting this approach in the field of services (e.g. Bask et al., 2010a; Brax and Toivonen, 2007; Pekkarinen and Ulkuniemi, 2008; Tuunanen and Cassab, 2011; Voss and Hsuan, 2009). However, little is known about how service modularity should be understood and better developed. Thus, the overall purpose of this research is to study the empirical literature on service modularity, to apply the theory to mobile payments, and to discuss future research opportunities. The underlying question guiding this research is: How is modularity applied in the service context? The approach utilised here is to adopt insights about modularity from production, organisations, and processes, into services.

1.2 Research motivation

This thesis builds upon and extends the idea that services can be modularised (e.g. Bask et al., 2010a; Böttcher and Klingner, 2011; Carlborg and Kindström, 2014; de Blok et al., 2010; Pekkarinen and Ulkuniemi, 2008; Tuunanen and Cassab, 2011; Voss and Hsuan, 2009, among others). Modularity in the service setting allows service providers to create and deliver new service offerings in such a flexible and cost-efficient way. Yet, services have not had a properly modularity treatment. Our central contention, however, is that earlier studies on modularity are rather static in insights and oversimplify the vision of a 'modular world'. Therefore, we need to theorise better about modularity in services. The

questions we address are about how and to what extent modularity can explain the dynamics of services sector innovation.

We argue that a shift to service modularity has taken place in the mobile payment industry. This thesis posits that most of the elements that constitute mobile payment systems utilise a modular principle in order to govern complex interaction among different economic actors. All parts of the system organise complex interactions between economic actors and its constituent parts through mediated interfaces that facilitate flows of information and intense interactions.

1.3 Aims, objectives, and research question

Central to this thesis is how actually modularity is applied in the service sector settings? In particular,

1. How does modularity of services affect the development of mobile payment systems?
2. How does it work, particularly in the context of developing countries?
3. What particular challenges does this context raise and why?
4. What explanation which seemed to work?

In doing so, the thesis have several objectives:

1. To delve into the extent to which modularity is adopted by mobile network operators (MNOs), banks, and other financial institutions
2. To ascertain factors that contribute and impede the adoption of modularity in developing mobile payment services
3. To find out and examine the inhibiting factors that determine the appropriation of modularity in developing mobile payment services

The findings of this research will lend support to the knowledge and understanding of service modularity and its application in service development. In particular, this study is significant in the sense that it will:

1. Allow the identification of the concept and framework of modularity that takes into consideration the notion of service development
2. Support and enrich a theory and model of service modularity that have similarities in their nature with product modularity

3. Provide the framework to examine different combinations of service modularity

1.4 Thesis structure

This thesis offers an exploration related to introduction of this research, review of relevant literatures, research methodology, cases examination, analysis and discussion, and conclusion. Accordingly the thesis is organised into eight consecutive chapters.

Chapter 1 describes the basis of this research. Research background, motivation, aims and objectives, as well as contributions of this study are elaborated in this chapter.

Chapter 2 critically reviews the field of service modularity. Relevant literatures are comprehensively analysed to give the essential knowledge of service modularity and to provide the reader with the present state-of-the-art knowledge in that particular field. This chapter helps to identify a gap in the literature and identify possible methods, techniques, and theories to fill that gap and further advance the debate. This chapter also unpacks the service provision and elaborates the decomposition logics. It links the theoretical gap between the abstract level of the theory of modularity with the lower-level modular framework and components.

Chapter 3 unfolds the research methodology being utilised. In addition, the research purpose and objective, research design, as well as data collection strategy are presented in detail. This chapter also describes the adopted method and justification of the reasoning.

Chapter 4 studies the modular design thinking in the context of mobile payment systems. This chapter reveals how modularity works in practice.

Chapter 5 focuses on the evolution of mobile payment systems. This is particularly important because mobile payment systems are inter-linked products that have precursors and followers. This chapter will also describe the influence of technological advancements towards the dynamics of payment industry.

Chapter 6 is where theory meets practice. It describes the data and results from the field. This chapter also provides a comparative analysis by contrasting the empirical case and explaining how the theoretical gap would be bridged by providing insights from the case.

Chapter 7 synthesises the research and formulates the result and analysis.

Chapter 8 will be the conclusive part of this thesis. This last chapter explains how our research findings address the research aims and objectives. Additionally, this chapter summarises the original contributions to knowledge of the thesis. Finally, our research limitations and opportunities for future work are pointed out.

Chapter 2

Rethinking Modularity in Services

Modularity is a particularly important notion in system design. It is also pivotal in our modern world since the boundaries of current organisational units and firms are expected to conform the boundaries of elemental technological modules ('mirroring'). We briefly discuss the theoretical and empirical literature to clarify the notions of modularity in the service settings. We also explore the problems and limitations of the theory and how can we extend the scholarly discussion in this field.

The basic argument made by our critics is that current literatures adopt modular principle from the production and manufacturing in such a careless way. It did not capture the multi-layered or multi-faceted characteristics of services yet. Another major concern among our ctitics is argument-building on the design choices underpinning the decomposition of service offerings into modules is scarce. The final contention by our critics is that if we want to make the most out of the modular thinking in service development, then we not only need to come up with unified definition, but also clear guidelines on how to utilise the concept in real world situation.

The structure of this chapter is as follows. We analyse a formal definition and application of modularity in Section 2.1. Then Section 2.2 presents the critical analysis of modularity in service setting. After that, in Section 2.3, we discuss how services can be decomposed into coarse-grained modules. Section 2.4 and 2.5 describes the typology of services and decomposition logic consec-

utively. Section 2.6 elaborates modularisation aim and strategy, while Section 2.7 analyse the role of customer at the crossing points. This chapter devoted to guide the theoretical discussion and the empirical analysis for the remainder of the thesis.

2.1 Understanding the context of modularity

As an attribute of complex systems, the concept of modularity is already well-established.[1] Modularity captures the degree of breaking apart a complex system into smaller subsystems (modules) that can be integrated in various schemes (Simon, 1962). A modular system is developed on many loosely-coupled components, whilst a non-modular system is made up a one big formation where everything depends on everything else (Baldwin and Clark, 2000).

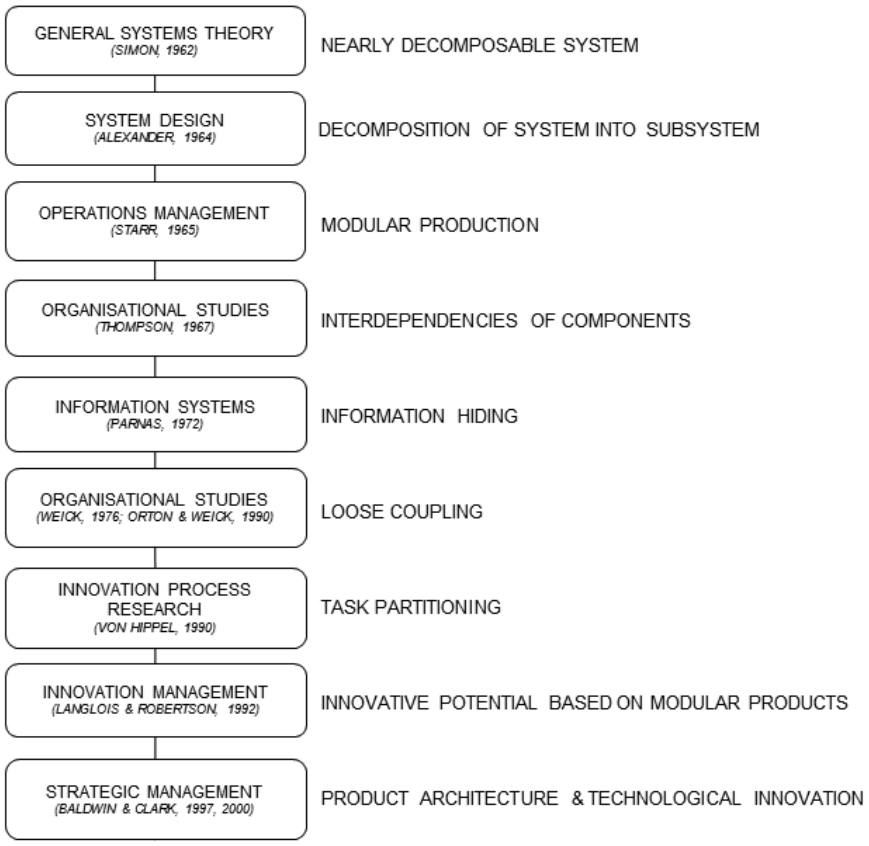
This terminology goes back to the design theorist, Christopher Alexander (1964) and the polymath, Herbert Simon's (1962; 1969) contribution to the design theory. Although they do not use the term 'modularity', both propose the distinction between decomposable and non-decomposable systems, and how to handle complexity by decomposing those into smaller subsystems.[2] Modularity has been discussed in a wide variety of system types with modular structure setting, e.g. buildings, biological structure, cognitive science, languages, software and enterprises, to organisation theory.

After Simon and Alexander, Martin Starr (1965) discussed modularity as a true variety of production strategy to satisfy what markets are looking for. Two years later, James Thompson (1967) hypothesises coordination mechanisms used in response to different pattern of dependencies. In about the same decade, a computer scientist, David Parnas (1972) suggested modularisation as a tool for managing complexity in software systems. He put forward the idea of information hiding, where each individual module conceals the information of particular design strategy from the rest of the modules in the systems. Interfaces between

[1] We should not confuse 'complex' with 'complicated' system. Complicated system tend to be more linear, determined, resulting in such controllable and predictable consequences. Complex system usually more adaptive, resulting in more innovative and unprecedented outcomes.

[2] Using the watchmakers as an illustration, Simon (1962) studied that a complex system could be hierarchically managed as a series of inter-related subsystems until the bottom level of elementary that we can achieve. Meanwhile, Alexander (1964) observed that no complex system will succedd unless they proceed to adapt in subsystem level that independent relatively to each other. Both credited the idea of 'selection by components' to an English psychiatrist and a pioneer in cybernetics, William Ross Ashby (1952).

Figure 2.1: Development of modularity study



Source: Author

those modules are designated to open up as few as plausible of their internal operations in order to minimise coordination costs.[3] However, it was Karl Weick (1976) who introduced the notion of loose coupling to organisational studies. He opened up an idea how social organisation interact in exchange relationships, borrowing the conceptual framework that formerly implemented in the computer science.

The more contemporary study of modularity perhaps can be followed back to the influential work of Carliss Baldwin and Kim Clark (1997, 2000) on product

[3]The knowledge about design decision in every module must be limited from the outside. Every team should know everything about their own module but only a few knowledge about other modules. As long as the changes only affect hidden partition, they would be considerably easier to implement. In the end, information hiding will help in making a complex system not only more adaptive, but also evolvable.

architecture and technological innovation; Richard Langlois and Paul Robertson's (1992) on industries' innovative potential that are based on modular products, as well as Eric von Hippel's (1990) work on task partitioning (see Figure 2.1). Karl Ulrich (1995) presented the idea of modular architecture that can be identified by a one-to-one functions plotting to decoupled interfaces and components.[4]

Melissa Schilling (2000) added her contribution by proposing the notion of reconfigurability of modular systems.[5] Although such concepts relate directly to the study of technological design (Alexander, 1964; Simon, 1962), they became more important recently due to the rise of modern technology (Baldwin and Clark, 1997). Given the enormous challenges of coordinating complex interdependent tasks, theorists have preferred to suggest that the formal structure of a design and development organisation ought to 'mirror' the configuration of a system being developed (e.g., Baldwin and Clark, 2000; Langlois, 2002; Orton and Weick, 1990; Sanchez and Mahoney, 1996; Von Hippel, 1990).[6]

One commonly cited case of inter-firm modularity is the shift in the computer manufacturing sector from a series of vertically integrated business organisations (de-verticalisation) to a group of horizontal sub-industries, for example processors, CPUs, monitors, hard disk drive (HDD), floppy disk drives (FDD), compact disc (CD), keyboard/mouse, printers and scanners, and application software (e.g. Baldwin and Clark, 2000; Miozzo and Grimshaw, 2005; Parnas, 1972).

In the 1950s, IBM established a Standard Modular System to apply mass production strategies and rationalising IBM's complex product line while minimising cost of upgrade for the customers at the same time. This project resulted in IBM System/360 in 1967, which was the earliest computer to be developed as a fully-interoperable modular systems, that not only a technological breakthrough but also an economically profitable (Baldwin and Clark, 2000). This change resulted in modular products and process structure that will potentially

[4]Karl Ulrich's (1995) definition on modularity tend to be different than the others in a sense that he relies on a predetermined stable list of functions that making it more appropriate and relevant in the ecosystems that are more well understood.

[5]Since a modular system generates heterogeneous outputs from heterogeneous inputs, it will satisfy consumer demands in variety. However, if the consumers preferred the same products, then modular design probably become irrelevant.

[6]The first stream of organisational modularity argue that modularity favours vertical disintegration (e.g. Baldwin and Clark, 2000), in accordance with the 'vanishing hand' of Langlois (2003). The second stream of organisational modularity posit that modularisation of the complex systems needs knowledge in the particular field and, if outsourcing is possible, will entail tight relationships with the suppliers (e.g. Prencipe et al., 2003).

disrupt the dominant players and change the industries.

Back in those days, there were just three computer projects available, where all of them were tightly-coupled and densely integrated. Thirty years later, however, there were hundreds of thousands of computer firms developing modules for each other (Baldwin and Clark, 2000). This shift to modular design then widely spread into other products and manufacturing design, i.e. automobile production (Pine II, 1993), everyday consumer purchases (Arnheiter and Harren, 2006) among others.

Even though have been researched in many different settings since the mid-1960s, modularisation processes does not always ended up with beautiful stories.[7] Modularity has its own pros and cons. On one hand, modularity create the whole system structure more comprehensible, making it easy to replace the components and distribute work among different groups of designer without them need to know the total structure of the system, which in turn, will reduce the effect that alterations in one part of the system have on the others (Baldwin and Clark, 2000; Orton and Weick, 1990; Parnas, 1972; Sanchez and Mahoney, 1996). In the same spirit, Schilling (2000) pointed out the ability of modular process to allow various configuration of the systems that will eventually prevent vendor lock-in due to standardisation.

On the other hand, however, modularity limits the design creativity since it requires well-defined interfaces, results in less than optimal performance since it using generic modules, overuses the same module within too many product varities, and requires a lot of time and budget in replacing the whole module while only one component (sub-module) within the system is faulty (Arnheiter and Harren, 2006). There is also a possibility of making very costly interfaces for some very specific modules, while for the system integrators (assemblers) can be burdensome in assesing the quality and interaction of different modules, thus making it difficult to integrate and assemble the modules (Arnheiter and Harren, 2006; Schilling, 2000). Finally, technological advancement does not always go hand-in-hand accordingly with the higher levels of modularity—sometimes,

[7] IBM developed a Standard Modular System in the 1950s to allow mass production and reduce cost in manufacturing transistor circuits that resulted in System/360, the first modular computer machine, that were binary compatible. Even though the project was a big success, the effort to modularise its system software was a total failure (Baldwin and Clark, 2000). They initially ordered 40 subprojects and more than a thousand engineers to build the system software, but unaware with the problems that came up among the code modules making the project fell further behind. The main architect of System/360, Frederick Brooks, believed that modular thinking cannot be applied in system software development. He failed to realise the information hiding principle in software design (Parnas, 1972).

interdependencies might lead to efficiency and better performance (Fixson and Park, 2008).[8]

Borrowing the concept from engineering literature, Baldwin and Clark (2000) illustrate the notion of modularisation process. A nonmodular systems have various dependencies among different elements, so that an alteration in one module will need alterations in other modules as well, that eventually will spread throughout the whole system. Moreover, the use of modularity followed Clark's (1985) assumption of one design hierarchy. This requires a prior information and knowledge on particular interdependencies as well as on how to manage them throughout a hierarchical modular design rules (Baldwin, 2015).

The modularisation process usually starts with identification of interdependencies, removal of the dependency using a 'design rule', elimination of the unwanted dependencies across different 'blocks' and retain the fruitful dependencies within blocks via systematic repetition of the previous steps, until the structure of the systems become modular (Baldwin and Clark, 2000). On one hand, the system will be interconnected within its smaller subsystems, but on the other hand, it will be independent across subsystems, except for design rules.

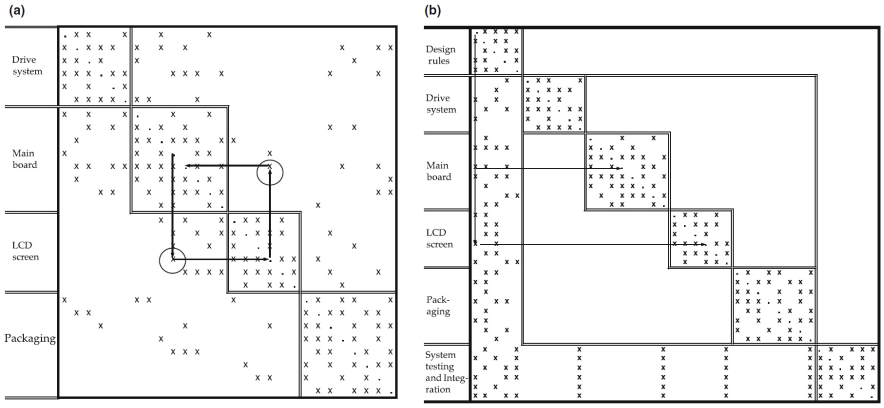
The process of modularisation are highly relevant for digital and electronic artifacts with the high benefits and cost that tend to be low since they are intrinsically easier to divided into independent subsystems (Baldwin and Clark, 2000). Modularisation also seems to be more suitable when customers prefer the possibility to mix-and-match according their own needs or the possibility for futher upgrade and additions later on.[9] Indeed, modularisation is a process that varies across different settings and time.

The process of modularisation can be described utilising a design structure matrix (DSM) (e.g. Eppinger, 1991; Eppinger and Browning, 2012). A DSM illustrates the design of a complex system in a set of columns and rows of a square matrix. If modifying one particular design selection affects another selection, an 'x' can be placed in the column of the first selection as well as the second row. Figure 2.2 portrays a hypothetical DSM for a laptop including four main components: main board, disk drive, LCD, and packaging. The left matrix shows the design before modularisation with lots of out-of-block x's describing the interdependency among different components (i.e. modify the LCD will

[8] Using the case of Shimano drive trains, nonmodular bicycle index-shiting system proved to be more superior and replaced older systems quickly (Fixson and Park, 2008).

[9] If consumers want the same product, it probably will make more sense to develop components separately and sell them as an indivisable unit (Schilling, 2000).

Figure 2.2: The process of modularisation



Source: Baldwin and Clark (2000)

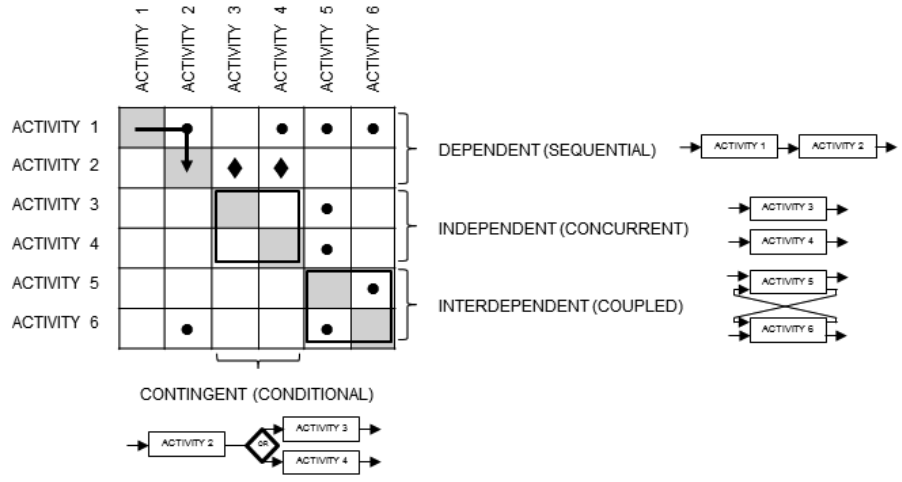
affect the main board and so on).[10]

The modularisation process begin with identification of unwanted dependency due to technical cause, then develop a 'standard' or 'design rule' to eliminate that dependency (generalisable procedure). As long as every groups follows that orders, they are allowed to independently make decisions of the other groups. When this steps followed consistently, dependencies across components will minimise and the whole system become 'near decomposable'—tightly-coupled within components but loosely-coupled across components (Baldwin and Clark, 2000). The right matrix shows the design after modularisation without out-of-block dependencies, illustrate that change on every component could be done separately from the others. The new arrows show hierarchical dependencies and replace cyclical dependencies among component decisions. Design rules have to be formed and communicated before the process begin, while testing and integration of the systems are required after the process to take the whole modules, test the entire systems, and address unexpected possible incompatibilities (Baldwin and Clark, 2000).

A DSM portrays system decomposition or partitioning into smaller subsystems (see Figure 2.3). Intelligent decomposition is particularly significant in managing a complex system (Alexander, 1964). Consequently, this architectural decomposition scheme allows system design and integration easier and

[10]The arrows illustrate the stream of selections that forms a loop between the LCD and the main board, thus, design process should flows between those components and adjust each other until they are fully compatible.

Figure 2.3: Activity relationships portrayed in a design structure matrix (DSM)



Source: Adopted from Bowning (2001)

more manageable. The significance of informed and intelligent decomposition has resulted in a number of matrix-based models. Normally, the system engineering process requires the following stages: 1) decomposing system into smaller elementes, 2) understanding the interactions between those elements and documenting it, and 3) analysing the possibility to reintegrate those elements through clustering (Eppinger and Browning, 2012). Every development project of a complex system includes these stages, even though they are not constantly approached in such a systematic or innovative way.

Some activities are perhaps highly decomposable and can be easily taken out or sequenced into the next phases without having to affect the whole project. A project that can be decomposed into activities that have few interaction with one another can be defined as decomposable project into modular task. Modularisation is the process of breaking apart those tasks and activities that are self-contained and well-defined, but can work effectively with other units (Baldwin and Clark, 2000). These units can be easily serve as a basis for organising production in the market or by contract, rather than through a hierarchical governance (Blair et al., 2011). Production activities that is highly decomposable can be more easily organised through markets and contracts rather than those that are non-decomposable.

Standardisation[11] facilitates modularisation process as it creates common language about technical performance, characteristic, measurement, as well as coordination and enforcement (Blair et al., 2011). Standardisation also enables firm participants to interact not only within the firm, but also with other unit outside of the firm. In a case of technology-intensive sector, in which most of the attributes are being standardised, transaction[12] become easier and modularisation become more attractive.

Processes, products, as well as organisations are a representation of a complex system (Alexander, 1964). The traditional approach to understand a complex system is to model it, by breaking it down into subsystems where we relatively know more, taking into account the integration and relationships between the subsystems that build up to the system's behaviour, and observing the external inputs as well as outputs with regard to their effect to the system (Baldwin and Clark, 2000). Places in the DSM that involve only a single transfer or several transfers between blocks are called "thin crossing points," while spots with many transfers and participants are defined as "thick crossing points." Baldwin (2007) posits that in technology production, transaction should be conducted at thin crossing points since interaction at thick crossing points are too costly to identify, measure, and compensate.

At its very core, the notion of modularity emphasises a set of activities in production systems that are dependent and interconnected with activities at other phases (Baldwin and Clark, 2000; Langlois, 2002). In the economic literature, most scholars conform with Coase (1937) on "make or buy" decision in relation with transactions costs, yet they do not come into conclusion over what attributes that cause transaction cost higher (or lower) in the internal production than in the market. In some cases, high-powered incentives can increase productivity and profitability (Holmstrom and Milgrom, 1994). However, in the context where the different stages of the production process are interdependent, high-powered incentives may no longer economically feasible and wasteful.

Interdependencies came from a specific investment in particular assets made

[11] The first case of industrial standardisation was probably at Harpers Ferry, in Virginia, United States, when John H. Hall developed his engineering tools, including gauging methods, machinery equipment, as well as completely interchangeable procedure for standardised rifle parts in late 1790s and early 1800s. Yet, Hall was considered to be a "Yankee in the garden" and they maintained resistance to the technological change. See *Harpers Ferry Armory and the New Technology: The Challenge of Change* by Smith, M.R. (Ithaca: Cornell University Press, 1977).

[12] Baldwin (2007) distinguish "transaction" and "transfer". Transaction are mutually-agreed with compensatory exchange, while transfer usually less formal, without prior agreement, and no measurement, evaluation, nor compensation.

by a party to the firm. Others affiliated with the firm can take advantage of this peculiar investment by forcing greater risks or requesting higher profit share. Thus, the party investing into the firm become vulnerable to this "hold up" as those assets will not generate optimal return without full cooperation from other parties (Williamson, 1985). Often times, it would be much cheaper and easier to distribute the various phases within a single firm, so that the managers are able to make the joint enterprise become more efficient and the participant will have less incentives and opportunities to demand more profit or push costs onto another party within the entity (Klein et al., 1978).

In the management literature, interdependencies arises from the technological discrepancies between production activities in the firm and other activities carried out accross firms (Baldwin and Clark, 2000). Thus, if the activities within the firm can be packaged into "modular" units, interdependencies between units become significantly minimised. The greater modular differences among those activities, the more independent, and the easier it supposed to be to regulate the dynamic coordinations and communications between different parties taking out the activities through legal contracts (formal) rather than by hierarchical arrangements (informal) inside the firm (Blair et al., 2011).

In the case of private enterprises, perhaps hierarchical arrangements will solve most of the problems. Each manager of the participant firms in the cooperation mutually agree to establish credible commitments to work together without having to become opportunist to the others (Williamson, 1983). Hierarchy and interdependency in production activities are closely linked to knowledge transfers.

In the field of management studies, some literatures attempt to seek the ways organisations "knows" things. It might initially started with tacit knowledge carried out by employees that eventually embedded in the routines adopted in the production activities. This special knowledge allows firms to acquire "rents" from producing goods and services that are worth more value on the market compared to the total of the costs of opportunity against all of its inputs (Blair et al., 2011). On one hand, firms should pay more attention on its core competencies and build the boundaries of firms to protect its valuable knowledge (Nelson and Winter, 1982). On the other hand, hierarchical arrangements is required to enable the efficient knowledge transfer within the firm without divulging any knowledge outside the firm (Kogut and Zander, 1992).

All in all, modular principle can be used to manage the complex and opaque transfers involved in projects and activities that difficult to be eliminated into

modules (Blair et al., 2011). This is in line with both Coasian (1937) and Williamsonian (1979) principle in governing the structure of the organisation in order to minimise transaction costs. The difference is that modular principle focuses on getting the task done by connecting tasks and transfers in a network, not by manipulating information and incentives to get the parties do the jobs. The transaction costs will be at the minimum level, according to Baldwin (2007), if the firms' boundaries are situated at the thin crossing points. This way, any exchanges could be facilitated as regular transactions and thus regulated by plain and straightforward market exchanges or through formalised legal agreements where the item that being traded and/or swapped can readily be recognised, calculated, and thus, compensated.

While the theory posits that in principle, modularity proposes a powerful and efective tool for adapting to uncertainty and managing complexity, the realisation of modularisation in practice appear to exhibit a complicated design challenge as well. This challenge can leads to uncertainties in itself. Furthermore, even though modularity in general has been introduced decades ago, we still do not have such unified definition. For instance, Baldwin and Clark (2000) and Baldwin (2015) describe modularity as developing a complex process or product by combining smaller independent subsystems, while Starr (1965) explains modularity as capacities to develop and produce different parts that could be assembled in various ways.[13]

2.2 Modularity in services: How it differs

Subsequent studies on modularity have taken steps forward into services setting (e.g. Bask et al., 2010a; Carlborg and Kindström, 2014; Pekkarinen and Ulkuniemi, 2008; Voss and Hsuan, 2009) since services are widely regarded to be the main driver for growth and profitability (Chesbrough and Spohrer, 2006). Firms are increasingly developing new service offerings and business models that mix tangible products and intangible services (servitisation) (Vandermerwe and Rada, 1988). Service modularisation believed to be a rational approach to achieve this purpose (Bask et al., 2011; Pekkarinen and Ulkuniemi, 2008; Raja-

[13] According to operations management literature, modularity is about component combinability or mix-and-match of components from the available set to obtain various product configurations (Salvador, 2007). Mass customisation is also a terminology that usually goes hand in hand with modularity and quite widely researched, however, mass customisation usually defined rather broadly by presenting efficient custom services or products through mass production (Duray, 2002).

honka et al., 2013; Voss and Hsuan, 2009). Modular design thinking have been proposed to bring variety at considerably low costs (de Blok et al., 2010; Tuunanen and Cassab, 2011; Voss and Hsuan, 2009). Thus, modularity in services considered to be an emerging research area that are worth to study closely.

Baldwin and Clark (1997) explained the importance of modularity for services. They posit that some services, for example in the financial services sector, are also being modularised. Because finance is highly developed and sophisticated, services in the financial sectors are rather straightforward to define, to examine, and to split apart (Baldwin and Clark, 1997). Liebenau et al. (2014) argue that the models of modularity and network integration are relevant in improving our understanding of emerging innovation in banking sector.

Hyötyläinen and Möller (2007) argue that modularisation focuses on collecting individual attributes so that the attributes in that particular module have not only as much similarities as possible but also are as reusable as possible as well.[14] In the context of human-intensive sectors, every kind of technology must be used systematically to industrialise services (Hyötyläinen and Möller, 2007).[15] In this case, it should be relatively simple to exchange the modules, via different sourcing options. New software modules, services providers, business partners, and suppliers can be attached or removed easily; without any negative operational effect. Pekkarinen and Ulkuniemi (2008) describe service modularity as a method to organise heterogeneity in customer demand and hypothesise that a modular service would also need modular processes and organisational architectures that accommodate such processes.[16]

In general, modularity can efficiently deliver services that require high degrees of customisation (Bask et al., 2010a; Böhmann et al., 2003; Meyer and DeTore, 2001; Nakano, 2011; Pekkarinen and Ulkuniemi, 2008). Modularisation offers at least three objectives, it: (1) makes complexity more manageable, (2) facilitates improvement and parallel work, and (3) enables adaptability to cope

[14] Indeed, the level of standardisation will differ according to strategic choices of the service provider (Lampel and Mintzberg, 1996). Some services can be pacakged and delivered as standard specification, while some other services requires high degree of customisation according to the customer's specific needs.

[15] Software design can provide an example how modular service works: coding is conducted in Bangalore, while interface design is developed separately in San Francisco. Even though the process modules of software development are conducted in various locations, the interface allows the information flow and keeps it interdependent.

[16] Modularity in services also needs some level of modularity in organisations to facilitate the utilisation of the core capabilities of the firm. Indeed, for many, or even most, service providers, this is particularly challenging since it needs significant effort to change and redesign their current architectural and operational processes at the operational or functional level.

with uncertainty (Baldwin and Clark, 2000). The potential advantages most frequently linked with services are that modular structure provides a basis for customisation, postponements of products, as well as outsourcing (Voss and Hsuan, 2009).

However, modularity is not necessarily the best tools achieve the optimal return policy and to satisfy customer demand (Schilling, 2000).[17] If the customer have different needs but the input is relatively homogeneous, scale flexibility can be obtained from modularity but perhaps unable to increase the plausible service configuration scope (Schilling, 2000). Thus, modularising services is definitely not a cure for all ills but it can generate significant advantages if implemented in the suitable context.

Modularity and its impacts on services can also be reviewed at various stages: (1) modularity at the organisational level, supply chain level, industry level, and network level, (2) modularity at the process level or service production level, and (3) modularity at service product level (Pekkarinen and Ulkuniemi, 2008). Every module of a service could be viewed as a single or multiple service packages delivering one attribute of a service. Process modules are indivisible, standardised process stages. With regard to the organisational level, modularity can be explained as the combination of multiple divisions inside the firm in order to reduce complexity of services and to attain higher flexibility in responding to service variety.[18]

Similarly, Bask et al. (2011) and Rahikka et al. (2011) divide service modularity at several different levels: modular service offerings, modular processes, and modular organisations. Service offerings refers to pre-built packages, processes refers to decompositioning processes into customised and standardised modules that are to be delivered independently and recombined into customisable service provision, while modular organisations refers to the organisation that allows flexibility to allocate personnel and resources within or outside the firm.

Although empirical and theoretical studies on modularity provided interesting insights on production and organisation, we must humbly admit that we know preciously very little on the application of modularity in services innova-

[17] In the case where the input are heterogeneous, but demand are similar or identical, the non-modular system is more cost efficient. Conversely, when input are homogeneous and demand are heterogeneous, the modular system is superior (Schilling, 2000).

[18] Some issues most commonly referred to modularity in services are for instance standardisation of interfaces, packaging of functionalities, and substitution and reusability of modules within the system (Pekkarinen and Ulkuniemi, 2008).

tion. Despite being widely studied in physical goods and production context, adopting the modular thinking into services might be problematic because of the generally observed distinctive characteristics between products and services (Voss and Hsuan, 2009). Thus, the implementation of services modularity will tended to be affected by several attributes that differentiate services provision from products generation.

Broadly speaking, services can be described as production processes that difficult to be stored and has to be produced at about the same time it consumed.[19] Thus, the consumer is being included in the service production activities and is becoming a service co-producer along with the service producer (Nakano, 2011). Due to this peculiar characteristics of services, both process and product are merged in the final service package (e.g. Van Der Aa and Elfring, 2002). Furthermore, the pivotal role of people is also another distinctive services attribute. As services being produced in close relationships between consumers and producers, thus, modular service deliverables will incorporate both human elements and technical attributes (Meyer and DeTore, 2001; Nakano, 2011; Pekkarinen and Ulkuniemi, 2008; Spring and Santos, 2014; Voss and Hsuan, 2009).

Another central attribute of service modularity is the concept of interfaces (e.g. Baldwin and Clark, 2000; Pekkarinen and Ulkuniemi, 2008; Schilling, 2000; Spring and Santos, 2014; Voss and Hsuan, 2009). Meanwhile, de Blok et al. (2014) define interface in services as the way in which two service components or service providers interact in a modular service system. Modular interfaces explain how different elements in a system can mutually interact among each other (Salvador, 2007). Interfaces provides common rules to control the interdependencies between the modules and ties the service modules altogether (Pekkarinen and Ulkuniemi, 2008). Similarly, de Blok et al. (2014) posit that modular interfaces play an important role in service delivery.[20]

Modular interfaces in services are usually seen as helping the flow of information and client movement from one stage engaged in service provision to the next; while in product modularity, interfaces are generally standardised and organise the interdependencies across different physical components that constitute the final products offering (Pekkarinen and Ulkuniemi, 2008; Rahikka et al.,

[19] Even on the regulation level, for example, *Regulation (EC) No 138/2004 of the European Parliament and of the Council of 5 December 2003* acknowledge that "Services are recorded at the time of purchase. Since services cannot be stored, the time of purchase is also the time of consumption" (2.023).

[20] Interfaces are generally consist of both tangible and intangible interactions between people, processes and procedures, as well as information flows. This might involve different service providers at different levels, from highly specialised to process-driven services.

2011; Tuunanen and Cassab, 2011; Voss and Hsuan, 2009). In modular services, a final service offering will be a mixture of one or several service elements or processes (Pekkarinen and Ulkuniemi, 2008).

Although the discussion on modularity in general has highlighted the linkage between product development and organisational architecture indicating that products with highly modular characteristics will result in more modular organisations (Baldwin and Clark, 2000; Sanchez and Mahoney, 1996; Schilling, 2000; Von Hippel, 1990), recent literatures have shown that this is not always the case[21] as product architecture and organisational architecture follow distinctive dynamics.

There is also several contesting paradigm in apprehending the modularity construct and underlying meanings (for example Campagnolo and Camuffo, 2010; Carlborg and Kindström, 2014; D'Adderio and Pollock, 2014; Gershenson et al., 2003, 2004). In the conceptual linkage between with loose coupling, for example, Orton and Weick (1990) suggest that relationship between modularity and the notion of loose coupling is causal; Schilling and Steensma (2001) posit that those two concepts are similar; Sanchez (1999) as well as Sanchez and Mahoney (1996) swap the aforementioned relationship; while Lei et al. (1996) relate the notion of loose coupling with integration.[22]

With regard to services in particular, there is also no single agreement in viewing modularity as a theoretical concept. For instance, Bask et al. (2010a) believe that modular strategy is a hidden property that should not be visible to the customers. However, Pekkarinen and Ulkuniemi (2008) perceive modular concept as a component of the final service offerings and thus the underlying processes and resources ought to be visible one the customer's side. They also propose the three dimensions of services modularity as: services, processes, and organisation (Pekkarinen and Ulkuniemi, 2008).

If a firm decides to build and deliver modular services provision, they have to develop an architecture that merges them (Pekkarinen and Ulkuniemi, 2008). In the context of modular principle in services, this is particularly interesting as service delivery systems are designed in a way that they are usually related to the organisational designs. The provision of services thus not only about

[21] For instance, Brusoni and Prencipe, 2001; Brusoni and Prencipe, 2006; Campagnolo and Camuffo, 2010; Carlborg and Kindström, 2014; Miozzo and Grimshaw, 2005; Zirpoli and Becker, 2011.

[22] There is also few studies exploring the inter-relationships and the design implications of service functions, service processes, as well as supply chain configuration, for the development of appropriate service operations strategies.

exploiting and integrating technical resources but also requires organisational capabilities. To appreciate the development of modularity in services and the ramifications of such service provision structure, it then would appear to be mandatory to incorporate organisational paradigms that are considerate to the aspect of social attributes in the provision of service.

Yet, most literature on modularity focuses only on a technical perspective—the capability to frequently dissolve as an assumption not being the focus of study (object). Within this paradigm, it is reckoned that the firm can anticipate interdependencies beforehand and that an architecture of modular products or services can be established. However, if the firm unable to exactly specify the interface and find that the architecture are imperfect, it will challenge the assumed embedded communication and interaction which is considerably expected as a result of modular architectures. Rather, it poses some concerns of what and how managers deal with such situation where unexpected happen or interface problems occured. This compelling concern has not attracted many interest in the empirical studies on services modularity.[23]

Unfortunately, there has been very few implementation of the notion of 'architecture' or 'modularity' in either services design and services development. The explanations for this could be the variety of service provision, the role of human involvement in service personalisation and customisation, and the inherent characteristics of the services as both processes and products (Voss and Hsuan, 2009). With regard to empirical methodology, to the best of our knowledge, it appears that we could not find any works on modularity in services utilising market-level data (quantitative data).

Furthermore, most empirical works emphasise on service modularity within a single company (e.g. de Blok et al., 2010; Hyötyläinen and Möller, 2007; Lin and Pekkarinen, 2011). Even though there appears to be adoption from product modularity and manufacturing modularity to services (e.g. Bask et al., 2010a), however, to what extent the theory established for the examination of product and manufacturing modularity are applicable in service-related modularity context is an unsettled question.

[23] Based on our empirical observations, it appears to be not only relevant but also particularly important to address that question to realise and appreciate the role as well as the implications of modular principle in the case of services settings.

2.3 On decomposing services

From our literature review, like modularity, there is no single definition of services. Judd (1964) described services as "a market transaction by an enterprise or an entrepreneur where the object of the market transaction is other than the transfer of ownership (and title, if any) of a tangible commodity" (p59). Meanwhile, Vargo and Lusch (2004a) defined it as "the application of specialized competences (knowledge and skills) through deeds, processes, and performances for the benefit of another entity or the entity itself" (p2).

Service offerings can also be portrayed as a mixture of intra-organisation elements of accessibility, personal market communication and auxiliary services, that are being managed and controlled by the marketer (Grönroos, 1978). Devlin (1998), on the other hand, posits that service offerings consist of a competitive package of organisation's resources to deliver superior value to the customer. Conversely, Vargo and Lusch (2008) hypotesised that organisation can only offer resources which yield service in the customer's value creating phases.

With regard to value creation and value delivery to the customer, there is a debate between servitisation vs. productisation. The term "servitisation" was initially proposed by Vandermerwe and Rada (1988) which argue that business organisations can create value in use and deliver it by adding services into the products. The term "productisation", which implies including a service component or a product component into services to be marketed as a product, was first introduced by Baines et al. (2007). Both servitisation and productisation can be applied along different dimensions and that both are vary in the product-service continuum (Oliva and Kallenberg, 2003)—on one hand, there are physical products with add-on services, while on the other hand, there are services with add-on physical products.

Developing service, thus, is about creating necessary condition for services that are valuable for customers (Edvardsson and Olsson, 1996). Service organisation cannot develop nor sell services as such, yet they develop prerequisites for services and offer value propositions—the actual value is created by combining the customer's value creation process with the organisation's resources (Vargo and Lusch, 2008). The prerequisites for service development can be categorised into: service concept (description of the needs and how to satisfy it), service process (activities needed to develop such service), and service systems (resources needed to support the process and realise the benefit) (Edvardsson and Olsson, 1996).

Service concept can also be elaborated into more detail as the benefit of service delivered to the customer (Heskett, 1986), or the representation of the customer's needs and how the customer's needs are going to be fulfilled by service package (Edvardsson and Olsson, 1996). More broadly, Goldstein et al. (2002) defined service concept as the integration between customer needs, core service, service delivery, and organisation's strategic intent. In the same spirit, Johnston and Clark (2005) describe service concept as the whole experience of core services delivered to the customer, customer's experience during the process, including the results and benefits from service delivery. Even though those definitions are rather divergent, we can probably summarise the service concept as what are the customer needs, how to satisfy those needs, and what are the core services to satisfy those needs.

A study by de Brentani (1989) indicates that services which are successful in terms of competitive performance have a new core benefit. Cooper and de Brentani (1991) found that fit with customer needs and product advantage over existing offerings are the second and third most important determinants of new service success. Yet, it is not always evident in empirical studies on new service development (NSD) what the core service concept under development is.

Silvestro and Silvestro (2003) investigate the core content of the service and the customer need that it fulfils and clearly indicates the need for the development of different service system elements, such as facilities, telephony and expert systems, to provide the value with the developed service offering. Silvestro and Silvestro (2003) highlight that a clearly defined service concept is a prerequisite "which marries the requirements of the target market(s) and the operational capabilities of the organisation, and against which their activities can be meaningfully evaluated" (p402). Consequently, the misalignment between the concept of service, the service delivery system, as well as the service process itself seems to be difficult to reverse in later stages. Furthermore, the authors point out that it is not enough that the service concept is clear with explicit strategic objectives; it should also be translated into explicit service specifications to ensure consistent service provision.

The study by Windrum and Garcia-Goni (2008) addresses a radically novel and contemporary health care service. In principle, they agree with Silvestro and Silvestro (2003). In addition, they argue that radical conceptual and organisational innovation does not require only changes in the organisation of resources by the service provider itself, but also those of the customers. In many studies,

the service concept is considered as a systemic approach to study service production (elements) and delivery (process) (e.g. Stevens and Dimitriadis, 2004). This, too, requires the formalisation of ideas (Stevens and Dimitriadis, 2004) but their unit of examination has been the development project instead of the service concept per se.

Few papers addressed the development of the ways of communicating about the service offering and its core benefit. Stevens and Dimitriadis (2004) point out that the service concept requires formalisation which enables the explicit description of final outcomes and process. In other words, customers need to know about the new features in the service offering before they become effective. Communication is important not only in terms of training customers, but also the salesmen within the company (Shulver, 2005), and external distributors in the company's network (Lenfle and Midler, 2009), as they need to be capable of communicating about the new features.

Service process related to a set of tasks and activities required to create and deliver the service concept (Edvardsson and Olsson, 1996). Some of these process happened behind the closed door inside the company whilst some of them need customer involvement or taking place in the customer interface (Mayer et al., 2003; Shostack, 1984). Customers, at least to some extent, participate in the service process (Grönroos, 1990; Williams and Anderson, 2005). This participation not only making the front-stage and back-stage intertwined, but also brings some sort of variability which implies that the company do not control the whole process (Larsson and Bowen, 1989). Thus, customer requirements must be clearly defined in advance before the company start producing and delivering the service (Fließ and Kleinaltenkamp, 2004; Larsson and Bowen, 1989).[24] Mayer et al. (2003) posit that the service process will be advised by the service system structures.[25]

Most studies indicated a need to change the processes and operations related to service production and service delivery. Windrum and Garcia-Goni (2008), Stevens and Dimitriadis (2004; 2005), and Stuart (1998) report projects where

[24] There are different opinions regarding to what extent we can define service process in advance, i.e. according degree of labour intensity as well as customisation and interaction level, demand diversity and customer participation (input uncertainty (Larsson and Bowen, 1989).

[25] In many service systems, technology such as information systems are very important (Chase and Hayes, 1991). Developing technology-based environments to create and deliver services is at the same time develop the service process. Indeed, in knowledge-intensive service setting, such as mobile payment services, identifying what, when, where, and how input from the customers will be processed is very uncertain and challenging (Larsson and Bowen, 1989).

the development of the service process forms a major portion of the new service development project. Particularly when the service concept is new to the company, changes are required in the internal processes (Silvestro and Silvestro, 2003).

With reference to internal, "back-stage" processes, studies by Stevens and Dimitriadis (2004; 2005) highlight the importance of formal service process planning and routinisation to ensure consistent production and delivery of the service. To some extent, these changes in the process are initiated by the change in the service concept (Windrum and Garcia-Goni, 2008). The level of changes in the service process is linked with the radicality of the change in the service concept (Stuart, 1998). Sometimes the focus seems to be purely on a new way of organising the process without changes in the core service concept (Chai, 2005).

In fact, Chai (2005) suggest that the main concern should be the service context and service activities, which are less experience-dependent service attributes. His view differs from the approach of defining the value proposition to customers and only then organising the service production accordingly. In their approach, the service process is first developed and only then the auxiliary service concepts are defined. Some papers addressed the development of new ways of delivering the service (Chai, 2005; Shulver, 2005; Stevens and Dimitriadis, 2004; 2005; Windrum and Garcia-Goni, 2008). According to this approach, the core value proposition of service concepts may remain untouched but the delivery changes the value proposition of the service provider. For instance, Stevens and Dimitriadis (2005) present a case in which existing financial products are bundled and delivered as a new offer. These kinds of changes require also changes in the service system.

Service system, according to Edvardsson and Olsson (1996), is the resources needed or readily available to the processing of service in order to carry out the service concept. Physical resources such as the environment or the appearance of the staff form the 'foundation' for the service process (Williams and Anderson, 2005). In general, the staff's characteristics, skills, competence, or expertise also have a pivotal role in shaping the service offering. Another inherent factor is the customers contribution (Larsson and Bowen, 1989; Sampson, 2000), thus making them aware and involving them during this co-creation process is mandatory (Edvardsson and Olsson, 1996). Furthermore, the structure of service system plays an important role to the co-creation stage in the service process (Bitner, 1992; Williams and Anderson, 2005) and the design of this service system structure ought to fulfill customers' preferences and experi-

ences (Collier and Meyer, 1998). Organisational control and structure, such as administrative support system or planning and controlling, also contribute in establishing the service system (Edvardsson and Olsson, 1996).

To the best of our knowledge, at this moment there are no empirical evidences on the development of customer role as a resource of the service system. Lenfle and Midler (2009) have indicated the problems emerging from this ignorance, as customers should be able to use the service the way they want it to create value. Those customers may be trained for greater role in the service process (Chai, 2005), and new customers may be acquired as resources in the service system (Shulver, 2005). Our review suggests that there is a particular interest in the adoption of new technology and equipment has been studied as a part of service development (Chai, 2005; Lenfle and Midler, 2009; Shulver, 2005; Silvestro and Silvestro, 2003; Stevens and Dimitriadis, 2005; Stuart, 1998; Windrum and Garcia-Goni, 2008). In addition, Shulver (2005) and Stuart (1998) discuss making changes to physical facilities. Stuart (1998) points out that as with other resources, also physical resources should be in fit with other elements of the service system, including organisational culture.

A number of studies have also focused on matters related to organisation and control which have been seen as a pre-requisite in the development phase of new service. Studies report the development of human resource management (Shulver, 2005; Stuart, 1998), knowledge management (Silvestro and Silvestro, 2003; Windrum and Garcia-Goni, 2008), financial structures (Silvestro and Silvestro, 2003; Stevens and Dimitriadis, 2005) and organisational restructuring (Stevens and Dimitriadis, 2005; Windrum and Garcia-Goni, 2008).

The decisions made regarding organisational structure and administrative support has important influence on the way in which other elements of the service offering are defined (Silvestro and Silvestro, 2003). However, these organisational changes should not be considered as an intra-company process but there may be changes in the organisation of customers' and other agents' resources (Windrum and Garcia-Goni, 2008). Important conclusion drawn by Shulver (2005) and Stuart (1998) is that there must be a full compatibility between the service system and other components of the new service. A new service concept should be transformed into processes and structures in the service system (Stevens and Dimitriadis, 2005).

From the review above, we can conclude that developing service is about developing a core content of the service that valuable to the customer, establishing the process related to creating and delivering those offering, and making avail-

able the service system required in the process of realising those content and delivering the value to the customer. Developing new service must be started with the development of organisation's prerequisites in order to realise customer value (Edvardsson and Olsson, 1996).[26] Finally, service system, service process, and service concept must go together in harmony (Silvestro and Silvestro, 2003). Indeed, due to the inherent characteristics of services itself, service firms usually continuously developing and improving their offerings after the first launch.

2.4 Service typology and modular characteristics

Tuunanen et al. (2012) proposed three main components of modularising a service: service module, service architecture, and service experience, that particularly useful in developing modular service design methods. These concepts follow the ideal of modularisation and are building on each other. In particular, their typology comes from service science and marketing research that are more fresh and novel, rather than engineering and operations literature that dominates the discussions on modularity.

Service module is comprised of communality, decomposition, reuse, substitution, and variation (Tuunanen et al., 2012). Commonality describes the categorising identical module variants within a specific type of module (Jiao et al., 2003). Hence, modularity describes a class of possible services through its decomposed module types. Particular services are developed utilising the notion of variation. These service variants use the similar types of module yet take on contrasting occurrences of each module type. Thus, service variants draw a distinction according to the commonality between module variants (Tuunanen et al., 2011). Meanwhile, the service modules share elements for common functions. To assess commonality, several indicators have been suggested in the literature. Nevertheless, the existing indicators emphasise on commonality and reflect a value increasing when commonality increases, but do not directly related with an increase in value due to diversity. Common functions are similar for all services, variant functions are the identical with different attributes, and unique functions are peculiar to an individual product. Common function ought to utilise common components, unique functions ought to utilise unique components as well, while variant functions ought to utilise variant components

[26] It appears that most studies focuses on developing internal staff and technological infrastructure, and less attention on the role and contirbution of customer during the co-creation stages.

proportionally.

Furthermore, a service can be broken down into service modules that have a distinct role and are independent from the other modules, i.e. they are loosely coupled (Baldwin and Clark, 2000; Bask et al., 2011; Böhmann et al., 2003). Further dividing may continue decomposition of the modules, ending up in a hierarchical modular structure, see, e.g., (Böttcher and Klingner, 2011). Within this structure, the lower level modules do not make use of the higher-level modules (Parnas, 1972). The conventional decomposition based on tasks and activities or timing is often insufficient to capture the benefits of modularisation such as shorter development time, flexibility, and comprehensibility of both a single module and the whole system (Parnas, 1972). Voss and Hsuan (2009) maintain that decomposing means dividing the service system functionalities into individual functional elements. Strong interdependencies within modules may require their further decomposition (Baldwin and Clark, 2000; Bask et al., 2011; Böhmann et al., 2003).

The notions of reuse and variation mainly rely on the concepts of commonality and decomposition (Jiao et al., 2003). Since the aim of service modularity is to decompose a service into smaller independent modules, a module type should be grouped into a set of components that share similar characteristics. Thus, commonality establishes the rule in grouping those similar module variants according to module types and their possible class of services. A particular service can be developed using the notion of variation. Meanwhile, service variants have similar types of module but they take on distinctive occurences of every type of module (Tuunanen et al., 2011). Pertaining to the aspects of commonality and distinctiveness, a trade-off exists when utilising a reuse concept (Robertson and Ulrich, 1998). Modules are customisable in nature, without ignoring the reuse-focused centre of the development method, to a certain level. As a result, the answer for solving the products' differentiations is to bring an adequate configuration of assets' variation points. These variation points then can be utilised to shape and adjust the assets while instantiating them into a service. These variation points typically in charge of an asset's centrals, the absence or presence of particular assets, or the attachment among those assets.

Finally, Wheelwright and Clark (1995) suggest specifying platform-based products that are able to fulfil the needs and expectations of the core customer groups and easily create subsidiaries through the substitution, addition, and removal of features. We build on this recommendation and assert that a module of service that is a fragment of a service system can be substituted with another

module without changing or disrupting the service or end product. In products, any mass customisation can be achieved by enhancing the ability factor to substitute (Voss and Hsuan, 2009). Modularisation thus makes it easier to attach or detach potential new components of services effectively and efficiently, both by outsourcing modular components to external suppliers and by internally sharing modular components (Bask et al., 2011; Raddats, 2011; Voss and Hsuan, 2009). The problem lies in interpreting services in a way that allows reuse maximisation (High et al., 2008).

Service architecture is comprised of service boundary, standard, interface, composition, infrastructure, interface, as well as outsourced and shared resources (Tuunanen et al., 2012). In terms of architecture, the boundaries between specific service modules are important. Boundaries define individual service modules in relation to other service modules within a particular service architecture, but also the external boundaries of the module (Böhmann et al., 2003). The external boundaries provide a detailed explanation of the scope of service. Furthermore, the boundary information details how the relationships between internal and external service modules are governed. This governing definition forms a boundary contract between modules (Böhmann et al., 2003). Similarly, modularity can be seen as a method to standardise the production of services as well as generate profitability and better customer value (Pekkarinen and Ulkuniemi, 2008). Standards therefore form rules for organising internal and external resources, i.e. service modules.[27]

According to Bask et al. (2011), the composition of service modules is closely related to the customisation of service modules. They have approached the issue by linking it to mass-customisation and the degree of customisation for specific service offerings and modules. Raddats (2011), in turn, discusses how service functionalities are decomposed into service components. Bask et al. (2010a) further describe a service offering as a modular system packaged together from service elements. Hyötyläinen and Möller (2007) have argued that the service elements for functionalities should be as common as possible within an individual service module. Tuunanen and Cassab (2011) have taken a service process based view. They define a service module as the mixture of service processes recognised by both the firm and the customer that breeds new, customisable packages of a service in such a systematic way. Tuunanen and Cassab (2011) characterise these service packages as service extensions using the concepts of base service

[27] In the service-oriented architecture (SOA) literature, standards are often linked to the governance structures of service modules and the organisation (Henderson and Clark, 1990).

(non-customised) and customised service extensions that are based on either the reuse or variation of service processes.

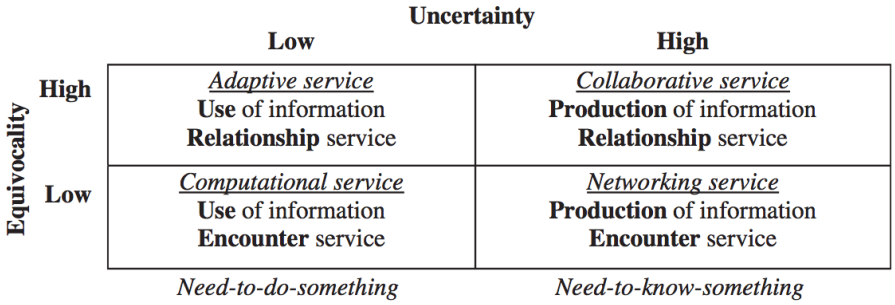
The service interfaces specify how service components and modules interact between each others (Raddats, 2011).[28] These service interfaces act as gates to the service module and provide its connections to other service modules. Moreover, the inside operations of a service module are hidden from other service modules and the interface limits their access. Böhmann et al. (2003) have similarly emphasised the need for forming standardised interfaces between service modules to enable the information flow. Hyötyläinen and Möller (2007) have presented that service blueprinting (Bitner et al., 2000) is very useful for depicting how interfaces function and how and what kind of information they transfer between service modules and service providers. Hyötyläinen and Möller (2007) especially refer to guidelines, tools, and methods that enable service interfaces.

All services are developed through the systems of service, which can be defined as task-based systems in which machines or human involvements operating task using information, technology, as well as other resources to produce services (Alter, 2008). The infrastructure describes both technical and non-technical requirements that need to be met for the provision of the service (Tuunanen et al., 2011). This can be e.g. the last kilometer broadband Internet access provided for the user or the core system network capacity (backbone) of the Internet provider that delivers a specific service. Therefore, the infrastructure also consists the information system (e.g. software, server computers, networks) enabling the provision of the service (Hyötyläinen and Möller, 2007; Tuunanen et al., 2011). The user interface (UI) that is accountable for the governance between the service offering and the user, i.e. for every non-computerised as well as computerised aspect of interaction, should be specified as well (Tuunanen et al., 2011).

According to the literature, service architecture should comprise a definition of shared and outsourced resources and of how the division of labour is done. The management of the outsourcing of various tasks across supply chain variations and across firms must be defined. This issue closely relates to the modularity of organisation and supply chains (see e.g. Bask et al., 2010b; Schilling and Steensma, 2001; Voss and Hsuan, 2009). The organisations of firms are becoming increasingly modular due to the outsourcing of functions and the use

[28] Janssen and Joha (2008) have depicted this interaction in the SOA literature, where technical service modules are limiting all communication with other service modules to specific service interfaces.

Figure 2.4: The diversity of organisational information services



Source: Mathiassen and Sørensen (2008, p139)

of service modules that located outside the firm, making the whole production system become increasingly modular in structure (Schilling and Steensma, 2001). This can even lead to greater modular structures at the industry level by sharing service modules within the firm or by outsourcing service modules to an external supplier (Janssen and Joha, 2008; Voss and Hsuan, 2009).

It is interesting to also relate the notion of modularity to the higher level business descriptions of services. To that end, Mathiassen and Sørensen (2008) proposes a distinction between four types of organisational services (see Figure 2.4). They focus on the dimensions of organisational information services, encounter-relationship, production-use, high-low equivocality, and high-low uncertainty. The proposed variations are characterised according to those dimensions, namely adaptive service, collaborative service, computational service, and networking service.

Finally, the service experience concept is further decomposed to four process-related constructs: task complexity, customer's role perception, value creation, and personalisation (Tuunanen et al., 2012). Tuunanen et al. (2010; 2011) have defined service process modularisation as the mixture of service engagement phases identified by both the firm and the customer that produces new, customisable provision of service with increasing utility in such a systematic way. This view builds on the service dominant logic (SDL) concept (Vargo and Lusch, 2004b) that means a shift from delivering services of pre-determined value to a new environment where firms only provide value propositions, and thus focusing on to the logic of value creation (Grönroos, 2008). Thus, both the user and the service organisation determine the total value of the service in use. More specifically, a service is a point in space and time where aforementioned engagement

of service materialises (Bitner et al., 2000). That interaction and exchange will happen when the customer's own perception of ease-of-use, utility, as well as simplicity have been fulfilled. Furthermore, the literature proposes that value creation is a process that occurs and materialises between a customer and a service provider (Grönroos, 2008; Vargo and Lusch, 2004b).

Michel et al. (2008) have argued that the customer's role is a key influencer for service innovations. Tuunanen and Cassab (2011), in turn, have proposed that the customer's role perception is related factors such as clarity, motivation, and ability. Thus, according to them these are key factors that affect the customer trialability of service delivery systems which depend on their role during service production process. Furthermore, customer's efficiency affects the service process quality as well (Xue and Harker, 2002). Therefore, customer efficiency should increase due to the benefit of a well-known service process (Cook et al., 2002). Tuunanen and Cassab (2011) have claimed that the customers with higher role clarity are anticipated to be more eager to test new service provisions, given their experience and tolerance for variety. Customers with lower role clarity, however, need to be convinced of the fact that learning a variety of the known service process is worth the struggle, particularly when the new process of service requires active involvement within the production of the service.

Service process modularity has been identified as the use of consecutive process stages that could be 'mixed and matched', or personalised, in service implementation to achieve flexible capability and customisation for various situations or various customers (Bask et al., 2010b; Voss and Hsuan, 2009). There can be a set of common processes and sets of processes for individual services. On the other hand, the choice of the customer regarding the service are influenced by the values they possess. If we combine those views, we can present value based personalisation of the service preferences so that the service reflects user's real or wished personality and allows combinations (mix-and-match) that are wished for.

Wemmerlöv (1990) characterise service processes by task complexity. The degree of task variety, the degree of technical skills needed, and the degree of interaction and communication between the customer and the system of service define task complexity of the service process experience. A high task complexity service experience escalates not only the cognitive load but also the search costs and the psychological risk of the customer (Vargo and Lusch, 2008). This is evident especially with less knowledgeable customers who do not understand

the service process. Tuunanen and Cassab (2011) argue that reusing a service process decreases the customer anxiety related to learning a new routine in a new service offering. Alternatively, modular alteration in a high task complexity service could raise the cognitive load, including the customer's challenge level.

Even though Voss and Hsuan (2009) propose the basis for service architecture work, they do not provide clear guidelines to utilise the concept in practice. In a similar vein, Tuunanen et al. (2012) provide service module, service architecture, and service experience typology, however, they do not apply the concept yet (see Table 2.1). Thus, this research will extend the research by borrowing their typology as a guidance to analyse our case of mobile payment systems in understanding service modularity beyond the focus of the service process. In particular, Tuunanen et al. (2012) suggested the future research to do case studies with service industry, especially with alternative approach such as interviews, FGD, action research, a Delphi study, or expert opinion on modularity study.

2.5 Service modules and decomposition logic

The most important question in examining service modularity, perhaps, is how to identify the individual subsystems and how to determine which of these subsystems can be developed as modules within such a service offering (Salvador et al., 2002). Whilst the service modularity literature offers diverse examples of decompositions leading to a wide variety of modularity types, a conceptualisation of the underlying service decomposition logics is lacking.

Thus, it is crucial to apprehend the decomposition logic, where the explication of the design choices involved in decomposing a service offering into modules. Different logics are emerging in the service modularity literature. One issue in this debate involves how the multidimensional nature of services influences the decomposition of a service offering into modules. That is, unlike with product offerings, service offerings not only have an outcome ('what' needs to be accomplished to fulfill the customer's needs) but also a process dimension ('how' this is to be achieved) (Goldstein et al., 2002; Grönroos, 2008). On this basis, Pekkarinen and Ulkuniemi (2008) make a theoretical distinction between service product modules (i.e., the service outcome dimension) and service process modules (i.e., the service process dimension). In contrast, Chorpita et al. (2005) decompose the service offering into modules that combine both outcome

Table 2.1: Modular service design typology

Key concepts	Definitions
Service module	A system of components that offers a well-defined functionality through a precisely described interface and with which a modular service is composed, tailored, cusomised, and personalised.
Commonality	A service module is common, variant or unique, the core modules providing communality and standardisation, and the variants and unique modules variety and diversity to meet users' different service needs.
Decomposition	Divisions of information, processes, and serices into modules (components, elements, units, nodes) that are independent of other modules, accomplish a certain function, and have an interface for integration.
Reuse	A service module can be reused as is or with minor revision in a different context in addition to the original context.
Substitution	A service module that is a part of service system can be replaced with another module without changing or disrupting the service.
Variation	A new variant is developed from a service module by making a major revision or modification to the module's functionality an/or interface.
Service architecture	Depicts the modular structure of the service, that is, (de)composition of the modules and their relationships, service interfaces, boundaries, as well as standards and technologies and shared or outsourced resources.
Boundary	A detailed description of the scope and contracts what comprise the service module within the service architecture and externally with customers and other actors.
Composition	Composition(s) of the service offering(s) based on customisation of service components, parts or processes.
Interface	Interfaces define how service modules interact with and connect to each other.
Standard	Standards define the rules for organising internal and external resources in a structured way.
Infrastructure	The technical framework needed to promotes the provision of service, such as technical back office, computer servers, and software.
Shared and outsourced resource(s)	The division of labour and tasks outsourcing across firms and supply chain variations by internally sharing modules or by externally outsourcing modules to a supplier.
Service experience	An outcome of the firm meeting the users' needs through modularity-enabled customisation, personalisation, and value creation of the service.
Personalisation	Personalisation through new combinations of service modules enables the customisation of the service to reflect user's real or wished preferences, values, and personality.
Role perception	The perceived utility of the modular service depends on customer's role clarity, the service peculiar characteristics, as well as the results the firm expect to attain.
Task complexity	A service process is characterised by low-level or high-level of the task variety, the required technical expertise, and interaction and communication exchange between the user and the system of service.
Value creation	The mixture of service encounter steps recognised to the firm and the customer that creates new, customisable service deliveries with increasing utilisation.

and process dimensions.[29] Another decomposition design choice concerns the level of decomposition, and this varies between studies. For example, Voss and Hsuan (2009) chose four decomposition stages: service company, industry, service component, and service bundle; whereas Moon et al. (2010) chose five levels on a different basis: service family, service, module, component and attribute. As a consequence of the different decomposition logics in the literature, the label 'module' is applied to a wide variety of service parts.

Given the presented conceptual definition of a module, decomposition logic matters. Decomposition results in: (1) the encapsulating of interdependencies within self-contained functional parts that can be conceptualised as modules and (2) the minimising of reciprocal dependencies between these modules (Baldwin and Clark, 2000; Carlborg and Kindström, 2014; de Blok et al., 2014; Ethiraj and Levinthal, 2004; Simon, 1962). These two main features give a modular design the following advantages. Firstly, modularly decomposed services afford incremental and localised innovation and optimisation within modules without affecting the overall design and thus help reduce design complexity (Ethiraj and Levinthal, 2004). Further, minimised reciprocal dependencies allow for standardised interfaces, i.e., "the set of rules and guidelines governing the flexible arrangement, interconnection, and interdependence of service components and service providers" (de Blok et al., 2014, p30), and this reduces coordination costs. Finally, as each module represents a distinct service function, the separate modules can be flexibly and efficiently recombined to meet specific customer demands; that is, they offer low-cost customisation.

Based on systems theory, a decomposition logic reflects the structure in which a system is separated into smaller subsystems. A modular service decomposition logic aims to subdivide the system in such a way that the dependencies within the resulting subsystems or parts are maximised and between subsystems minimised. Moreover, each subsystem should fulfill a specific function (Baldwin and Clark, 2000; Salvador, 2007; Simon, 1962; Ulrich, 1995). It follows that decomposing a service offering involves three consecutive, though partly iterative, design steps: (1) defining the boundaries of the service offering that will be decomposed; (2) determining the decomposition level(s) on which functional parts will be identified; and (3) identifying the most relevant interdependencies

[29] For example, in decomposing psychotherapy, they had outcome-oriented modules such as parent monitoring, psycho-education and skill building whilst, at the same time, prescribing the delivery order of these outcome-oriented modules. This illustrates how different design orientations can be chosen.

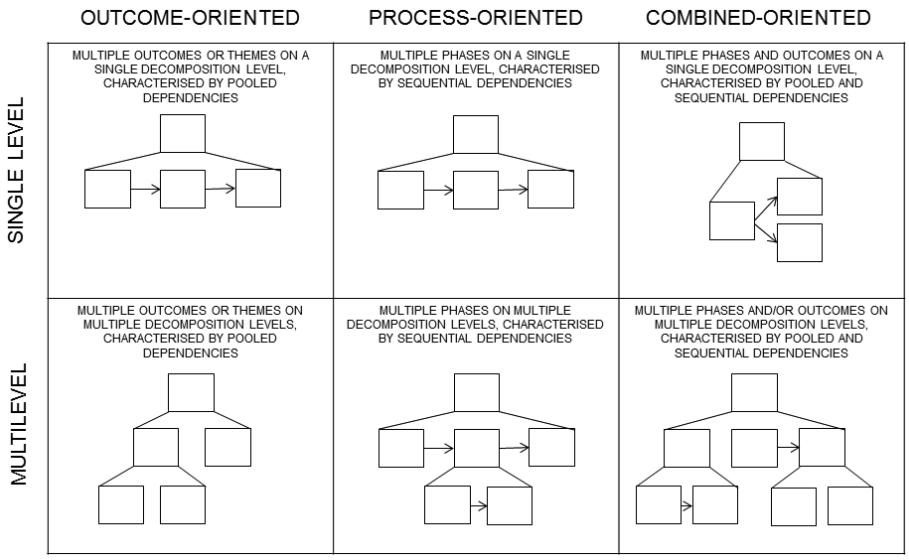
and isolating them (Brusoni, 2005; Simon, 1962; Ulrich, 1995).

The first step in modular service decomposition involves defining the boundaries of the system to be decomposed (Simon, 1962). The boundaries of a service offering can refer to both the outcome ('what' is delivered) and the process dimension ('how' that service is delivered) (Grönroos, 2008). The outcome dimension describes the bundle of services, both tangible and intangible, and includes the reasons for the service provider existing and why users go to the service company (Grönroos, 2008). The process dimension refers to the interactions between service provider and customers and to the activities that need to be carried out to transform customer inputs into service outputs, i.e., service specification, production and delivery. Thus, this first decomposition step involves making a design choice over the 'decomposition orientation', which may be outcome-oriented, process-oriented, or a combination of outcome and process orientations.

The second step in the decomposition involves identifying subsystems within the defined service offering; that is, service parts with a specific function. Functions are commonly expressed in linguistic terms such as 'providing', 'helping' and 'facilitating' (Ulrich, 1995). Here, a design choice also has to be made because functional parts can be defined on various decomposition levels (Ulrich, 1995). Functional parts can be formulated on the level of an overall service offering (e.g., helping people to overcome depression) or on a detailed level of activities (e.g., teaching a relaxation exercise). This is in line with Simon's (1962) idea of hierarchical systems. In decomposing a service offering, a design choice has to be made concerning the decomposition level(s) on which to identify functional parts (see for example Fixson, 2005). These functional parts are 'candidates' for becoming modules.

The third step in modular service decomposition involves analysing interdependencies to ensure that the parts that make up a module are mutually interdependent and that the interdependencies between modules are minimised (Baldwin and Clark, 2000; Bask et al., 2010a; Böttcher and Klingner, 2011; Campagnolo and Camuffo, 2010; Simon, 1962). This decomposition step draws on the idea of 'nearly decomposable', as discussed by Simon (1962), who theorised that the behaviour of the decomposed parts, in the short run, should be relatively independent. In analysing the dependency patterns, we draw on Thompson's (1967) hierarchical typology of three distinct dependency types: pooled, sequential and reciprocal. Pooled dependence is the loosest form of dependence where each part or module fulfills fully independent functions whilst

Figure 2.5: Service decomposition



Source: Ulrich and Tung (1991)

drawing on common resources (Thompson, 1967). Sequential dependence occurs when one module's output is another's input. Reciprocal dependence is the most complex form, and is similar to sequential dependence but with a cyclical effect. The design choice made in this step revolves around the types of interdependencies between subsystems accepted and designated as module candidates in step 2. As such, it may be necessary to iterate between steps 2 and 3.

Together, the decomposition steps (boundary setting, decomposing on one or more levels, minimising interdependencies) constitute the service decomposition. The logic underlying this decomposition is represented in the design choices that are made: i.e., the 'decomposition orientation', the 'decomposition level' and the 'dependencies allowed'. Combining the theoretical possibilities in the first two choices results in six distinct decomposition logics.

The design choices made during the decomposition steps are reflected in the resulting modularity types. That is, the choices made during decomposition determine what kinds of subsystems become modules and in which ways the modules within a service offering can be related. Ulrich (1994) developed a modularity typology for products that distinguished the following types: (1) component-sharing modularity, (2) component-swapping modularity, (3) mix modularity, (4) bus modularity, (5) cut-to-fit modularity, and (6) sectional mod-

ularity. With minor modifications, these six types can be applied to service provisions. Most importantly, we have included both process dimensions and the outcome of a service offering (Grönroos, 2008). The adapted modularity types and their specific aims are depicted in Figure 2.5 below.

1. Component-sharing modularity: In this type of modularity, both the outcome and process dimensions are standardised and also, by definition, the interfaces with other (modular) parts. These modules can be used in a range of service offerings. An example of such a modularity type includes 'the provision of a bank statement', which can be used within several banking services.

2. Component-swapping modularity: This modularity type offers mutually exclusive choices within a fixed service-offering composition. These options are highly standardised in terms of outcome, process and interface. An example is the option within travel insurance for either 'World coverage' or 'Asian coverage'.

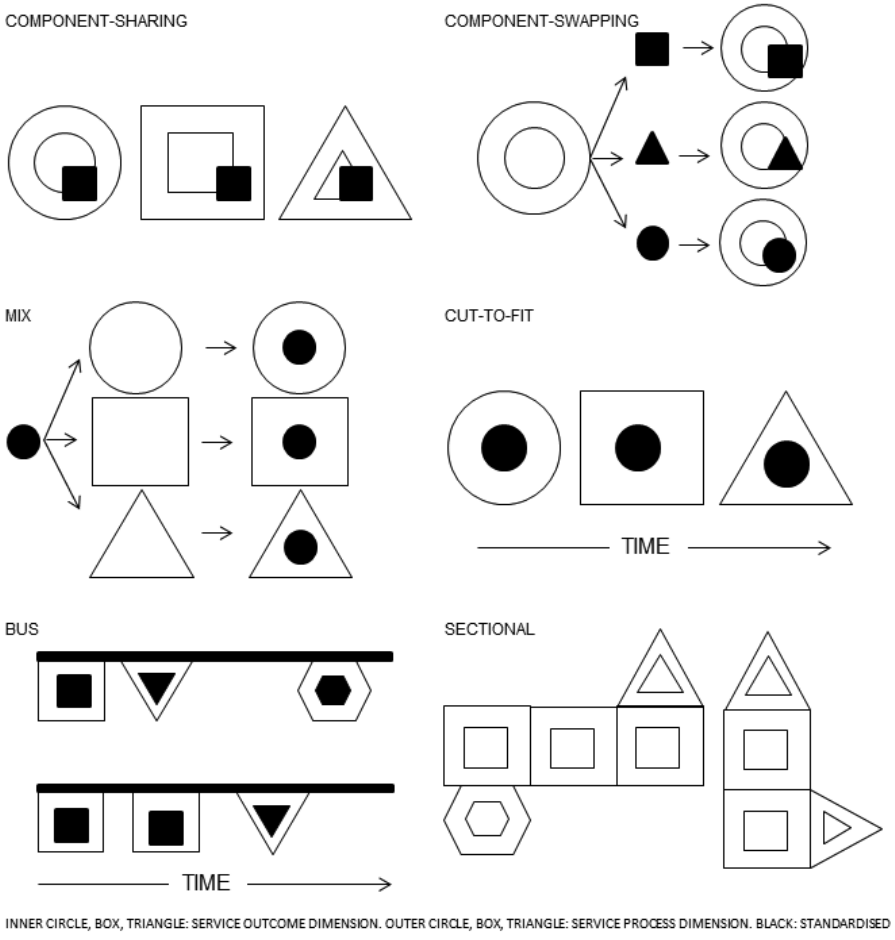
3. Mix modularity: This type of modularity offers predefined options concern ing process aspects of the service offering that will influence the overall service experience (i.e., the outcome). The processes and interfaces are standardised. An example includes the provision of either 'one-on-one' or 'group' therapy.

4. Cut-to-fit modularity: In this modularity type, aspects of the service process are adapted during delivery without this affecting other modules. This requires modules to have standardised interfaces and outcomes. For example, patients awaiting elective surgery will have a medical induction with a doctor and a more general induction with a nurse. Both inductions can be personalised in terms of duration, scheduling and interpersonal behaviour without affecting the outcome.

5. Bus modularity: In this type of modularity, a base line service offering (a fixed composition of one or several modules) is pre-specified regarding which modules can be added or subtracted. This modularity type can be seen in the standard sequence followed in consultancy projects: problem identification, solution development and, finally, implementation.

6. Sectional modularity: This modularity type offers an unrestricted combination of modules in creating the service offering. To provide this kind

Figure 2.6: Modularity types



Source: Ulrich and Tung (1991)

of variety, the interfaces between the modules have to be standardised. Examples can be seen in banking services where a customer can combine the various services offered by a bank (current account, checking account, savings account) in many different ways.

Thus, as with product offerings (Salvador et al., 2002), decomposing a service offering may lead to different modularity types. Currently, what constitutes a module in a service offering, and how service offerings can be decomposed into modules, is vague (Voss and Hsuan, 2009). This lack of clarity and certainty hampers the development of scientific knowledge, as well as the effective application of a modular approach in practice. As such, there is a need to systematically analyse and critically reflect upon the different service decompositions.

2.6 Modularisation aim and strategy

The modularisation aim is the first contingency that we expect to be related to the design choices concerning a decomposition logic. As in production environments (Campagnolo and Camuffo, 2010), the modularisation aim might put a stronger emphasis on increasing variety or on gaining efficiency through lowering costs. When the aim stresses variety, the decomposition logic is expected to be outcome-oriented, to distinguish functional parts on a single, highly aggregated decomposition level and to restrict the dependencies between the decomposed parts to pooled ones. In this way, the variety is transparent for customers, who can then mix and match service parts that are closely related to their needs in a wide variety of ways. Moreover, decomposing functional parts on a high decomposition level (i.e., with a low level of detail), allows the modules to be personalised during delivery to match an individual customer's specific needs (de Blok et al., 2010; Rahikka et al., 2011; Voss and Hsuan, 2009). Personalisation may, for example, involve changing duration (such as offering a six- or an eight-week course), the quantity of identical activities (such as eight or ten chemotherapy sessions) or the scheduling of activities (e.g., in the morning or in the afternoon).

In contrast, when the modularisation aim stresses enhancing efficiency through lowering costs, the decomposition logic may be process-oriented, may distinguish functional parts on multiple, relatively detailed decomposition levels and may allow the dependencies between parts to be both pooled and sequential. In this way, the potentially limitless 'ad hoc' range is limited to a pre-specified

sequence of service modules. This will reduce the coordination costs of combining these modules. Moreover, decomposing a service offering into modules on a detailed level leaves fewer opportunities for personalisation, putting more emphasis on standardisation, which reduces costs. The above arguments suggest that the modularisation aim, provided it is explicated in advance, directs the design choices. Geum et al. (2012) argue that the modularisation aim should 'drive' the modular service design (and not vice versa). Although the service modularity literature does recognise the relevance of the modularisation aim (Bask et al., 2010b; Geum et al., 2012), there is a lack of critical reflection on how the aim may influence the design choices during decomposition.

A second set of contingencies that we would expect to be related to the decomposition logic concern the service characteristics 'input and throughput uncertainties' that make up the service routineness. Services differ in the extent to which customers' inputs and customer interactions may affect the service (Larsson and Bowen, 1989). Customers may provide information, assets or themselves as inputs to the service production process. The extent to which these inputs are known to the service organisation prior to the actual service encounter varies (Chowdhury and Miles, 2006), creating input uncertainty. Throughput uncertainty related to the lack of structure and predictability during the service delivery stages and to the interdependencies between the necessary service activities (Mills and Posner, 1982). Service offerings with high levels of throughput uncertainty are often targeted at solving complex and ill-structured problems that are characterised by multiple perspectives (Broekhuis and van Donk, 2011) and that may be hard to decompose on a detailed level.

The boundaries of the service systems to be decomposed varied across the cases. In some cases, coordination processes, management processes, or resources were distinguished as modular parts of the service offering, whereas these are not functions that can be delivered to the client. The differences in boundary settings and in decomposition levels on which the service offerings were decomposed reflected the term 'module' being applied to a wide variety of constituents. Only few literature explicitly discussed the decomposition in terms of arguments as to how service parts were assembled into modules in order to minimise the dependencies between modules. The remainder did not describe how the service offering had been decomposed into modules, although in all cases the authors did refer to modules. With regard to the relationship between decomposition logic and selected contingencies, it seems that there is no clear relationship between the modularisation aim and the decomposition logic.

The only obvious pattern is that cases aiming at providing variety more often apply an outcome orientation. In routine and semi-routine service offerings, a multilevel combined orientation decomposition logic was generally applied.

The modularisation strategy refers to the design choices concerning a decomposition logic. We found that at least four of the six theoretical logics have been applied in practice: single-level process-oriented (e.g. reinsurance, Meyer and DeTore (2001)), single-level outcome-oriented (e.g. IT services, Miozzo and Grimshaw (2005)), multilevel outcome-oriented (e.g. cruise services, Voss and Hsuan (2009)), and a multilevel combined orientation (e.g. logistic services, Pekkarinen and Ulkuniemi (2008)). We failed to find documentary evidence of empirical cases involving the multilevel process-oriented and single-level combined outcome and process-orientation decomposition logics. This raises the question as to whether these theoretical options constitute valid decomposition logics when it comes to service offerings. A possible explanation for not finding all theoretically possible decomposition logics is the small number of cases reported in the scientific literature. In most of the cases, the choices underlying the decomposition logic of a modularised service design were barely addressed. However, these are essential design choices because they determine to what extent core modularity principles are achieved in a service design: here, modules should (a) have specific functions, (b) be relatively independent of each other and (c) have standardised interfaces (Schilling, 2000; Ulrich, 1995). It is through making such design choices, either consciously or unconsciously, that the potential added value of modularising a service is fully or partly achieved. Our analysis of the literatures also shows that the appropriate modularity types depend on these design choices.

In the field of product modularity, a relationship has been established between the modularisation aim and the decomposition logic (Campagnolo and Camuffo, 2010). However, we found that the relationship between the modularisation aim and the decomposition logic was less straightforward. Those cases that emphasised providing variety to clients did not always apply a different decomposition logic to those that stressed efficiency through lowering costs. However, and in line with our expectations, those that primarily aimed at creating variety for clients always included an outcome orientation. Here, the aim was to match the variety in 'what' was delivered with the range of client demands. Moreover, adopting an outcome-oriented decomposition logic makes the variety on offer more transparent to customers than when a process-oriented decomposition is used (Pekkarinen and Ulkuniemi, 2008). Further, it is a matter

of degree as to whether one is aiming at providing variety or efficiency (through lowering costs), and the emphasis may be path dependent (Mahoney et al., 2000). That is, when a service supply system offers only a very small number of standard services, modularisation can be used to expand the options (Moon et al., 2010). Conversely, in an unstructured supply system beforehand, where any client wish is answered, modularisation serves to rationalise the options (de Blok et al., 2010). Given this situation, our research on mobile payment includes the aim as a possible contingency.

With regard to service routineness and decomposition logic, here, we found a clear relationship between service routineness and decomposition logic. In non-routine service offerings, the single-level process-oriented and single-level outcome-oriented decomposition logics were applied, whereas multilevel logics were mainly applied in routine and semi-routine offerings. We believe this is logical because, in non-routine services, the exact nature of the service needing to be delivered to the client only becomes known as the service delivery progresses. Moreover, as non-routine settings have many reciprocal dependencies (Thompson, 1967), it will be harder to isolate these dependencies within individual modules. As a result, the more fine-grained forms of decomposition will be harder if not impossible to achieve. The commonly applied use of cut-to-fit, bus and sectional modularity types in the non-routine service offerings fit with this explanation. Routine and semi-routine services were decomposed in a hierarchical manner, and module outcomes and processes, and interfaces, were standardised. With such services, it is relatively easy to pre-specify service outcomes and the processes required to deliver them. Consequently, the common application of component-sharing, component-swapping and mix modularity types in semi- and in routine service offerings seems appropriate.

2.7 Crossing points and the role of customers

The theory of modularity (Baldwin, 2007; Langlois, 2002; Schilling, 2000) describes how the boundaries of firms and the structure of vertical contracting are positioned in the industry. Modular theory of the firm proposed the concept of crossing points to explains where the task networks are located. The whole task network will be decomposed into more sets of specialised sub-networks in this crossing point with transactions presenting among them.

Baldwin (2007), built on the transaction cost theory, proposes the notion of task networks as the systems of production whereby both "thick crossing points" and "thin crossing points" are existed. The thin crossing points usually are linked with low transaction costs that requires minimum interaction as well as limited information exchange between the stakeholders and with 'information hiding' between the various stakeholders. This is usually happen for arm's length transactions in which the cost of identifying, calculating, and compensating goods or services are easily transferred. She also posits that modular interfaces appear to emerge at "thin crossing points" inside the network (Baldwin, 2007). She also explained that "regardless of its intended purpose, modularisation necessarily creates new module boundaries" (p179) with minimum regular transaction costs and related thin crossing points.

On the other hand, thick crossing points, with many interdependencies to manage, hence require substantial exchanges of information as well as communication and cooperation through informal (relational) contracts and/or formal contracts.

It is not difficult to imagine that complex system such as a mobile payment system comprised of network links that could be characterised as service-provision relationships that are mutually exclusive. Thus, all of the coordination activities starts from the firm toward a concept of transactions within bigger institutional formations as bounded relationships in order to create mutual value creation.

Transactions conducted within bigger institutional framework sometimes can be classified in terms of products that can be viewed as bounded relationship tangibility. In this case, discreet goods or products that are standardised parts of a complex system, represent modular structures defined by comparatively "thin". The transaction costs are low, but the interactions are quite busy, and the networks are quite complex in creating and developing mutual value together (Baldwin, 2007; Langlois, 2002). On the other hand, Spring and Araujo (2009) argue that the differences between thick crossing points and thin crossing points does not separate between services and goods, since what they define as "services" can be identified and transferred, and thus categorised and shaped by thin crossing points. Furthermore, the technology, particularly IT, tend to be difficult to differentiate.

Instead of debating between services and goods, Vargo and Lusch (2008) take different approach by differentiating indirect service provision (i.e. through goods or products) and direct service provision. To a certain degree, it can be

asserted that indirect service provision (in this case, is mobile payment system) is identical with thin crossing points that are relatively easy to recognise the boundaries of the system and leads to increasing efficiency for the service beneficiary and the service provider. Both parties benefited from decreasing transaction costs due to facilitated resource acquisition and capability to arrive at a market price. However, this indirect activity will also reduce the effectiveness of service provision compared to direct service delivery such as consulting or medical (health care) service (de Blok et al., 2010; de Blok et al., 2014).

On the other hand, it can be asserted that direct service provision such as medical (health care) service provision can be more effective than indirect service provision (e.g. via medical equipment or third party involvement) due to higher transaction costs—albeit perhaps less efficiently. Yet, there remains several exceptions, particularly as technology becomes cheaper and able to minimise transaction cost in such a dynamic interactions and environments (e.g. medical or health care software or health care system that can interactively provide information and assistance to the patient daily).

Our observation is that, in the literature on service modularity, argument-building on the design choices underpinning the decomposition of service offerings into modules is scarce. Most literatures investigate whether they could recognise modularity in a given practical setting. We identified four decomposition logics: single-level process-oriented, single-level outcome-oriented, multilevel outcome-oriented, and multilevel combined orientation. We found a relationship between the decomposition logic and the modularity types. The aim of the modularisation did not seem to explain the decomposition logic fully; rather, we found that the decomposition logic applied was related to the service routineness. Thus, it is important to be more explicit and give detailed attention to establishing clear boundaries for the service system being decomposed, the decomposition level(s) on which the functional parts of the service system are specified and how dependencies between modules are minimised.

A successful modular supply requires an intensive and often time-consuming design process (Baldwin and Clark, 2000). Thus, one should first identify why a service offering should be modularised: is it to provide variety, to lower costs or to balance variety and costs with an eye on efficient customisation? Second, the input and throughput uncertainties need to be considered, as the routineness of the services offered may have consequences for the appropriate orientation (outcome, process, combined) and decomposition level. Alongside cost reductions, modular architectures can offer greater transparency to clients on

what can be delivered. Providing an overview of modules, and how they can be mixed and matched, could guide the service-specification process (de Blok et al., 2010; de Blok et al., 2014). How the service modularity concept, including the modularity types specified and decomposition logics identified, contributes to balancing the variety and costs of non-routine service offerings is a relevant topic for our theoretical contribution.

We also realise that there is lack of a unified definition of modularity in services. We also found that literature of modularity in service is mostly influenced by manufacturing modularity that follows the traditional system view and approach. Thus, it did not capture the multi-layered or multi-faceted characteristics of services yet. There are also perhaps too much focus on generalisation and debates on prescription/prediction; yet what we need, and that is currently missing, is what we can do to overcome forces that constrain the alignment of technical, organisational, and services modularity. With regard to practicality, it appears that there are no clear guidelines on how to utilise the concept in practice. Lastly, most studies we found focused on a single case study or single companies which lack of comparative analysis and difficult to generalise into broader population.[30]

[30] For instance, de Blok et al. (2010) and de Blok et al. (2013) on a healthcare provider in Netherlands, Ulkuniemi and Pekkarinen (2011) on a logistic service provider, Voss and Hsuan (2009) on a sea cruise service, among others.

Chapter 3

Research Methodology

The discussion of theoretical perspectives and methodology is significant for study of the sort described here. The newness and complexity of the issues researched as part of this study also demand rigorous methods. The objective of this chapter was to define the methodological and theoretical footing on which this study has been carried out.

This chapter elaborates on how we design the study to how we achieve our results. The main emphasis of this research is focused on understanding how and under which circumstances services are being developed in such a modular way. Thus, we are interested in investigating modularisation process in relation to organisational structures and business processes. In particular, how the process become more loosely coupled or less loosely coupled as well as when and how those elements are being combined and recombined to achieve organisational flexibility and profitability.

First, we discuss how we come up with service modularity as a theoretical lens to address the question of this study. We then explain the method and approach in Section 3.2. Further, Section 3.3 presents the cases and how it is being justified. Section 3.4 explains the validity and reliability of the analysis. All of these elements serve as the foundation for which the findings are later analysed.

3.1 On theoretical concern

Modularity has been chosen as a central tool in this thesis to investigate the mobile payment systems in the developing countries. Since the late 1990s, due to the rise of modern technology (Baldwin and Clark, 2000), modularity has shown its distinctive contribution in the literature of technological change and economic institutions. Modularity expresses that the division of labour in design has enabled organisations to exploit new opportunities through vertical integration by promoting specialisation in technical manufacturing as well as organisational innovation.

Modularity is about managing complexity in technology, production, and organisation (e.g. Baldwin and Clark, 2000; Langlois, 2002; Sanchez and Mahoney, 1996). It is also hinges on the system in what the system theorist Herbert Simon (1969) described as 'nearly decomposable' system[31]—that is, a system that is comprised of a set of relationships such that module boundaries can be outlined and shown those communications and coordinations are close within the module but scattered between modules (Baldwin and Clark, 2000; Bask et al., 2010a; Garud et al., 2008). This would make information hiding possible (Parnas, 1972): decisions can be made in one particular module regardless to what is going on in the other modules.

Friedrich Hayek's (1945) postulate of markets as tools for managing information contributes to what we would define modularity. Every economic actor holds some sort of local knowledge about their own resources utilisation, but only have to consult prices to make economic decisions in acquiring and utilising those economic resources. The knowledge that every economic agent utilises can affect prices in the market where no other agent has the information and knowledge of it. Prices in the market are functioning as interface that interconnect every participants, whilst hide the other irrelevant information at the same time. Contrastingly, a central planner is non-modular and is anticipated to acquire and take action based on this information. Any market information that have been ruled out in the first place does not have to be interact with the central planner.

Even though most research on modularity focus on the manufacturing, there have been calls for research in other areas (Campagnolo and Camuffo, 2010). Service providers can benefit from modular thinking and strategy (Spring and

[31] It should be noted that Simon (1962) does not discuss systems in terms of the "modularity" construct, even though there are very close resemblance.

Araujo, 2009) by efficiently streamlined service processes and organise demand heterogeneity (Pekkarinen and Ulkuniemi, 2008). Indeed, service modularity is still in its infancy (Carlborg and Kindström, 2014) and research into specific area of services still relatively limited (Bask et al., 2010a). Yet, the operationalisation of the theory in the service contexts and the strategic decision framework available for service firms were fairly limited. Most research on service modularity also still heavily influenced from the manufacturing and assessing modularity purely from the system view. What if we were wrong? Are we missing something here?

Modularity can be utilised to address the mobile payment systems from different point of view. Even though mobile payment has attracted a lot of attention and criticism from academics and practitioners (e.g. Au and Kauffman, 2008; Chatain et al., 2008; Dahlberg et al., 2008; Dahlberg et al., 2015; Duncombe and Boateng, 2009; Jenkins, 2008; Ondrus and Pigneur, 2006; Pousttchi et al., 2009), most studies still focus on the consumer side and how they adopt a particular payment system. Relatively little consideration has been designated on the producer side (financial institutions, mobile network operators, etc). Additionally, most business organisations and market-oriented study on mobile payment lack rigour and methodology, contributing to the confusion in the literature. Attempting to shed a light in the literature gap, this study tests and validates the theory in different contexts and settings to contribute to the literature of management and organisation studies. We were particularly looking at how modularity principles are applied, how they can be practically implemented, and what important strategic decisions need to be addressed in order to develop and provide modular service offerings. By doing that, we expect to provide empirical insights into how modular thinking and strategies can enhance more efficient and effective service provision.

We argue that most, if not all, elements that constitute mobile payment systems utilise modular principles in order to organise complex interaction between different economic actors and deliver efficient service provision. As organisational theorists have continuously emphasised, modular principles help to organise complexity in team production (e.g. Baldwin and Clark, 2000; Bask et al., 2010a; Langlois, 2002; Sanchez and Mahoney, 1996). By identifying the conditions of interfaces, a number of tasks might prevail in one module, causing the whole system not only more flexible, but also more robust and easier to use.

The choice of the cases to be studied in this thesis is derived from a strategic sampling approach, considering their social, economic and technological con-

text. The social and economic conditions in which projects are developed are commonly seen to be determinants of much of the decisions and outcomes that are seen in mobile payment systems (Dermish et al., 2012; Pousttchi et al., 2009). The social and economic conditions of each particular country will also help to grasp the development context and contemporary state of the enterprise surrounding mobile payment systems. It also appears that the technological context in which these projects take place determines the success and failure of project deployment (Duncombe and Boateng, 2009; Evans and Pirchio, 2015). The rationale behind the case selection was not to choose representative cases of a given category but to choose cases which display a high degree of the phenomenon under study (Pettigrew, 1990) and are polar in the sense of covering the 'known range and variation' (Hakim, 2000).

3.2 Method and approach

This thesis draws on both quantitative and qualitative data gathered during a two-year of desk research and field study. Those data were obtained from primary as well as from secondary sources. Multiple data sources allowed us to triangulate several different evidence (quantitative and qualitative) as well as various kind of collection methods (such as document analysis and interviews) within the case and generate more solid and robust substantiation of constructs and underpins arguments for its contributions to knowledge.

The main references of our qualitative data comprised of 19 in-depth interviews conducted with various actors and stakeholders in the mobile payment industry. Interviewees included technical directors, company developers, project managers, industry experts, as well as technical experts from regulatory bodies. Interviews were conducted in such semi-structured way and lasted 175 minutes in average.[32] Qualitative insights presented by our interviewees demonstrated to be significant and important for apprehending the dynamics of modularity in service development. This phase has also allowed us to recognise and analyse patterns or trends as they evolved from within case being studied (Eisenhardt, 1989a).

Secondary sources of qualitative data gathered from about 539 documents,

[32] When a particular finding can only be gathered from interviews, we need at least two people having the same conclusion to corroborate this finding. We also value interviews from a later time rather than interviews of the same people at earlier time to take into account that opinions might change due to new insights or experience during the development phase.

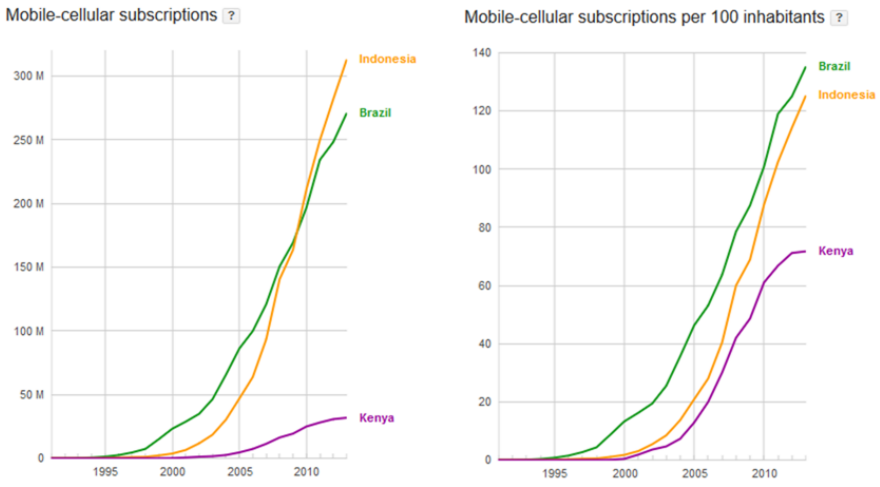
consists of company annual reports, industry reports, trade journals, technical journals, newspapers and magazines articles, as well as websites articles. We also analysed 126 patents on mobile payment systems worldwide. Primary sources of quantitative data came from a sector specific database, namely GSM Association (GSMA) and the International Telecommunication Union (ITU). We also extracted data from WorldBank Global Findex to complement the study. We then utilised the pattern-matching strategy advised by Yin (1994, 2003) by comparing an empirically-based pattern with an alternative or estimated one. The use of that aforementioned strategy presumes the establishment of rival or contested explanations and justifications that include independent variables that are mutually exclusive.

3.3 Justification of the case

This thesis illustrates the case of mobile payment systems in the developing economies. This case was selected for two main reasons. First, mobile payment is a kind of modular ecosystem that has relied on continuously improving technologies (mobile devices, communication technologies, application software, etc.) and relatively stable interdependencies with the remaining of the system. The emerging specialised suppliers and third-party service providers share risks and revenues of the development of mobile payment systems. Thus, this kind of modular mobile payment interface provides avenues to the research on innovation in modular service systems. The second reason is that mobile payment relates to the larger product of mobile services that are multi-component and multi-technology in nature. The multi-faceted nature of mobile payment systems allows the examination of the nature and the dynamics of organising innovation in such a complex and sophisticated service offerings. This peculiar characteristics lends itself to be explored with regard to pattern variations of interdependencies.

We use an explorative case study of Oi Paggo (Brazil), TCASH (Indonesia), and M-PESA (Kenya) where service modularity to be found, in order to develop propositions about how such practices are being managed and organised. The cases were selected taking three specific criteria into account: (1) adoption level, (2) geographic location, and (3) data availability. As the most profound case on mobile payment adoption, M-PESA will serve as a benchmark to contrast the other two cases. M-PESA will also represent the dynamics of a country with a

Figure 3.1: Mobile-cellular subscriptions in Brazil, Indonesia, and Kenya



Source: International Telecommunication Union 2015

high adoption rate. TCASH will represent a country with moderate adoption rate, while Oi Paggo will represent a country with low adoption rate in mobile payment services (see Figure 3.1). Indeed, it is also expected that these cases will provide adequate pictures of emerging economies from different continents.

We adopted a comparative case study method, that are often utilised in the field of management of technology, innovation, and strategic management, and applied the similar framework to examine several cases (Eisenhardt, 1989a; Leonard-Barton, 1990). Yin (1994) defined case study as "research situations where the number of variables of interest far outstrip the number of datapoints (p13)." Case study research is probably the most suitable method when it comes to producing a thorough in-depth examination into a contemporary circumstances, such as modular design in the topic of mobile payment systems development in the emerging economies. The main aim of conducting case study research is to understand the case or cases themselves from data interpretation and from this understanding expand or test theory (Creswell, 2007). Thus, case study is preferred in situation where we have little power over events, the issue is on contemporary phenomenon, and answering questions that begin with how, who, and why (Yin, 1994).

Prejudices against case-based research are that it lacks rigour and objectivity (Remenyi et al., 1998), that it lack of generalisability (Bryman and Bell,

2015), and that it is not automatically become a representative case of qualitative research (Farquhar, 2012). Since the objective of case study is usually to obtain an in-depth apprehension, thus objectivity is perhaps not something that is should be achieved. Rigour can be achieved by utilising coherent and consistent research design, protocols, and justifications. Secondly, the objective of case study research is not to generalise sample into the population, but rather, to generalise a particular phenomenon into the theory. Last but not least, this research triangulates several different sources of data (quantitative and qualitative) and different method of data collections (document analysis and interviews) to provide robust fundamentals for the findings and underpins claims for its contributions to the literature. Thus, criticism of the method can be directed through comprehensible assertions of the research objectives, conform to accepted empirical research protocols, and transparent research method and design.

3.4 Validity and reliability of the study

The literature on research methodology has suggested a set of strategies and actions to address reliability and validity (i.e. Eisenhardt and Graebner, 2007; Gibbert and Ruigrok, 2010; Silverman, 2004; Yin, 2003), and we tried our best to follow those guidelines indeed.

Construct validity relates to the extent to which a research action result in such a precise observation of the world (Denzin and Lincoln, 2005), thus, it is important for a researcher to avoid such 'subjective' judgments and develop a well-considered set of strategies instead (Yin, 2003).[33] The positivist literature describe two strategies to ensure construct validity: utilise different ways to examine the phenomenon (triangulation) by utilising multiple data collection plans and various data refernces (Denzin and Lincoln, 2005; Pettigrew, 1990; Yin, 2003), and develop a clear procedures in order to help the subsequent researcher to rework or reconstruct the research to final conclusions (Yin, 2003). This research adopted different sources of data, from archival sources to interviews to triangulate and corroborate the data. In particular, we transcribed interviews and drafts to be reviewed by peers and shared with key informants

[33] Some interpretivists rejects this criteria to ensure such 'credible' research because objectivity cannot be achieved from different point of views since many of qualitative models are incompatible with the premise that 'correct' fixes of the world can be achieved differently from specific methods of looking at it (i.e. Silverman, 2004)

for accuracy and consistency (Gibbert and Ruigrok, 2010). This research has also reported the clear chain of evidence during the data collection and analysis stages, including firms and case selection, time frame, interviewee approach, references to data analysis procedures, discrepancy between planned and actual data collection, and how this affected results and how such problems were contained (Gibbert and Ruigrok, 2010).

Internal validity refers to the existence of a reasonable causal relationships that is credible enough to support the conclusions (Yin, 2003). This is also often called logical validity. Unlike construct validity that is applicable when collecting the data, internal validity pertinent to the data analysis stage as well, even though the decisions relating to internal validity were made during the initial phase (Yin, 2003). The most important challenge regarding internal validity is how to convince the researchers themselves as well as their readers that the research findings are also genuinely generated from rigorous examination of their empirical data and observation rather than on a few well-chosen cases (Silverman, 2004). He suggested several strategies to address this 'anecdotalism' problem by using constant comparative method, utilising comprehensive data treatment, and analysing deviant-case observation (Silverman, 2004). In order to achieve internal validity, this research has formulated a concise research framework which was explicitly derived from the literature on modularity (Yin, 2003), empirically compare observed phenomenon with previous research on service modularity and mobile payment as well as with predicted results (Denzin and Lincoln, 2005; Eisenhardt, 1989a), and triangulate theory to interpret our findings and verify the results using multiple perspectives (Yin, 2003).

External validity or generalisability usually refers to whether the research under studied can be generalise for the population (statistical generalisation), making it probably irrelevant for case study researcher. Instead, researcher may focus on analytical generalisation, which relates to whether the empirical findings can be generalise to theory, rather than to infer conclusion about the population (Yin, 1994). Case studies might also be utilised to develop theoretical framework and provide analytical generalisation (Eisenhardt, 1989a). Indeed, conducting a case study must be accompanied by clear and concise reporting about how the researcher choose the case as well as the details on the context so that the reader may comprehend the case study authors' sampling selections (Cook and Campbell, 1979).

Reliability concerns about eliminating random error, which allow future researchers to come up with the identical conclusion if they lead the research

along the same methods (Denzin and Lincoln, 2005). Silverman (2004) posits that this consistency has to rely on the researcher's representation and interpretation of what happened and what was going on. Even though there are no research that completely free from the fundamental assumptions that assist it (Gibbert and Ruigrok, 2010), the researchers can focus on transparency and replication aspects of the study. This research has carefully documented and clarified the procedures to show that transparency has been presented. This study also organised interview transcripts, preliminary findings, and research notes collected during the research to facilitate retrieval for future study and replication (Leonard-Barton, 1990; Yin, 2003). As suggested by Silverman (2004), we transcribed the interviews and used inter-rater reliability checker to ensure the coding of the materials, as well as presenting the data on the report. The results of the analysis were then illustrated and discussed in a subsequent interview with a senior manager of mobile payment providers.

Chapter 4

Mobile Payment as a Modular Service System

Because mobile payment systems are a key element of financial inclusion drives in many developing countries, it has attracted much attention. The numerous actors and the variety of technologies that make up such systems makes it appropriate for the examination of the character and extent of service modularity.

As mentioned in previous chapters, a shift to service modularity has taken place especially in the mobile payment industry. Most of the elements that constitute mobile payment systems utilise a modular principle in order to organise complex interaction among different economic actors. Each part of the system organise complex interactions between economic actors and its constituent parts through mediated interfaces that facilitate flows of information and intense interactions.

This chapter reveals the modular design thinking in the field of mobile payment systems. In particular, it seeks to domesticate modularity theory in the form of low and mid-level abstractions involving generic modular components. Section 4.1 describes the criteria for modular service system while Section 4.2 analyses the technical element of modularity in detail. Section 4.3 reviews modularity and technological aspects of mobile payments. Section 4.3 describes the modular principle in organising mobile payment systems and Section 4.4 discusses the comprehensive mobile payment systems framework.

4.1 The criteria for modular service system

As discussed in previous chapter, we believe that the concept of modularity explains how structure and conditions help in facilitating and managing the relationship between economic actors in the mobile payment ecosystem. Within this particular context, information and resources available to different parties involved are very fluid and highly interconnected. No one has full knowledge of the whole project. The sequence of phases is full of unpredictability. Thus, coordinating information and resources in production activities should be governed in a way that accomodates some sort of flexibility.

Nevertheless, the modular principle can be used to manage the complex and dense interactions involved in projects and activities that could not be eliminated to smaller modules (Blair et al., 2011). The transaction costs will be at the minimum level, according to Baldwin (2007), if the firm boundaries are at the thin crossing points.[34] Those particular characteristics are not too uncommon in the mobile payment ecosystems.

The following qualities attributes are anticipated in a modular system:

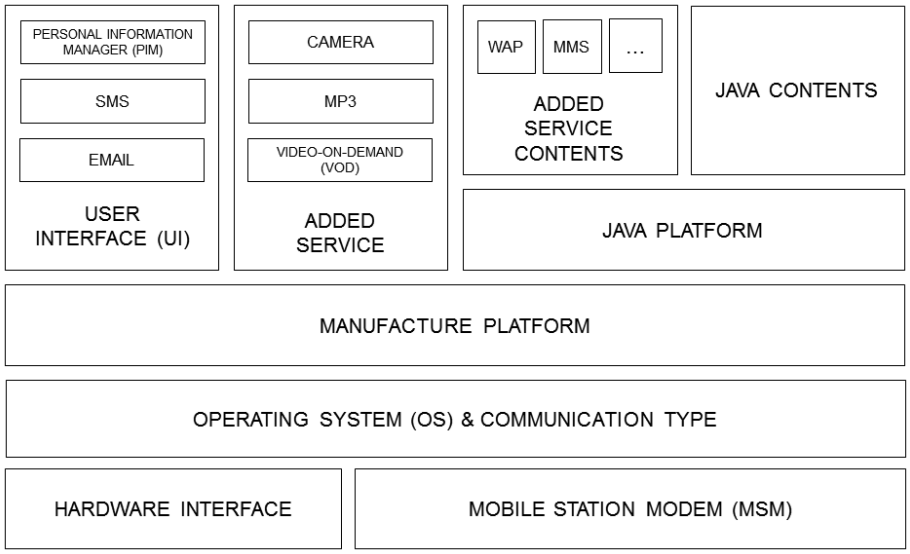
1. Comprehensibility. According to Parnas (1972), by looking at how the module is being implemented and what interfaces are connecting the module to the others, system developers will have an understanding of the module (modular reasoning). Simply put, a developer can build a particular mobile payment module by looking at how the module being implemented and the interfaces that interconnect to the other modules.

2. Changeability. Both Baldwin and Clark (2000) and Parnas (1972) agree that local changes made possible due to the modular design. If there are any alterations inside the module X, the other corresponding modules that solely rely on X's module interface do not have to be modified, since the module interface is not changed. For instance, it is possible for the system developer to change the configuration of the SMS processing centre without modifying settings and configurations in other mobile payment elements.

3. Parallel development. Modular design enables different modules to be developed simultaneously, as long as the module interfaces have been speci-

[34] Exchanges can be facilitated as transactions and regulated by formal legal contracts or by simple market exchanges as long as what is being transferred, swapped, or exchanged can readily be recognised, calculated, and reimbursed.

Figure 4.1: Mobile software module



fied (Parnas, 1972). Parallel development will reduce the need of communication and shorten the time-to-market (Baldwin and Clark, 2000). In the case of mobile payment, for example, a team of developers can work on the user interface (front-end) while at the same time other developers enhance the capacity of network server (back-end) without affecting the whole system.

Many, if not all, of the design components that formulate Baldwin and Clark's (2000) notion on modularity can be viewed in the designs of mobile payment system. We quickly summarise the descriptions of the central elements from Baldwin and Clark (2000), as they are seen in our examples. We describe all the vocabulary and definitions below.

1. Design. Design of a complex system is described as an abstract definition of the structure and functionality of an artefact. Source code can be included within this particular definition and category.

2. Hierarchies. Parnas (1972) defined the concept of design hierarchy in the sense that a module X is rely on module Y (dependent) if X has to understand Y in order to attain its functionality, for example if Y is observable to X.

3. A media for communicating and articulating design: A medium represents the configuration and fundamental structure of modular design elements in which a designer prefers to work with. Program design code such as Java fit this definition.

4. Parameters of design. Parameters, or the components of design, are the factors or attributes of the artefact that regulate the design variation and distinctive categorisation. New parameter values will result in alternatives for new design. For example, if a system designer uses Java as the medium, then the design parameters are the primary fundamental elements such as attributes, objects, classes, packages, and methods.[35]

5. Module. A module consists of a set of structural elements that are solidly together. It can also be defined by the set of tasks it operates, that is identical to an operation or a service it provides. Modules related to these peculiar characteristics: increase the range of manageable complexity, allows parallel development, and accommodates uncertainty (Baldwin and Clark, 2000).

6. Modular operators. Modular operators are the source of variation (Baldwin and Clark, 2000), since design evolution is actually a value-seeking process.

7. Abstraction. It conceals and simplify the complexity of the component. We can represent complex modules as one parameter or a single parameter to reduce the complexity as long as what is inside need not be uncovered.

8. Design rules and interface. These particular design rules define the modular interfaces that system designers utilise to link a module with other corresponding modules.

9. Modular architecture. This architecture presents a framework that enables for both integration of function as well as independence of structure.[36]

While preceding studies on modularity mostly view modularity as a single-faceted form, using the case of mobile payment systems, we identify modularity in services as a multifaceted construct at different hierarchical level: organisational, functional, technological.

[35] In this thesis, we stay at the granularity of interfaces and classes.

[36] In this thesis, we consider frameworks for allowing mobile payment services as architectures.

1. Organisational: banks, non-bank financial institutions, mobile network operators (MNOs), regulators, technology partners, vendors, suppliers, etc.

2. Functional: system owners, system operators, payment processors, settlement and clearing institutions, custodians, etc.

3. Technological: design interface, operating systems, application software, communication networks, etc.

The extensive interaction among system's components results in the complexity and difficulty in understanding the structure and behaviour of the system. Thus, service modularity should be viewed as a multi-faceted form, that needs a robust and thorough empirical analysis. This multifaceted construct is what we believe still missing from the current studies on service modularity. Since complex systems in the real world settings are usually recognised in fully interconnected "spaghetti" form (Langlois, 2002), a valid modular definition is not readily apparent and effort must be expended to achieve it.

4.2 Technological element of mobile payment system

Technically speaking, a mobile payment system is a computer-based imple- mentation system that facilitates transfer and/or movement of digital money and currency through a secure wireless transmission. The system relies on a terminal component that sends and receives a portion or a whole of data and information related to a payment and/or transaction of at least one good or service. A mobile phone (or mobile device) that is capable to do mobile payment transactions must comprise at least a mobile payment module, a secure public-key cryptography (PKC), and a wireless transmitter to send and receive payment data to the terminal component and linked account.

The mobile payment module aforementioned above establishes a link to a particular account associated with a particular form of electronic money or currency. The form of currency can be an exchange of a good or a service, a kind of micro-payment, a line of credit, a stored value card, a pre-paid or post-paid card, a disposable card, or cash.

The mobile device being used in the mobile payment system communicates with the terminal component with either wireless fidelity (Wi-Fi), near field

communication (NFC), Bluetooth connection, or radio frequency identification (RFID). To serve that purpose, a mobile device usually requires a kind of secure computing base with the capability to host a virtual machine (VM) environment and perform a boot mechanism over secure transmission line.

Meanwhile, the customer account has to be linked with at least one of a financial institution, such as a bank, an insurance company, a co-operative, a credit card company, a brokerage house, an investment fund, or perhaps a particular website. There is also a certifying authority organisation that independently validates and verifies the component of a mobile device by issuing an electronic certificate with a designated expiration date. The mobile payment module is also protected by a virtual security machine through various kind of protection methodologies such as a randomised given password, a personal identification number (PIN), a public-key cryptography (PKC), a token verification system, or a combination of those aforementioned methods above.

A typical mobile device relies on a connection between a payment terminal and a user's mobile device in a secure protocol. This system might embed a dedicated component to facilitate wireless payments digitally and securely to a payment terminal module utilising mobile payment linked to an account. The system can also utilise a secure protocol to connect with the user's mobile device in which he/she can put some commands and instructions through a secure interactive screen (touch screen) or keypad mechanism. This protocol can be designed accordingly to give the customer such a convenient features in using and operating the system, including the ability to connect and use a mobile payment card or managing one's finances.

Such input mechanism can also be a trustworthy medium to allow a user to authorise a payment transaction on his/her mobile device. In some cases, the mobile device can also comprise a kind of payment card to enable wireless payment. Such system might also embed a VMM along with an I/O driver that have been secured appropriately. The I/O driver will bridge the connection between the main module with other devices such as a keypad, a storage, as well as an (interactive) mobile screen. Some manufacturers will put these drivers in a separate VM to minimise the size of VMM, even though it might increase overhead runtime. However, the main VM will assume that the system only play a conventional role as a mobile device OS and communicate with other systems, be it a payment terminal or external wireless network. The payment module itself can be installed either inside or outside a VM. However, a payment module that is implemented outside the system (isolated) might ensure the integrity and

reliability of the module.

In our cases, a component can include a processor that runs a process or several processes simultaneously, an object, a function, a program, an executable, a library, a routine/subroutine procedure, and/or a combination of hardware and software. Both an application that runs on a server can also be categorised as a component as well. One or several different components can be installed inside the main system or localised separately on other distributed system. Furthermore, a mobile payment system can also be executed as an apparatus or a method utilising general programming or engineering procedures to generate subsystems as an integral part of the main system.

A properly running environment should include a stable OS that might be kept on a secure storage device to manage resources and control processes of the main system. System applications benefited from resource management performed by the OS through data programme and program modules stored on disk storage or in system memory. A mobile payment system might also be combined with several OS or a combination of different OSes.

In general, any information or command entered by a user into the main system via input device(s) will be forwarded to the central processing unit utilising the embedded system bus through interface port(s). On the other hand, output device(s) will inform the result of command and information processing to the user. Output device(s) will utilise the same type of interface port(s) as input device(s). However, an adapter is probably required to ensure that output devices (e.g. speakers, monitors, graphical processing unit (GPU) cards, printers, etc.) will work flawlessly without any compatibility issues. The adapter will also link the system bus with the output device(s) as well.

The main system itself may run in a networked system via logical connections to one or more systems in a remote location. Such remote system(s) are connected to the main system via a network interface (logical connection) and then connected through communication and transmission line (physical connection). Network interface, in most cases, will encompass any communication networks, be it wire or wireless such as local-area networks (LAN) or wide-area networks (WAN).

With regard to system architecture, it is usually associated with the system modules. The boundaries between modules are the design rules. These design rules establish which dependencies are factored into a separate set of design decisions that are made before any other design decision is made. If two groups of design elements have a single interdependency—such as the format of a data

file—then this data format design task can be made earlier in the design process rather than later.

Eventually the design rule (or a series of design rules) that separates two modules can become fixed and future development can occur in parallel. An interface is therefore a first line of defence that an architect has in preserving the technical integrity of the system. This fixed set of design rules is called an interface, and they may be standardised. Thus, future modifications can be made to modules without affecting other modules. It also becomes possible to replace modules with different implementations or even to reuse modules in different contexts where the interface is the same.

In the case of mobile payment systems, modules are interrelated and work together to establish a network connecting subscribers with the system. Below are examples of a typical SMS-based mobile payment systems that are the most basic (standard) systems and which are currently widely used by banks, financial institutions, as well as mobile network operators (MNOs). The role and function of each particular module can be explained as follows:

1. Mobile station (MS), is a client or customer's device which has the capability to receive and send short messages (SMS), and is usually a mobile phone with digital technology. Applications that can be used from the device also depend on the service provided by the operator. A typical MS contains of subscriber identity module (SIM) as well as mobile equipment (ME). An ME comprises a radio transceiver element, a display unit, and digital signal processor (DSP), while the SIM used so that the user can be recognised by the network. There is no need to use the sophisticated MS—as long as the MS can receive and send SMS, customers can join the service.

2. A base station transceiver (BTS) serves as a device to communicate with all mobile station (MS) and is active in the coverage cellular area. A BTS implements the signal modulation and demodulation, equalisation, and coding error. Some BTS can connect with a base station controller (BSC) as well. The radius of a coverage area ranges between 10 metres to 200 metres for the smallest cell up to a few kilometres for the largest cell. A BTS can typically serve 20-40 communication calls simultaneously.

3. A base station controller (BSC) provides the control function on several BTS under the coverage. A BSC can handle a function handover, cell

site configuration, radio resource settings, as well as power and frequency tuning on a BTS. A BSC is a hub (concentrator) to connect with the core network. A typical GSM network usually controls up to 70 BTS.

4. A mobile switching centre (MSC) is a system that performs functions switching and control telephone calls in a mobile telecommunications network. A MSC also performs the function billing (connected to the billing system) and acts as a gateway to other networks. MSC is the module that will send a short message to a destined user through the nearest available base station.

5. A visitor localisation register (VLR) is a kind of database that stores static information of the customer or client data of a home location register (HLR) that are being roamed on other HLR. This information is required by the MSC to be able to serve the roaming customers. VLR also contains dynamic user information that is being "attached" at the mobile network, including geographic location. VLR usually is physically integrated with the MSC.

6. A short message service centre (SMSC) plays a significant role within the SMS architecture. A SMSC's main function is to convey short messages between short message entities (SME) with MS, as well as to save and forward the short messages (save the message if the SME recipient is not currently available). A SMSC also serves to inform the sender regarding the status of SMS messages that have been sent, whether it has been received or not by the mobile destination. If the destination phone is in an active state and can receive the SMS, the phone will send back a confirmation message to SMSC stating that the message has been received. SMSC then sends back the status to the sender. If the destination phone is off or inactive, the message sent will be stored on the SMSC until the validity period is met.

7. A home location register (HLR) is a part of the network that contains detailed information of each subscriber. An HLR is usually able to organise hundreds or even thousands of subscribers. In a typical GSM network, the signalling is based on protocol Signalling System Number 7 (SS7), equipped with the use of mobile application protocols (MAP). A MAP is used for location and subscriber information exchange between HLR and other network elements such as MSC. HLR may also be referred to as

database which is used to store permanent data and customer profiles. If requested by the SMSC, the HLR can provide routing information from certain customers as well. HLR also can provide information about the status of the destination: whether active or not, if it is detected that the customer is active and authorised, then the HLR can be initiated to provide this information to the SMSC.

8. The server is mainly a database that stores customers and companies' data and is connected to the world wide web or the internet. In the network of mobile payment system, the computer server communicates with ESME through the Internet as well as with other companies' servers that have partnered with the mobile payment system.

9. A core payment system is a network in which the mobile payment system plays the role as external short message entities (ESME)—a device besides MS that can function to receive or send SMS. ESME is generally used for creating more service variety to customers or to improve performance of the telecommunications network operators. Through ESME, customer data and balances are kept, as well as requests from customers to check balances, change their PIN, purchase goods or services, pay bills, put cash-in, take cash-out, and transfer cash.

There are multiple ways of implementing the mobile payment system, for example a tool kit, control, driver code, standalone or downloadable object, application programme interface (API), software, that allows other services and applications to utilise the payment modules of the system. The most common approach are perhaps from the point of view of a software object or an API.

With respect to interaction between several components, a mobile payment system may comprise those specified components or sub-components, a number of specified components or specified sub-components, and/or supplementary components with several combinations and permutations of the preceding. These specified sub-components might also be installed as integrated components, tightly coupled to different components via communication line rather than isolated inside the parent system (hierarchical).

In addition, a single component or several components can also be merged into a sole component producing cumulative function or can be separated into a number of sub-components. Further, any single or several middle layers (for example, a management layer) might be facilitated to interactively coupled to

other sub-components to generate and deliver integrated functionality. Several features can be assembled with one or more other desired features that came up during the implementation phase and considered to be superior than any other peculiar applications.

It is, indeed, very likely to report every plausible configuration of components or methodologies since every component mentioned above may result in further combinations and permutations, due to complexity, variations, and perhaps, alterations and modifications.

In spite of being determinant factors, the mobile technologies are important in the configuration of the mobile payment system because they can either inhibit or allow different topologies and resource services (Au and Kauffman, 2008).[37] Alternatively, simply broadening the coverage and capillary of the mobile networks in a geographical region would allow financial services and the mobile payment system to be offered to communities who have not yet been catered for and allow the presence of agents and banking correspondents in that region.

The main mobile technologies employed in the mobile payment system topologies include the following:

1. Short Messaging Service (SMS). This employs the short message service of the MNO, because it is relatively cheap to adopt. One of the main restrictions to its dissemination as the dominant platform for mobile payment systems is security concerns and other potential vulnerabilities. This is mainly because data traffic cannot usually be directly encrypted and information is often stored in mobile devices without proper security. Many procedures use SMS for confirming payments.[38] Users can send a text with a series of commands or parameters, e.g., merchant's ID, transaction code, PIN number, and amount or quantity to be billed/charged.

2. Unstructured Supplementary Service Data (USSD). This concerns a service for sending messages especially in GSM networks, which is used in a similar way to SMS. However, it usually has faster traffic and can provide relatively higher security than SMS since it does not allow messages received in the mobile devices to be sent or stored. This technology is employed as a transaction method in several financial mobile services such as

[37] For example, the spread of Near Field Communication (NFC) features and technology in mobile devices would allow innovative offline non-intermediated mobile services to be offered to the mobile devices.

[38] 3GPP TS 23.040 Version 7.0.1.

mPay in Poland, Wizzit and SWAP Mobile in South Africa, M-PESA in Tanzania, as well as Mobipay in Spain. With USSD[39] users do not have to type or input any command, since the instructions and informations are submitted like an MSISDN.[40] It would sometimes can accommodate simple menus to be displayed to the user.

3. SIM Card with SIM Toolkit (STK). This concerns the printed circuit or chip and is used in mobile devices with GSM technology.[41] Apart from identifying and authenticating the client, it allows the mobile programme to be operated while also enabling users to navigate in micro-browsers. As well as this, in the SIM chips, it is possible to store encryption keys properly and thus provide greater security in data communications and electronic transactions, even in the case of communications technology that does not possess built-in security (like SMS and USSD). An example is M-PESA in Kenya and M-banxafe in Belgium.

4. Interactive Voice Response (IVR). These services operate through voice recognition and sometimes even biometric voice authentication, in an interactive way by means of a technological system programmed with the menu of services rendered. It enables a phone caller to choose commands and instructions through a voice menu and respond through keyboard entry or voice. Since it is relatively a cutting-edge technology, its costs still remain high. Considering pricing models usually employed, the total cost of the transaction can be very high because it will be charged according to the time of the voice transmission and not data traffic volume. Benefits derived from this technology can eventually offset the amount invested: the use of mobile channels with financial relationships both for high-end devices (of high cost and performance) and low-end devices (of low cost and performance) would allow a single strategy combined with different services for different publics. First-generation mobile payment system such as Paybox utilise IVR technology.

5. Wireless Access Protocol (WAP). This is a notion identical to internet banking; it uses mobile data networks with better multimedia resources than the SMS and USSD technologies by allowing better usability and

[39] GSM 04.90 Version 5.0.1.
[40] For example, *123*4*5678#.
[41] SIM Toolkit (GSM 11.14) ensures interoperability between a SIM and a mobile devices. It is a series of procedures and commands to use during the GSM network operation phase.

ease of adoption for users who already have other digital financial services. Users can select his/her desired option from the menu, press the particular button, then enjoy the payment service. WAP-based topology (WAP 1 or WAP 2.0 version) would make it possible to build reasonably secure environments, since services would be centred on internal mobile issuer servers, as occurs in common internet banking services.

6. Mobile apps and web-apps. As well as providing the basic services already mentioned, this technology allows the supply of more complex services for banking and finance, such as insurance and home brokerage. They are readily customised in accordance with the user interface and provide a very secure and reliable channel. In many cases, it is necessary for an application, which must be available in several platforms, to be recorded in the mobile device, which can be inconvenient for many users and companies, although in many cases the potential benefits can justify its adoption.

7. IP mobile networks. These are data networks that allow broadband services in alternative networks (Wi-Fi, WiMAX, and others) for the data networks of the MNOs. Although they are not strictly technologies designed to offer mobile payment system, they can be employed for this end and have features similar to the services provided by WAP technologies or even internet banking services.

8. Personal area network (PAN). These technologies are connections made possible for short range communications functions such as Bluetooth and near field communication (NFC). They can be recommended for transaction services and direct payments (non-intermediated) between clients' mobile devices and POS or ATM equipment, or vending machines and transportation tickets.

9. Calling line identification presentation (CLIP). This is a GSM supplementary service that sends out the caller's number to the called party's (counterpart) phone throughout the ringing mode. This is also usually called mobile subscriber integrated services digital network number (MSISDN) that can be set up when there is an incoming call but before the call is accepted.[42] CLIP is usually utilised in collaboration with IVR technology to authenticate user. Yet, there are also CLIP that are working standalone such as Cashbeam in which both payees and payers ought to dial a

[42] ETS 300 648.

predetermined number in which the last several numbers show the price of a particular good or service.

10. Java 2.0 micro edition (J2ME). It supplies a series of runtime environments as well as application programming interfaces (APIs) that enable the use of the Java computer programming language and other corresponding tools to build application programmes for mobile phones (MIDlets). A graphical user interface (GUI) is usually provided by J2ME as well as the capability to establish secure connections to the mobile payment server. An example of J2ME mobile payment is Obopay in the United States.

11. Near field communication (NFC). A NFC is actually a system based on radio frequency identification (RFID). A NFC is implemented to communicate with other electronic devices in a short distance[43] that are not physically connected.[44]

Technology availability, especially in the hands of individuals, would be a significant variable in the topological constitution of the mobile payment system. In emerging world where most mobile phones are pre-paid, mobile devices are predominantly low-end and, in some cases, very expensive. In such cases, it can be argued that offering services with high-end technologies using data networks is more costly and so would be confined to a small proportion of the population who would be able to have preferential access to other efficient electronic payment means.

Thus, it is more plausible to think that technology and services that are most strongly recommended in the mass topology for mobile payment systems would be those that already exist in low-end mobile devices (for example via SMS or USSD with specific SIM cards, as is the case of Oi Paggo in Brazil). This way, even though it cannot be established as decisive, the technology would be an important limiting or driving factor in the different alternative topologies for mobile payment systems and, as a consequence, a part of the technological strategy of the mobile money operator.[45]

[43] It typically less than 4 cm.

[44] For example, a credit card company JCB deployed a pilot programme utilising NFC technology along with other seven mobile payment companies in 2006. This collaborative system enable Nokia phone users in Amsterdam to do payment transaction at any stationary merchants.

[45] In accordance to the EU directive 2000/46/EG Art 1, a mobile money operator providing electronic money services in Europe should obtain either a full banking licence or at least an e-money licence. In the case of Contopronto AS, the company holds an electronic-money license due to their prepaid product-based account.

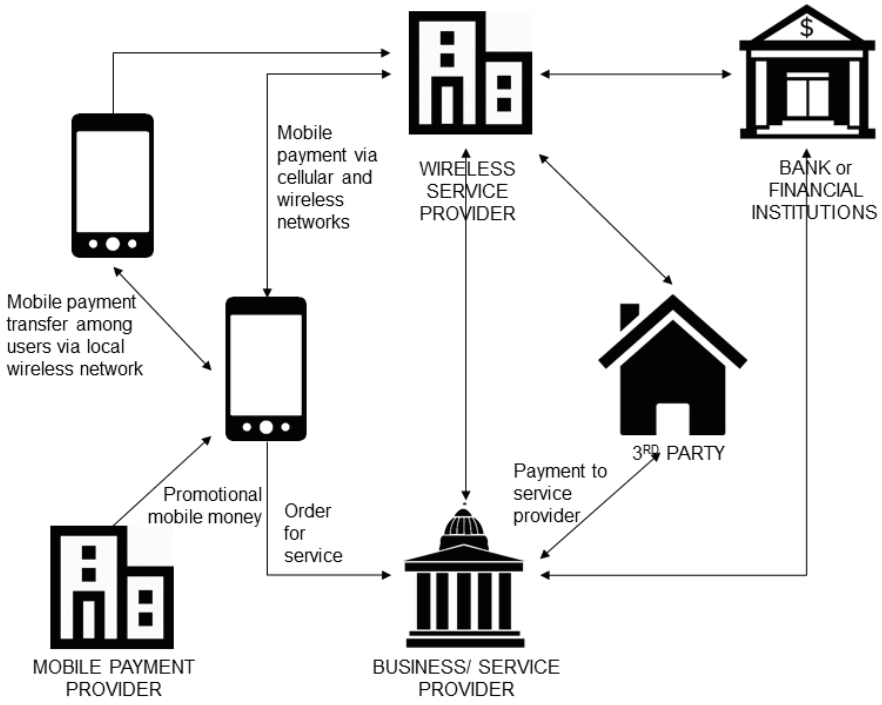
4.3 Modularity in organising mobile payment

Mobile payments have been utilised for more than 10 years, yet, what looks more simple and straightforward is actually far from representing the complexity and reality of what happened behind closed doors. Mobile payment systems operate in networks with shared common infrastructures such as telecommunications networks, settlement systems, and attract new customer by offering them value extracted from the use of these infrastructures (Steiner, 2005). Thus, mobile payment systems exhibit strong economies of scale derived from greater network coverage and better cost structure. The existence of this positive network effect as well as greater returns from such positive feedback, encourage the arising natural monopolies in the sector. Mobile payment systems facilitate users without banking account and/or securities account to perform financial transactions through their mobile phones—sometimes they do not have to open an account with an existing (traditional) financial institution that makes those mobile payment systems different from mobile banking and securities account (Chatain et al., 2008). The services are not based on a pre-existing banking account or financial account and are also mostly delivered through a non-bank institution (such as an insurance or a credit card company) as well.

Mobile payment ecosystems consist of a network of organisations and individuals that ought to be in such a mutual collaboration and cooperation for mobile payment systems to take root, proliferate, and grow explosively (Jenkins, 2008). This ecosystem spans a various number of different stakeholders, including banks, mobile network operators (MNOs), retailers, regulators, international financial institutions and donors, utility companies, airtime sales agents, employers, civil society organisations, as well as end users. The current typology of the mobile payment system, in its various configurations, can be aligned with possible phases of expected maturity for mobile financial services, as suggested by Chakravorti and Kobor (2005), which include the following: (1) vertical initiatives (the company alone), (2) strategic alliances and partnerships with some agents, and finally (3) a regulated and interoperable eco-system among the other (3rd party) institutions. A typical digital payment scenario is portrayed in Figure 4.2.

Figure 4.2 depicted the relationships beetween the customer, the merchant, the acquirer, as well as the provider. In our example, the customer is making the payment to the merchant (business or service provider). The third intermediary organisation is the acquirer that has a close connection with the related

Figure 4.2: A typical mobile payment scenario



Source: Author

merchant. Meanwhile, the wireless service provider is also the intermediary that interacts with the customer. The purpose of the whole interactions is to transfer the value from the customer to other customer or from the customer to the business and service provider. In this case, bank or financial institution settles and pays the related parties.[46] The main difference between conventional payment system (such as credit card) with mobile payment system is that the customer must utilise mobile devices (mobile phones) in order to realise a payment or a transaction.[47]

Compared to other players, MNOs usually have a large number of customers and also have control over the subscriber identity module (SIM) of their customers', making the impact and influence of MNO-based mobile payment scheme is enormous (see Table 4.1). But, MNOs also unable to manage a payment system solely, since they have minimum experience in managing money (transactions) and the risks associated with every transactions and payment systems.

On the other hand, we realised that financial services are capable in managing risk and liquidity. They have been doing payment services since 1900s and can realise cross-border payments.[48] Furthermore, the handset manufacturers also play an important role. Even though they have no experience in payment systems, they control the capacities of the technology that influences the deployment of a mobile payment system. Finally, software developers also responsible in administering the infrastructure by developing standard compliant tools and technologies that would link the various components of the mobile payment stages.

We argue that in order to bring the mobile payment system to the open and dynamic environment and shape it to fulfill customer's needs, the cooperation and collaboration of all players in the market is inevitable. Initiating and establishing a universal open solution rather than a proprietary (or closed) solution with such an exclusive coverage is mandatory (Evans and Pirchio, 2015) since all mobile payment systems are deployed and managed under constraints levied by government regulation and legislation at the country level, regional level, or international level (Chakravorti and Kobor, 2005).

Although several mobile payment schemes present, nowadays there is still

[46] Other scenarios might involve swap the token, that can be physical or electronically-based, between the merchant and the customer.

[47] Sometimes the merchant may also use mobile devices or mobile phones as well.

[48] In some cases, banks or MNOs or may also solely become the mobile payment service provider and deliver limited services to their customers on their own.

Table 4.1: Organisations involved in mobile payments

Organisation	Main attributes
Bank/financial institutions	A number of customers, a number of merchants, established infrastructure in payment, operators for bank cards
Mobile network operators	A number of customers, a number of merchants, established infrastructure in telecommunication, control of customers' device, infrastructure for billing
Independent providers	Quick response, minimal or no infrastructure, limited number of customer base
Others (supporting providers, technology partners, etc.)	Basic and general components provision, technical capabilities, other supporting services

Source: Author

no dominant mobile payment business model in the sector. The most common schemes are bank-centric, MNO-centric, and third-party-centric. Banks and financial institutions typically have been dominating payments and financial transactions, owning both customers' accounts as well as merchants' accounts, including clearance and settlement procedures between those for a long time. Mobile operators are relatively new but have been able to manage their account successfully within their network. In a bank- or financial institution-dominated scheme, bank or financial institution manages the mobile payment systems while the MNO responsibles over the airtime connection only between the bank or financial institutions and the user. On the contrary, in the MNO-controlled scheme the MNO does the payment (billing) and most of the time also establishes revenue-sharing arrangements with several MNOs to widen the coverage and increase the number of their customer.

A main advantage of the third-party-centric is that the third-party institutions allow every mobile user to become their customer, regardless of user's bank, financial institution, or mobile provider. For a particular merchant willing to utilise a mobile payment solution, joining up with third-party institution is usually more efficient rather than joining up with several different MNOs. However, an independent third-party firm will have to establish a user base first, most likely from zero, that unarguably is not such an easy task to do.

Even though the aforementioned scenarios dominate current mobile payment schemes in the sector, there are also composite or mix models in which

several key business partners collaborate, most likely under a revenue-sharing arrangement. Such a mix or composite model is generally cited as a win-win scheme, and is wider as it tends to get country-wide acceptance and establish partnership with several key players from various other domains.

The lack of collaboration and coordination between the main stakeholders is unarguably a main challenge to mobile payment systems success (Dahlberg et al., 2015; Ondrus and Pigneur, 2006). We speculate that perhaps a win-win solution ought to be established in which banks and MNOs co-operate congruously in a non-exclusive scenario. In this utopian scenario, each partner focuses on core business and attempts to increase revenue by delivering core services. It is too expensive for banks to develop mobile payment platform from the scratch. Joining together will give MNOs additional income other than airtime services and will increase average revenue per user (ARPU). This way, interoperable cooperation will integrate new infrastructure technologies, make cross-border payment functionality possible, reduce dependability on specific player, and ensure acceptance points at a higher rate, which in turn will push the mobile payment system further to achieve critical mass.

Since all main players in the mobile payment market have their strengths and weaknesses, the 'ideal' configuration should be rooted on strong partnership (Pousttchi, 2008). Partnerships are generally relied on mutually agreed terms and conditions (T&C).[49] In the context of mobile payment system, Pousttchi et al. (2009) differentiate between technological aspect, legal aspect, customer relationship, psychological aspect, and expertise.

All in all, at the functional level, modularity related to how a mobile payment service provider creates and delivers value, manages relationship between them, and acquire capabilities through their partnership network. The functional configuration governs the composition and management of certain activities that is needed to develop a customer value proposition. Despite the variations across different mobile payment procedures, most employ the identical process such as initiation, registration, confirmation, authentication, as well as settlement (Dahlberg et al., 2015).

Most steps require a user registration before using the service or immediately after his/her first usage. The registration process may be initialised using mobile

[49] For the purpose of this thesis, we define a partnership in accordance to the resource-based view (RBV) of the firm, emphasising the impact of cooperation and its contribution in exploring and exploiting resources that the mobile payment system operator currently does not have. This collaboration will usually result in cost structure improvement.

device (mobile phone), via the internet, or offline. A dedicated registration for a mobile payment procedure might not needed if customer data are accessible from the current business partnerships and collaborations.[50] However, Mallat (2007) warns that customers can be cautious that their financial transactions are sniffed, monitored, their personal information is exploited or abused, and that they will get unintended ads and promotions when they joined a new payment instrument.

4.4 Comprehensive mobile payment framework

It appears that there is no sufficient research on the integrated view of mobile payment business framework (Dahlberg et al., 2015). A notable exception was perhaps Pousttchi (2008) and Pousttchi et al. (2009), who borrowed Osterwalder's (2004) business model ontology, proposed a detailed abstraction level of mobile payment framework as well as the dynamic relationships among the related attributes in detail. Pousttchi (2008) define mobile payments as "a type of payment transaction processing in which the payer uses mobile communication techniques in conjunction with mobile devices for initiation, authorisation, or completion of payment" (p182).

Mobile payment systems can be viewed and examined as two sides of a coin: on one hand, it is a means of payment for real-world situations, yet on the other hand, it is also a function of system-inherent payment for mobile business transactions (Dahlberg et al., 2015; Evans and Pirchio, 2015). Mobile payment systems may become a tool providing payment functionality in other situations outside mobile business transactions such as buying refreshments at vending machines, payment in stationary electronic or internet commerce, paying another person who acts as a service provider or a merchant, and money transfer between consumers (Kreyer et al., 2002).

Pousttchi et al. (2009) enhances the mobile payment business model ontology in previous study with two additional foundations: threat consideration and perspective of finance. They follow Osterwalder (2004) framework and introduces morphological blocks that represent several characteristics of the abstraction layer. Table 4.2 summarises the abstraction layer at the first and second level of the mobile payment framework.

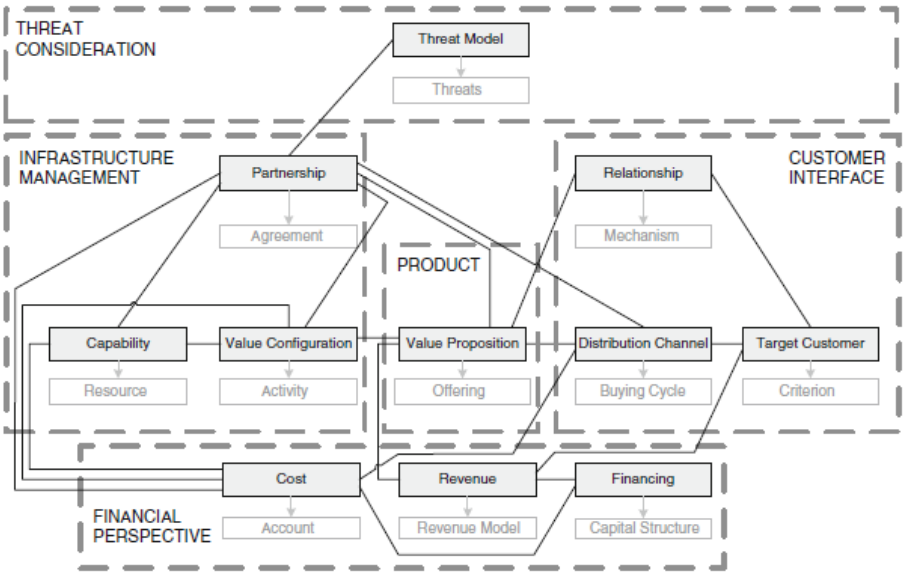
[50] An example M-Pass, a joint operation between O2 and Vodafone in Germany, in which telephony users are automatically pre-registered as an M-Pass user as well.

Table 4.2: Abstraction layer of the framework

Pillar	Building block	Description
Product	Value proposition	Overall view of offers that are of value to the customer
Customer interface	Target customer	A segment of customers wants to offer value to
	Distribution channel	A means of getting in touch with customer
	Relationship	Linkage between service provider and the customers
Infrastructure management	Value configuration	The activities required to provide value proposition
	Capability	Assets or resources required to provide the procedure
	Partnership	Cooperative agreement between service provider and other companies to create value
Financial perspective	Cost	Represent money of all the means employed in the business model
	Revenue	The way an mobile payment service provider makes money
	Financing	The capital structure of the mobile payment service provider
Threat consideration	Threat model	The potential and profound threats to the economic success of the business model

Source: Adapted from Pousttchi et al. (2009, p370)

Figure 4.3: Business model framework



Source: Pousttchi et al. (2009)

The whole foundations and overall building blocks is showed in Figure 4.6. The relationships among the building block are symbolised with non-directional edges. According to this framework, the value proposition of the product is developed by configuring customers' value and distributed using the distribution channel. The value propositions are maintained with target customers via relationship. Partnership manage the capability of the firm, value configuration, value proposition, as well as the distribution channel. Cost, revenues, and financing are represented in the financial perspective pillar (Pousttchi et al., 2009).

The pillar of the product comprises all elements of what a mobile payment system developer provides their users (Pousttchi et al., 2009). The customer interface pillars includes most customer related attributes, particularly the selection of the intended customers, channels of distribution, and the type of relationships the firm is willing to maintain with its particular customers since a mobile payment system involves various economic actors (Au and Kauffman, 2008). Infrastructure pillar considers of how a mobile payment system developer creates and delivers value. The financial pillar is crossing all the remaining pillars and mutually influence each other (Pousttchi et al., 2009). The last pillar,

threat consideration, describes profound threats and potential to the economic success of a mobile payment systems business model (Pousttchi et al., 2009).

Even though the framework seems complex and can be used as a working base, the building blocks appear to be purely descriptive and cannot capture the dynamic and flexibility nature of mobile payment system. The model also have not yet identified and indicated the pre-defined instances of the ecosystem as well as the direct and indirect restrictions. Secondly, the model has not been tested empirically within an appropriate context. Thirdly, the model is not particularly described in a formal language. The framework also do not include any measurement nor evaluation metrics to analyse mobile payment business models further. Thus, the framework is more suitable for a priori before offering a mobile payment procedure rather than a posteriori evaluation.

The most important thing that cannot be captured from this model is how different actors (such as banks or other third party institutions) may emerge as a key player in the mobile payment ecosystem. Despite its limitations, we can use the framework as a baseline to compare our mobile payment cases. However, we will put more emphasis on a micro-perspective of the firm in order to uncover the important resources owned and controlled to give better comprehension of the dynamics of mobile payment system.

Chapter 5

The Payment Systems Typology

This chapter unpacks the history and development of mobile payment systems. This is particularly important because mobile payment systems are inter-linked products that have precursors and followers. This chapter also describes the influence of technological advancements towards the dynamics of the payment industry.

Mobile payment systems can be elaborated as payments for any kind of products, services, or bills utilising mobile phone or mobile device by exploiting wireless characteristics as well as other communication features and benefits. Mobile devices (such as smart phones, tablets, etc.) can be utilised in a numerous scenarios of payment, from purchasing electronic materials, tickets, transport fares, as well as to perform electronic transactions such as paying invoices and other bills. Purchasing physical products via mobile payment systems is also possible, either from the vending machines, ticketing machines, as well as at any manned point-of-sale (PoS) stations. In addition to that, a lot of payment instruments nowadays and most electronic payment systems have also been mobilised.

Section 5.1 elaborates the history of mobile payment systems. The next section, (Section 5.2) describes the evolution of mobile payment systems. Section 5.3 elaborates the existing ecosystem and value chain configurations of mobile payment systems. Lastly, Section 5.4 extends the discussion into the de-verticalisation of the industry.

5.1 Histories of mobile payment systems

The relationship between banking (financial institutions) and telecoms (MNOs) is not uncommon (van der Boor et al., 2014). The first commercial utilisation of mobile technology in banking was probably in 1995 when Merita Bank of Finland developed SMS alerts to inform balances and other account updates to their customers.[51] This is a producer innovation in which users are not involved in any of those initiatives.

In the U.S., PayPal started providing online payments and mobile payments in 1998. Their network grew exponentially after being acquired by eBay. During its inception, PayPal relied on eBay users by providing them person-to-person (P2P) electronic payment. However, the company soon grew beyond eBay users. PayPal has more than 110 million active users in 190 countries by 2012.[52]

The introduction of prepaid phone credit perhaps begin in 1998 in Philippines. They use SMS technology as a method of passing top-off credits between mobile phone users in exchange for goods or services.[53] Until 1999, the exchange of this airtime credit via SMS was still a free service. Some mobile phone users were transferring airtime and then converting it into cash money, making it a means of transferring purchasing power from the sender to the receiver. It then became a common practice in Philippines.

In Asia and Middle East, the concept of money transfer has been existed since thousand years ago. They use the word "*hawala*" that was derived from Arabic word for transfer and "*hawaladar*" for individuals that formed an informal network who perform wiring services. The transactions were based on trust between one another through *hawaladar*. When the mobile technologies came, they moved from high-frequency radios or satellite phones to mobile phone network. This changes allow them to perform the transaction quickly and settle the accounts immediately.[54]

In 2006, John Owens from the Rural Bankers Association of the Philippines—Microenterprise Access to Banking Services (RBAP-MABS), was approached by his nanny who complained that she could not send the money to

[51] http://neurojava.net/2010/03/25/sms-that-good-old-messaging-service/

[52] http://paypal-media.com/assets/pdf/fact_sheet/PayPal_Q3_2012_Fast_Facts.pdf.

[53] See Lallana, E., (2004). SMS in business and government in the Philippines. *ICT4D Monograph Series*. Available at http://unpan1.un.org/intradoc/groups/public/documents/other/unpan024834.pdf.

[54] It is often claimed that as early as 1996 in Afghanistan, Osama Bin Laden as well as his networks utilised mobile phones to perform monetary transactions through his *hawaladar*. See http://www.rense.com/general21/noc.htm.

other family members. While she was happy that her salary was paid in G-Cash, most of the family members did not own mobile phone and lived in the rurals.[55] He then came to the bank and proposed a solution along with the telecom opeartor. Globe Telecom then created a kind of optional message field that can be used by rural banks to develop further into mobile banking features. Since September 2006, they launched their new mobile banking feature.

Developed and managed by Safaricom, M-PESA was launched in 2007 to serve Kenyan unbanked population. By 2012, they have more than 50,000 agents in the country and handles more than $1 billion money transfers per month. Similar examples can be found in Uganda (MTN), Tanzania (Vodacom), as well as in South Africa (FNM).[56]

In 2012, the French Cityzi, established by four MNOs, was able to marketed more than one million phones with Near Field Communication (NFC) features. At the same time, several MNOs in Denmark also launched a common mobile payment system to take more active role in providing payment services.[57]

Other than P2P payments, government-to-person (G2P) payments is also growing significantly in several developing countries. For example, in Brazil and India, government subsidies are regularly distributed via a network of government institutions in cash. To increase the efficiency and reduce the possibility of leakage or corruption, they began using mobile technology for G2P payments.

Indeed, different type of products emerge and appeal to different countries as well as different customer segments. This implies that firms and regulators have to choose their technology, platform, and market carefully.

5.2 The deployment of mobile payment systems

Millions of people are reliant on mobile money in everyday life, and even more will continue to be so. Mobile payment systems are often considered as a common extension of existing traditional and electronic payment systems that will complement them. Nowadays, mobile devices are becoming a kind of personal trust devices (PTD), that are frequently regarded to be controlled and owned

[55] See Mendes, S., Alampay, E., Soriano, C., Soriano, E. (2007) *The Innovative Use of Mobile Applications in the Philippines—Lessons for Africa.* SIDA, Stockholm. Available at: http://siteresources.worldbank.org/EXTEDEVELOPMENT/Resources/20071129-Mobiles_PH_Lessons_for_Africa.pdf

[56] See Cobert, B., Helms, B., Parker, D. (2012) Mobile Money: Getting to Scale in Emerging Markets. *McKinsey Quarterly*, February 2012.

[57] See Gupta, S. (2013) The Mobile banking and Payment Revolution. *The European Financial Review*, February-March, 2013, 3-6.

by the owner (single-user).

Mobile payment system is not merely a plain and unsophisticated mobilisation of the traditional or electronic payment system (i.e., providing a mobile feature to the current electronic payment mechanism), as the context (such as market structures, business models, stakeholder relationships) as well as capabilities (such as end-user technology) are not alike (Au and Kauffman, 2008; Dahlberg et al., 2015). Thus, in our cases, we define mobile payments as follows: Any kind of transaction in which a mobile device is being utilised to start, run, and/or verify this transaction.[58]

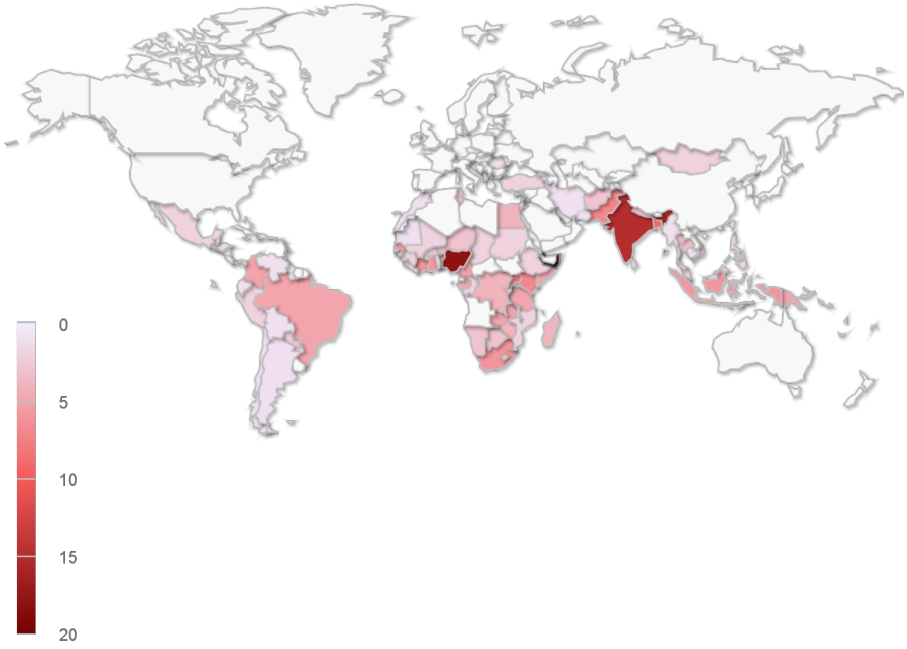
The field of mobile payment in general is relatively new and thus is often misunderstood. At the moment, a mobile phone or any other mobile device is not merely a means of payment. Rather, it is a medium by which financial transactions can be initiated, processed, and/or confirmed. A mobile payment is also not merely about accessing a payment service through internet using a mobile device. Even though the mobile version of the service might have similar functionality, mobile payment design and implementation differs due to the different approaches and contexts (Karnouskos and Fokus, 2004).

The terms mobile payments and mobile banking are often used by people interchangeably, yet, they are not the same thing and the difference is important to understand. Mobile payments generally relates to services that are generic and universal, and that can be performed by related service providers other than banks or financial institutions. Mobile banking also usually linked with the bank procedures and tend to be narrower in scope. Thus, mobile banking can be categorised as a sub-domain that sit under the mobile payment umbrella.

Many discussions among research scholars and business practitioners that highlight the importance of mobile payment systems. It is perceived to have an important impact in electronic and mobile commerce. Mobile payment systems have been an important driver of socioeconomic development in the emerging economies (Dahlberg et al., 2015; Duncombe and Boateng, 2009). Coupling a global instant payment ability with content management would result in a strong

[58] Contrary to common stereotype, mobile payment systems actually do not limit themselves only to payments using mobile device (cell phone), but are also to payments using any other electronic device with mobile capabilities, such as a tablet PC, a PDA, a smartphone, a payment terminal, or any device that are capable of starting, performing, and/or validating a payment transaction. In general, however, when we talk about mobile payment or mobile payment system, we usually relate to the type of transaction method through any mobile device with telephone capabilities (such as smartphones) rather than through a mobile device with wireless connection in general (such as iPad or tablet PC). For the rest of this thesis, we also promote this description, as virtually all current available systems assume this.

Figure 5.1: Mobile money chart worldwide



Source: GSMA Mobile Money Deployment Tracker 2015

combination (e.g. Au and Kauffman, 2008; Dahlberg et al., 2008; Dahlberg et al., 2015; Dermish et al., 2012; Duncombe, 2011; Mallat, 2007; Pousttchi, 2008).

At the moment, there are 263 live deployments and 101 planned deployments of mobile money around the world (see Figure 5.1). In a handful of those countries, one or two of the schemes ignited and grew explosively, yet most mobile payment schemes have not ignited at all (Evans and Pirchio, 2015).

Attributes such as innovations in technology, improvements in socioeconomic environments, as well as the high mobile device penetration rate are pushing mobile payment systems development in certain developing markets.[59] Mobile payments can promote and encourage a variation of service provisions—in particular, person-to-person money transfers (P2PT). P2PT is particularly important for developing countries since it enables financial services delivery to the unbanked population. Mobile payment systems have also managed in helping

[59] A well-designed mobile payment system has emerged in Kenya that had over 18 million mobile payment subscribers. See Standage, T. (2011). Virgin Territory. *The Economist*, 17 November 2011.

disaster recovery and emergency response.[60]

We identified several factors that encourage mobile payment growth in developing countries below.

1. Socioeconomic conditions: Perhaps the most important factor that fostering mobile payment growth in emerging economies is lack alternatives to cash (Duncombe and Boateng, 2009). Most people in emerging economies do not own a checking account nor a credit and debit card. Poorly developed infrastructures combined with high fees of money-transfer services making mobile payments look attractive (Evans and Pirchio, 2015). In some countries (such as Kenya, Tanzania, and Zimbabwe), people incline toward the use mobile banking to avoid getting robbed.

2. Cost efficiency: Most transactions conducted in developing countries are low in value but high in volume. Opening a bank branches become not feasible since it needs a huge initial investment, equipment, infrastructures, as well as human resources and security officers. Branchless banking looks more appealing because it leverage local resources, utilise local infrastructures, as well as equipment and human resources (such as mobile phones and agent shops). Thus, mobile payment system is considered to be beneficial to the lower-class families and bottom-of-the-pyramid (BoP) population.[61]

3. Diffusion of mobile phones: As mobile phones getting cheaper and financial services remain inclusive, mobile payments become more favourable (Duncombe, 2011). In some countries, people can have more than one mobile phones. In sub-Saharan countries, it is proved that more household have mobile phones connectivity than access to clean water or sustainable electricity.

4. Convenience: In most developing countries, mobile payment is more convenient (Dermish et al., 2012). People does not have to travel far from home to pay in or withdraw money, adding significant time and cost to

[60] For example, after the earthquake in Haiti in 2010, Mercy Corps along with Voilà distributed virtual mobile vouchers. They developed a simple and inexpensive mobile phone loaded with $40 TCASH (using a mobile payment system from Indonesia's largest MNO, Telkomsel Indonesia), was then given to each earthquake victim. Finally, subsequent aid distributions managed just by utilising an SMS technology.

[61] Cost for a typical mobile payment transfer is about 1 percent. For example, cost for transferring money via MTN and Wizzit in South Africa is only about $0.05. Before MTN and Wizzit, people have to pay $30-$50 to deliver cash to relatives.

the already high fees. This is not a problem in developed countries since banks and ATMs are just across the street.

5. New initiatives: There are several new initiatives of international organisations and NGOs (e.g. IFC/WorldBank, Gates Foundation, GSMA, etc.) that promote and facilitate the adoption of mobile payment systems (Jenkins, 2008). For instance, M-PESA in Kenya was initiated and developed by Safaricom/Vodafone with the support from UK Department of International Development (DFID). Telenor Pakistan (Easypaisa) also received a $6.5 million donation in 2012 from the Gates Foundation.

There are also several factors that are limiting further mobile payment growth.

1. Heavy regulations and restrictions: This is probably the most detrimental factor that challenges the mobile payment growth. Insistence from banks to play a central role in the ecosystems are also limiting mobile payment growth (Evans and Pirchio, 2015). Unfortunately, most mobile payment-related legislations are moving slowly compared to technological advancement.[62]

2. Limited collaboration: In most cases, the lack of collaboration has created a roadblock in the ecosystem (Au and Kauffman, 2008). For example, it took more than 5 years for M-PESA to be able to collaborate with commercial banks so that its customers can withdraw money from bank's ATMs. Collaboration is important since most traditional banks usually do not have supporting tools to deal with mobile payments.

3. An underdeveloped ecosystem: Poor infrastructures, lack of standards, minimum mobile phones features, congestion in the telecommunication network, including outages that have restrained the ignition of mobile payment systems in developing countries (Duncombe and Boateng, 2009). In some cases, there are also interoperability issues and the need for particular types of intermediaries to solve the trust issues and to help in reducing "chicken-and-egg" problems.

[62] When M-PESA was introduced, at that time there were no particular regulation on mobile money in Kenya. Safaricom found the loophole and exploited it to ran the operation with no proper banking license as can be regularly seen nowadays. Retail banks in Kenya assumed M-PESA as a Ponzi scheme and request an investigation by the Central Bank of Kenya. Then the audit showed that M-PESA provided "bank-grade security level and controls" (Duncombe, 2012). Meanwhile, CellBazaar in Bangladesh failed to ignite in the market due to a inadequate technical support and lack of policy support for mobile network operators (MNOs) to offer and deliver such mobile payment services in the country.

4. Security problems: Developing countries are more likely to be victims of cybercriminals (Karnouskos and Fokus, 2004). First, developing countries usually do not have adequate legal frameworks and enforcement mechanisms to combat cybercrime. Secondly, sometimes the customers are not particularly knowledgeable and pay less attention regarding security issues. This also implies that advanced technology are probably not appropriate in the context of developing countries.

Considering a number of factors that drive and hinder mobile payment growth above, it is important for all key players in the ecosystem to focus on the long-term goal of mobile payment systems. Obviously, the most important goal of any payment system is to increase efficiency that, in turn, will promote economic growth. As for mobile payment, it not only offers an alternative way of doing a financial transaction, but in particular, it targets the micro-payments which is not possible through real cash. However, whether the key players developing and implementing this technology are ready to make a full-scale commitment is remains to be seen.

5.3 Mobile system and value chain configurations

Mobile payment systems are fostering the development of a new ecosystem of market participants including MNOs, retailers, banks, card operators, device suppliers, technology vendors, service providers, and trusted service managers (see Table 5.1 for some examples of mobile payment systems).[63] Main regulatory considerations emerge, including electronic money and electronic payment system, mobile payment services regulation, consumer data protection, as well as standards and privacy.

As can be seen from Table 5.1, most of the mobile payment systems were deployed in developing countries, notably in Africa and Asia. Mobile payment systems were mostly utilised to perform person-to-person transfers (P2PTs), but also to make small purchases, pay bills and fees, as well as purchase some goods or services. Almost all of the MNOs providing mobile payment systems were also operating in several different countries in the region, making it easier to do cross-border transactions and remittances.

The contractual landscape connecting the main key players inhabiting the

[63] See Kshetri, N., Acharya, S. (2012). Mobile Payment in Emerging Markets, *IEEE IT Professional*, 14(4) July/August, 9-14.

Table 5.1: Examples of mobile payment systems

Mobile payment system	Country coverage	Main uses
Safaricom's M-PESA	Kenya, Tanzania, South Africa, Afghanistan	Make person-to-person transfers (P2PTs), receive mobile phone credits, pay school fees, pay electricity bills, save money
Easypaisa	Pakistan	Pay utility bills, make domestic and international P2PTs, use as a mobile wallet, increase air time credits
Voilà's T-Cash	Haiti	Receive salary, make P2PTs, pay bills
Airtel Money	India and 16 African countries, including Kenya, Tanzania, Uganda	Make P2PTs, make purchases
MTN MobileMoney	Africa, including Uganda, Ghana, Cameroon, Côte d'Ivoire, Rwanda, Benin	Make P2PTs, pay for goods and services, check balances, buy air time, pay utility bills, school fees, or tuition

Source: Kshetri and Acharya (2012, p10)

Table 5.2: Mobile payment system category

Category	Type
Location	Remote transactions
	Proximity/local transactions
Value	Micro-payment systems
	Mini-payment systems
	Macro-payment systems
Charging method	Post-paid payment systems
	Pre-paid payment systems
	Pay-now payment systems
Validation of the tokens exchanged	Online mobile payment
	Offline mobile payment
Number of chips/slots	Single chip payment systems
	Dual chip payment systems
	Dual slot payment systems
Approach	e-coin based payment systems
	Account based payment systems
General procedure	Wireless wallet payment systems
	IrFM-based payment systems
	RFID-based (Smart Phone Covers)
	Top-up
Inventive approach	Mobile cash card
	Barcode paperless receipt
	PhotoPay

Source: Adapted from Karnouskos and Fokus (2004)

ecosystem is also rapidly emerging, with main issues including revenue models, technology development, customer ownership, as well as risk and liability. Players participated in mobile payments will have to carefully examines their and others' roles, along with regulatory factors in establishing and executing their strategy and how to approach contractual consultations.

Whilst mobile payment systems are starting to take off, they are presently at an early stage and fragmented as a product of a huge number of competing platforms that obviously in the short-run will increase fragmentation (see Table 5.2 for a typical mobile payment categorisation).

In most cases, mobile payment systems do not have a separate set of legal regulations, particularly in developing countries. On the other hand, however, regulation is deeply layered and pervasive, widely according to the "mobile", "payments", "retail", and "technology" type of converging value chains described and classified above. The structure of contracts are also still at an inception

stage, but have already been implemented at every field and tier of the system. Mobile payment systems are beginning to develop at the outset of frequently experienced aspects of technical risk and financial/economic reward.

The following issues and concerns are probably best interpreted as a set of problems or concerns around the following themes, and these four themes will guide our case analysis as well:

1. Structural identity of the deal of the system: Who are the related parties and stakeholders involved in the deal? How and where does the contractual deal suitable into the system? Describe the dependencies between their link in the contractual chain and any other link/dependency. What technology solution are they dealing with? Different regulatory and contractual treatment might required depending on whether they are dealing with display app, online mobile payment, or digital mobile payment technology. Are there any flexible change control mechanisms?

2. Payment flows: Are they crossing the traditional regulatory banking boundary? What might look like an electronic money or payment system might not be on closer examination (and vice versa). How do they get paid? Evaluate whether the model includes deduction or set-off mechanisms or whether payment for the goods or services provided is against invoice, gross or net, etc. What is the financial and business model? Consider how the revenue and all the relevant costs that arise from the deal will be shared and allocated between the contractual parties (and, if different) all the players in the relevant ecosystem. Competition law considerations may be relevant in relation to customer pricing and restrictions. VAT structuring is also likely to be critical.

3. IPR and data: What is the status and the position of an IPR? What licences in/out are being given? What foreground and background IPR is being licenced, assigned or withheld? Who has what rights to particular sets of data in the databases? How will customer data be used? If they control personal data that arises through the mobile payments ecosystem they participate in, what data protection law duties do they have, to whom and how far do they extend? Who owns the customer? The arrangements will need to determine which party contracts with and bills the customer and who owns the data relating to and coming from customer use of the service, etc. (and the extent to which that information can be passed to

and used by others).

4. Risk and liability: What is the worst scenario that can happen? How do they manage their risk by limiting liability? What kind of liability that will be capped or uncapped, and how will regulatory be dealt with? What happens if the mobile phone is stolen? Who bears what risk? What are the consequences if there is changes in consumer product offering? What is the impact on the other relationships? What would that be if the environmental dynamics outside the firms' control are changes, for example, regulatory change, change in tax treatment, technological change?

Mobile commerce is apparently much bigger than simply mobile version of e-commerce. Mobile commerce changes the place where demand is created through using the mobile handset's unique features and brings supply closer to that point. Mobile payments harness this evolution from electronic-commerce to mobile-commerce and are set to grow quickly in the short and medium terms (Dahlberg et al., 2015).

The regulatory issues pertaining to mobile payments are novel at least in two respects: First, in grouping together the previously disparate areas of electronic money, electronic payments, mobile service, data privacy, consumer protection, as well as ICT regulation; and secondly in the novelty of the specific questions that arise, particularly in relation to interpreting the electronic money and payment system regulation (Chatain et al., 2008).

Mobile payments also require a new contractual ecosystem (Jenkins, 2008), where parties entering into these arrangements need to pay particular attention to how their deal fits into that ecosystem, payment flows (for business and regulatory purposes), the IPR position (in particular as to who "owns" the customer) and liability and risk. Players involved in mobile payments will have to carefully examine their roles and others', as well as regulatory aspects in determining their strategy and how to approach contractual discussions.

In order to achieve critical mass, several criteria will obviously ought to be met by any mobile payment system provider. The requirements for the mobile payment systems are not only business-based or technology-based, but also economic-based and social or cognitive-based as well (Chakravorti and Kobor, 2005).

We found that MNOs and banks shows the highest interest in providing mobile payment services. Our reviews showed that local and standalone schemes usually only have limited success (see, for instance, Dahlberg et al., 2008;

Dahlberg et al., 2015; Duncombe, 2012; Evans and Pirchio, 2015). However, because mobile payment is actually a payment mechanism, it is the customer that appear to be the most important hub in the chain in a sense that a customer needs to pick mobile payment rather than other forms of payment, and it is usually the merchant who has to be available and prepared to accept mobile payment.

Other than a number of key players mentioned above, there are also several consortia that are particularly active in the domain of mobile payment systems. They can be driven by MNOs, driven by banks or financial instituions, driven by manufacturers or technology partners and vendors, or cross-industry driven. At the moment, none of them is widely accepted. Also, a company can participate in more than one consortia.

Finally, the proper legislative framework should be present in order to promote adoption and ignition of mobile payment systems. The case of European Union shows that even though there is a common directive, implementation at the country level remains a challenging work.

To make this ecosystem works, a critical mass is inevitably required on both sides to avoid chicken vs. egg problem. Indeed, every mobile payment service must be prepared to fulfill the customer needs, the merchant needs, as well as the needs of financial institutions.

Various expectations emerge among the key economic actors of a mobile payment system (see Table 5.3). We found several general requirements and neccessities that found to be important and relevant for any mobile payment project deployment, for example:

1. Usability and simplicity: In the developing countries, most people are less knowledgeable and unaware about payment mechanisms. They also usually only have basic mobile phones with limited features. Thus, simplicity and user-friendly interface largely determine whether users will use a mobile payment system. On the other hand, it should also has the abillity to personalise the service according to his/her day-to-day financial activities.

2. Universality: Mobile payment systems should favours the logic of universal payment services, combining person-to-person (P2P), government-to-person (G2P), business-to-consumer (B2C), business-to-business (B2B), at the local, regional, as well as global coverage, both high-value low-frequency and low-value high-frequency payments in a user-transparent fashion.

Table 5.3: Expectations among different mobile payment stakeholders

Stakeholder	Expectations
Merchant	Shorter transaction time, minimum investment and usage cost, interoperability and compatibility, integration and simplification, increasing trust and security, customisation possiblities, real-time status and reporting
Customer	Reduced learning curve, better personalisation, trust and security, wide availability, minimal additional cost of usage, support for other payments, interoperability, anonymous payments capability, minimal procedures, real-time status, ability to pay anywhere, anytime, any-currency, P2P transactions ability
MNO	Possibility to add value, increasing customer loyalty, new revenue channels, increasing ARPU
Device manufacturer	Huge market adoption, widely-used and open standard, low-cost integration, minimal time-to-market, capability to perform several application at the same time, relationships with banks, financial institutions, MNOs, or other vendors
Bank	Loyalty of the customer and branding, opportunities for new business, system ownership and system application, security and trust maximisation, integration—especially with the existing infrastructure

Source: Adapted from Kshetri and Acharya (2012)

3. Interoperability: Standardisation is important in order to enable network interconnection and make the system cost-effective and technically easy. Every component in mobile payment development should be assembled according to universal standards and open technologies in order to attract other system to interact and join on a broader scale and at multiple levels. For example, any mobile phone should be able to connect with any PoS device, and any mobile payment application must run smoothly on different kind of mobile phone. Since the number of adoption level is critical, thus standardised solution and plug-and-play modules are mandatory.

4. Cost and speed: Mobile payment system should cost-effective compared to other payment alternatives. It also has to be cost-effective in terms of maintaining the system and running day-to-day operations. On the other hand, mobile payment system should also reduce transaction time and automate manual processes to increase delivery.

5. Integrality: It should be possible for mobile payment system to reuse existing platform and infrastructures. This will be particularly relevant to those who are resistant to adapt such as conventional banking sectors. Different channels and networks, such as payment card systems, current account, online payment platform, etc., should also be supported. The user should be able to select his/her own processing partner on a per transaction basis.

6. Security, trust, and privacy: Upon joining a mobile payment scheme, customers are considered to trust the system. Providing access to banking account to an unknown company is different than granting that access to a verified and trusted company. Thus, people will not use the mobile payment system unless it has been tested and secured appropriately. Furthermore, mobile payment service provider should also minimise fraud and theft as well as give some sort of user privacy support.

7. Local market understanding: As mentioned above, it is important to attract users to join the system with new incentives. Often times, the ability to use mobile device in itself may not be sufficient. Both users and merchants want to see additional benefits. The understanding of local context become particularly important. Additionally, the similar success recipe might not relevant to other country as a result of different socioeconomic

conditions. Sometimes, an appreciation of peculiar characteristics on a per-territory or, even better, per-city basis become increasingly necessary.

8. Cross-border payments: To make a mobile payment system broadly acceptable, every provider ought to ensure that any cross-border transfer will run as smooth as national or local transfer and payment. This smooth transaction should be possible regardless of the customer location (for example whether the customer is currently roaming or not). Lastly, any mobile payment system ought to be prepared to manage transactions across different countries in any place and in any (or major) currency available.

Those aforementioned expectations above can easily be solved by utilising modular structure. Modularity in the value chain and ecosystem will allow mobile payment system providers to fulfill customer's needs as well as manage complexity and attain flexibility.

5.4 Mobile technology and de-verticalisation of industry

With regard to industrial aspects, mobile systems rely on investment in infrastructure, radio spectrum, as well as mobile handsets (Steiner, 2005). The mobile industry itself is progressing rapidly, exacerbated by its convergence with computing technologies, and involves a high degree of complexity—including equipment manufacturers, contractors, platforms, retailers, and service providers (Baldwin, 2007).

The vertical structure of mobile network operators has been shifting towards greater modularity over time. Before the emergence of mobile telephony, mobile network operators were highly integrated and usually nationally-owned. They bought the equipment and infrastructure from dedicated vendors, implementing network capital, and then reselling the airtime to the customers. In the 1980s, with the cellular technology become apparent, vertical disintegration set in, and maintains the trend via the migration to 3G and 4G technologies. This trend resembles that seen in other industries, such as the PC industry (Baldwin and Woodard, 2008).

Several aspects of the industry structure are particularly interesting. For instance, it appears that modules that have materialised have promoted the capitalisation of global economies of scale in the manufacturing of technology,

including chips, devices, applications, and infrastructures. Thus, cutting the vertical supply chain will prompt in increasing dominance of big players.

Second, the primary modules, such as module boundaries and the links connecting modules, remains to be coordinated and controlled by mobile network operators. Independent suppliers and technology partners join the production process through actions taken by the mobile network operator.

Furthermore, the mobile platform has now emerged into a "platforms of platforms." Consequently, complementors to the network have in turn developed their own platforms, including handset manufacturers and operating system software developers. A huge part of the competitive effort requires investment in the ecosystem that will draw attention of enterprising applications and include the work of independent firms.

Thus, "openness" can be decreasing or increasing even as the number of independent parties in the supply chain drops, depend on the terms on which firms collaborate are restrained by platform organisers implicitly via industry standards or explicitly via legal contract. This implies that the path of modularisation process is multi-dimensional.

Modular systems can distribute incentives of ownership through standardised interfaces across a huge number of firms coordinated. Thus, modularity accommodates communication and helps in managing a complex system (Langlois, 2002). Modules, or partitioned pieces, may be hidden or visible. Where information is embedded in the node, the substitution of this hidden module with a better product does not affect system functioning (Baldwin and Clark, 2000). Conversely, a visible module comprises design rules that other modules must follow in order to attain system compatibility (Baldwin and Clark, 2000).

Modularity simultaneously benefited from both specialisation and economies of scale. Competitive forces are released to develop modular components to complement the value chain when workable interfaces can be achieved at low cost. It allows entry by innovators to participate in providing particular inputs where the innovators have comparative advantage(Brusoni et al., 2007). This still relevant even when they do not have or have only a few competences as integrated suppliers of a bigger share of the output in the industry. This, however, does not diminish the role of organisations in developing interfaces and coordinating production process. Thus, an equilibrium between those of the external suppliers and the interests of the system architect and are.

Observing international markets, a single national telecommunications operator used to dominate the whole mobile value systems. Presently, the system is

specialised and globalised across geographic and business segments (Steinbock, 2003). Firms continuously looking for optimum profit by constantly exploring and making adjustment. Mobile network operators today are moving in the similar general direction implying that market efficiency is fueling the migration.

Indeed, institutional differences and cultural distinctions may explain the differences observed in mobile markets. However, it seems obvious that such cross-sectional factors will not minimise the strong modularisation emerged across all systems. Thus, the organisational nature to coordinate complex technological change, the financial implications of this evolution, and empirical analysis of vertical integration are all prime candidates to be investigated further.

All in all, what makes our cases interesting is that modularisation of previously integrated goods has resulted in a global distribution of the supply of goods. We suspect that the similar trend is currently happening within services. The innovation dynamics of mobile phone platforms, combined with disruptive characteristic of mobile payment systems, attracted us to further investigate.

Chapter 6

Case Studies

This section is where theory meets practice. We sought to analyse and evaluate service modularity in a real-life situation. We conducted three case studies of mobile payment systems with the goal to examine the important criteria and factors affecting service modularisation and to sketch and propose a framework for modularising services.

The intention of this chapter is to present and analyse a number of issues and dilemmas which have occured and been experienced in the case organisation. We discuss the stage and process of modularising services from the point of design and conceptualisation to delivery and consumption by customers. We try to collect as much relevant information as possible to relate the phenomenon with the theory of modularity.

This chapter provides a descriptive analysis and comparative evaluation of mobile payment systems in three different projects: Oi Paggo in Brazil (Section 6.1), TCASH in Indonesia (Section 6.2), and M-PESA in Kenya (Section 6.3). This chapter also explains how the theoretical gap will be bridged by providing insights from the case studies in Section 6.4.

6.1 Case 1: Oi Paggo

In this section, we describe the findings of our first case study in Oi Paggo in Brazil. As an observant outsider, we were interested in how Oi Paggo was developed and evolved over time. We particularly focused on the technological development project and also on the business organisation working on service

development. We consider data gathered from the document analysis to be the most reliable, but we also follow up on the data by conducting interviews.

The 'original' Oi Paggo was launched as a pilot project in Natal and Uberlandia in 2006.[64] As the first mobile payment provider in Brazil, Oi had 450 accredited establishments, 12,000 registered users, and an average of 80 transactions per day at that time.[65] The original Oi Paggo exceeded 250,000 users, 75,000 registered merchants, and 3 million yearly settled transactions in 2009.[66] In 2007, they acquired Paggo Empreendimentos S.A. and adopted Oi as the company's sole brand for all its services.[67] Oi developed their mobile financial services solution based in mobile technologies such as SIM Browsing, USSD, JavaCard, and J2ME.[68]

6.1.1 Country background information

With regard to financial institutions, the federal government has controlling interest through Banco de Brasil SA and the National Bank for Economic and Social Development (BNDES). The BNDES is a federal company owned and controlled by the Brazilian government as part of the Ministry of Development, Industry, and Foreign Trade. The purpose of the BNDS is to support Brazil's development projects. Banco de Brasil SA is controlled by the governement but some of its shares are traded on the stock market. The purpose of Banco de Brasil SA is to implement the credit policy and financial policy of the government.

[64] Originally it was being developed as a credit service to top-up prepaid but then being used for general purchases.

[65] See http://www.estadao.com.br/noticias/geral,oi-estreia-servico-de-pagamentos-moveis,20070117p13934

[66] See http://techinbrazil.com/online-payment-for-e-commerce-in-brazil and https://www.linkedin.com/company/paggo

[67] In 2009, Oi concluded its operational integration with Brasil Telecom. In 2010, they announced a partnership with Banco de Brasil and Cielo to offer payment services through mobile telephones. In 2011-2012, they conducted company restructuring to merge three listed companies into just one: Oi S.A. See http://ri.oi.com.br/conteudo_en.asp?idioma=1&tipo=43738&conta=44

[68] In 2013, Banco do Brasil and Oi initiated a collaboration and cooperation to deploy Oi Carteira, a mobile wallet service that provides their customers to open an account, make payments and transfers at a massive number of merchants and retailers. Initial payments to the Oi Cartiera can be executed at any Banco do Brasil agencies as well as any authorised correspondents, or online via their website, provided the customer already owns an account at Banco do Brasil. Oi Cartiera system utilises SMS-based technology to manage data transfer and interchange and the customer is charged a R$8.00 monthly fee to use the service. The case will mainly focus on the development of the 'original' Oi Paggo, but will also take into account the newer version of Oi Cartiera as well. See http://techinbrazil.com/status-of-mobile-payment-in-brazil

Figure 6.1: Map of Brazil

Source: www.mapsofworld.com

Brazil's banking system has a reputation as the most financially inclusive in Latin America with about half of the population having an account in a conventional banking system. There are 15 branches and 18 ATMs for every 100,000 residents. Yet, only six banks (of 42 commercial banks with more than 10,000 branches) dominate about 80 percent of the market. Banco Azteca is the largest with more than 12 million customers and contributes to over 10 percent of this share.

Brazil was the first country in the region to adopt regulation on outsourcing of services to agents or non-banking correspondents.[69] This has resulted in an

[69]The Central Bank of Brazil (CBB) began opening up the regulation and giving licenses

increase in financial access such as transfers, deposits, and bill payments. In each of the country's 5,564 municipalities, there is at least one licensed agent or supervised branch office. Yet, Brazil is still struggling with the expansion of banking services to reach poor people in order to deliver credit and savings.

The government's policy for financial inclusion[70] focuses on two pillars: microfinance and retail agents. However, there is still poor credit information available for people in the lower income class. There are also an unintended implications of bank outsourcing that threaten the continuity of the agent model itself.[71] Unions demand wage equality between agent employees and bank employees. The cental bank realised the potential problem of these demands, but has not yet implemented or proposed any changes.

According to the Brazilian Institute for Applied Economic Research (IPEA, 2015), there are at least 55 million adults without any banking accounts in Brazil. However, Anatel reported that in June 2015 there are more than 282.4 million active mobile phones, implying a penetration rate at 115 percent in the country. This pattern shows a similarity to other developing countries in a way that mobile payments exhibits an unmatched promise for expansion as a result of the significantly increasing adoption and high penetration of the use of mobile phones across all regions and social classes and the huge proportion of the population without access to financial institutions.[72]

Even though mobile wallet solutions were introduced in Brazil around 2006 and currently there are about ten mobile payment solutions or mobile wallet initiatives available, none of these have achieved a critical mass yet.[73] The largest operators—Vivo, Claro, Oi, and TIM—dominate 95 percent of market share, divided almost equally among them. GSM is the technology standard in Brazil and more than 80 percent of cell phones in use are pre-paid.[74] Electronic wallets have been developed, mainly oriented to remittances, from the U.S., Europe, and Japan. However, about 63 percent of those who received remittances already had a bank account.[75]

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to permitted partner (agents) to offer various financial services and products in any location since 1999.

[70] Yet, it has not been formalised in either Law or government decree.

[71] CGAP (2010) Regulation of Branchless Banking in Brazil. *CGAP*. January 2010.

[72] Lundgaard, H. (2015) Status of mobile payment in Brazil. *Tech in Brazil*. http://techinbrazil.com/status-of-mobile-payment-in-brazil. 20 August 2015.

[73] See http://techinbrazil.com/online-payment-for-e-commerce-in-brazil

[74] See Flores-Roux, E.M. and Mariscal, J. (2010). The enigma of mobile money systems (June 2010). *Communications and Strategies*, 79, 41-62.

[75] See Anatel (2007) Telefonia móvel mantém crescimento e se aproxima dos 115 milhões de acessos 23 de November de 2007. *Anatel*. Available at

6.1.2 The role of government and regulators

The regulatory authorities play a pivotal role both in banking systems and telecommunication systems in the country. The government has continually made significant changes in terms of banking law and practices in order to respond the 2008 financial crisis.[76] They are also progressively converging their legal and regulatory policy with the Basel III standard. Attention is also given to the implementation of the Principles of Financial Market Infrastructure published by the Internatinal Organization of Securities Commission (IOSCO) and the Committee on Payment and Settlement System (CPSS).

Banking in Brazil is regulated by the government, the National Monetary Council (CMN), and the Central Bank of Brazil (CBB).[77] The CMN is responsible for overseeing monetary and credit policy to ensure economic stability as well as social development in Brazil. Every bank operating in Brazil is required to submit their operations, credit positions, and other related information to the CBB. On the other hand, CBB audits banks through its auditors to make sure they are complying with current policies and regulations. The CBB has the necessary power to enact administrative sanctions on institutions that do not comply with the regulations.

The Brazilian Consumer Defence Code (CDC) and the Federal Constitution regulates consumer relations in Brazil. The Consumer Protection Agency (PROCON) also has the authority to impose penalties on banks. Any consumer can claim liquidated damages and reparations in court caused by banks in consumer relations. The CBB and CMN have also issued certain circulars and resolutions to regulate how banks conduct their business with clients. Any client that feels damaged by the misconducts of banks can file a complaint with the CBB.

The Brazilian telecommunication sector has its roots in Law 9472 of 16 July 1997, the Telecom Act (the General Telecommunications Law), that set forth in establishing the National Telecommunications Agency or Anatel to regulate and oversee the sector. Anatel is a special autonomous agency with its own management and legal identity. Anatel is also financially independent from the

http://www.anatel.gov.br/Portal/exibirPortalNoticias.do?acao=carregaNoticia&codigo=14987

[76] For example, they proposed National Monetary Council Resolution No. 4,122, dated 2 August 2012 which explains the requirements and procedures for financial institutions regarding their operation, authorisation, control, and reorganisation. See also CMN Resolution 4,192, 4,193, 4,194, and 4,195 on strengthening and improving the ability of financial institutions during economic and financial shocks.

[77] See Vieira et al. (2015) Brazil Banking Regulation. *TozziniFreire Advogados*.

federal government as well as MNOs and other private entities in the industry.

The focus of the telecom policy is to promote competition and universalisation of services. Before Anatel, the regulation in the sector was made on a per service basis, but Anatel is considering converging the services. However, the telecom regulators cannot regulate or supervise the IT and media industries since they are beyond the prerogatives and authority set forth by Brazilian law.

With regard to universal service obligations, Anatel will periodically perform audits of telecommunication companies to ensure that the universalisation and continuity obligations have been fulfilled. The Fund for the Universalisation of Telecommunications Services (FUST) was also formed to help in financing the cost incurred during the implementation of the universalisation and continuity requirements that unable to be restored from the efficient and effective operationalisation of the service.

Brazil was a signatory to the World Trade Organization (WTO) Basic Telecommunications Agreement. However, they withdrew their commitment in July 2001 due to objections received.[78] Now they do not have any political and institutional commitment nor contribution in the WTO.

The telecommunications sector has been privatised since the late 1990s. However, the government still holds substantial stakes or management powers in many telecoms companies. In particular, BNDES plays an important role as a shareholder in some MNOs, such as Oi. Through Decree 2,617 of 6 May 1998, every company providing telecommunication services must comply with Brazilian law and have their main position of administration and business function in the country. The user agreement must also comply with the Consumer Defence Code as well as the Civil Code.

Before privatisation, the direct provision of telecommunication services was not efficient and was low in quality. Due to underinvestment and poor supply of services, there was a blackmarket for telecommunication services provision. Thus, it seems that the privatisation was a success and helped Brazil to become one of the most advanced countries with regard to technology and variety of services.

There is no exclusivity in the telecommunication sector. Both incumbents and new entrants may apply for any telecom service licence. However, Anatel may prohibit one company from registering for more than one licence in conflicting provinces and regions. Anatel also performs the homologation and the

[78] See Ferreira and Kujawski (2013) Brazil Telecoms and Media. *Barrett Ferreira, Kujawski e Brancher Sociedade de Advogados (BKBG).*

analysis of all pricing plans of MNOs. It also has the power to restrict and limit the concentration of licences and avoid MNOs having significant market power.

In particular, the Economic Supervisory Secretariat as well as the Council for Economic Defence (CADE) are responsible for preventing and controlling antitrust practices in the telecoms sector. For example, in October 2010, the Spanish group Telefónica which controls Vivo in Brazil announced an increase in its holding in Telecom Italia, TIM's controller in Brazil.[79] Since TIM and Vivo are competitors in the mobile industry, with that increase, Telefónica have hold a 50 percent share in the market. CADE then forced Telefónica to sell its interest in TIM or find a partner for Vivo.

In May 2013, the Brazilian government published the "Medida Provisória" 615 which regulates the system of mobile payments in the country, amplifying the Banco Central's supervision of the entities involved. Following Decree No. 8061/2013, Brazil had already begun conducting digital switchover in the country's major cities. Thus, it is predicted that the process will be completed by December 2018 and the range of 700 MHz that was previously utilised for analogue transmission would be returned to the government and be used for the development of 4G technology.

In November 2013, the Central Bank along with the National Monetary Council (Conselho Monetário Nacional/CMN) published Resolutions numbers 4.282 and 4.283, as well as other documents, numbered 3.680, 3.681, 3.682 and 3.683, setting out the initial regulatory framework that rules the authorisation and operation of arrangements and institutions of mobile payments, according to Law number 12.865, of 9 November 2013. The decree states:

> *"[Mobile payments] are funds stored on a device or e-system that allows the end user to perform payment transaction. [It] converts physical or book-entry money into electronic money, or vice versa... and accepts or manages the use of electronic money as regular payment activities." (Ozores, 2013)*[80]

At that time, there were two mobile payment plans offered by MNOs in Brazil: Zuum (a joint-venture between Vivo and MasterCard) and Oi Carteira[81] (Oi

[79] http://www.telecomitalia.com/content/dam/telecomitalia/en/archive/documents/media/Press_releases/telecom_italia/Corporate/Financial/2010/PR_58percentArgentina.pdf

[80] Ozores, P. (2013) Government issues decree to regulate m-payments. http://www.bnamericas.com/news/telecommunications/government-issues-decree-to-regulate-m-payments?lang=en.

[81] Oi Carteira was developed by tehnology partner Paggo Soluções, a joint-venture between Oi and Cielo.

and Banco do Brasil), both using the SMS technology.

6.1.3 Organisations and business models

Paggo was originally a private start-up that was acquired for R$75m (about US$46m)[82] in late 2007 and operates on the Oi network.[83] A substantial investment went to IT and other supporting services infrastructure. They have a consumer credit licence that was sufficient to legally provide a credit business in Brazil . From the very beginning, they focused on the low-end market that was underserved rather than on the high-margin market.

As mentioned above, Oi Paggo was initially launched in limited areas, including Rio de Janeiro, Minas Gerais, and Bahia. One of the interviewees explains:

> *"The product was launched gradually... used for pre-selected customers only to be evaluated further." (0287)*

During the initial launch, it appears that Oi Paggo was actually able to gain traction, particularly in under-penetrated markets. Oi Paggo was also heavily promoted with TV advertisements featuring the Brazilian footballer Ronaldinho.

Paggo was then undergoing a strategic restructuring after the death of its president, Massayuki Fujimoto, in February 2013.[84] The strategic reformulation of Paggo began to be debated more intensely among members. After February 2013, Paggo was led by an interim executive Rogerio Signorini, the new markets director of Cielo and representative of acquiring network in the Paggo board of directors. The fact of being tied to a network of acquiring (Cielo) and a bank (Banco do Brazil) turned Paggo, an enabler of mobile payments in these two companies, and less a disruptive agent in the financial market, as they had tried to be in the past, when they were just Oi, as implied in the following quote:

> *"Our goal is to mobilise banking... we want our customers to use their mobile phones and act as if the phone is a core bank branch." (0370)*

In May 2013, Banco do Brazil and Cielo issued Oi Cartiera, a reloadable prepaid card that allows users to purchase goods and to transfer money. Compared

[82] The currency of Brazil is Real (BRL/R$). At the time of writing, US$1 equal R$3.962.

[83] Paggo used to develop their product independently and then in-sourced. This model are similar with Cyworld and SK Telecom in South Korea.

[84] See http://www.minhaoperadora.com.br/2013/07/oi-paggo-passara-por-reestruturacao.html

to the 'original' Oi Paggo, Oi Cartiera works both on mobiles as well as on a traditional card. During the early launch stage, Oi Cartiera was only made available to pre-selected customers with credit rating or proof of income approval. Transactions are conducted via proprietary S@t Push technology, which encrypts transactions, which are not stored on customers' phones. The new service costs R$8 monthly and allows one withdrawal per month. The value of the surplus rate for other withdrawals, which is R$1 (about US$0.275) per transaction, is deducted from the balance available on the card. To issue the traditional card, the customer pays a flat rate of R$10, which is reimbursed in bonus minutes.[85]

In relation to the business model paradigm, it appears that the company focused on adding new services, rather than transforming, to build structure novelty. The company wants to complement the service with traditional banking products and channels. They are also focusing on high-volume, low-value transactions as well as a traditional business model based on intermediary activities.

Unfortunately, today Oi Paggo has not been able to achieve critical mass. The initial expectation were not met and there was a long delay in reaching significant market share. Thus, the company changed its initial model which became a continuing part of the iterative process. The main business model became informationising banking services and targeting customers who probably already have a banking account and want additional access and mechanisms towards their own money.

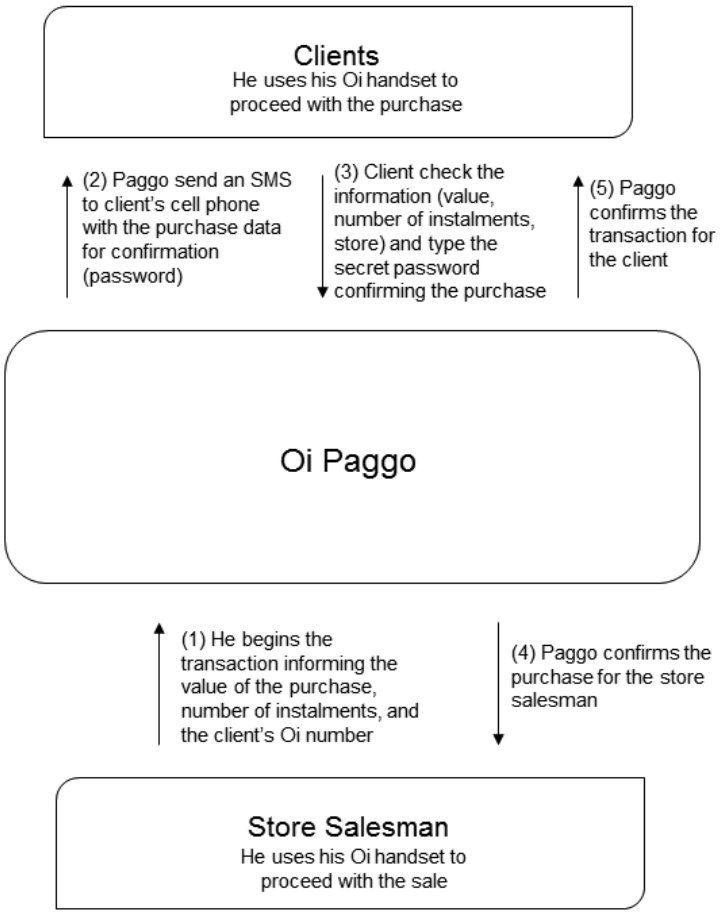
The customers only have a light involvement during the service development process. It seems that the company is also not particularly interested in attracting or building a new customer base, especially those who are financially excluded and at the bottom-of-the-pyramid (BoP). Customisation becomes a modular characteristic that is dominant in determining when and where the customer want to access the mobile payment system.

6.1.4 Technology and architectural design

The architectural design of Oi Paggo is quite basic and straightforward (see Figure 6.1). The customers open up a credit account, use their mobile phone to purchase some goods and services, then s/he will get a separate billing state-

[85] See http://www.tudocelular.com/oi/noticias/n28564/oi-carteira-eletronica-recarregavel.html.

Figure 6.2: Oi Paggo design flowchart



ment on a monthly basis that can be paid via the bank, online, or at payment agents. From the merchant side, Oi Paggo provides a point-of-sale (POS) device for free (which is a mobile phone with Oi SIM and active services), but charges a standard fee (about 2.99 percent of the transaction) without on-going additional fees. Later, Oi Paggo added several supplementary features, for example: utilities payments, top-up services, credit for top-up, and P2P transfer.[86]

By design, Oi Paggo offers several advantages: it is very simple to use, it does not need the customer to be present at a POS, it charges separately from

[86]They charged R$ 0.99 (or about US$ 0.56, which was significantly cheaper than banks and other money-transfer services) to transfer the money that the receiver can withdraw at banks, retail shops, or other correspondent networks.

the phone billing, and it is available for both pre-paid and monthly subscribers, with relatively cheaper fees as well as lower interest and fines. For Oi, this spillover brings a new potential revenue from lower class customers. Yet, it allows Oi to promote mobile services to the merchants who are heavier users. This differentiation gives Oi a bigger market share and enables it to perform on a non-subsidy term in the pre-paid market. The complicated part of the system is in software integration and in the back end (such as tax collection, fraud management, and merchant accounting) rather than at the customers' end.[87]

The system relies on standard SMS technology. With regard to the market category, Oi Paggo is aimed at mini payments (somewhere below US$20), initially charging pre-paid users but then moved to post-paid users after they merged with Oi Cartiera.

At the organisational level, Oi Paggo developed everything in-house with minimal interaction with outside parties and vendors. The architecture was centred on a core of mobile money services including its own applications and database. Before being acquired, Oi Paggo was developed independently, even though some modules were actually copied from existing applications that were then altered over time.

After its merger and restructuring, problems arose due to different information system enterprises existing across the (new) firm. Thus, differences in processes and routines become problematic in the daily operational of the company. Most of the time, they simply chose one particular scheme that they thought to be the most suitable to be copied and adjusted. This pragmatic method resulted in a lack of harmony between different modules and components. Further, it was not responsive enough when existing modules needed to be altered or new modules needed to be added.

The following quote describes this issue:

> *"We are seeing a growing number of technical problems, usually due to the compatibility and interoperability. Rather than making a radical improvement, we prefer to take pragmatic and sometimes temporary solutions." (0159)*

The initial scheme was regarded to be too lengthy to launch, encouraging them to develop to a new architecture, about the same time as they were in undergoing

[87] MNOs are business of 'post and package', and Oi Paggo is pretty much a 'package' effort. Notice the scheme where SMS sent both from and to the mobile handset means that the 'post' charges already included (upstream party pays).

strategic reformulation in 2013. The new enterprise architecture system became more centralised but at the same time also comprised of more standardised subsystems. However, the variations in the smaller subsystems was designed to be overlapped by developing a series of coomon mobile payment system processing modules in which the new single subservices could be designed and configured. As a result, this new scheme was considered to be more efficient and reduce the time-to-market. Further, the new mobile payment processing modules can also be easily reutilised and, if necessary, reconfigured.

The deployment of new architecture has also not only affected the technical operations of Oi, but also had profound impact on organisational practice. It appeared that organisational structure was also altered, particularly as a consequence of the changing relationship and interaction between IT infrastructure and line of mobile payment business.

The company found that one of the most challenging factor in fostering mobile payment in Brazil is technological interoperability. One of the interviewee describes this:

> *"[We] find it difficult to work on the [technological] interaction and the compensation model between the banks and operators." (0827)*

In order to tackle such an issue, the company believe that they must come up with a more attractive proposal than most current arrangements. MNOs are not only sharing revenue with financial institutions, but also data.

6.1.5 Overall evaluation

We gathered data during our observations to particularly consider what happened behind the development of Oi Paggo through document analysis and interviews. We have evaluated the structure and contents of mobile payment system development. Table 6.1 below exhibits a selection of service modularity attributes identified at Oi Paggo.

With regard to the modular quality attribute, our findings indicate that Oi Paggo's structure allows its developers to implement only certain modules by looking at how the interfaces interconnect with other modules (comprehensible). It also indicates that Oi Paggo's technical structure allows localised changes without having to change other modules that exclusively dependent on its interface (changeability). During the implementation of the new enterprise system, the engineers revealed that parallel developments existed. By engaging

Table 6.1: Evaluation of service modularity attributes

Service modularity aspects	Findings
Pre-conditions	Component-sharing modularity
Information flows	Centralised
Coordination	Hierarchical arrangements
Degree of coupling	Tight coupling
Production of services	Parallel development
Customer involvement	Limited
Post-conditions	Component-swapping modularity

in this parallel development, they can focus on their particular module development and reduce time-to-market.

All in all, the case of Oi Paggo showed that a modular structure can be used to manage the complexity of the projects and activities that cannot be eliminated to modules.

6.2 Case 2: TCASH

In this section, we elaborate our second case study of TCASH in Indonesia. We sought to examine how TCASH was being developed by Telkomsel Indonesia (see Figure 6.2). We were particularly interested in the technological development project and business department working on service development. Relevant policy and regulation from the telecommunication regulator as well as from the finance minister will also be included in our analysis. We consider data gathered from the document analysis to be the most reliable, but we also followed the data by observation as well as conducting interviews.

Telkomsel, the largest MNO in Indonesia, launched TCASH in November 2007 as a mobile wallet solution allowing customers to make retail payments using their mobile phones. The service permits users to hold an electronic money wallet in their phones which can then be used to pay bills and merchants across the country.[88] The registration process requires an SMS and a visit to a cash-in agent to comply with 'know your customer' (KYC) regulations. The overall ecosystem is heavily reliant on a large base of merchant partners which allow people to pay with their electronic wallet, including major brands such as Garuda Airline, most electricity carriers, and Indomaret retail network.[89]

[88]The currency of Indonesia is Rupiah (IDR/Rp). At the time of writing, US$1 equal to Rp 14,048.

[89]See IFC (2010) Mobile Banking in Indonesia. Available at: http://trpc.biz/wp-

Figure 6.3: TCASH kiosk in a shopping mall

Source: Author

6.2.1 Country background information

In Indonesia, an archipelagic island country with more than 250 million people, about 75 percent of the population have a mobile phone,[90] most of whom are young adults (15-29 years old) and live on Java and Sumatra Islands.[91] The market is dominated by three MNOs: Telkomsel (around a 48 percent share), Indosat (27 percent), and XL Axiata (19 percent), and most of their customers favour a prepaid account (about 95 percent).[92] It is, however, estimated that

content/uploads/2010-03_IFC_MobileBankingInIndonesia_Report.pdf.

[90] It is quite common in Indonesia for a person to have multiple mobile accounts, for example, one for making calls and sending texts, while the other for internet and social media account (data plan).

[91] In this regard, Indonesia is not too far away from the average percentages of 80 to 85 percent in most western countries.

[92] There are currently about eleven operators operating in Indonesia, yet this number will probably have to go down to five or six. With the large investments in infrastructure that are needed and the stiff competition, it is expected that consolidation will need to take place. Consolidation, merger, and acquisition are also quite common in Indonesian telecoms. By the end of 2002, the government policy at that moment allowed investment to Indonesia and Indosat sold 41.94% of the shares to Singapore Technologies Telemedia Pte. Ltd (STT) and it became a foreign investment company. On November 2003, Indosat merged with Bimagraha, Satelindo and IM3 (a subsidiary company of Indosat). On March 2007, STT handed over its Indosat shares to Qatar Telecom QSC (QTEL) and at the end of 2008 the official ownership of the company is by QTEL with 40.81% of the shares and the government of Indonesia and public hold 14.29% and 44.90%. In mid-2009, Axiata from Malaysia

Figure 6.4: Map of Indonesia

Source: www.mapsofworld.com

about 40 million people who have mobile phones do not have a bank account.[93] Financial inclusion remains a problem in Indonesia, particularly for those in rural areas and remote islands, with only about seven bank branches for every 100,000 people.[94]

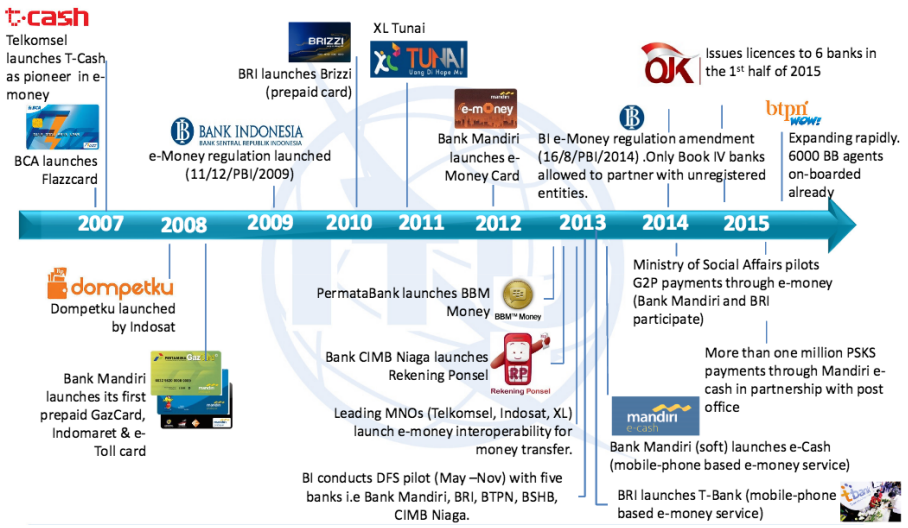
All of those three largest MNOs have launched their own mobile payment systems. Telkomsel's TCASH was the first in 2007 and dominates the market. A year later, Indosat's Dompetku was launched to the market, even though during its initial launch, it was not qualified to provide remittance services.

and Etisalat from Emirates became the major shareholders of Excelcomindo Pratama and changed the name into XL Axiata. SingTel from Singapore also owns 35% of Telkomsel. See http://www.wikinvest.com/stock/PT_Indosat_Tbk_%28IIT%29/Merger_Satelindo_Bimagraha_Im3

[93] See Flaming, M., Prochaska, K., and Staschen, S. (2009) *Diagnostic Report on the Legal and Regulatory Environment for Branchless Banking in Indonesia.* CGAP, IFC, and GTZ.

[94] In developed countries, the ratios of bank branches per 100,000 people are four to six times more than those in Indonesia. The lack of availability, combined with geographical situation (hills, mountains, islands, etc.), discourages customers to use bank services. They would prefer a bank that comes to them and open up a branch or set up cash machines near them.

Figure 6.5: E-money development in Indonesia



Source: Bank Indonesia (2015)

XL Axiata developed XL Tunai in 2011.[95] Most of these systems offered basic mobile payment services, such as cash-in and cash-out as well as the ability to buy goods and services through selected merchants. As expected, in their infancy, retail payment services were only available in very limited merchants, but banks and MNOs are starting to join in to the market offering their own mobile payment services (see Figure 6.3).

Although appearing promising, mobile payment systems in Indonesia face some serious challenges, for example geographic coverage is still limited, technological issues on the merchant side, relatively small networks of merchants versus limited marketing awareness to attract new customers (chicken and egg problems), and consumer behaviour that still favours cash, particularly for daily purchases. As illustrated by the following quote:

> *"[Our] typical customers are in general very picky... they will usually wait until merchants start adopting [the new mobile payment service]. On the other hand, merchants are not willing to take the risk, unless they believe that the customer is going to use [the service]." (0557)*

[95] A couple years later, banks also entered the mobile payment markets by offering similar services to those MNOs, for example CIMB Niaga with Rekening Ponsel and PermataBank with BBM Money. See also Figure 6.2.

Despite those challenges, the company believe that mobile payment systems will have a bright future in Indonesia for several reasons, including the growing middle class population, the dominance of younger population who are familiar with new technology, increasing penetration of smartphones and internet connection, as well as the economic growth and stability in the country. One of the informant elaborates:

> *"Today we are only focused on delivering the service without really taking into account the profitability factor. But in the future, we think that [this mobile payment service] will be very profitable. So, this is a kind of long-term portfolio investment for us... The youth population is growing. The middle-class population is growing. Technology is getting cheaper. There is nothing to worry about with the political and economic stability [of the country]." (0319)*

6.2.2 The role of government and regulators

Banking in Indonesia is regulated by the Central Bank (Bank Indonesia/BI) and directed through a fundamental framework called the Indonesian Banking Architecture (Arsitektur Perbankan Indonesia/API) launched in 2004. API was the result of the Presidential Instruction No. 5 of 2003 that was focused on promoting Indonesian economic growth. From 2014, the role of banking supervision was then given to the Financial Services Authority (Otoritas Jasa Keuangan/OJK).[96]

Mobile payment in Indonesia is regulated through E-Money Regulation (No. 11/12/PBI/2009 enacted on November 2009) that was issued by Bank Indonesia or the central bank and Branchless Banking Regulations (November 2014) that were promulgated by Otoritas Jasa Keuangan (OJK) or the financial services authority. The E-Money Regulation gives licences for banks and non-banks institutions or non-financial institutions (such as MNOs as well as other third party vendors and suppliers) to develop, distribute, authorise, process, as well as finalise (settle) e-money transactions. Meanwhile, the Branchless Banking Regulations only gives permission for banks and other financial institutions to provide plain and unsophisticated savings accounts for their customers.

The government itself is continuously encouraging and promoting the utilisation of e-money instruments. One of the informants emphasised that:

[96] See Achmadi et al. (2015) Indonesia Banking Regulation. *Soemadipradja & Taher.*

> *"[The government] wanted to push towards cashless society. It has become one of the main parts of the national agenda, especially in relation to anti money laundering and counter-terrorism financing. Also, the government believe that moving to the cashless society will reduce the likelihood of corruption, be it at the country level or at the local and regional level." (0715)*

There are several restricted partnerships that impede growth. First, e-money regulations only give permission for banks under Book IV category to cooperate with unregistered entities (such as airtime agents, small shops, etc) in providing electronic payment services.[97] Second, MNOs and smaller banks can establish partnership with registered legal entities only in providing e-money services. This restricts the scaling up of their operations and reduces the optimal utilisation of their platform and capacities usage, particularly for MNOs who rent/borrow airtime from the others. Third, unregistered entities actually have an important role in digital financial services, especially in serving the unbanked regions and population.[98]

Nevertheless, there are a couple of things that work well in Indonesia. For instance, government and regulators are fully committed to and supportive of promoting and scaling up digital government-to-persons (G2P) transactions in the coming years. They are also supporting the growth of branchless banking, especially in rural areas and remote islands. This kind of initiatives are expected to significantly increase the number of mobile payment users in Indonesia. In particular, President Joko Widodo called for developing immediate efforts to put the country as the largest digital economy in the region in 2020.[99]

Further, mutually inclusive cooperations that have been formed between different stakeholders (such as banks with MNOs, banks with co-operatives, banks with nonfinancial institutions, etc.) will demonstrate that such partnerships will not only become positive for the telecommunications sector, but also the financial sector as well. Indeed, some regulatory clauses need amendment (e.g. removing barriers and restrictions for smaller agents, MNOs, and non-Book IV banks, as well as other exclusive cooperations) to stimulate the growth of branchless banking. There is also an immediate matter to recognise

[97] Book IV (Buku 4) are commercial banks with minimum capital requirement Rp 30 trilion or about $2.2 billion.

[98] In Kenya and Tanzania 30 percent and 51 percent of agents own and/or run small convenience stores respectively.

[99] See http://en.tempo.co/read/news/2016/09/28/056807894/Indonesia-Can-Become-SE-Asias-Largest-Digital-Economy-Jokowi

customer needs and channel demands that can be done by conducting thorough customer-centric market research in order to develop suitable products and create a positive customer experience. Fraud and client protection also need to be taken into a serious consideration in any mobile payment project installment.

6.2.3 Organisations and business models

PT Telekomunikasi Selular (or usually called Telkomsel) is a majority-owned division of Telkom Indonesia (or PT Telekomunikasi Indonesia Tbk.). Telkom Indonesia has 65 percent stake, while the remaining 35 percent stake owned by Singapore Telecommunications Limited.[100] The company's business operations in the country have increased exponentially since the introduction of its post-paid cards commercially on 26 May 1995. It operates with GSM 900-1800 MHz, Wi-Fi, GPRS, EDGE, along with 3G and 4G network regionally, and through 323 foreign roaming partners in more than 170 countries internationally (2008).

Telkomsel offers its users (customers) with the option between different kind of prepaid option (namely simPATI, Kartu As, and Loop), or kartuHalo post-paid option. Telkomsel also offers its subscribers a number of value-added services (VAS) and programmes. The company currently has the leading share in Indonesian mobile market with about 46 percent of the total number of mobile subscribers, or about 122 million subscribers in 2015.[101] The company also has one of the most expansive network coverages in Indonesia at this moment, allowing network coverage in more than 97 percent of country's area. This makes Telkomsel the only one MNO in the country that provides network coverage in (almost) all of Indonesia's regencies and provinces. As illustrated by the following quote:

> *"[We] want to be the biggest and the leader in the industry... Not just in mobile communication but also in other complementary services, including our TCASH mobile payment." (0381)*

Developed in-house by Telkomsel, in the beginning, TCASH failed to see the adoption rates experienced by other products around the world. At that time, it is reported that only 4.7 million people used the service, or less than two percent of the population—with only about 100,000 of those actively using the

[100] See http://www.telkomsel.com/media/upload/annualreport/AR_TSEL2014.pdf.
[101] See http://info.singtel.com/sites/default/files/invrel_areports/Singtel_AR2014_b.pdf .

platform regularly.[102] Since then, TCASH has been growing at a considerably stable rate with the most users come from outside Jakarta or outside Java, the main island. As described by an interviewee:

> *"In 2011, we had about 8.2 million active users. About 32 percent comes from Sumatra island and 14 percent from Sulawesi, Maluku, and Papua island. Only about 12 percent come from Jakarta. On average, there are about 100 transactions a day in Jakarta, while the other islands have more than 160 daily transactions. This is quite interesting, to be fair." (0562)*

Although TCASH has obtained a license for P2P transfers, Bank Indonesia (the central bank) requires all agents to have cash-out capability, making it a daunting task for a small rural shop.[103] This has led the company to have a meagre 2.08 agents for every 100,000 people. As such, TCASH users tend to use the service for low-value, high-volume payments such as buying mobile phone top-up, and paying weekly or monthly bills rather than remittances or cash-in/cash-out among TCASH users.

In 2015, however, TCASH had more than 20 million users and over 1,000 merchant partners.[104] Even though the market is still growing, the company admits that the TCASH user base is mostly dominated by people outside of Java island. Indeed, to increase the number of TCASH users in Greater Jakarta and Java island, the company has been constantly promoting the service, either via above-the-line or below-the-line marketing programmes.

It appears that TCASH has an ecosystem that is mainly reliant on partners. Meanwhile, most of the merchant stores where it offers the service are directly competing with the formal banking sector which is relatively better off than other Asian and African countries. However, the banks themselves are devising mobile money strategies which could leverage their network of PoS and ATMs, outpacing Telkomsel in terms of service reachability with customers.[105] The limitation in providing P2P transfer service to compete with informal remittances methods means TCASH is unable to leverage its key strength as an

[102] See The Jakarta Post, 2 February 2011, available at http://www.thejakartapost.com/news/2011/02/02/tcash-a-new-payment-method-mobile-era.html

[103] See IFC report on Mobile Banking in Indonesia (2010), available at http://www.ifc.org/wps/wcm/connect/1a5695804723d0248b21ab2b131bed2a/Mobile%2BBanking%2BFinal%2BReport.pdf

[104] See http://selularpress.com/berbekal-nfc-telkomsel-hadirkan-kembali-tcash/

[105] See Caballero, L. (2012) *Strategic Analysis of Mobile Money Ventures in Developing Countries.* Massachusetts Institute of Technology Thesis.

MNO: its airtime network. This situation seriously hampers TCASH's ability to generate network effects and multiply adoption rates.[106]

Since the business model tends to be transformative and focuses on increasing the novelty and variety of the service, Telkomsel relies on its merchant networks. Consequently, the company will lack short-term profit, while most of theirs other MNO products and services usually have relatively short-term cycles. Thus, the network operators who can dominate the mobile payment markets are those who have resources and adequate profitability to "compensate" such balances.

6.2.4 Technology and architectural design

Three different mobile systems are used in mobile telecommunications in Indonesia. GSM has a relatively wide coverage area for each base transceiver station, and often covers remote areas as well. The speed of the more recently introduced CDMA (100 Kbps) is ten times faster than GSM (9.6 Kbps) but has a smaller coverage area. 3G UMTS (Universal Mobile Telecommunication System) and 3G (CDMA2000 1xEV-DO) technology entered the mobile telecommunication industry in 2002 and has been adopted by almost all MNOs; allowing users to transfer high volumes of data.[107]

TCASH is a kind of external short message entity (ESME) system developed by Telkomsel that can send and receive text messages (SMS). ESME can be developed further to offer more services to customers or to improve the network performance of the MNOs. In this ESME, TCASH stores its customers' data, performs and processes transactions, and makes adjustments as well as settlements (see Figure 6.4). Customers can purchase goods and services as well as pay their bills using mobile phones.

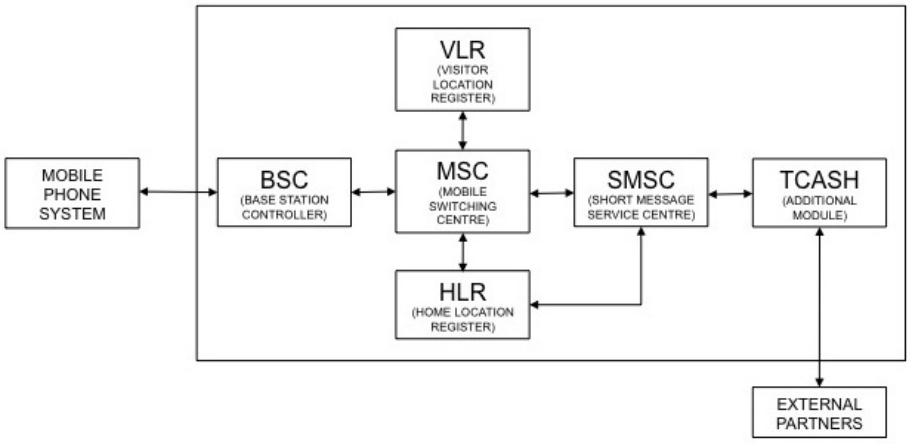
TCASH can be activated by calling *800*88# and following the instructions.[108] Customers can top-up their balance via Telkomsel branch (GraPARI),

[106] See Camner, G. (2013) Snapshot: Implementing Mobile Money Interoperability in Indonesia. *GSMA Mobile Money for the Unbanked*. Available at: http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/10/Implementing-mobile-money-interoperability-in-Indonesia.pdf

[107] The latest development is that 4G technology has been introduced through WiMAX (Worldwide Interoperability for Microwave Access) that can handle faster data transfer and wider coverage areas. Bandwidth is divided into two kinds: Licensed (needs a license from the frequency regulator in certain areas and the licensed bandwidth can be used exclusively by the provider for data transfer) and Unlicensed bandwidth (can be used by anyone). In Indonesia, government and companies are waiting for each other with regulations and plans to launch 4G. This development has however taken off slower than expected.

[108] When it was first launched, to use the services, the customers must register by sending

Figure 6.6: TCASH architectural design



Source: Internal document

cash machine, or Indomaret retail shop. There are two types of TCASH services at the moment. All Telkomsel subscribers can use basic services with a maximum balance of Rp 1,000,000 (or about US$76), while full services that have a maximum balance of Rp 5,000,000 (or about US$382) are only available for post-paid customers. Pre-paid Telkomsel users will enjoy basic services such as checking their balances, changing their PIN codes, putting cash-in, or paying bills; while post-paid Telkomsel users will benefit from full services, including P2P transfer and taking cash-out. In 2015, Telkomsel also started to offer NFC features for TCASH users.[109]

Telkomsel was working with TCASH for several years before it was launched to the market. In order to support the deployment, a special organisational unit was being established to design and maintain the mobile payment system development. Design and management of this new service was actually part of the enterprise system which Telkomsel had already developed and operationalised based on an existing enterprise architectural framework. They built a set of process architectures that specified generic service processes, which was become the prototype of TCASH, across their individual service offering.

According to an interview with the product manager of TCASH, this prototype was not comprised of a set of idiosyncratic process and systems, rather, the process redesign in which they developed TCASH did not have major con-

an activation SMS.

[109] See http://selularpress.com/berbekal-nfc-telkomsel-hadirkan-kembali-tcash/

sequences for the entire process architecture of the system. Company materials show that they migrated to the new platform later on, not because of the TCASH implementation, but rather to increase their overall performance and improve service delivery to the customer.

> *"The focus [of this development] should be to enhance our service offerings and improve our service delivery [of TCASH] in order to put the company ahead of the competitors." (Internal circullar, 24 November 2009)*

At the organisational level, Telkomsel worked together with several vendors, technology partners, system consultants, as well as their parent company. They have been working with different outside parties, however, since most part of the enterprise systems are standardised thus they have no problem in finding partners to fill their requirements. The customers also play an important role in the system. Another interviewee added:

> *"We invite some of our customers. Not only to do the [market] research or FGD, but also to get an insight into the user interface and involve them in the beta-testing." (0780)*

6.2.5 Overall evaluation

We gathered data during our observations to particularly look at what happened behind the development of TCASH through document analysis and interviews. We have evaluated the structure and content of mobile payment system development. Table 6.2 below exhibits a selection of service modularity attributes identified at Telkomsel.

When we take a closer look at the TCASH mobile payment service in particular, it suggests the importance of service delivery process design in delivering service providers' core capabilities. The modular approach, although not deliberately implemented, provides not only valuable insights to process designers in developing platforms, but also for system architectures in terms of standardisation and reusability. The extent to which standardised service components being used in the company was slightly different than the others.

The well-documented and already tested services modules were stored in a kind of service repository. The company can easily add, modify, or remove certain modules without having an effect on the whole system. Specific components which are peculiar to the existing system can be introduced and tested on the

Table 6.2: Evaluation of service modularity attributes

Service modularity aspects	Findings
Pre-conditions	Mix modularity
Information flows	Decentralised, distributed
Coordination	Hierarchical arrangements
Degree of coupling	Tight coupling
Production of services	Incremental development
Customer involvement	Moderate
Post-conditions	Mix modularity

basis of requirements within the beta testing environment. They realise the economics of components and modules substitution needs knowledge sharing and component/module reuse. In the case of TCASH, although it might not happen often, specific components can emerge because of the lack of appreciation of the current availability of the components rather than because of the dynamic and heterogeneous requirements.

Telkomsel has also been working extensively with their partners during the mapping and developing service process on several levels. This process has been conducted on the justification of the need for case analysis. If the end users need some new features to be made available, and Telkomsel initiates the process by defining needs and requirements, which comprises a set of service processes and modules necessary to deliver those new features. All the processes were constructed on the basis of standardised modules which involve components and modules in the enterprise framework.

With regard to the modular quality attributes, our findings indicate that the structure of TCASH allows designers and developers to comprehend the module by looking at the implementation of the modules and the interface itself (comprehensibility). The way they developed TCASH also allows localised alterations within the system. If they need to modify certain modules, other modules need not to be modified as well since there are only very few modules that depend exclusively on TCASH interfaces (changeability).

All in all, the case of TCASH indicates that the structure and interaction between service process modules can be designed, developed, and maintained in such a modular way.

6.3 Case 3: M-PESA

This section describes the findings of our third case, M-PESA in Kenya. We were interested in how M-PESA has been developed and how it has evolved. We particularly focused on the technological development project and business organisation working on the service development. We also sought to analyse relevant policy and regulation that might affect mobile payment development in Kenya. We consider data gathered from the document analysis to be the most reliable, since M-PESA is probably the most popular case of mobile payment and financial inclusion.

M-PESA was deployed in 2007 by Safaricom, along with its part-owner Vodafone. M-PESA facilitates customers to withdraw and deposit money, send money to other M-PESA customers, as well as top-up their mobile phones. All of those transactions can be done via SMS without requiring the customers to have a bank account. M-PESA quickly became an alternative to non-bank account transfers (such as Moneygram or Western Union) and gathered a captive market share of 6.5 million customers in May 2009 with more than two million daily transactions. In May 2010, they offered M-Kesho, partnered with Equity Bank, to offer a savings account with interest-bearing.[110] In November 2011, they had more than 14 million customers and more than 28,000 agents—encompassing the demographic and geographic coverage of many other banks and financial institutions in Kenya.

6.3.1 Country background information

Kenya is an East Africa country with about 44 million people. Other than cultural/ethical conflict, Kenya also faces challenges such as high unemployment as well as poverty and crime. At the moment, there are about 20 million mobile money accounts, and 79.2 percent mobile phone penetration and 78.2 percent internet penetration. In terms of value, Kenya's Electronic Payment and Settlement System (KEPSS) held the highest throughput value of KSh 191.84 billion in 2014.[111] However, in terms of volume, the mobile payment platform was the highest with about 2.5 million daily transactions in 2014.[112]

[110] With more than 20,000 licensed vendors joined, M-PESA customers are also able to use savings account, micro-loan, as well as micro-insurance products using their M-PESA accounts.

[111] The currency of Kenya is Shilling (KES/KSh). At the time of writing, US$1 equals to KSh 102.4.

[112] See http://unctad.org/meetings/en/Presentation/CII_EM5_P_SMwaura_en.pdf

Figure 6.7: Map of Kenya

Source: www.mapsofworld.com

The experience in Kenya shows that mobile payment systems were able to leverage economies of scale by utilising MNOs' capacity to encourage the power of the informal sector, labour market, infrastructural development, as well as support from the government and regulators. The combination of those factors shows the peculiarity of the Kenyan situation—demand for remittances, distribution networks of informal sectors, penetration of the formal financial market—making it difficult to replicate the story in other developing countries. On the other hand, it also implies that it is not a trivial task to pull off a successful business model.[113]

6.3.2 The role of government and regulators

Banking in Kenya is regulated by the Central Bank of Kenya (Benki Kuu ya Kenya or CBK). The CBK is responsible for supervisory and oversight functions over commercial banks, microfinance banks, foreign exchange bureaus, mortgage finance institutions, money remittance providers, non-bank financial institutions, credit reference bureaus (CRBs), building societies, and representative offices established in Kenya by foreign banks.[114]

Legal regulations and acts that supervise the payment infrastructure in the country are as follows (see Figure 6.5): Central Bank of Kenya Act, National Payment System Act (2011), Proceeds of Crime Act and Anti-Money Laundering Act (2012), Kenya Information and Communication (Amendment) Act (2013), National Payment System Regulations (2014), as well as Consumer Protection Act. Kenya is also currently working on upcoming legislation on data protection and cyber/computer crimes.

Even though the country seems to have light regulation, Safaricom tend to consider the regulation factor seriously. As stated by the former CEO of Safaricom, Michael Joseph, in a radio interview[115]:

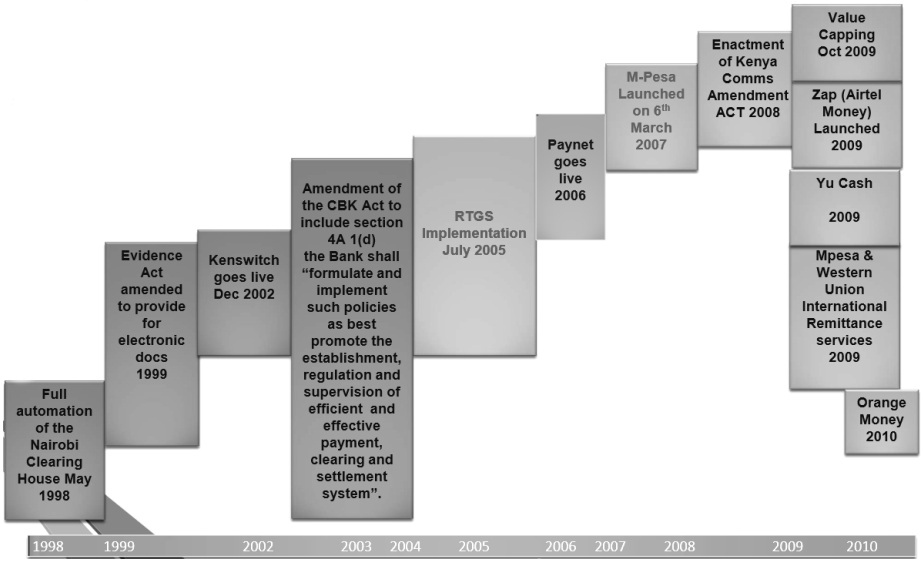
> *"In our case, we behave as if we are regulated. So we do whatever the central bank wants us to do, even though they have no regulations to enforce us. So we behave as if we are regulated."*

[113] See Nobel, C. (2011) Mobile Banking for the Unbanked. Available at http://hbswk.hbs.edu/item/mobile-banking-for-the-unbanked

[114] See Central Bank of Kenya (https://www.centralbank.go.ke/index.php/bank-supervision/).

[115] The Bottom Line. BBC Radio. Monday, 18 February 2013.

Figure 6.8: Framework and regulation development



Source: Central Bank of Kenya 2012

6.3.3 Organisations and business models

Safaricom was established in 1993 as an organisational spin-off of the Kenya Post and Telecommunication Corporation, the foregoing state-owned telecommunications operator. Safaricom Limited is a leading MNO in the country that was established on 3 April 1997 as a privately owned LLC, a division of Telkom Kenya, under the Companies Act. On 16 May 2002, it was then transformed into a publicly owned LLC.[116] Safaricom Limited network operation was relied on an ETACS network (analogue transmission technology) and then in 1996 was modernised and changed to GSM technology. The licence was granted to Safaricom Limited in 1999. A UK multinational company, Vodafone Group Plc, of the United Kingdom bought a 40 percent ownership in May 2000 which includes management responsibility for Safaricom Limited. The company then was became a public company in 2002 where the Government of Kenya still controlled 60 percent of its stake, whereas 25 percent of which was auctioned

[116] According to the State Corporations Act (Chapter 446) Laws of Kenya, it is clearly mentioned that Safaricom was categorised as a state-owned corporation in which the Government of Kenya has about 60 percent ownership of the company. Those shares were controlled through Telkom Kenya Limited (TKL) that was also a state-owned corporation according to the Act. The law also implies that Safaricom is also controlled by the Government of Kenya or controlled by a state corporation.

off through the Nairobi Securities Exchange in 2008.[117]

Safaricom enjoyed a customer base of about 12 million in January 2010, mostly are located in the capitol and big cities of Nairobi, Nakuru, Mombasa, and Kisumu. Safaricom main competitor is Airtel (Airtel Kenya). Other competitors include Orange Wireless and Essar's YU (which they acquired, in cooperation with Airtel).[118] Safaricom in collaboration with the Commercial Bank of Africa introduced a mobile banking service in November 2012 to serve Kenyan unbanked population.[119] Safaricom then partnered with Changamka Micro Health and Britam in 2014 to offer insurance product to the low income population in Kenya.[120]

M-PESA is actually a type of mobile payment system initiated by Safaricom, a subsidiary of Vodafone, to offer a new method of financial services to the unbanked population. With help and assistance from a UK Department of International Development (DFID) grant scheme, the team (Vodafone M-PESA) had chosen Kenya as a pilot study for deploying microfinance institution-based loan (MFI-based loan) repayment and disbursal system. Unfortunately, early version of the pilot tests demonstrated to be too challenging to incorporate and merge smoothly with the existing MFI systems. Yet, the Vodafone team persevered, continuously working on the pilots, believing in the mobile device future potential to empower Kenyan people to do more effectively and efficiently what culture and habit they already done in massive amount of quantity: sending money back home (from workers in urban areas) to relatives or family members (in rural areas) without having to to have a formal banking account.

Thus, Safaricom developed a kind of service to repay and receive money utilising the network of its airtime resellers. By doing this, Safaricom could offer more competitive loans compared to the existing institutions without having to deal with cash. On the other hand, the customers benefited from the ability to track their budget easily.[121] Yet, when it was launched for the first time,

[117] See "Our Heritage." About Us. Safaricom. http://www.safaricom.co.ke/about-us/about-safaricom

[118] Barton, J. (3 September 2014). "Safaricom and Airtel buy out Essar's Yu for $120M." Developing Telcoms. http://www.developingtelecoms.com/business/deals/121-operators/5426-safaricom-and-airtel-buy-out-essar-s-yu-for-120m.html

[119] Kenya's Safaricom revamps mobile phone banking with CBA, International: Reuters, 2012. Available at: http://www.reuters.com/article/2012/11/27/kenya-telecoms-banking-idUSL5E8MR7SN20121127

[120] It is known as Linda Jamii. See "How Does The Safaricom Linda Jamii Insurance Service Work." Naibuzz. http://naibuzz.com/2014/04/19/34/

[121] See Hughes, N. & Lonie, S. (2007). M-PESA: Mobile Money for the "Unbanked" - Turning Cellphones into 24-Hour Tellers in Kenya. *Innovations: Technology, Governance, Globalization*, Winter & Spring, 2(1-2), 63-81.

customers faced an interoperability problem with Faulu, the microfinance institution working together with Safaricom. Thus, M-PESA shifted and refocused on sending remittances back home and making payments. Since then, M-PESA has allowed customers to pay for nearly everything, meaning cash is becoming obsolete.[122]

> *"Our main business is voice and data. Financial services are not our co-product. So, [to launch and provide] M-PESA was as a means of creating loyalty with customers. We did not have to make money. It was designed to break even. Everyone knows that. But once you have certain a certain volume of transactions, you start to make money. And in fact, M-PESA does make money for us. It is public knowledge that it makes 18 percent of our revenue in Kenya and 14 percent in Tanzania."*[123]

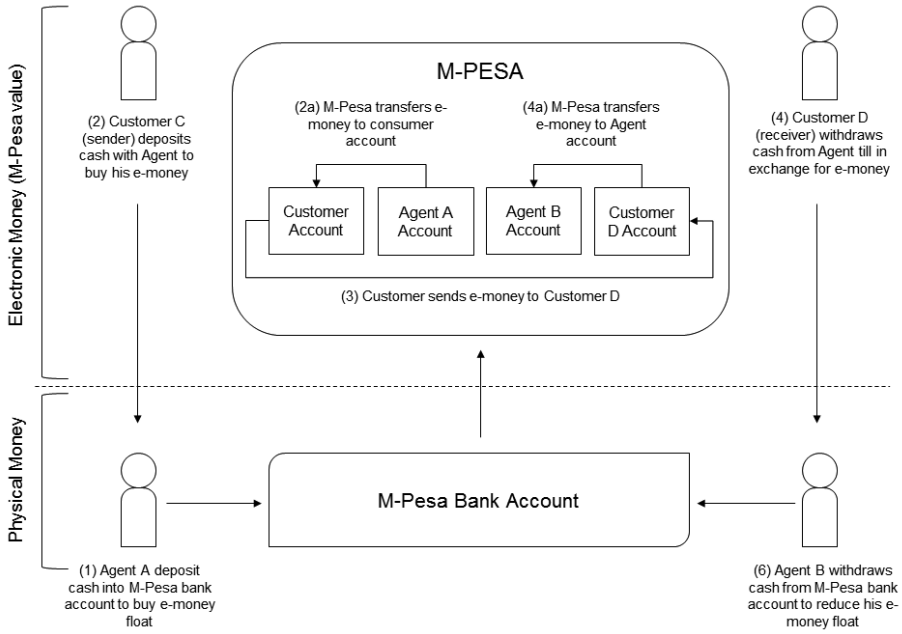
6.3.4 Technology and architectural design

The M-PESA system believed to be the most developed and matured ecosystem for person-to-person transfer (P2PT) in the emerging world. It involves the following steps (see Figure 6.6). First of all, the customer (C) gives the money to any M-PESA airtime agent nearby (A1) to top up credits or e-cash to his/her phone. C's personal identification number (PIN) as well as the A1's personal identification (ID) number are required for the verification. C has also required to proof a valid identification (ID) record (such as passport or identity card) to validate the transfer. Both A1 and C are then notified via SMS once the process has been verified and the transfer goes through. Meanwhile, to transfer (electronic) cash to another person (D), C types D's mobile phone number, the amount of money to be transferred, as well as his or her PIN. A confirmation text or SMS arrives at C and D. Lastly, D can withdraw his/her cash from any M-PESA airtime agent nearby (A2) by typing the amount of cash to be withdrawed, the airtime agent's ID, as well as his or her PIN. D has also required to authorise his or her withdrawal by showing a legitimate identification card to A2. Both A2

[122] Interestingly, public transportation such as buses and matatus (colourful minibuses) are different. The driver/conductor choose to bypass the system as M-PESA threaten their existing profit structures. See http://gatescambridge.wordpress.com/2014/10/28/why-kenyas-public-transport-system-is-fighting-cashless-payments/

[123] According to the interview of Evan Davis with Michael Joseph, a director of mobile money at Vodafone and former CEO of the Safaricom. The Bottom Line. BBC Radio. Monday, 18 February 2013.

Figure 6.9: M-PESA basic scheme



and D are then informed with the information of the aforementioned payment arrangement above with an SMS or a text-message.

The basic architecture of M-PESA aforementioned above was initially created in 2005. It had the major advantage that it was constructed in partnership with MNOs. This gave it access to (more or less) free SMS/USSD/IVR, use of the SIM (security of the app and compatibility across phones) and trustworthy reporting of the Mobile Station International Subscriber Directory Number (MSISDN) for authentication purposes. On the downside, nobody came close to predicting how popular it would be. Much of its life has been spent trying to raise its performance to keep ahead of demand. This is one of the major reasons they have not opened up APIs to external organisations—the system would be overloaded.

Safaricom developed and configured the system internally. The initial mapping was designed using business process modelling to help them visualise the system and its requirements. The proposed configuration was broken down into several architectural layers, from the high layer to the basic layer across schemes. From the higher layer of flowchart and descriptions, they were able to explain the business aspects of every smaller service and sub-service, including every

activity and the prerequisite conditions for deploying the service. Most of these processes involve IT within their enterprise system. Some of these activities can be automated completely, while some others might involve close interaction with customers or end-users.

Another interviewee added that they want to shift the responsibility for technical action away from the customer. M-PESA users do not need to be or to do anything, since everything is "hidden" in the technical module. See the following quote:

> *"Our customer is anybody who uses our network... [That way] we wanted to simplify everything. Simple mobile phones. Simple commands and instructions. As long as [the system] can perform well." (0447)*

Much of their focus is given to the standardisation of the modular processing components in order to be able to reuse the components for different schemes or services delivered to the customers. This process (along with their strategic preferences) leads to differences in the choice of modularity configuration compared to other cases. However, making sure that there is an appropriate degree of reusability in standardised components is difficult for managers. The company wanted to enforce some sort of architectural principles, but the documentation required was not widely available.

6.3.5 Overall evaluation

We gathered data during our observations to particularly look at what happened behind the development of M-PESA through document analysis and interviews. We have also evaluated the structure and contents of mobile payment systems development. Table 6.3 below exhibits a selection of service modularity attributes identified in M-PESA.

The case supports our arguments that process architecture can be decomposed so that it can be used for evaluating the service modularity at the processes level. Safaricom has been developing and redesigning its processes in order to be applicable across a range of service provisions (not only mobile payment services), enabling almost full service configurations.

Our case on M-PESA also suggests that the application of modularity comes with several tradeoffs that should be considered during the redesign and redevelopment of service systems. For example, reusability of some processes may

Table 6.3: Evaluation of service modularity attributes

Service modularity aspects	Findings
Pre-conditions	Bus modularity
Information flows	Centralised
Coordination	Hierarchical arrangements
Degree of coupling	Tight coupling
Production of services	Incremental
Customer involvement	High
Post-conditions	Bus modularity

not actually be actually as simple as the company predicted, even though all the elements are standardised. The problem arises from lack of documentation on what modules and components have been used and in what ways they were previously developed.

With regard to the modular quality attribute, our findings indicate that the system modules were being developed hand-in-hand with development of other modules as well. This parallel development proved to minimise the time-to-market and the complexity in the communication and information flows. A particular module in the system also can be altered, if necessary, without having to change the others since almost no modules depend exclusively on the mobile payment interface (changeability). Lastly, the case shows that any developers and system designers can understand the module only by looking at the deployment of the current system and the module interfaces that the other partners referenced and interconnected by it (comprehensibility).

Since its very beginning, Safaricom was interested in monetising airtime and became very successful.[124] Financial inclusion thus comes as a result of M-PESA in stimulating the local economy, not because M-PESA brought the unbanked population to the bank and/or financial institution.

It appears that there was no particular vision yet on security over third party providers:

> *"We are interested in utilising our air time. The security aspect of the system is already covered." (0493)*

All in all, this last case illustrates that a complex service system such as M-PESA is comprised of different modules and components that are structured in

[124] According to the interview of Evan Davis with Michael Joseph, a director of mobile money at Vodafone and former CEO of the Safaricom. The Bottom Line. BBC Radio. Monday, 18 February 2013.

a modular way.

6.4 Reflections on the case studies

Data analysis during this stage followed an iterative process and notes were transcribed to identify any inductive patterns in the data. Data collected from the interviews and secondary sources reveals not only the detailed operational strategic decisions that were faced by the mobile payment systems providers, but also the regulatory environment in which the mobile payments operate.

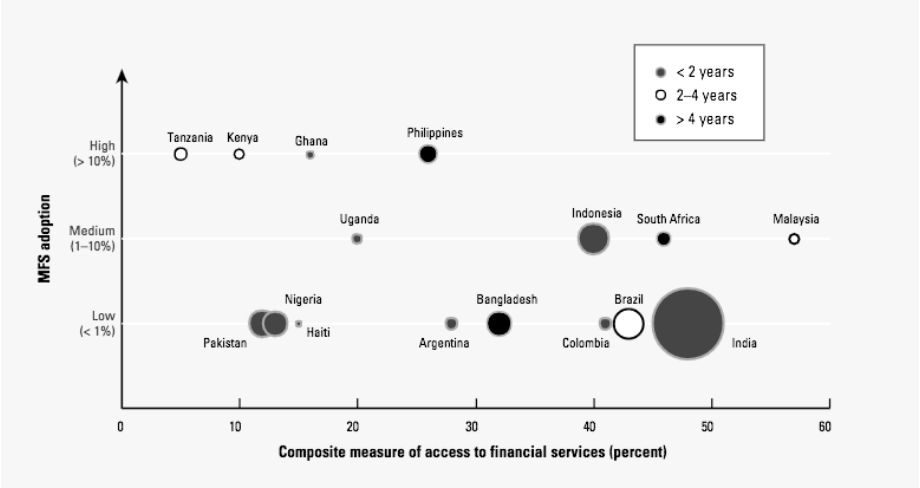
All of the countries studied have sufficient and strong regulation both in the financial sector as well as in the telecoms sector. However, it appears that regulations are not strategically aligned. An overlap between mobile payment (or electronic money) regulation covered by the telecoms authority and the regulation enacted by Central Bank or Ministry of Finance is not uncommon. In some situations, the insistence that financial institutions play an important function in the scheme appears to be detrimental to the adoption of mobile payment systems. Further, even though they have a kind of national agenda with regard to the e-money implementation in the country, Brazil and Kenya do not state their agenda clearly in legal decrees or laws.

> *"[But] the regulators around the world, not so much in the developed world, but in the emerging market, have got a goal of financial inclusion, and the G20 goal of financial inclusion is endorsed by them. And therefore they are trying to encourage financial inclusion and ... trying to have a light touch regulatory environment around mobile money."*[125]

In Kenya, M-PESA has grown explosively, while in Indonesia TCASH has only been moderately adopted and adoptions tends to be low for Oi Paggo in Brazil. This is in line with the findings from The Mobile Financial Services Development Report 2011 (see Figure 6.7). The report indicates that realising mobile payment opportunities means taking a very local and contextual view. Although mobile payment systems have been a success story—particularly in serving the unbanked population, overcoming barriers to e-commerce, and disrupting traditional retail payments—in some developing countries, a company cannot directly

[125] According to the interview of Evan Davis with Michael Joseph, a director of mobile money at Vodafone and former CEO of the Safaricom. The Bottom Line. BBC Radio. Monday, 18 February 2013.

Figure 6.10: Adoption of mobile payments in emerging countries



Source: The Mobile Financial Services Development Report 2011

replicate the success in other markets.

We speculate that mobile payment systems are a kind of 'emerging market innovation,' which will succeed in those countries with less infrastructure, with people being excluded from the formal banking system, high inequality between rural and urban areas, and also lack of alignment and heavy regulation in banking and telecoms. These factors, we believe, are what affect whether mobile payment systems take off or fail. Once a country moves upwards (better infrastructure, higher income level, financially inclusive, lower inequality), perhaps there will be only small incentives to innovate in mobile payments (see Table 6.4 and 6.5).

From Table 6.4, it can be seen that on the surface, Brazil is the most advanced country in terms of financial access. Brazil has 45.47 branches of commercial bank per 100,000 adults, compared to Indonesia and Kenya with 8.69 and 5.04 respectively. Brazil also has 117.86 ATMs per 100,000 adults, meanwhile, Indonesia only has 16.79 and Kenya only has 9.21 ATMs per 100,000 adults. Brazil also has the highest percentage of debit cards and credit card users compared to the other two countries.

With regard to mobile phone usage (Table 6.5), we can see that Kenya has a significantly higher number in all indicators compared to Brazil and Indonesia. Kenyan people are not only using mobile phones to pay bills, but more importantly, to send and receive money. While more than 60 percent Kenyan people

Table 6.4: Quantitative cases comparison

	Brazil (2011)	Brazil (2014)	Indonesia (2011)	Indonesia (2014)	Kenya (2011)	Kenya (2014)
Account at a financial institution (% age 15+)	55.86	68.12	19.58	35.95	42.34	55.21
Account at a financial institution, rural (% age 15+)	54.06	63.02	15.23	28.45	38.74	53.06
Saved at a financial institution (% age 15+)	10.29	12.33	15.29	26.56	23.28	30.18
ATMs per 100,000 adults	117.86	n/a	16.79	n/a	9.21	n/a
Credit cards (% age 15+)	29.24	32.05	0.50	1.60	6.07	4.63
Debit cards (% age 15+)	41.18	59.16	10.54	25.94	29.94	34.66
Commercial bank branches per 100,000 adults	45.47	n/a	8.69	n/a	5.04	n/a
Inflation, consumer prices (annual %)	6.64	n/a	5.36	n/a	14.02	n/a
Mobile account (% age 15+)	n/a	0.86	n/a	0.45	n/a	58.39
Mobile account, rural (% age 15+)	n/a	0.41	n/a	0.48	n/a	56.33
Mobile account, income, porest 40% (% age 15+)	n/a	0.80	n/a	0.28	n/a	52.51
Mobile account, income, richest 60% (% age 15+)	n/a	0.89	n/a	0.56	n/a	62.40
Population, total (in million)	196.93	n/a	243.80	n/a	42.03	n/a
Population, age 15+ (in million)	147.63	n/a	171.65	n/a	24.17	n/a

Source: World Bank Global Financial Index

are using mobile phone to receive money and around 50 percent to send money, there are only around 10 percent who are utilising their mobile phone to pay bills. This peculiar characteristic cannot be seen in the other two countries.

Most of our sources agree that the future of mobile payment systems is bright, as described thoroughly by the following interview:

> *"We will stay [I think] at the bottom of the pyramid services... and grow tremendously, looking at all sorts of micropayments, not just paying your electricity bills. [We are] looking at micro insurance, which is a big field, micro health insurance, which can be massive... way more than a tiny amount of water and electricity bills. This will grow tremendously, provided we focus on the bottom of the pyramid and we do not challenge the banks at their serious customers. This business will be very big in the next five years, but it will continue to grow with and without banks in different modern worlds."*[126]

Even though banks have a reputation in managing risk and 'plumbing' (intermediary roles), we should probably not underestimate the capability of MNOs in managing accounts. MNOs also have better expertise in providing payment services in a more viable manner than banks. Here, we would argue that MNO-based mobile payments have a higher chance of success than bank-based mobile payments. We also suspect that the evolution of mobile payments will mirror the evolution of MNO business. This is not only obvious in the case of Kenyan M-PESA, but also in the case of Oi Paggo and TCASH (see Table 6.6).

As can be scrutinised from Table 6.6, Brazil has a low level of mobile payment system adoption, Indonesia has a moderate level, while Kenya has the high level of adoption. Not all of those aforementioned countries have strong regulation both in the financial sector and the telecommunication sector. It seems that Kenya has the possibility to align telecom and financial regulations regarding mobile payments. We could not find evidence regarding this alignment in Brazil and Indonesia.

Another difference that can be seen from our case is that all of the countries have different national agenda regarding the adoption and diffusion of mobile payment systems. Brazil developed mobile payments initially to provide cash transfers to the unbanked population. Indonesia was concerned about moving

[126] According to the interview of Evan Davis with Michael Joseph, a director of mobile money at Vodafone and former CEO of the Safaricom. *The Bottom Line*. BBC Radio. Monday, 18 February 2013.

Table 6.5: Mobile phone usage in 2011 (% age 15+)

	Brazil	Indonesia	Kenya
Receive money	0.83	0.62	66.65
Receive money, male	1.21	0.80	71.59
Receive money, female	0.47	0.45	61.92
Receive money, rural	0.00	0.10	65.13
Receive money, young adults (% ages 15-24)	0.79	0.00	62.07
Receive money, young adults (% ages 25+)	0.84	0.83	69.29
Receive money, income, poorest 40%	0.31	0.00	53.24
Receive money, income, richest 60%	1.18	1.04	75.65
Receive money, primary education or less	0.35	0.18	49.60
Receive money, secondary education or more	1.27	1.10	81.90
Pay bills	1.25	0.23	13.43
Pay bills, male	1.44	0.10	16.67
Pay bills, female	1.07	0.35	10.33
Pay bills, rural	0.00	0.19	12.83
Pay bills, young adults (% ages 15-24)	0.79	0.00	11.37
Pay bills, older adults (% ages 25+)	1.40	0.30	14.62
Pay bills, income, poorest 40%	0.72	0.18	4.41
Pay bills, income, richest 60%	1.62	0.26	19.49
Pay bills, primary education or less	0.76	0.00	5.11
Pay bills, secondary education or more	1.70	0.47	20.88
Send money	0.00	0.57	60.48
Send money, male	0.00	0.69	69.16
Send money, female	0.00	0.45	52.16
Send money, rural	0.00	0.26	58.69
Send money, young adults (% ages 15-24)	0.00	0.00	57.25
Send money, older adults (% ages 25+)	0.00	0.76	62.33
Send money, income, poorest 40%	0.00	0.00	43.27
Send money, income, richest 60%	0.00	0.95	72.03
Send money, primary education or less	0.00	0.00	41.32
Send money, secondary education or more	0.00	1.19	77.60

Source: World Bank Global Financial Index

Table 6.6: Qualitative countries comparison

	Brazil	Indonesia	Kenya
Adoption of mobile payment systems	low	moderate	high
Financial sector regulation	yes	yes	yes
Telecom sector regulation	yes	yes	yes
Telecom and financial sector regulatory alignment	n/a	n/a	ad hoc
National agenda	cash transfer to the unbanked	moving towards cashless society	address financial inclusion
e-Money licensing	non-specific	yes	no
MNO role as banking agent	yes	yes	yes
Proportional KYC requirements	yes	no	yes
Existence of mobile payment consumer protection policy	yes	yes	yes
Existence of AML/CFT regulation	yes	yes	yes
Mobile G2P payment	n/a	n/a	yes

from a cash-based society to a cashless society. Meanwhile, Kenya focused on remittances and addressing financial inclusion of their citizens.

At the micro level, we use a modular principle to analyse the payment process and summarise the case by the processes, subprocesses, modules, and options found at different operational levels as well as their classification by process type into base, reuse, and variation options. We posit that the transition towards modular settings is adopted from the architecture of the firm to a pre-existing service architecture. Thus, in these cases, the relationship between technology and organisation is two-way.

In the detailed analysis of the managerial-level and operational-level delivery process of the mobile payment systems in the cases studied, we were able to identify the options for the ordering, payment, and settlement modules and to define rules and boundaries for each modular option of the service provision type.

Even with such a range of sizes and types of firms, Table 6.7 demonstrates the predominance of certain common modular strategy decisions. All of the cases being studied appear to have similar business and technological platforms. However, they live in a different environment and are imposed by different kinds of regulation as well. The majority of the mobile payment functions in the case

studied are considered to be a service. The functional configurations as well as the product lines contribute towards flexible service systems. On the other hand, the management of product or service and the orientation of service also managed using modular engineering principle. Taking into account those aforementioned features and characteristics from the end user's perspective allows us to organise configuration and manage changes of service-oriented system, such as mobile payment systems, effectively and efficiently.

Table 6.7. above also illustrates the modular characteristics of the case. Similarities and differences in the ICT system were found between the firms in the cases studied. Telkomsel and Safaricom adopted technology from their parent companies. Later on, they customised and tailored the information systems to support the mobile payment accordingly. On the other hand, Oi developed their system in-house and it was custom-made. Tailored systems provided flexibility as changes could be implemented quickly. This also goes simultaneously with the changes in Oi company and divisional structure due to mergers, acquisitions, and corporate restructuring. With regard to the information systems strategy, it appears that Oi focused on allocating its resources to develop the system while Telkomsel focused on automating and streamlining the process. Meanwhile, Safaricom seems to be concentrated on optimising its service delivery while at the same time developing its service derivatives.

Even though the data suggests that the modular principle has been embraced, none of the mobile payment mechanisms deliberately intended to apply modularisation principles in their delivery processes. Instead, service process modularisation is realised in the options provided by the availability of technology to customise and develop new service offerings to the customer. The front-end customer service is menu driven and has a predefined set of service options within the service modules. In particular, the cases of Oi Paggo and M-PESA show that modularity is capable of dealing with complexity and flexible enough to respond internally (in the case of Oi Paggo, organisational changes and restructuring affect the way in which the company develop and enhance the service provision) and externally (such in the case of Kenyan M-PESA, changes in customer needs and preferences influence the way in which the modular service was customised and adjusted).

The construct of service modularisation itself is perhaps quite difficult to understand in hindsight, but by examining the concrete design and development of the actual service process from both the firm's point of view and from the customer's point of view, we can gather more than enough evidence. We

Table 6.7: Comprehensive overview of the case studies

	Oi-Paggo	TCASH	M-PESA
Background	Launched as a pilot in 2006, to the general market in 2007, many changes and restructuring	Launched in 2007, as a spare capacity to develop further, but market and regulation did not catch up	Introduced in 2007 as a microloan product, quickly shifted into P2P and remittances, and has grown rapidly
Agent network	Extensive network, affiliated establishments	Limited network	Extensive network, reliable and consistent
Environment	Changing	Stable	Stable
Product variety	Focus on P2P transfer and remittances	Focus on small/micro payment, remittances came later on	Focus on P2P transfer and remittances
Business platform	One of the leading mobile operators, fierce competition	Leading mobile operator, strong technological support	Leading mobile operator, strong support from regulators and existing institutions
Technology platform	SMS-based	SMS-based, and has further developed to NFC	SMS-based with PIN
Regulatory platform	Strong support from the very beginning	Lack behind, late support	Loose at the beginning, strong support later on
Modularisation strategy	Component-swapping modularity	Mix modularity	Bus modularity
Modular at technology	Moderate	Moderate	Modular
Modular at functional	Moderate	Moderate	High
Modular at organisa-tional	High	Low	Moderate

can also, as shown from the cases mentioned above, examine the structure of power and relationships among different economic actors outside the firm, i.e. regulators, suppliers, technology vendors, etc.

However, it is necessary to emphasise that no attempt has been made to quantify the potential economies of scale benefits associated with such a modularisation move, so any net saving or profit is likely to be understated. Finally, due to the recent changes in the corporate and organisational structure of Oi, the case of Oi Paggo is a little bit difficult to compare directly with the other cases.

Chapter 7

Synthesising the Research

Building on the findings of the previous chapter, we returned to the question framed in the beginning of this thesis: how modularity is actually applied in the service sector settings. We analysed the empirical evidence which was driven by the theoretical interests underpinning the research.

According to the identified issues elaborated in the previous chapter, there are several things that could be synthesised to be discussed further. We divide the analysis into two main categories: (1) process and mechanism of service modularisation experienced by the organisation and (2) the technological development of mobile payment system.

In section 7.1 we revisit the theoretical concept of service modularity and see how it is relevant in practice. Section 7.2 focuses on the advantages and benefits of firms that were being structured in modular forms. The next section, 7.3, describes the industry-level modularity and de-verticalisation of the sector. Lastly, section 7.4 calls for mobile payment re-conceptualisation.

7.1 Revisiting services modularity

Modularity in services has been viewed as a pivotal factor in developing service orientation within the firm (Bask et al., 2011; Böhmann et al., 2003; Voss and Hsuan, 2009). Pertaining to this view, services should be developed as modular units and assembled by mixing and matching those units accordingly to customer demand (Bask et al., 2011; Rahikka et al., 2011; Tuunanen and Cassab, 2011; Ulrich, 1994; Voss and Hsuan, 2009). On one hand, modular services must

have standardised baseline services, customised services, as well as the combinations between the two. On the other hand, modular services must made reuse of processes possible during the implementation in order to accomodate flexibility and customisation (Bask et al., 2010a). These attributes are evident in our cases of mobile payment systems.

Tuunanen and Cassab (2011) state that service process modularisation allows firms to achieve market impact efficiency from the extension of services via reusability and variation of existing processess. However, taking into account what has been shown from the case studies, servitisation also poses challenges, not only internal (such as design strategy, organisational transformation, etc.) but also external (such as changes in customer needs and preferences, changes in regulation and power structure, etc.). Thus, service providers must deliver stellar service packages to the customer in the front end, but at the same time, they have to operate efficiently in the back end while managing changes and complexity in their environment.

In the previous chapter, we discussed the implementation of modular principles in service development. We argue that modular service systems represent some sort of functionality that can be implemented using components (either software or hardware) to any degree of variations as long as the implementation is strictly compatible with the conceptual model (design rule). The modular principle provides a guiding design template that includes the structural dimension as well as dynamic aspects of abstract components that can be implemented using components determined by the system designers. However, echoing Simon (1962), we did not find a system that was totally built up of independent modules—there are always some unrecognised intermodular interdependencies.

The cases confirm our proposition in the way that the application of service modularity was affected by several key service attributes, such as: customers engaged in the production of services (co-producer), both service process and service product are combined in the final service offerings, and that service package will incorporate both technical as well as human factors. Yet, even though modularity in general has been around for the last two of decades, it still lacks of unified definition. We need a particular definition that is not borrowed from product manufacturing, instead, a description that incorporates those several key service attributes as well.

In a product manufacturing, modularity proves to be particularly useful in improving configuration, enhancing upgradeability, and offering several strategic flexibilities in product architecture (Baldwin and Clark, 2000; Cabigiosu et al.,

2013; Garud and Kumaraswamy, 1995; Gershenson et al., 2003; Sanchez, 1999). However, the linkage between modularity and flexibility is not that obvious, and perhaps, affected by different circumstances (Jacobs et al., 2007; Schilling, 2000; Worren et al., 2002). Complementary elements in the organisation also facilitate organisations with manufacturing structure that is modular to enhance their flexibility of the organisational strategy (Worren et al., 2002). Yet, some authors argue that following product modularity does not always result in strategic flexibility (Baum and Wally, 2003; Cabigiosu et al., 2013; Eisenhardt, 1989b). In our case, organisational structure and product architecture seems to be a two-way relationship that is continuously evolving and the two influence each other mutually (Zirpoli and Becker, 2011). However, even though modularity promotes flexibility, they are not at the same level.[127]

We admit that modularity in services was influenced by modularity in product manufacturing. It appears that the current literature mostly approaches modularity from a traditional system view that tends to be static in insight and oversimplify the complexity of the 'modular world.' However, due to the distinctive attribute of services, modularity in services setting is usually more heterogeneous and complicated than products. Business services can exist in different dynamic relationships (i.e. B2B, B2C, B2G, etc.), might involve low or high human involvement, can be knowledge-intensive or be no-knowledge at all, and can also be physically-based or IT- or IS-based. Thus, modularity in services must be viewed as multi-layer or multi-level. Obviously, there is a need for a re-conceptualisation of service modularity that is not purely simplistic, but also incorporates heterogeneity and multi-layer/multi-faceted characteristics of services.

We propose that a modular service development should really start with the identification of service requirements, in line with Edvardsson and Olsson (1996). A modularity approach will provide better adaptability and greater flexibility to a firm in producing service provisions. However, a systematic modularisation mechanism must be followed to facilitate the process of segregation and decomposition. As suggested by Silvestro and Silvestro (2003), service systems, service processes, and service concepts must go together in harmony to create and provide optimal value to the customer.

By decomposing services into a series of service modules, then service process

[127] We found that flexibility is derived from the standardised interfaces of modularity, which is why they are not at the same level. This is in line with the notion of flexibility by Sanchez and Mahoney (1996).

activities that consist of identical service content can be mapped and grouped according to their similarities and reusability. The focal point of modularity in services is that it is built upon the concept of independency in function in which every service function ought to be independent of other functions (Geum et al., 2012; Schilling, 2000). Thus, service modules should be defined in a mechanism where interactions between modules are minimised but might be high within a module (Ulrich, 1995).

In decomposing services, it is important to distinguish functional elements as well as physical elements. Physical elements relate to the physical systems which are installed to hold up the services or to support functional location in which those service activities carry out. Functional elements are single service transformations and operations that give rise to the entire functioning of services system. Thus, to accurately plot the activities to the service modules, mapping those activities becomes crucial. It is also particularly important to separate common elements and distinctive elements within a service module.

We also added two building blocks to the proposition, namely cost estimation and analysis as well as service evaluation. Cost estimation and analysis seems to be ignored in the literature. We believe that the modularisation process has its cost, for example, from pre-existing interdependencies that can cause incompatibility problems. Feedback and evaluation are also a component which is usually abandoned in service development. Even though a modular system can evolve faster and more easily, there is a risk of being 'locked-in' to a 'non-ideal' situation.

7.2 Fortune favours modular service firms

Service modularity is particularly relevant for reducing complexity, minimising cost, making firms more adaptive to the heterogeneity of customers' demands and to the changing market dynamics. Langlois (2003) argues that in such a constantly changing environment, modularity is predominantly worth the effort. Modularity theory complements mainstream organisational economics, which is closer to the theory of relationships rather than the theory of production. Modularity is a powerful concept to explicitly integrate technology into analysis, showing how it may affect interfirm relationships in the case of services.

The 'traditional' modularity theory appeared to emphasise technological discontinuities and architectural changes (Langlois, 2002). It is thus assumed that,

implicitly, technological change occurs inside the boundaries of certain modules and does not impact the interdependencies between the modules and their accompanying interorganisational relationships. Our cases of mobile payment systems suggest that this is probably not the case. We found that when the technological dynamic is changed, firms need to coordinate with their suppliers, vendors, and other related parties in order to share information according to the situation and thus adapt and change their behaviours and expectations reciprocally.

Mobile payment systems are currently being developed in such modular ways, but we found that not every modular service system is the same. We did not find any case that is fully modular nor fully integral. They are somewhere in between or close to one end of the spectrum. We also argue that modularisation in the sector follows different trajectories and patterns. The changing path can be obviously seen in the mobile payment system, perhaps due to its technology-intensive nature. However, patterns in other industries might be completely different.

We content that the benefit of modularity does not come without cost: pre-existing interdependencies can stimulate unanticipated problem, conditions might change and require specialised modularisation—rational choice vs. random variation of modularity. Thus, the decision to apply the modular principle ought to be deliberate. Rather than questioning whether we should become modular or not, a more fruitful pursuit would perhaps be to ask how to maximise the benefit of modularisation.

Research on modularity has also provided a significant addition to the literature of economic organisations and technological change. This shows that, especially during the design stage, technical modularity and advancement in the division of labour has opened new and alternative pathways for the organisations other than vertical integration, through promoting vertical specialisation in production manufacturing as well as in innovation (Brusoni, 2005).

What seems to be counterintutitive is that some revisionist studies argue that the interest in modularity has gone too far. Rather than investigating difficulties and challenges that service firms are facing in developing and operationalising modularity, there is a propensity to generalise empirical findings and examinations that are too narrow and context-specific. We are not intended in advocating an alternative option or explanation, more modestly, we were working toward shifting the arguments away from frivolous debates to an empirical discussion that enquires about what factors could limit the alignment of tech-

nical modularity, organisational modularity, as well as market modularity.[128]

Another related aim is to examine what firms can do to solve these issues. We explore new evidence from the mobile payment sector—which is a considerable, innovative and cutting-edge industry—as a benchmark of wider industry patterns and trends. Also, the thesis suggests that, even in these industries, there are strong counter-forces pushing the structure of the organisation to transform into more integrated, rather than arm's length. Our cases on mobile payment systems show how cognitive complexity and competitive dynamics cause limits to modularity. In the industry where technological change is very high and unpredictable, codification cannot reduce complexity. We thus argue that modular collaboration needs more and better coordination through hierarchical arrangement and corporate management.

7.3 Industry-level modularity

Findings from the industry-level, although perhaps somewhat indicative, show that, first, modularity works best in technology-intensive and network-effect industry. It is easier to decompose technology-intensive services than human-intensive services. On one hand, in order for products and services to obtain benefits from the network, they need to be compatible and standardised. This standardisation makes decomposing services easier, which in turn makes services more modular.

Secondly, modularity influences the exploitation of global economies of scale and cutting vertical supply chains (de-verticalisation of the industry). Modularity benefits from specialisation and economies of scale simultaneously. Competitive forces are released to encourage complementary components in the value chain when workable interfaces can be attained at low cost. Thus, modularity favours disruptors with strong comparative advantage to play a part in providing particular inputs, even when the disruptor has limited or even no experience as integrated suppliers of a bigger share of the output of the industry.

Third, the modularisation path is multi-dimensional: 'openness' can increase or decrease according to the number of participating firms, industry standards, platform organisers, etc. Modular systems can allocate incentives of ownership

[128] We find that it is essential to align between technical, organisational, and market modularity. It can be started at the organisation/business operating model (e.g. business capabilities, business processes, organsiation, people, roles, etc.) to technological/system operating model (e.g. technological capabilities, technological structure, development tasks, etc.).

across numerous firms managed through standardised interfaces. Modularity thus accommodates communication and information sharing, as well as assisting the management of a complex system (Langlois, 2002). Modules, or partitioned pieces, can be visible or hidden. A visible module comprises design rules the way in which other modules should follow in order to attain full compatibility of the system (Baldwin and Clark, 2000). However, on the other side, while information is embedded in the node, substituting this hidden module with other better modules would not change the overall system performance (Baldwin and Clark, 2000).

Furthermore, a basic platform appears to be better governed (design rule) by the MNOs rather than the banks; but the most important economic agents are the users. On the other hand, it appears that the mobile platform in general has become a "platform of platforms." Thus, members in this network (e.g. chipset manufacturers, mobile software developers, etc.) will try to develop their own platform, competing with the existing ones. These include the work of independent firms, since a bigger portion of the competitive power requires huge investment in the system that will, in turn, attract other enterprising applications.

Lastly, mobile payment systems are a highly regulated sector. Regulatory power may influence the structure of the industry by imposing policies to support their own interests. Our cases confirms Evans and Pirchio (2015) in the sense that mobile payment systems will not grow exponentially where there are heavy regulations and dominance of banks to play a central role in the mobile payment ecosystem. KYC regulations and agent restrictions appear to be detrimental to the ecosystem.

7.4 Calls for mobile payment re-conceptualisation

We offer a thesis that mobile payment system is a complex service system, albeit perhaps not deliberately, that was developed in such a modular way. There are a series of instruments, actors, rules, and processes involved in the operationalisation of a mobile payment. There are at least three main elements involved: payment instruments, processing systems, and settlement. At the lowest level, the participants in the mobile payment ecosystems are banks or MNOs, settlement agents, technology partners and vendors, and regulators. The ecosystem is not only challenged by commercial factors (balancing costs and profitability)

or technical factors (functioning technology solution and security), but also legal factors (such as legal audits and regulatory supervision) and market factors (achieving critical mass).

First, due to the complexity of the system, we believe that developing such services in a modular way will offer benefits in terms of efficiency and flexibility. The cases studied in Chapter 6 shows that the modular principle enables innovation and technological progress, which in turn will allow improvement and efficiency in the payment ecosystem. Furthermore, rapid technological changes and business restructuring led to a series of increasing interdependencies in the market. The mobile payment ecosystem is becoming increasingly connected. These interdependencies will promote interoperability and economies of scale, which in turn, will lead to increasing efficiency.

Secondly, modularity goes hand in hand with dislocation and concentration. Due to regional integration and globalisation, banks and MNOs are expanding their operations across borders and becoming regional or international players. The changes in location systems (dislocation) might promote the setting up of infrastructure of the market outside the country. Nowadays, national markets are continuously being challenged by multi-national and international players (or local players which are owned or partially owned by international groups of players), that create the economies of scale effects required to challenge the national incumbents. On the other hand, the consolidation and merger of financial institutions and infrastructures in the market might foster significant volumes of transactions being away from inter bank standardised systems to intra bank processes, in which they continuously internalise transfers and payments. This trend, however, is particularly relevant for bank-based mobile payment systems and not for MNO-based mobile payment services.

The remarkable triumph of mobile payment systems in some developing countries (for example M-PESA in Kenya) is quite remarkable and perhaps can serve as a blueprint for adoption and diffusion of mobile payment systems in the rest of the developing world. However, it should be underlined that understanding of local market is important and, thus, simply imitating what they have done will probably result in wasteful attempts.

Finally, we need some sort of standardised definition regarding mobile payment, as well as other terminologies that often come along with it, i.e. mo-

bile banking,[129] mobile money,[130] mobile wallet,[131] mobile commerce,[132] mobile PoS, and mobile finance.[133] Those terms often seem to be synonymous or contradictory, depending on the time and context settings.

However, it is mobile payment and mobile money that sometimes overlap. Some literature argues that mobile money focuses on converting cash directly into digital money and P2P platforms through mobile phones. Some others emphasise the 'virtuality' of money that enables its users to pay for products or services without the presence of cash or cards. Some others argue that mobile money is the ability to receive and send money using mobile devices.

Even though mobile payments are generally described as a means of payment using mobile devices, we argue that the source of funds could be anything. Consequently, mobile payments could eventually become a part of mobile wallets, mobile banking, mobile money, or any such service. We also posit that mobile payment will continuously evolving and developing more coverage, including social benefits (G2P), tax payments (P2G), salary transfers, open loop payments, and so forth.

The popularisation of mobile payment system will perhaps eventually make it 'obsolete.' Just like "open source software" is now becoming "software" and "mobile phones" are now simply becoming "phones", although somewhat indicative, "mobile payment systems" will perhaps simply become "payment" in the near future.

[129] Mobile banking is designed as an access channel for our existing banking accounts. Customers can do a number of transactions (for example paying bills, sending and/or receiving money, checking balance, applying for loans), through this but it is assumed that they have already established a relationship with banks and/or financial institutions.

[130] Mobile payments ought to be linked to MNOs, such as Vodafone, whereas mobile banking would be leaning more towards people with banking accounts, such as Barclays, HSBC, and so forth.

[131] Mobile wallet usually refers to online payment companies that allow their users to conduct payments via mobile instruments (e.g. Amazon Payments and Google Wallet). Yet, some literature categorises mobile payments such as M-PESA and Airtel Money as a mobile wallet as well.

[132] Mobile commerce is probably the easiest term to define. Basically it means that we conduct certain transactions or buy some products or services from websites and/or applications using our phone (e.g. eBay and Paypal). Mobile PoS is also quite obvious. It can be defined as taking in-store payments as a merchant (e.g. Square).

[133] Mobile finance is usually a kind of extension of mobile banking that has particular purposes, for instance, loan applications, online stock trading, and so forth.

Chapter 8

Conclusion

We began this study by asking a simple question of how modularity is actually applied in the service sector settings. It turns out that this study is not as simple and obvious as we anticipate beforehand. We also find a number of unexpected, unpredicted, yet interesting findings along the way.

In this chapter we show how the research findings answer the aims and objectives of this research. We discuss and summarise the case with respect to their implications for both practice and theory. We also describe several consequences to the extant literature on service modularity and to business practitioners and policy makers regarding the contribution of this research.

Section 8.1 describes several lessons learned from the cases on service modularity. Section 8.2 extends the discussion with regard to the mobile payment research. In addition, this chapter will propose the original contributions of the thesis to the knowledge as well as to the business practices in Section 8.3. Finally the possible limitations of the research and opportunities for future work are pointed out in Section 8.4.

8.1 What can we learn from service modularity?

This thesis emphasises the benefit of modularity in managing complexity by reducing interdependencies through standard interfaces and retaining efficiency by recombination/flexibility and economies scale from reusability. Modular systems can assign ownership incentives among different firms within a coordinated network through standardised interfaces, and thus promotes communication and

assists the organisation of a complex system (Langlois, 2002). Modules or partitioned pieces may be visible or hidden from the outside. Where information is compressed in the node, the substitution of this hidden module with a better attribute does not change the performance of the system (Baldwin and Clark, 2000). However, on the contrary, a visible module incorporates design rules that other modules have to follow in order to attain system compatibility (Baldwin and Clark, 2000).

Modularity theory proves to be useful in explaining the dynamics of mobile payment ecosystems that were not captured using other theories. It describes the boundary of the systems, interdependencies among the modules, as well as power relations among different economic actors. Modular thinking also provides an explanation of why some particular aspects of property have been more compliant than others. Modular strategy benefits from both specialisation and economies of scale. When viable interfaces are attainable cheaply, complementary components will be created by the competitive force that is released in a value chain.

Modular principle enables entry by innovators to provide particular inputs that the innovators can manifest comparative advantage, even in a situation where such companies have no competence or little experience as integrated system providers of a bigger part of industry outputs. This, however, does not reduce the capacity and function of organisations in developing interfaces as well as communicating and managing production processes. A balance between the interests of the system developer and those of the external partners becomes materialised.

We anticipate that the application of service modularity will be influenced by three key attributes that differentiate services from products. First, in service production, customers are engaged in the process and become co-producers along with a service provider. Second, both the service process and service product are inseparable elements in the final service offering. Finally, every modular service package will incorporate not only technological factors but also human factors. Modularity within the service domain has been closely associated with productisation of services and our consideration of modularity in services has been hugely affected by the preciding literature on modularity in production and manufacturing. We have shown, however, both how earlier theoretical treatments can be made congenial to services and in our case of mobile payment systems we have shown how the application works.

One of the most important concerns in modularity study is that there is no

current 'best' or 'ideal' modular form or 'best' or 'ideal' architecture with which we could contrast and set side by side the results and balance between strategic needs and functional needs. Since every company (or service system) has a distinctive strategy, thus the architecture will not become similar or identical. DSM emerged from an engineering paradigm, but as mentioned by several researchers, it is difficult to describe a a single 'correct' decomposition method of a good or a service. The series of related components might eventually become completely distinctive, resulting in different clusters of module and matrices in the end. Mapping the example of mobile payment systems also revealed a gap in the literature. It lacked the means to represent how the environment in which a service is deployed affects the value of its design.

These benefits do not, however, come without cost. On one hand, service modularisation might overlook interdependencies that exist and cause unexpected problems. However, it might rule out interdependencies in some values. Secondly, the dynamic nature of the environment might change and, thus, require different kinds of modularisation. Even though a modular system can evolve more easily and faster than a non-modular system, a modular system might end up with 'non-ideal' solutions, subject to the variation of the modules itself and subject to whether the variation of configuration is randomised or selected rationally.

In the case of service organisations, the attributes of services are easier to overlook. Modular organisations can be viewed as a panacea for overcoming complexity and attaining flexibility, specifically in addressing coordination problems of associating outputs to inputs. However, as long as the modular service firm can overcome the coordination challenge and the input is valuable enough, our experience with modularity theory and human artefacts would prompt us to anticipate a major role for modular configurations.

In the case of mobile payment systems, contrary to what has been proposed by literature on product modularity, we find evidence that transactions between participants such as customers and regulators were mainly conducted at thick crossing points with many transfers and participants are involved. It implies that the boundary of what changes hands in providing mobile payment services are not easy to identify. Thus, in order to achieve efficiency, service providers must acquire competencies and required ability so that they can arrive at a market price.

8.2 Significance of mobile payments

Mobile payment systems are perhaps not indispensable to our lives yet. Mobile payment will not automatically transform people's lives. The success story is often what attracts attention, however, a success is often a result of a series of previous failures.[134] We also found that modularity allows the smooth performing of systemically important mobile payment, processing, clearing, and settlement, that is aligned with public goals and public services. In the mobile payment industry, the transition towards modular settings appear to be adopted from the organisational architecture to a pre-existing service and product architecture.

Mobile payment systems operate in such networks with shared common infrastructures and compete for producing and providing value to the customers on the basis of these infrastructures. Three attributes of industry and network structure are immediately of interest. First, the modules that have been developed have influenced the taking advantage of global economies of scale in applications, devices, technologies, platforms, and infrastructure development. Therefore, cutting the vertical supply chain more finely may encourage large players to extend their domination. Second, the basic platform continues to be governed by MNOs—including service module boundaries and the linkages bridging service modules. Many of the independently supplied firms joined the co-production activity through decisions and actions taken by the MNOs. Third, 'openness' might be decreasing or increasing even as the number of independent parties in the supply chain drops. That is perhaps because the terms and conditions (T&C) on which these companies cooperate and collaborate are forced, either implicitly through industry standards or explicitly through contract or other indicators, by the platform organisers. Thus, the modularisation strategy is multi-dimensional.

These analytical approaches are likely to be valid in those industries that are particularly technology-intensive and enjoy network effects. This is because it is they that apparently benefit most, and earliest, from modularisation. They are also more prone to volatility and are best able to exploit the dynamic potentialities of modular architectures.

Recalling back to the case of mobile payment system, it seems to make more sense to think of the modular relevance and value of these services to

[134] M-PESA is not the biggest success story, it is one of the most well marketed and documented. There are stories like M-PESA in Bangladesh, Philippines, Pakistan, etc.

the main economic agents involved and then decide if there is any chance of introducing the new technology or if the technological definition of topology should be essentially based on the current technologies predominant in this market. In addition, the opportunities for economic agents involved should be evaluated, since, even though they recognise the value of a possible technological acquisition or adoption of a mobile payment system, they must take account of financial constraints and spillovers (for example, the financial acquisition of new mobile devices to make it feasible to have access to more sophisticated financial services and payments).

Mobile payment systems will result in divergent trajectories. We may assume that their adoption is a product of the previous and current configuration of the market or the industry, particularly the attribute of the structure (e.g. the type of economic actors, market competition, the relationships of power) as well as the corporate strategy. We also need to embrace the diverse characteristics of people, including their values, beliefs, and cultures; and that those factors will determine the rate of organisational and technological learning at the local as well as national level. Thus, comparing the experience with successful cases such as Kenya's M-PESA is not a sound way to assess mobile payments. Even if all the mobile payment providers adopt service modularity, the technological and organisational strategies do differ.

Mobile payment is revolutionising finance and commerce, especially in the emerging countries. However, its initial launch and deployment on smart phones is considered to be a disaster. Inadequate security protocols and technologies, combined with liability models that exclusively occupy the users to be responsible entirely for any losses, put the mobile money pilot experiment in jeopardy. Some argue that best practices might help, but secure application development still has a long way to flourish.

Historically, central banks and payment systems have developed in tandem in order to achieve monetary and financial stability. Our analysis can help understand how mobile payment systems can now contribute to the overall development, including promoting financial inclusion.

8.3 Theoretical, methodological, and practical contribution

This thesis contributes to the emerging literature on modularity in services. The main theoretical contribution of this study is to the technology and management of innovation literature. We test and validate the theory of modularity in services using the case of mobile payment services.

Modularity can be used to describe and explain the structure and relationship in the services sector. It also uncovers the dialectical process between innovator and regulator. On one hand, innovators aim to dominate the market and launch innovation more quickly in order to achieve critical mass. On the other hand, we can confirm that regulation stabilises systems in a way that promotes innovation. An additional element of this contribution to the services literature is that the modularity seems to work well in knowledge-intensive industries that enjoy network effects.

Second, we propose a redefinition of modularity in services. The current literature does not include the peculiar characteristics of services: (1) the customer is engaged during the service production stages and, along with the service provider, becomes a co-producer of the service, (2) the final service delivery is an inseparable mixture of service process and service product elements, and (3) both human factors and technical factors will shape and incorporate the modular service package. We modestly hope that this study shows the potential for new research to further advance these debate around modular architectures and service production.

With reference to methodological contribution, our cases not only show the power of the case study method in explaining complex social phenomena, but also the potential of the case study method for theory construction—as long as it follows validity and reliability criteria. We also found that a good research should be driven by the problem in the real world, rather than methodology-driven. Thus, a combination between different kind of methods and data will do the task best.

Even though the main objective of case study design is not to generalise theory, generalisability can be increased by strategically choosen cases. We found that extreme cases (i.e. M-PESA in Kenya as a widely successful case and Oi Paggo in Brazil as a case which did met its initial expectation) might lead to more information being revealed rather than a typical or average one

(TCASH in Indonesia).

With regard to the contribution to practice, this thesis provides insights into how to create and organise services in such a modular way. Modularity is associated with flexibility and agility, which is particularly relevant in the current business world. This thesis describes how MNOs established service provision to maximise compatibility in fulfilling customers' needs and, at the same time, complying with regulators. Since most studies on mobile payment focus on the market trends and consumer adoptions, our research, utilising modularity theory, contributes to shedding a light on not only the front-end (consumer side) of modularity theory but also back-end (producer side) of mobile payments.

Finally, in the context of developing economies, financial inclusion and poor infrastructure combined with rapid diffusion of mobile phones are making mobile payments more appealing. However, proper collaboration among key players and the right legislative and legal framework should be in place to promote mobile payment adoptions. It is hoped that this study might inform system owners or business managers with regards to effective modularisation.

8.4 Limitations and future directions

Our study on service modularity within mobile payment systems suffers from several theoretical and empirical limitations that might lay out avenues for future studies.

First of all, we characterise innovation in services within the context of modularity only. Analysing innovation in terms of not only modularity but also architecture (Henderson and Clark, 1990), will perhaps provide some interesting and complementary findings.[135] Secondly, we did not consider the possible impact of our subject area of mobile payment systems digitally allowing for more complex behaviour than that derived from modular recombinations alone. The discussion on how it may be beneficial or problematic to consider modularity under digitality aspects (e.g. Tilson et al., 2010; Yoo et al., 2010) will makes for interesting new developments.

This thesis is relied on three in-depth mobile payment case studies and so can only provide an existence proof of modular principle in mobile payment sys-

[135] We assumed that modular changes within the mobile payment systems do not alter the overall design of mobile systems, whereas architectural innovation assumes a modification in the whole system and relationships between different components of the system.

tems. We deliberately chose projects in developing countries to capture dynamics that perhaps could not be found in developed countries. We would expect our findings to apply to other mobile payment systems in emerging economies, but future comparative studies with larger samples or with more extreme cases could confirm the extent to which our findings are generalisable. Since all of our cases are MNO-based, subsequent studies on bank-based or third party-based models will add to the discussion in the literature of mobile payment systems.

We also believe that modularity in services needs further theoretical and empirical study on design, definition, as well as advancement with regard to methodology and measurement. In particular, the present investigation focuses on a technology-intensive industry that incorporates the network effect. Studies on non- or low-technology industries are still incipient, which indicates that greater attention might be given to the topic. Another key concern is how to measure the benefit and cost of, and thus, evaluate service modularity. This question makes the study of service modularity more challenging.

Some other opportunities for subsequent studies were discovered. Further research will address managerial and organisational perspectives that are particularly focused on the social aspects of service provision. We have shown the extent to which the concepts, frameworks, as well as principles developed for examining modularity in product manufacturing are also useful in service settings. This approach can now be extended with research from other disciplines where modularity approaches are becoming influential, for example, design sciences, information systems, organisation theory, strategic management, operations management, and public policy.

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Appendix

Technical element of mobile payment system

This section gives complementary information on the technological aspect of a typical mobile payment system.

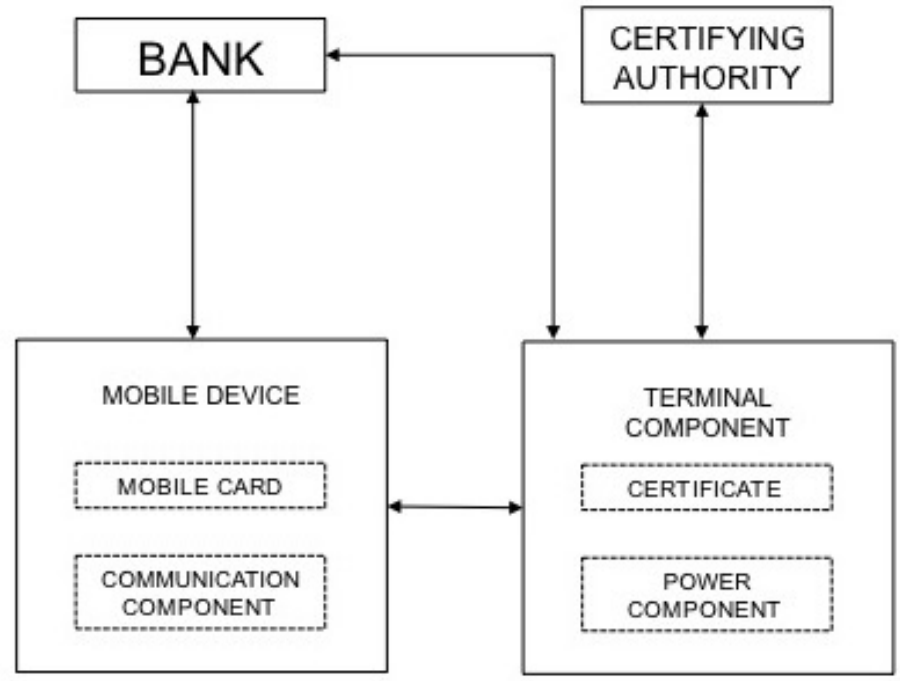
Technically speaking, a mobile payment system is a computer-based implementation system that facilitates transfer and/or movement of digital money and currency through a secure wireless transmission. The system relies on a terminal component that sends and receives a portion or a whole of data and information related to a payment and/or transaction of at least one good or service. A mobile phone (or mobile device) that is capable to do mobile payment transactions must comprise at least a mobile payment module, a secure public-key cryptography (PKC), and a wireless transmitter to send and receive payment data to the terminal component and linked account.

The mobile payment module aforementioned above establishes a link to a particular account associated with a particular form of electronic money or currency. The form of currency can be an exchange of a good or a service, a kind of micro-payment, a line of credit, a stored value card, a pre-paid or post-paid card, a disposable card, or cash.

The mobile device being used in the mobile payment system communicates with the terminal component with either wireless fidelity (Wi-Fi), near field communication (NFC), Bluetooth connection, or radio frequency identification (RFID). To serve that purpose, a mobile device usually requires a kind of secure computing base with the capability to host a virtual machine (VM) environment and perform a boot mechanism over secure transmission line.

The virtual machine environment is important in providing an operating system (OS) for the device and in interacting with at least one of a terminal component or a service provider network wirelessly. A typical virtual machine

Figure 8.1: Typical mobile payment structure



environment usually includes a secure component to monitor at least one virtual machine called virtual machine monitor (VMM). The VMM component uses an input/output (I/O) driver to bridge the gap with at least one of the hardware such as a mobile screen, a keypad, or a secure storage[136] on the mobile device.

Meanwhile, the customer account has to be linked with at least one of a financial institution, such as a bank, an insurance company, a co-operative, a credit card company, a brokerage house, an investment fund, or perhaps a particular website. There is also a certifying authority organisation that independently validates and verifies the component of a mobile device by issuing an electronic certificate with a designated expiration date. The mobile payment module is also protected by a virtual security machine through various kind of protection methodologies such as a randomised given password, a personal identification number (PIN), a public-key cryptography (PKC), a token verification system, or a combination of those aforementioned methods above.

[136]This is usually equipped with some sort of hardware-based encryption technology to protect the stored data.

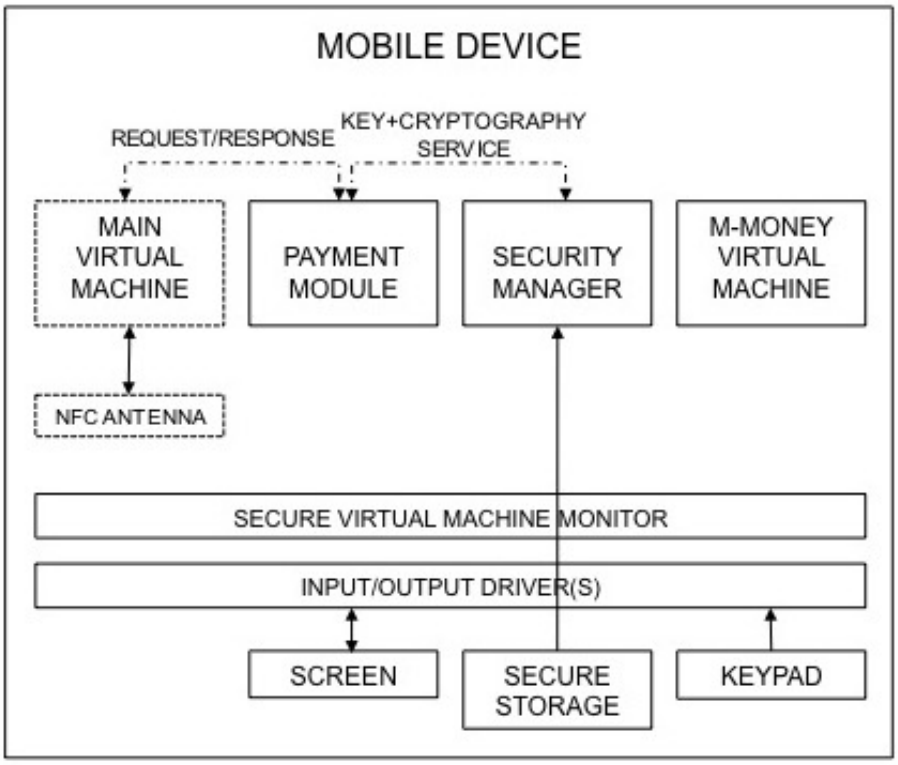
Figure 8.1 shows a simplified technical summary of the typical mobile payment system. It illustrates a system that facilities wirelessly and securely communicating valuable and personal data between a mobile phone or mobile device and a corresponding terminal. For example, a typical transaction will begin at the user's mobile device. The terminal will initiate a connection, establish a secure transmission line, and perform a transaction. The terminal then will forward the user's request to the bank. Lastly, the bank will contact, verify, and validate the mobile device before completing the transaction in a separate process. Finally, the bank will handle the payment transmission by directly communicating to the mobile device user.

Even though the mobile system already has an added security protocol embedded within the cellular network, any user cannot simply trust the link between the bank and the payment terminal, especially when a user is doing a payment transaction outside the home calling area (roaming). First, the payment transaction might be not cost-effective due to the roaming fees and, secondly, the transport protocol which connect and communicate between the bank and the mobile device may utilise different kind of cryptography. In both cases, the merchant's system cannot read or interfere the credentials of the user and validate or authorise payment transactions.

Figure 8.2 portrays a technical diagram of a generic system block inside a typical mobile device. It shows a connection between a payment terminal and a user's mobile device in a secure protocol. This system might embed a dedicated component to facilitate wireless payments digitally and securely to a payment terminal module utilising mobile payment linked to an account. The system can also utilise a secure protocol to connect with the user's mobile device in which he/she can put some commands and instructions through a secure interactive screen (touch screen) or keypad mechanism. This protocol can be designed accordingly to give the customer such a convenient features in using and operating the system, including the ability to connect and use a mobile payment card or managing one's finances.

Such input mechanism can also be a trustworthy medium to allow a user to authorise a payment transaction on his/her mobile device. In some cases, the mobile device can also comprise a kind of payment card to enable wireless payment. Such system might also embed a VMM along with an I/O driver that have been secured appropriately. The I/O driver will bridge the connection between the main module with other devices such as a keypad, a storage, as well as an (interactive) mobile screen. Some manufacturers will put these drivers

Figure 8.2: Technical aspect of mobile payment device



in a separate VM to minimise the size of VMM, even though it might increase overhead runtime. However, the main VM will assume that the system only play a conventional role as a mobile device OS and communicate with other systems, be it a payment terminal or external wireless network. The payment module itself can be installed either inside or outside a VM. However, a payment module that is implemented outside the system (isolated) might ensure the integrity and reliability of the module.

In our cases, a component can include a processor that runs a process or several processes simultaneously, an object, a function, a program, an executable, a library, a routine/subroutine procedure, and/or a combination of hardware and software. Both an application that runs on a server can also be categorised as a component as well. One or several different components can be installed inside the main system or localised separately on other distributed system. Furthermore, a mobile payment system can also be executed as an apparatus or a method utilising general programming or engineering procedures to generate subsystems as an integral part of the main system.

Figure 8.2 describes system architecture that operates in the suitable mobile payment running environment. A properly running environment should include a stable OS that might be kept on a secure storage device to manage resources and control processes of the main system. System applications benefited from resource management performed by the OS through data programme and program modules stored on disk storage or in system memory. A mobile payment system might also be combined with several OS or a combination of different OSes.

In general, any information or command entered by a user into the main system via input device(s) will be forwarded to the central processing unit utilising the embedded system bus through interface port(s). On the other hand, output device(s) will inform the result of command and information processing to the user. Output device(s) will utilise the same type of interface port(s) as input device(s). However, an adapter is probably required to ensure that output devices (e.g. speakers, monitors, graphical processing unit (GPU) cards, printers, etc.) will work flawlessly without any compatibility issues. The adapter will also link the system bus with the output device(s) as well.

The main system itself may run in a networked system via logical connections to one or more systems in a remote location. Such remote system(s) are connected to the main system via a network interface (logical connection) and then connected through communication and transmission line (physical connec-

tion). Network interface, in most cases, will encompass any communication networks, be it wire or wireless such as local-area networks (LAN) or wide-area networks (WAN).

With regard to system architecture, it is usually associated with the system modules. The boundaries between modules are the design rules. These design rules establish which dependencies are factored into a separate set of design decisions that are made before any other design decision is made. If two groups of design elements have a single interdependency—such as the format of a data file—then this data format design task can be made earlier in the design process rather than later.

Eventually the design rule (or, in our cases, a set of design rules) that separates two modules can become fixed and future development can occur in parallel. An interface is therefore a first line of defence that an architect has in preserving the technical integrity of the system. This fixed set of design rules is called an interface, and they may be standardised. Thus, future modifications can be made to modules without affecting other modules. It also becomes possible to replace modules with different implementations or even to reuse modules in different contexts where the interface is the same.

In the case of mobile payment systems, modules are interrelated and work together to establish a network connecting subscribers with the system. Below are examples of a typical SMS-based mobile payment systems that are the most basic (standard) systems and which are currently widely used by banks, financial institutions, as well as mobile network operators (MNOs). The role and function of each particular module can be explained as follows:

1. Mobile station (MS), is a client or customer's device which has the capability to receive and send short messages (SMS), and is usually a mobile phone with digital technology. Applications that can be used from the device also depend on the service provided by the operator. A typical MS comprised of mobile equipment (ME) module and subscriber identity (SIM) module. An ME contains a radio transceiver element, a display unit, and digital signal processor (DSP), while the SIM used so that the user can be recognised by the network. There is no need to use the sophisticated MS—as long as the MS can receive and send SMS, customers can join the service.

2. A base station transceiver (BTS) serves as a device to communicate with all mobile station (MS) and is active in the coverage cellular area. A BTS

implements the signal modulation and demodulation, equalisation, and coding error. Some BTS can connect with a base station controller (BSC) as well. The radius of a coverage area ranges between 10 metres to 200 metres for the smallest cell up to a few kilometres for the largest cell. A BTS can typically serve 20-40 communication calls simultaneously.

3. A base station controller (BSC) provides the control function on several BTS under the coverage. A BSC can handle a function handover, cell site configuration, radio resource settings, as well as power and frequency tuning on a BTS. A BSC is a hub (concentrator) to connect with the core network. A typical GSM network usually controls up to 70 BTS.

4. A mobile switching centre (MSC) is a system that performs functions switching and control telephone calls in a mobile telecommunications network. A MSC also performs the function billing (connected to the billing system) and acts as a gateway to other networks. MSC is the module that will send a short message to a destined user through the nearest available base station.

5. A visitor localisation register (VLR) is a kind of database that stores static information of the customer or client data of a home location register (HLR) that are being roamed on other HLR. This information is required by the MSC to be able to serve the roaming customers. VLR also contains dynamic user information that is being "attached" at the mobile network, including geographic location. VLR usually is physically integrated with the MSC.

6. A short message service centre (SMSC) plays a key role in the SMS architecture. A SMSC's main function is to convey short messages between short message entities (SME) with MS, as well as to save and forward the short messages (save the message if the SME recipient is not currently available). A SMSC also serves to inform the sender regarding the status of SMS messages that have been sent, whether it has been received or not by the mobile destination. If the destination phone is in an active state and can receive the SMS, the phone will send back a confirmation message to SMSC stating that the message has been received. SMSC then sends back the status to the sender. If the destination phone is off or inactive, the message sent will be stored on the SMSC until the validity period is met.

7. A home location register (HLR) is a part of the network that contains detailed information of each subscriber. An HLR is usually able to organise hundreds or even thousands of subscribers. In a typical GSM network, the signalling is based on protocol Signalling System Number 7 (SS7), equipped with the use of mobile application protocols (MAP). A MAP is used for location and subscriber information exchange between HLR and other network elements such as MSC. HLR may also be referred to as database which is used to store permanent data and customer profiles. If requested by the SMSC, the HLR can provide routing information from certain customers as well. HLR also can provide information about the status of the destination: whether active or not, if it is detected that the customer is active and authorised, then the HLR can be initiated to provide this information to the SMSC.

8. The server is mainly a database that stores customers and companies' data and is linked to the internet. In the network of mobile payment system, the computer server communicates with ESME through the Internet as well as with other companies' servers that have partnered with the mobile payment system.

9. A core payment system is a network in which the mobile payment system plays the role as external short message entities (ESME)—a device besides MS that can function to receive or send SMS. ESME is generally used for creating more service variety to customers or to improve performance of the telecommunications network operators. Through ESME, customer data and balances are kept, as well as requests from customers to check balances, change their PIN, purchase goods or services, pay bills, put cash-in, take cash-out, and transfer cash.

There are multiple ways of implementing the mobile payment system, for example a tool kit, control, driver code, standalone or downloadable object, application programme interface (API), software, that allows other services and applications to utilise the payment modules of the system. The most common approach are perhaps from the point of view of a software object or an API.

With respect to interaction between several components, a mobile payment system may comprise those specified components or sub-components, a number of specified components or specified sub-components, and/or supplementary components with several combinations and permutations of the foregoing.

These specified sub-components might also be installed as integrated components, tightly coupled to different components via communication line rather than isolated inside the parent system (hierarchical).

In addition, a single component or several components can also be merged into a single component producing aggregate function or can be separated into a number of sub-components. Further, any single or several middle layers (for example, a management layer) might be facilitated to interactively coupled to other sub-components to generate and deliver integrated functionality. Several features can be assembled with one or more other desired features that came up during the implementation phase and considered to be superior than any other peculiar applications.

It is, indeed, very likely to report every plausible configuration of components or methodologies since every component mentioned above may result in further combinations and permutations, due to complexity, variations, and perhaps, alterations and modifications.

In spite of being determinant factors, the mobile technologies are important in the configuration of the mobile payment system because they can either inhibit or allow different topologies and resource services (Au and Kauffman, 2008).[137] Alternatively, simply broadening the coverage and capillary of the mobile networks in a geographical region would allow financial services and the mobile payment system to be offered to communities who have not yet been catered for and allow the presence of agents and banking correspondents in that region.

The main mobile technologies employed in the mobile payment system topologies include the following:

1. Short Messaging Service (SMS). This employs the short message service of the MNO, because it is relatively cheap to adopt. One of the main restrictions to its dissemination as the dominant platform for mobile payment systems is security concerns and other potential vulnerabilities. This is mainly because data traffic cannot usually be directly encrypted and information is often stored in mobile devices without proper security. Many procedures use SMS for confirming payments.[138] Users can send a text with a series of commands or parameters, e.g., merchant's code, PIN num-

[137] For example, the spread of Near Field Communication (NFC) technology in mobile devices would allow innovative offline non-intermediated mobile services to be offered to the mobile devices.

[138] 3GPP TS 23.040 Version 7.0.1.

ber, and amount to be charged.

2. Unstructured Supplementary Service Data (USSD). This concerns a service for sending messages especially in GSM networks, which is used in a similar way to SMS. However, it usually has faster traffic and can provide relatively higher security than SMS since it does not allow messages received in the mobile devices to be sent or stored. This technology is employed as a transaction method in several financial mobile services such as Wizzit and SWAP Mobile in South Africa, M-PESA in Tanzania, Mobipay in Spain, as well as mPay in Poland. With USSD[139] users do not have to type or input any command, since the instructions and informations are submitted like an MSISDN.[140] It would sometimes can accommodate simple menus to be displayed to the user.

3. SIM Card with SIM Toolkit (STK). This concerns the printed circuit or chip and is used in mobile devices with GSM technology.[141] Apart from identifying and authenticating the client, it allows the mobile programme to be operated while also enabling users to navigate in micro-browsers. As well as this, in the SIM chips, it is possible to store encryption keys properly and thus provide greater security in data communications and electronic transactions, even in the case of communications technology that does not possess built-in security (like SMS and USSD). An example is M-PESA in Kenya and M-banxafe in Belgium.

4. Interactive Voice Response (IVR). These services operate through voice recognition and sometimes even biometric voice authentication, in an interactive way by means of a technological system programmed with the menu of services rendered. It enables a phone caller to choose commands and instructions through a voice menu and respond through keyboard entry or voice. Since it is relatively a cutting-edge technology, its costs still remain high. Considering pricing models usually employed, the total cost of the transaction can be very high because it will be charged according to the time of the voice transmission and not data traffic volume. Benefits derived from this technology can eventually offset the amount invested: the use of mobile channels with financial relationships both for

[139] GSM 04.90 Version 5.0.1.
[140] For example, *123*4*5678#.
[141] SIM Toolkit (GSM 11.14) ensures interoperability between a SIM and a mobile devices. It is a series of procedures and commands to utilise throughout the GSM operational stage.

high-end devices (of high cost and performance) and low-end devices (of low cost and performance) would allow a single strategy combined with different services for different publics. First-generation mobile payment system such as Paybox utilise IVR technology.

5. Wireless Access Protocol (WAP). This is a notion identical to internet banking; it uses mobile data networks with better multimedia resources than the SMS and USSD technologies by allowing better usability and ease of adoption for users who already have other digital financial services. Users can select his/her desired option from the menu, press the particular button, then enjoy the payment service. WAP-based topology (WAP 1 or WAP 2.0 version) would make it possible to build reasonably secure environments, since services would be centred on internal mobile issuer servers, as occurs in common internet banking services.

6. Mobile apps and web-apps. As well as providing the basic services already mentioned, this technology allows the supply of more complex services for banking and finance, such as insurance and home brokerage. They are readily customised in accordance with the user interface and provide a very secure and reliable channel. In many cases, it is necessary for an application, which must be available in several platforms, to be recorded in the mobile device, which can be inconvenient for many users and companies, although in many cases the potential benefits can justify its adoption.

7. IP mobile networks. These are data networks that allow broadband services in alternative networks (Wi-Fi, WiMAX, and others) for the data networks of the MNOs. Although they are not strictly technologies designed to offer mobile payment system, they can be employed for this end and have features similar to the services provided by WAP technologies or even internet banking services.

8. Personal area network (PAN). These technologies are connections made possible for short range communications functions such as Bluetooth and near field communication (NFC). They can be recommended for transaction services and direct payments (non-intermediated) between clients' mobile devices and POS or ATM equipment, or vending machines and transportation tickets.

9. Calling line identification presentation (CLIP). This is a GSM supplementary service that sends out the caller's number to the called party's

(counterpart) phone throughout the ringing mode. This is also called MSISDN (or mobile subscriber integrated services digital network number) which can be set up when there is an incoming call but before the call is accepted.[142] CLIP is usually utilised in collaboration with IVR technology to authenticate user. Yet, there are also CLIP that are working stand-alone such as Cashbeam in which both payees and payers ought to dial a predefined number in which the last several numbers show the price of a particular good or service.

10. Java 2.0 micro edition (J2ME). It supplies a series of runtime environments as well as application programming interfaces (APIs) that enable the use of the Java programming language and other corresponding peripherals to build application programmes for cell phones (MIDlets). A graphical user interface (GUI) is usually provided by J2ME as well as the capability to establish secure connections to the mobile payment server. An example of J2ME mobile payment is Obopay in the United States.

11. Near field communication (NFC). A near field communication is a system relied on radio frequency identification (RFID). A NFC is implemented to communicate with other electronic devices in a short distance[143] that are not physically connected.[144]

Technology availability, especially in the hands of individuals, would be a significant variable in the topological constitution of the mobile payment system. In emerging world where most mobile phones are pre-paid, mobile devices are predominantly low-end and, in some cases, very expensive. In such cases, it can be argued that offering services with high-end technologies using data networks is more costly and so would be confined to a small proportion of the population who would be able to have preferential access to other efficient electronic payment means.

Thus, it is more plausible to think that technology and services that are most strongly recommended in the mass topology for mobile payment systems would be those that already exist in low-end mobile devices (for example via SMS or USSD with specific SIM cards, as is the case of Oi Paggo in Brazil).

[142] ETS 300 648.

[143] It typically less than 4 cm.

[144] For example, a credit card company JCB deployed a pilot programme utilising NFC technology along with other seven mobile payment companies in 2006. This collaborative system enable Nokia phone users in Amsterdam to do payment transaction at any stationary merchants.

This way, even though it cannot be established as decisive, the technology would be an important limiting or driving factor in the different alternative topologies for mobile payment systems and, as a consequence, a part of the technological strategy of the mobile money operator.[145]

[145] In accordance to the EU directive 2000/46/EG Art 1, a mobile money operator providing electronic money services in Europe should obtain either a full banking license or at least an e-money license. In the case of Contopronto AS, the company holds an electronic-money licence due to their prepaid product-based account.

Coding scheme and description

Following are the final coding scheme being utilised in this study (Table 8.1).

Table 8.1: Selected coding scheme

Root node	Sub node 1	Sub node 2	Sub node 3
Services modularity	Characteristics	Changeability	Interfaces
			Standardisation
		Comparability	Attributes
			Quality
		Parallel development	Design rule
			Modular operator
	Strategic advantages	Run time	Better performance
			Improved reliability
			Resource consumption
			Stability
			Maintenance
		Design time	Optimised re-use
			Division of work
			Cost reduction
			Flexibility
Mobile payment	Considerations	Profitability	Two-sided platform
			Service quality
			BoP customer
		Interoperability	Standard
			Interface
		Security	Convenience
			Risk
	Factors influencing	Regulation	Telecom sector
			Banking sector
			Other related legislation
		Technological advancement	Modular platform
			Prevention of reverse engineering

Table 8.2: List of interviews

Date	Code	Title	Affiliation
27/07/2013	TPM	Product Manager	Telkomsel
28/07/2013	THT	Head of Technology	Telkomsel
28/07/2013	TSA	System Architect	Telkomsel
22/02/2014	TPM	Product Manager	Telkomsel
23/02/2014	THT	Head of Technology	Telkomsel
24/02/2014	TSAN	System Analyst	Telkomsel
09/08/2014	TTS	Technical Staff	Telkomsel
10/08/2014	TTS	Technical Staff	Telkomsel
05/05/2014	OMPSD	Marketing, Product, Sales Director	Oi
05/05/2014	OHSD	Head of Strategy and Business Development	Oi
08/07/2014	OBDM	B2B Data Mining	Oi/Telemar
08/07/2014	OUE	User Experience Designer	Oi/Telemar
14/05/2015	OBD	Business Developer	Oi S.A.
15/05/2015	OBD	Business Developer	Oi S.A.
09/07/2014	SCO	Communications Officer	Safaricom
13/07/2014	SSE	Sales Engineer	Safaricom
17/10/2014	VSDM	Service Delivery Manager	Vodafone
10/11/2015	GSM	Service Manager	GSMA
03/09/2015	OTE	Technical Expert	Others

List of interviews

Following are list of interviews for this study (Table 8.2). Some of the informants were interviewed more than once to follow up further and explore possible emerging issues. The interview code is used to refer to the interviewee in the material excerpts.

Interview questionnaire—researcher version

Introduction:

1. Introduction and explanation of the objectives of the study
2. Basic details relating to the company—possibly available on websites or reports
    (a) Vision, mission, and positioning in the market
    (b) Total revenue/profitability/market share
    (c) History, current issue, and recent developments (M&A, spin-off, etc.)
3. Interviewee details

General product/service questions:

1. How did this new mobile payment service idea come out?
    (a) How much time did it take to develop this new service idea into a real service?
    (b) Did you work with customers when developing this new service?
    (c) If yes, what kind of customers? Did you use any particular tools and techniques?
2. How does your company discover customer expectations and generate new product and service opportunities? (Market survey, interviews, FGD, observing customers' behaviour, mimicking other competitors, reverse engineering successful products, instincts?)
    (a) How is your organisation getting feedback on the market acceptance of your products?
    (b) How do you compare your products/services with your nearest competitors?
3. To successfully deliver this new service to the customers, which aspects of the service process did you consider when designing this new service? (Understanding customers' needs, driven by "technology-push," integrate solutions/combine services, adapt other competitors?)

4. What are the challenges you presently face when aligning your products and services with customer needs?

    (a) What are the most critical issues that your organisation is facing? (Competition, rising cost, R&D, regulation, industry standard, IP protection, design criteria, etc.)

    (b) What are the areas of competition that your company is facing? (Features, pricing, service, ease of use, reliability, conformance, etc.)

Service development questions:

1. How did you develop this new mobile payment service?

    (a) If your company or business unit is producing and delivering more service variety or more product variety and customisation today, then how is this activity performed?

    (b) If your company is producing and delivering more service variety or more product variety and customisation today, then how your company's or team unit's organisation is structured to accommodate and facilitate such activity? Is there any changes in partnerships, supplier relationships, outsourcing activities, etc.?

    (c) How did you think about the human resources involved in the service design project?

    (d) How did you consider knowledge management in the service design project?

2. Is there any formal service development process and/or clear and well-communicated strategy?

    (a) Is it undertaken by a particular development team or group?

    (b) Are the teams or group within your company or business unit can be easily re-assigned or re-organised in order to respond internal and/or external changes during the development process?

    (c) Who is responsible from the conception to implementation?

    (d) What is top management's role in service development?

    (e) How do you coordinate between management and other personnel? Between different functional groups?

(f) How do you provide such conducive environment to service development?

(g) How do you ensure that it has enough resources dedicated to it?

(h) Is there any reward mechanism for personnel who get involved in the development?

3. How did you collaborate with other MNOs, banks, technology partners?

(a) Is it necessary to have such a cross-functional team?

(b) How do service development efforts differ when partner firms' goals different?

(c) How do you encourage collaboration and participation? Is there any reward mechanism?

(d) How do you identify partners that have a high probability of success in development and collaboration?

(e) How can strategic cross-functional/cross-company service development efforts be sustained in the long run?

4. How do you utilise technology and innovation activities in delivering your customised products?

(a) Are you using some sort of standard? Are the systems available to every person in the company?

(b) Do you use any specialised or customised systems that are rarely available and can only be used by very few companies?

(c) Do you have a kind of standard interfaces that allows interaction and integration between different kind of systems?

(d) How do you work on the sub process standard that become a basis for other service production activities?

(e) Can those sub processes work independently and separated completely from one another? Why or why not?

(f) Can those sub processes being customised in order to incorporate customer needs or environment changes during the service development process? Why or why not?

5. Are there any tools and techniques were used to facilitate the service process design? Do you apply any tools and techniques in service design process?

   (a) What are these tools and techniques?

   (b) Why do you need to apply these tools and techniques?

   (c) Did you use any tools or techniques to speed up the introduction of new service?

   (d) If yes, what are these tools and techniques?

6. How did you measure the effectiveness and efficiency of the service design?

   (a) Did you perform a formal procedure to audit your service development?

   (b) Based on some standard measurements?

   (c) Did you have any ideas to improve the effectiveness and efficiency of the mechanism to develop new service concept into real service?

   (d) What activities are necessary for successful service development execution?

End note:

1. Are there important things about your company's experience in service development being neglected here? Would you suggest a particularly good and/or unique practice of service development?

2. The interviewer will write up this interview and send it back to you for corrections. Please feel free to add more information.

3. Would you like to see the report that will be produced as a result of this study?

Thank you very much for your participation.