FLEXIBLE PLATFORM AS A SERVICE ADOPTION IN BUSINESS

A CAPABILITY FRAMEWORK FOR SUPPORTING INTEROPERABLE AND PORTABLE CLOUD SOLUTIONS

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EXTENDED ABSTRACT

Situation. Cloud service adoption is growing in organizations, with roughly 93% of businesses either planning to adopt cloud services, or expand their existing cloud service portfolios. There are a myriad of cloud providers offering a broad range of service models (Infrastructure, Platform, Software, Business Process as a Service), which can be deployed in various ways (private, public, hybrid, community). The Platform as a Service model is the least adopted, but has the highest growth rate of all cloud service models. This means that businesses are quickly adopting PaaS, integrating this type of cloud solution within existing IT landscape and business processes.

Complication. The rapid expansion of cloud technology and service providers outraces the establishment of interoperability and portability standards to facilitate integration between inter-cloud services, and cloud / non-cloud applications. Moreover, the experience of cloud adopters is limited; business and technical stakeholders report lack of skills and expertise as the number one challenge with cloud service adoption and integration. Thus, companies adopt cloud with insufficient capabilities to understand and solve challenges, such as ensuring interoperable cloud-based systems, portable data and applications, and minimum vendor lock-in. This is especially problematic with the Platform as a Service model (PaaS), the least understood cloud service model, and arguably the most complex to adopt by organizations.

Research Gap. Research and practitioner literature is thin on discussing how to manage the issues of vendor lock-in, interoperability and portability of systems, in PaaS adoption, so that the flexibility of the company is ensured to address the volatile market and technological cloud environments. While research exists on the capabilities needed to successfully adopt and manage IT and cloud solutions, they are not focused enough to target new developments in the field of PaaS. This means that current research cannot be easily applied in practice, many steps being needed to specify it for PaaS adoption cases. In addition, research on the context factors that influence the relevance of various capabilities for various cases of cloud adoption is underrepresented, with most sources being either non-scientific (whitepapers, blog posts) or deeply technical.

Objective. This thesis aims to increase understanding of the different types of capabilities that support large firms' *flexibility*[1] in PaaS adoption, depending on the organization's cloud readiness[2] level. I explain how capabilities enable interoperability, portability and minimized

[1] Throughout the thesis I use the term "flexibility" in cloud as the degree of preparedness of organizations to maintain interoperable and portable cloud and non-cloud systems and applications within their IT portfolios, and avoid vendor lock-in at cloud service adoption, in order to address changes in the cloud landscape. For the case of PaaS adoption, I use the term "PaaS flexibility" or "flexible PaaS adoption".

[2] I refer to a company's degree of cloud experience, skills and existing resources to support cloud adoption as "cloud readiness".

vendor lock-in, as core attributes for achieving flexibility with respect to PaaS. I specify how a company's cloud readiness is a context factor that can influence the priority of acquiring different sets of capabilities, under four domains of cloud management (business, technical, supply, governance). The thesis intends to deliver a capability framework aimed at cloud stakeholders in large companies, to help them identify what skills, knowledge and structures are needed to support flexible PaaS adoption, contingent to the company's cloud readiness level.

Approach. First, I review practitioner and scientific articles to explain interoperability, portability and minimized vendor lock-in as key properties for ensuring a company's flexible PaaS adoption -- which I explain as the ability to integrate existing infrastructure, applications and business processes with novel cloud solutions and PaaS platforms. Flexibility is motivated as a desirable characteristic of the organization for reacting to changes in the volatile cloud environment. I introduce and motivate the relevance of capabilities in IT and cloud management, as specialized skills and knowledge that a company should gain for supporting flexible PaaS adoption. Capabilities are categorized into four cloud management domains (Business, Governance, Technical, and Supply) distinguished from literature. The domains are relevant for indicating in which direction the company should invest to acquire capabilities, based on their existing skills and resources. Thus, the theoretical foundation states the relationships between flexibility as the goal, capabilities as the solutions, cloud readiness as a context factor, and the framework as the structure that holds these relationships so that they can be interpreted as a whole, and applied in a practical context of PaaS adoption. The theory is supported by empirical data, collected through a number of six semi-structured interviews with relevant IT and cloud practitioners from three large Dutch companies, and analyzed in order to draw the specifications for building the *capability framework for flexible PaaS adoption*[3]. Finally, an evaluation of the whole research process and final deliverable is made ex-ante, by verifying both practical applicability and research quality criteria, and specifying limitations.

Results. The analysis of empirical data, from the six interviews, indicated that flexibility in PaaS adoption is a relevant goal for some businesses, but that it is still difficult to achieve for companies that do not have experience with cloud and PaaS utilization. There is positive qualitative evidence indicating that specific capabilities can increase flexibility of PaaS adoption in business, and that a company's cloud readiness influences the priority of different capability domains when adopting PaaS. I found that firms inexperienced in cloud should focus on business domain capabilities as a priority, for building a strategy and business case for PaaS, and also because they do not have enough fundaments over which to develop technical or governance capabilities. Intermediate cloud experience companies having constructed a business case and somewhat aligned cloud initiatives with strategy should invest in technical capabilities, for preparing IT architecture and application landscape for cloud transformation. Finally, experienced cloud and PaaS companies should focus on all four domains, because at this level they are equally important and dependent

[3] The framework is a decision support tool in form of a table categorizing the capabilities needed for PaaS adoption by a company's cloud readiness, by the cloud management domain the capabilities belong to, and by the priority of each domain with respect to cloud readiness.

on each other for flexible cloud operation. The cloud supply management capabilities become prominent at this stage for managing a partner network rather than supply chain, to create value and smoothen operation of PaaS technologies. Analysis of empirical data from interviews were used as specifications for building the practical deliverable - the capability framework that operationalizes capabilities and categorizes them based on relationships found. Finally, evaluation of the research process and framework emphasizes that research was conducted following scientific research guidelines and that research quality criteria such as empirical validity, reliability, and verifiability of data were considered. From a practical perspective, the applicability of the framework is tested ex-ante, evaluating the purposiveness of goals, and the reliability and generalizability of framework contents. Future research is proposed to extend the breadth and depth of findings, in a longitudinal studies of the framework applied in a practical contexts, but warnings are formulated on the fast-paced changes in the cloud environment, which might render studies invalid if made in too much depth.

Recommendations. IT architects or IT managers in companies can use the results of this thesis as a starting point, to identify the capabilities needed to achieve flexible PaaS adoption. Within a comprehensive roadmap for cloud transformation, the framework can be used after a systematic analysis of the current state of cloud and PaaS readiness and goals in their company, to judge what capabilities are achievable and desirable for attaining goals. For continuing scientific research, the thesis results can be extended to incorporate other context factors that influence what capabilities are applicable and how. Alternatively, the findings may be scoped vertically, to understand how capabilities can be specified for specific adoption cases. A mention about the deliverable of this research is that it does not provide the tools and knowledge for assessing the maturity (or readiness) of a company's cloud state, nor does it make explicit how capabilities should be acquired to increase maturity.

Thus, a company should have a strong understanding of their cloud needs and strategy before using this model. First, companies should thoroughly assess their current maturity levels in IT and cloud management and related capabilities. This should be done in a systematic way, by following IT maturity assessment practices (CMMI, Cloud Maturity Models, etc.) internally, or by hiring external parties to help with a more objective assessment. Second, companies should focus on gaining capabilities incrementally in order to reach a target cloud flexibility level. Interview respondents admitted that a leap towards cloud is too risky and may lead to failure if the architecture, business processes and culture are not prepared for change. Third, companies should ensure that they choose capabilities that fit their specific needs and context factors. These dependencies are cloud strategic intent, PaaS use case and complexity, existing resources and capabilities in cloud and IT, and the relevance of flexibility in PaaS adoption. Further case studies and quantitative studies should be done to underline which capabilities fit to which needs, and what other context factors influence the relevance of capabilities.

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CHAPTER 1 INTRODUCTION

1.1 Introduction

This chapter introduces the research context, research problem and questions, proposed solution, and the approach to reach it. Subchapter 1.2 defines cloud computing from a technological and business perspective, explains the motivations and benefits to adopt cloud, and provides an overview of PaaS, the cloud service model in the spotlight of this thesis. With the cloud and PaaS contexts introduced, the problem, motivations to solve it, and objective can be understood in Subchapter 1.3, which describes the scientific and practical problem, delimiting the research scope and formulating the research objective and questions. Finally, an overview of the research approach and methods is provided, followed by a conclusion detailing the main ideas of this chapter in Subchapter 1.4.

1.2 Research context

This subchapter explains the basics of cloud computing from both technological and business perspectives, focusing on PaaS adoption and its use cases. I describe the motivations and use cases for PaaS services as a foundation to understand integration problems and the importance to surpass them when adopting PaaS, so that a company can be flexible in response to volatile technological and market environments. Moreover, the wider cloud context shows that while these motivations and issues characterize cloud as a whole, they are most prominent in the case of PaaS, warranting the urgency to study this service model and not the others.

Cloud computing is a model for accessing shared pools of configurable computing resources that can be rapidly provisioned and released with minimal management effort and service provider interaction (Mell, 2011). Cloud has been an important topic from both technological and business points of view in the past decade. The tendency of businesses towards higher client-orientation and servitization is enabled in many cases by cloud computing, which disrupts the way in which companies operate internally and in relation to clients and value networks (Vendrell-Herrero, 2014). Some core advantages of cloud services are increased business agility, reduced costs, scalability of services and IT infrastructure, new customer value creation, and reduced IT barriers to innovation (Marston, 2011). Market reports show that roughly 87-93% of organizations, from various industries, and with different IT maturities or goals utilize or plan to utilize cloud services (Cloud Growth, 2016; RightScale, 2015). Thus, the theorized ubiquity of cloud computing across different industries and markets to produce business value (Marston, 2011) continues to be proven in practice. However, many companies struggle with cloud adoption, and just like it is the case with IT in a company (Carr, 2003), the value of cloud technologies heavily depends on successful integration with business and strategic aspects (Blumenstein, 2013).

Cloud services are generally split into three broad service models: Infrastructure as a Service (IaaS), PaaS (PaaS) and Software as a Service (SaaS) which deliver different type of computing resources as a service (Mell, 2011). This paper focuses on PaaS, but also applies

learnings and elements of the other models which are strongly linked together: PaaS is most of the time used to develop, deploy and run software working as SaaS, using resources such as storage, memory, processing power and bandwidth from IaaS sources (Mell, 2011).

This thesis contributes to cloud service adoption and transformation by proposing capabilities that reduce cloud service lock-in, and help maintain interoperable systems and portable applications. Capabilities are human-resource based skills and knowledge, which give the capacity of a team, internal or external to the organization, to execute tasks and activities that influence business performance and goals (Feeny and Willcocks, 2006). Another definition postulates capabilities of an organization as possessing particular collections of specialized equipment and the required abilities of organizational members to operate the equipment (Nelson and Winter, 2009). Applying Nelson and Winter's line of reasoning in the context of this thesis, capabilities ensure the "list of ingredients" (or resources needed) and the "recipes to use them" (skills needed) to obtain a desired result: flexible PaaS services. The practical business context of cloud computing warrants the need for capabilities; the absence of skills and experience is reported as the number one challenge with cloud service adoption (RightScale, 2016). Within the thesis scope, capabilities focus on increasing the flexibility[4] of an organization.

Flexibility is the ability of companies to react to change by adapting their IT services, resources, and structures (Gong and Janssen, 2012). From an evolutionary perspective, an organization needs to be flexible in order to survive in the context of a changing environment (Nelson and Winter, 2009), which is exactly the case with cloud and PaaS. Thus, through acquisition of capabilities that ensure interoperability, portability and minimized vendor lock-in of novel PaaS solutions, a company increases its flexibility for adapting these solutions to changing environmental conditions. The capabilities and research are directed towards large organizations (public or private) with complex internal IT systems and IT-dependent business processes, and high demand for developing or maintaining software applications. The following subsections introduce how cloud services meet business demand, what is PaaS from a technological and business point of view, and how is PaaS adopted and utilized in practice.

1.2.1 Cloud services in business

This section is meant to explain the basics of cloud service models in practice and the most researched areas in science with respect to business adoption of cloud computing.

I introduce the three models that are the most prominent in the cloud service technology and business landscape: Software as a Service or SaaS, Platform as a Service or PaaS, and Infrastructure as a Service or IaaS, as defined by NIST (Mell, 2011). First, SaaS allows consumers to utilize service provider applications on a cloud infrastructure without any client responsibility or control of infrastructure, development or maintenance. Clients access applications through an interface and may or may not configure the SaaS environment to

[4] Throughout the paper, I use the term flexibility as an umbrella term for the properties of interoperability, portability and minimized vendor lock-in of a PaaS solution and its supporting infrastructure, processes and dependencies.

their needs. (For example, Google Docs is a free SaaS word processor application, while Salesforce provides a broad range of SaaS applications for managing functions such as Customer relationship management, Supply Chain Management, Sales, etc.) Second, PaaS enables clients to develop, deploy[5] and operate software based on provider-side platforms (web servers, database management, operating systems, programming languages, libraries, services and tools for development & operation, etc.) and provider-side cloud infrastructure (network, servers, storage, etc). The user is in control of their applications and various levels of control over what infrastructure components they can choose and configure from the provider (for example, Microsoft Azure provides both PaaS and IaaS services, supporting programming languages and frameworks that are Microsoft-specific and third-party system software and systems). Third, IaaS services offer processing, storage, networks and other computing resources to clients that need to store data, host networks or run software. Providers have control over the infrastructure alone and not over any higher-level layers, who are configured and operated by the client. A depiction of the three models and their connection is represented in Figure 1-1:

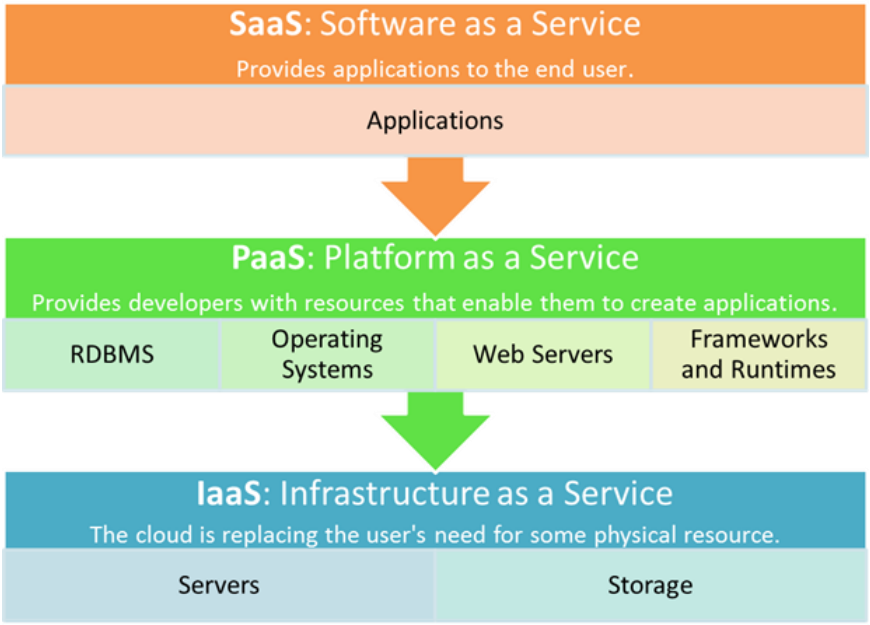

FIGURE 1-1. CLOUD MODEL STACK (ELLIOT, 2011)

In the past several years, researchers treated the less studied business perspective of cloud computing trying to understand cloud adoption issues (El-Gazzar, 2014) and determinants (Low, 2011; Asatiani, 2015), cloud business model innovation (Berman, 2012), cloud strategy (Blumenstein, 2012), cloud governance (Joha and Janssen, 2012) and many other topics. By now, it is widely accepted, although not a rule and difficult to predict in what contexts, that cloud services can bring value to organizations (Marston, 2011). Sean Marston concisely points out some of the business advantages of cloud computing in his article (Marston, 2011). To name a few - lower cost of entry for smaller firms that do not need to invest heavily in IT infrastructure and resources, easily scalable services depending on

[5] I use software deployment as the set of activities making a software system or application ready for use.

demand/load, almost immediate access to hardware and software resources for quick time-to-market and low up-front investments, etc. With PaaS, companies can keep control of the applications they own or want to develop and run in the cloud, without the need to purchase infrastructure and tools, and maintain them. The PaaS service usually includes support for all software development lifecycle activities such as testing, deployment, operation and updating/patching. Users may want to deploy an application onto the cloud as a SaaS solution or integrate it with traditional software applications (Beimborn, 2011). Figure 1-2 shows the division of responsibility and control over resources of PaaS between client and service provider. Making abstraction of why a company decides to adopt cloud, I treat the problem of how they can do it while keeping vendor lock-in, interoperability and portability of the PaaS cloud service and related systems under control.

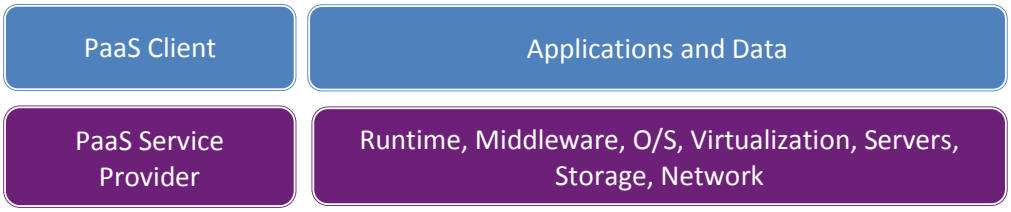

FIGURE 1-2. CLIENT VS. PROVIDER RESPONSIBILITY IN THE PAAS MODEL

1.2.2 The cloud market

This section is meant to place the reader into context with the immense popularity of cloud service adoption, and to describe why it is often difficult for client companies to choose a cloud service provider. Reviewing the latest market research reports with respect to cloud service adoption utilization in enterprises, adoption by service model, and dominating cloud vendors gathered these findings.

Cloud computing is today almost ubiquitous across all industries and firm sizes - 89 to 93 percent of respondents from nearly 1000 companies interviewed globally (from two global scale research surveys) report using cloud services in some form (Peraza, 2015; Spiceworks, 2016). Cloud is the most popular at enterprise level; 97% of companies with over 1000 employees have cloud initiatives included in their strategy (RightScale, 2015). The most adopted cloud service model is Software as a Service, with 60% of total cloud expenditure going to SaaS applications, followed by IaaS and PaaS (Cloud Growth, 2016). However, PaaS is the fastest growing model, because SaaS is usually used for non-differentiating tasks (CRM, ERP, office applications, etc.) and not core-competencies of the firm. Infrastructure as a Service is also increasingly replacing costly owned infrastructure, especially if used for non-core data and application operation. Regarding deployment model of cloud - private, public, or hybrid, 82% of Enterprise respondents report using a multi-cloud strategy which involves all three deployment models (RightScale, 2015).

With respect to the choice of vendors, this is split by what type and deployment model is used. As I will not go into the numbers, I underline that the dominating public cloud vendors are Amazon's AWS followed by Rackspace and MS Azure (for IaaS), Salesforce, Azure PaaS and Google App Engine for PaaS and Salesforce, LinkedIn, Workday, Drop Box and Google for SaaS. The enterprise private cloud usage is the playground of different vendors and open source PaaS platforms, which are VMware's Cloud Foundry, OpenStack but also non-open

source VMware VSphere, Citrix Cloud Stack and MS Azure Pack. (RightScale, 2015). The vendors posted are only the top few, being followed by a large number of smaller vendors that grow yearly, filling up niches and providing customized services that the large providers do not ensure. Thus, except for the IaaS domain, which is by far dominated by Amazon with a 57% market share, there are a myriad of options to choose from and they are changing yearly. This information is stated here to show the difficulty of a cloud adopter to choose between vendor types, without the appropriate skills and knowledge.

1.2.3 The PaaS model: a client perspective

This section describes the common use cases and motivations for PaaS cloud service adoption. The objective is to understand why PaaS is one of the most difficult models to adopt and manage, but also expose why efforts in surpassing these difficulties are worthwhile due to the potential benefits brought by utilizing PaaS platforms in various ways. PaaS can be easily characterized by the following quotes (Emison, 2013):

> *"Bring your code, we'll handle everything for you." (…) "IT can focus on writing code to solve business problems and leave the mechanics of infrastructure and operations to the vendor."*

PaaS services provide the infrastructure and tools needed for software developers to build and run applications (as a SaaS or otherwise). Development teams and IT managers usually do not need to bother with detailed planning for and configuring the infrastructure on which they deploy the application. Also, the client is free of worries with respect to dynamic scaling of software as this is done "automatically" through the service, depending on load or other expansion/compression requirements (Hurwitz, 2010). A common characteristic of companies interested in PaaS is that they want to take control of development and operation of their applications but do not want to manage the supporting infrastructure and development environment (Mell, 2011). This implies that the organization already owns or plans to acquire software development capabilities for PaaS-based software development and/or operation. While there is no clear distinction of how companies adopt PaaS with respect to their industry or private/public domains (Corbin, 2015; IDC, 2015), there are several salient application use cases (Mathon, 2014) from a client perspective, as seen in Figure 1-3.

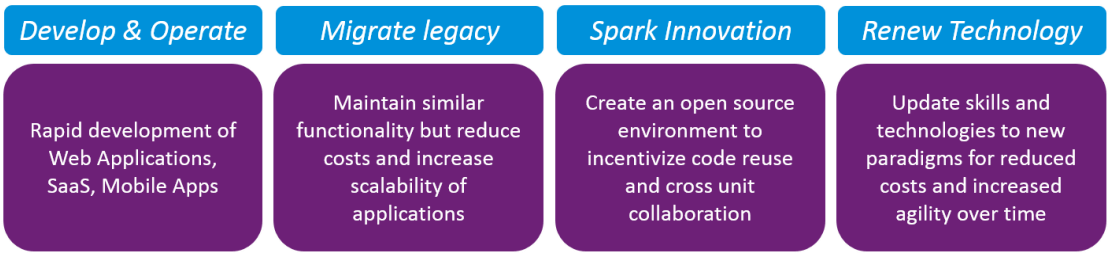

FIGURE 1-3. PROMINENT PAAS USE CASES

To begin with, a common range of use cases deal with incrementally redesigning applications to work and be delivered as SaaS applications rather than "enterprise" software (relieving customers from having to install, update and partially maintain the applications) (Mathon, 2014), or migrate legacy applications from costly on-premise hosting and

maintenance to the cloud (The Open Group, 2011). Some of the advantages organizations that develop software (for internal use or sales) seek to have with such a move are multi-tenancy; virtualization; scalability of performance, load or storage; switch from CAPEX to OPEX expenses; agile, location-independent development and continuous delivery of software (Marston, 2011; Mell, 2009). For an explanation of some of these benefits please see Sean Marston's article on the business perspective of cloud computing (Marston, 2011).

Moreover, PaaS is also used for more disruptive reasons, when organizations want to leverage new business opportunities based on PaaS, or redesign existing business and software development processes and routines (Mathon, 2014). An example for the former reason is the initiation of pilot or short-term IT project initiatives to quickly develop and deploy applications that fulfill business or market needs (Mathon, 2014). Many applications needed by business do not have to run for years as they did in the past, but for months (for example, for the duration of a marketing campaign), making rapid development and deployment essential (Lehmann, 2015). For example, the building of a cloud based application "factory" - a platform on which to develop apps and services that work as SaaS ensures that developers have everything ready to quickly release software. Due to the on-demand delivery of PaaS services, the applications can be continued (if successful) or discontinued at minimum sunk costs if pilot results are unsatisfactory, or not needed anymore. A use case for redesigning existing business and software development processes is building an open source application environment, or an internal application environment open for collaboration within the company, based on PaaS, and involving all IT stakeholders (developers, testers, operations, IT managers, etc.). Especially within large companies that have multiple IT development teams, this initiative can increase code reusability, cross-project communication between developers, and spark innovation and growth of development capabilities (CloudRamblings, 2014).

These categorizations are not exhaustive for all types of PaaS services and are not mutually exclusive of each other. Vendors can deliver them in either a bundled package of functions and models (for example, PaaS and IaaS together), or as isolated modules that provide only some sort of functionality, such as: cloud testing environments, cloud service management, integration and configuration platforms and others (Hurwitz, 2010). Also, different vendors give access to different levels of configuration of the infrastructure and programming environment to their clients. While some clients require high need for infrastructure configuration and control (Gillin, 2015), other clients prefer prepackaged black-boxes that right away allows them to build and deploy applications (Hurwitz, 2010). This adds complexity in management and work processes: IT operations and development must work together internally and externally with the PaaS provider to ensure that different stages of the SDLC are covered (configure, develop, build, deploy, test, monitor). This situation gives rise to more companies using DevOps teams and tools in combination with PaaS for continuous integration and delivery of software applications (RightScale, 2015).

1.3 Problem statement and research objective

In the previous section, I introduced concepts related to cloud computing and PaaS to understand how they can be used to create value to business, and set the groundwork for

understanding the challenges and potential problems integrating novel PaaS solutions and achieving flexibility in the organization with respect to cloud and PaaS. Further in this subchapter, I present the practical and scientific problem of cloud computing and PaaS, and then scope towards the knowledge gap and resulting research objective of this thesis. The subchapter exposes the motivations to conduct this research from a practical point of view: identifying the practical problem and its urgency and relevance for practitioners, and from a scientific point of view: identifying the gap in cloud computing adoption challenges and solutions research.

1.3.1 Practical Problem

1.3.1.1 Actual and desired situation

Despite the cloud computing's market emergence almost a decade ago (Armbrust, 2009), companies are still struggling to extract value out of cloud services. This struggle can be explained by drawing a parallel between cloud and its parent domains of IT application in business. A key determinant for IT to deliver on its promises to business is successful integration of new IT solutions and practices with existing business processes and IT systems (Blumenstein, 2013). This asks for a certain degree of flexibility from a company to change its internal structures with respect to changes in the market, so that it can incorporate these changes (Nelson and Winter, 2009). As a specific form of IT outsourcing, cloud services carry with them the threats of vendor lock-in, significant efforts for integrating cloud solutions with existing IT systems and business processes, and possible loss of control over key resources and processes (El-Gazzar, 2014). In addition, the novelty and lack of understanding of PaaS in business deters its successful adoption. A market report by NTT Communications in 2015 revealed that many enterprise customers are unsure and confused about the business benefits of PaaS and how they should manage PaaS services and vendors. Moreover, ICT decision makers argue that smoother migration paths should be provided, along with greater support for cloud transformation (NTT Communications, 2015). However, there is no best practice or methodology to offer a solution to these issues because the cloud vendor environment and existing technologies are changing fast - most companies do not have business models that account for the rapid changing of cloud (and implicitly, PaaS) (Blumenstein, 2013). An interview respondent from Exact Software shows an insightful opinion on some of the client-side requirements for cloud adoption:

> *"For successful and sustainable cloud adoption, constant updates in knowledge are needed about technical and vendor specific changes that occur."*

Senior Software Engineer, Exact Software[6]

The lack of knowledge and practices is aggravated by the lack of universal standards, problem that appears in different proportions for each of the main cloud computing models, with high prominence in PaaS (CSCC, 2014). Standards that would help migration, interoperability and portability are still split between different clusters and open groups and

[6] Quotes from interview responses are introduced throughout the text before presenting interview data collection and analysis. To view the full interview response table, please check the Annex at 6.7. Interview Responses.

are not universally available from all vendors - a situation that nurtures vendor lock-in (Di Martino, 2015). As a consequence, client's application portfolios remain on standby - they are neither ready for cloud (less than 20% of app portfolio is cloud-ready - Rightscale Report, 2015), nor is there a plan to do this in the absence of a clear direction (standards, guidelines, clear vendor benefits and business application). A response to the lack of standards and vendor lock-in problem is the progress of the Open PaaS platform model (Hurwitz, 2010; CSCC, 2014) and alternatively, the rise of more integration technologies that separate and abstract software applications so that they are more easily portable and interoperable (such as containerization - Docker.com; or APIs and other interfaces) (CSCC, 2014). But there is still no clear horizon of when and how unified standards will emerge, and integration technologies require significant in-house development skills or money spent on third party cloud integrators. Therefore, one of the few solvable issues by a cloud adopting company is the lack of in-house skills and resources, or capabilities. Figure 1-4 breaks down the problem of PaaS adoption and summarizes the points made above:

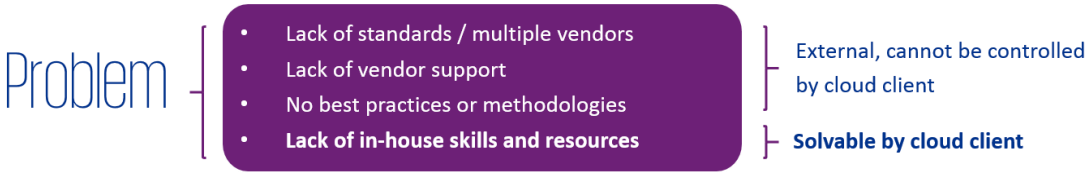

FIGURE 1-4. CONTROLLABLE AND UNCONTROLLABLE FACTORS THAT AFFECT THE CLOUD COMPUTING ADOPTION SUCCESS

Despite these complications, business does not wait - companies want to leverage advantages of early adoption at the price of high switching costs of moving to a standard or open source later (CSCC, 2014). This is why obtaining capabilities in-house is desirable over other solutions. To increase flexibility, companies should acquire a range of capabilities for managing cloud transformation. I argue that it is desirable for practitioners to have a reference framework that can indicate these capabilities and the context factors that influence how and where they can be applied.

1.3.1.2 Problem scope

This section is purposed to scope towards and motivate why PaaS is chosen for research as opposed to the other service models, based on the introductory information provided in 1.2.3 The PaaS model: a client perspective. Due to the very broad scope of cloud computing technologies and business applications, I argue PaaS as the model with the most challenges for flexibility. PaaS implies that a client wants a high degree of control over customizing and deploying their application, but they do not want to tie themselves to buying physical infrastructure (IaaS) and middleware software, and configuring the environment required for supporting development. As seen in market report studies exposed in the introductory chapter, despite PaaS being least adopted of the three, with the increasing need of large enterprises to develop applications in-house for various internal and external purposes, PaaS has the greatest growth rate. A PaaS client must consider how easily they can migrate an application to or from a PaaS environment, and how internal capabilities can be used for this transition (programming languages, DevOps capability, SDLC capabilities, existing IT systems portability & interoperability).

This study is aimed at large companies with high demand for software applications, complex internal IT, and need for leveraging cloud agility, scalability and on-demand provisioning. Large companies have the required resources and motivation to gain capabilities needed for “cloud flexibility”.

1.3.1.3 Problem ownership

The problem of flexibility with PaaS is relevant for cloud service clients, cloud brokers and open standard groups, while cloud service providers have a mixed role, because they are partly interested in locking in clients. In this thesis I assume that service providers neither encourage nor block the mitigation of the problem unless incentivized to do so. I consider cloud service clients as the main actors with clear business incentives to increase their “cloud flexibility” through systems interoperability and application portability capabilities. Cloud brokers have a supporting role, aiding IT managers decide what capabilities are needed, how to implement them, and providing additional capabilities that are not feasible to be developed in-house.

This study is written with the end goal of providing a decision support framework for IT & Enterprise architects, as well as IT managers for mitigating vendor lock-in and maintaining interoperability and portability in PaaS adoption. Responsibility falls on a cross-functional/cross-hierarchical range of stakeholders, with emphasis on architects and project managers as seen in Figure 1-5 Business problem owners.

C-level IT or Technology Executive. Designing cloud strategy and overseeing implementation and possible PaaS use cases. Deciding on enterprise-level PaaS integration needs. Vendor lock-in should raise considerations of planning finances needed for cloud initiatives and scenarios that involve PaaS switching or upgrading costs. Main decision makers on the relevance of avoiding lock-in, the need for interoperability & portability, and what resources can be dedicated to acquiring the capabilities to meet these goals.

IT project/portfolio managers. Decide if in-house capabilities should be acquired for implementation of goals, or propose an outsourcing approach. Establish capabilities needed to implement project and portfolio PaaS decisions. Make decisions based on market, technology and standards reports, select IT cloud service providers, manage IT readiness for cloud adoption from a technical, business process and cultural standpoint.

IT architects. Decide on long-term flexibility of IT architecture and application landscape with respect to increased number of cloud and non-cloud applications and services interconnected. Together with network and application tech specialists, they are mostly responsible for monitoring existing standards, adapting cloud service applications, and making recommendations on cloud service choice based on technical considerations of interoperability and portability.

Contract and SLA specialists and auditors ensure that equitable agreements and service levels are decided, monitored and maintained, add clauses to avoid lock-in to the degree required by business, contribute to exit strategy formulation, and update contracts and SLAs with respect to

Cloud brokers are external, integrating actors. Not all capabilities can, or are feasible, to be acquired in-house. Some of them can be outsourced to external parties such as cloud brokers, integrators and consultants. For example, cloud brokers can help companies integrate their

FIGURE 1-5 BUSINESS PROBLEM OWNERS

1.3.2 Scientific problem and knowledge gap

There has been extensive research on both technical and business aspects of cloud computing adoption, mostly focusing on how organizations can take advantage of this new technology and create value, reduce costs, redesign business processes, become more agile, and other expected benefits. The motivations for adopting cloud services, including PaaS have been well researched and understood, fact which is supported by the almost ubiquitous adoption of cloud services in one form or another, as shown by market reports (RightScale, 2015; Transparency, 2015; RightScale, 2016). However, there seems to be a difference between the promises of cloud and their actual fruition due to integration problems of cloud with existing IT and business assets and processes. There are only a few articles recommending the means through which integration can be achieved, determining a gap in research.

More specifically, the issues of integrating cloud solutions within existing enterprise contexts and minimizing vendor lock-in continue to prevent companies from having flexible IT

systems. Sustainable and flexible cloud service adoption and usage can be partly solved if studying the problems of vendor lock-in, system interoperability, application portability, and exit strategies. Research is fairly abstract and does not refer to PaaS-specific adoption issues. I challenge the capability frameworks proposed until now (Feeny & Willcocks, 2006; Joha & Janssen, 2012) which treat IT and cloud adoption, pointing out that these studies lack applicability in practice, because capabilities are too abstract and take in account too few context factors. Taking this in account, I note that there is a research gap for studying the means through which PaaS flexibility can be achieved. As the PaaS field is emerging, there is a wide horizon to be explored with respect to how IT/cloud capabilities apply in PaaS adoption.

Research in the IT management and cloud field (both business and technology oriented) cannot yet offer applicable answers to practitioners about the capabilities needed for flexible PaaS adoption, and neither does it shed too much light over why these capabilities are needed and how do they fit with a company based on its characteristics. To help reduce this broad knowledge gap, this thesis intends to enhance understanding on the need for capabilities, while also studying one factor that affects the relevance of capabilities, which is cloud readiness.

I choose gaining internal capabilities as a potential solution to PaaS flexibility not only due to existing research and practitioner support in this direction (Joha and Janssen, 2012; Kleinveld and Janssen, 2015), but also in light of how alternatives compare to this solution. An alternative is outsourcing most capabilities as total outsourcing (Lacity et al. 1996), which in the case of PaaS means outsourcing not only the PaaS service but also the functions to manage and integrate it with existing systems. However, this solution brings about several other problems with loss of control over IT direction and own knowledge base, difficulty of managing a complex outsourcing landscape (Lacity et al. 1996) and adds up increased risks and considerations of data privacy, business continuity, and other well studied outsourcing risks (Clemons, 2011). Since PaaS is mainly targeted at core, non-commodity applications, total outsourcing cannot be applied as core functions and applications are very rarely outsourced (CloudGrowth, 2016).

The diametrically opposed solution to total outsourcing is total in-sourcing, or not using a PaaS provider at all but creating an on premise platform with similar properties as an outsourced PaaS. However, this implies that all capabilities for building a PaaS from ground level are needed from a technical, business, supply and governance perspective, which is extremely costly and difficult to achieve. Moreover, in this case many of the financial benefits of cloud that vendors can sustain due to economies of scale (Marston, 2011) are forfeit: the company needs to acquire and manage all equipment and software for building up an on premise PaaS.

Up until this point, I motivate the scientific and practical need to research the issues of achieving flexibility in the volatile environmental context of cloud and PaaS solutions, so that companies can adapt their existing organization and processes to benefit from novel cloud technologies. Based on Nelson and Winter, 2009, I motivate that flexibility can be achieved by acquiring a broad range of in-house capabilities related to PaaS adoption. I propose that capabilities are arranged in a framework so that it is a point of reference for practitioners,

based on the structure and characteristics of capability frameworks proposed and tested in practice in Feeny and Willcocks, 2006 and Joha and Janssen, 2012. I challenge these articles and contribute to the view on capabilities by adding context factors that influence capability applicability. The following sections formally define the research objective and subsequent questions needed for achieving the points mentioned above.

1.3.3 Research objective and research questions

This section describes the thesis objective and the research questions to be addressed in order to achieve it. The research objective indicates an explorative direction of research in the space of PaaS adoption, proposing to increase understanding into how capabilities can support interoperability, portability and minimizing vendor lock-in, to achieve flexibility with respect to cloud and PaaS solutions.

> *Research Objective: Increase understanding of the capabilities needed for flexible PaaS adoption.*

To reach this objective, a series of research questions must be answered through theoretical and empirical research. The main research question inquires on the capabilities needed and how they should be chosen to help flexible PaaS adoption with respect to context factors.

> *Main RQ: What are the structure and contents of a capability framework that supports flexible PaaS adoption?*

To answer the main research question, I distinguish two subsequent questions. The first question is mostly related to building a theoretical framework and explaining the concepts and relationships between capabilities, flexibility and cloud readiness in the context of PaaS adoption.

> *Q1: How can capabilities, flexibility and cloud readiness be understood and related in the context of PaaS adoption?*

SQ1.1: What is the meaning and relationship between capabilities and flexibility in the context of PaaS services adoption?

Answering the first sub question involves specifying what capabilities and flexibility mean in the context of this research. The answer is found by literature review and it builds theory around how the two related concepts. The relation between capabilities and flexibility is tested empirically by answering SQ 2.1 and becomes a key specification for constructing the capability framework, based on empirical research findings. The following sub question helps explain the cloud readiness context factor and its influence on capability domains in PaaS adoption.

SQ1.2: Is cloud readiness a context factor that influences the relevance of capabilities for flexible PaaS adoption?

The answer to this sub question is found through literature review. Having defined what capabilities are and how they can support flexible PaaS, I look to differentiate between the types of capabilities needed based on a company's cloud experience and resources (or cloud readiness). Capabilities are categorized into four application domains based on (Feeny and

Willcocks, 2006; Joha and Janssen, 2012) articles which I challenge because they make this categorization of capabilities too abstract and difficult to apply in practice. Thus, I set to find out how companies prioritize between capabilities, depending on their cloud readiness. This distinction serves as another core specification for building the framework.

The second research question is oriented towards obtaining the specifications for the framework through empirical evidence.

> *Q2: What capabilities support flexible PaaS adoption, and can they be prioritized contingent to a firm's experience with cloud?*

The second research question is answered by practitioner interview responses from three companies with different cloud readiness levels. They specify capabilities needed for flexibility in cloud, the relevance of flexibility, and the priority of different cloud management domains depending on their company's cloud readiness. Q2 is split into two sub questions:

SQ2.1: What capabilities are core for supporting PaaS flexibility?

This question is answered using the data obtained from three companies and six interview responses, building upon the capabilities found from theory and practitioner articles. This answer also brings evidence to support a relationship between capabilities and flexible PaaS adoption. Capabilities are organized in a table, categorized by domain and linked to parent capabilities from Joha and Janssen, 2012, along with an explanation on how they contribute to PaaS flexibility.

SQ2.2: Which of the four capability domains is higher priority, contingent to a firm's cloud readiness?

At this point, the core capabilities are categorized under their corresponding domains and their relationship to support flexibility is established. It remains to understand the context factor of cloud readiness and how it influences priority of capability domains. The final sub question seeks to understand the relationship between the importance of a certain domain, and the cloud readiness of the PaaS adopting company, by analyzing empirical data. With the answer to this sub question I can include this relationship as the final specification for the capability framework.

Upon answering the research questions and sub questions, the theorized relationships between concepts have been supported by empirical evidence, thereby underlining the assumptions and specifications for building the capability framework. The framework is represented as a table containing the core capabilities for flexible PaaS adoption categorized by three specifications: cloud management domain, level of cloud readiness, and priority of cloud management domain with respect to cloud readiness level. The following section explains the research approach followed to attain the objective.

1.3.4 Research approach

This section provides an overview of the research methods used to attain the research objective and answer the research questions. Due to the novelty of the subject in both practice and theory, the research approach adopted is qualitative and exploratory. It helps

create a space of understanding upon which further case studies and quantitative research can be done to gain more in-depth insights and prove the applicability of the framework.

The research strategy followed in this thesis draws from the design oriented research of Verschuren & Hartog (2005), but does not follow the design cycle entirely, due to the research being exploratory and novel. I explain the steps that are similar and different from the design cycle approach in the following paragraphs. The first step is conducting desk research through literature review and secondary sources data gathering. The secondary sources data gathering imply going through market research and non-scientific articles or news reports to establish the current and projected technological and business developments of cloud computing in general, and PaaS in particular. This is a useful way to gain knowledge into what the challenges related to PaaS are with respect to interoperability, portability and vendor lock-in from practitioners. In the search for these sources, the Google search engine proved most useful, and lead to websites with a wealth of information about the progress and practical applications of PaaS. The sources were found in surveys from known market and IT technology research groups (Gartner, VMware, IDG, HBR, IBM) and science news articles or reports found on reliable business and technology websites (such as CIO, The Open Group, Forbes, etc.).

Afterwards, the literature review commenced into more scientific articles and relevant white papers, providing more in-depth information on the business implications and challenges of PaaS and cloud adoption. This step precedes the literature review for theory building and was done through searching on the Google Scholar search engine, with combination of keywords such as “PaaS integration”, “capabilities”, “capability framework”, “PaaS adoption challenges”, “flexibility, interoperability, portability”, “cloud vendor lock-in”, and others. The results found were from recognized academic and industrial journals (Elsevier, Emerald Insight, IEEE, HBR, etc.), books, and also reliable whitepaper sources (The Open Group, Cloud Standards Customer Council, National Institute of Standards and Technology). These sources helped build the context of what technical and business requirements a company needs but also what potential benefits there are when adopting a PaaS solution. Matters of integration with existing systems and business processes were discussed, scoping in towards the perspective of interoperability of systems, portability of applications and data, and vendor lock-in minimization. These steps build the first hunch (Verschuren & Hartog, 2005), which identifies the goals that are set out with the research.

The final desk research step consists of a second round of literature review that is meant to build the theoretical framework upon which the thesis lies. I look in depth into the concepts of capabilities, flexibility, and cloud readiness (based on IT and cloud maturity literature) in the context of applying them on PaaS adoption in organizations. Here I find the core articles that suggest the capability frameworks that support IT and cloud management and adoption. Also, I obtain the base articles that describe capabilities and flexibility in a high-level sense, at organizational level, so that I can focus gradually into the scope of interest of PaaS. Based on these articles, I build theoretical relationships that are transformed into specifications by bringing supporting evidence from empirical data. The second step of the design cycle is partly fulfilled here – finding requirements and assumptions for the capability framework. This step is continued in the data collection stage, because requirements and assumptions cannot be established only by desk research due to the novelty of this subject.

Next, I design and conduct six semi-structured interviews with practitioners who have different experience levels and goals with cloud and PaaS adoption from three Dutch companies. The interviews are designed as semi-structured due to the novelty of the subject and the various levels of experience, understanding and knowledge of the respondents with respect to the subject. Thanks to the flexibility of the semi-structured interviews, answers were quite in-depth and gave a feeling of how the respondent perceives PaaS challenges, and the capabilities needed to mitigate them. The interviews were conducted with respondents from three different companies, chosen based on the company's experience with cloud (low, intermediate and high). All companies were chosen such that IT is a core part of their business. Data analysis was made by reduction and categorization of responses, based on topic areas and questions, to arrange answers into results that can serve as specifications for building the capability framework. The interview protocol and processing of responses gathered will be detailed later in the paper. This sequence of steps is matched with the requirement and assumptions gathering, and the next two steps in the design cycle – the structural specifications for building the framework and the design of the prototype.

Finally, evaluation was made ex-ante, by reflecting logically on the problem and objective definition, theoretical and empirical research conducted, and building of the framework, with respect to standard research quality attributes such as validity, reliability, purposiveness, generalizability and preciseness. This final step of research corresponds with the plan evaluation from the design oriented approach of Verschuren and Hartog (2005), so that conclusions and future research can be delineated. The flow of the research activities is depicted in Figure 1-6.

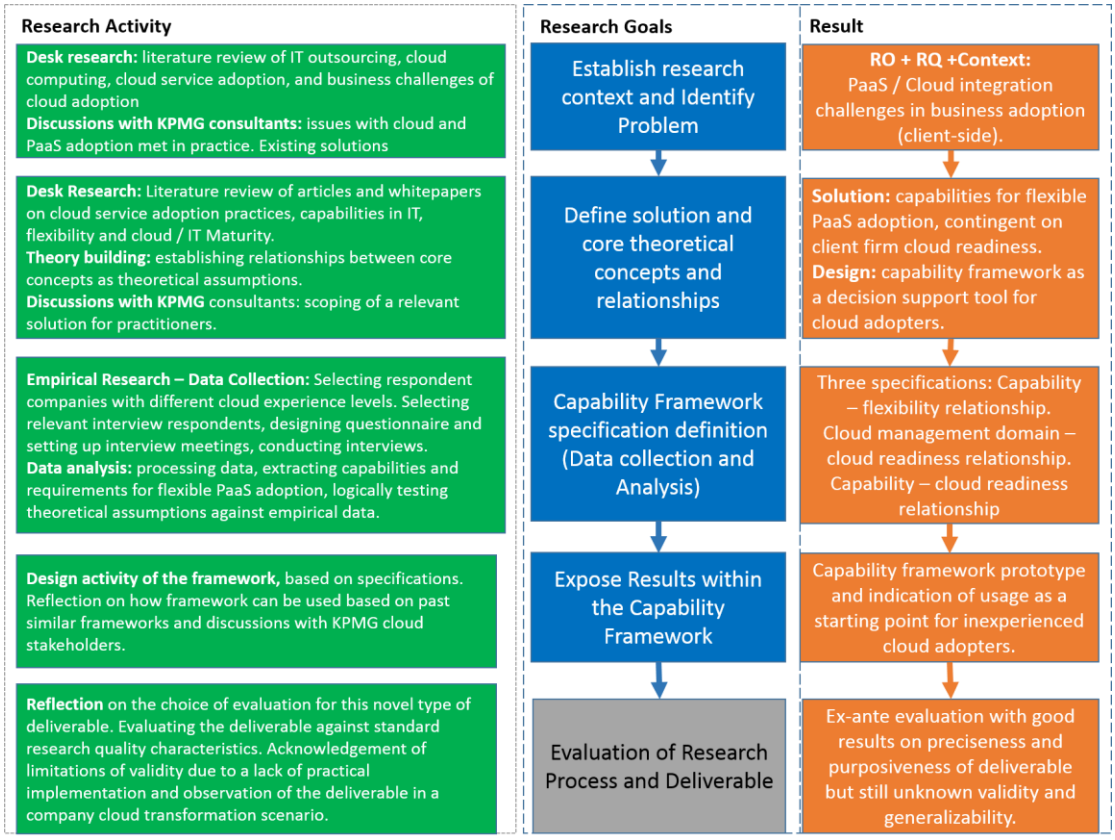

FIGURE 1-6. RESEARCH FLOW MAP

1.4 Chapter conclusion

This chapter has introduced cloud computing from the perspective of large private cloud service clients, with emphasis on the PaaS cloud service model, providing an overview of business, technology and the market environment. This information underlined the fast-growing but volatile context of PaaS adoption, which calls for a more flexible stance of organizations (Nelson and Winter, 2009), and the lack of knowledge and preparedness of most companies to adopt it, which calls for the need of a PaaS capability framework to support adoption (Feeny & Willcocks, 2006; Joha and Janssen, 2012), but which need to be detailed further to be applicable in practice. PaaS strengths and weaknesses were described, and integration issues with a company IT and business landscapes were found as barriers for reaping promised the benefits of IT flexibility by using cloud and PaaS services. The problem statement detailed these issues further and motivated the scientific and practical relevance to find a solution for supporting flexible PaaS adoption.

The acquisition of capabilities was argued to be a relevant solution from both scientific and practitioner points of view. On the one hand, scientific research warrants the usefulness of capabilities in IT and cloud service management, but there is a research gap in the particular case of flexible PaaS adoption. On the other hand, practitioners report that the number one problem in cloud adoption is in-house lack of skills and expertise to manage and integrate new services, making alternatives of in-house capabilities acquisition less relevant. I proposed to fill the research gap by defining the research objective and subsequent questions, which aim to create understanding on how capabilities benefit flexible PaaS adoption, and what context factors influence the relevance of different capabilities. I underlined how the answers to the research questions, found through empirical evidence, define the specifications for building a capability framework, based on a similar structure with previously successful but too general capability frameworks. The final deliverable was specified to be an aggregation of theoretical and empirical results, operationalizing capabilities found and linking them together into a table based on the relationships found.

The following chapter explains the context of PaaS adoption focusing on flexibility challenges and its constituent components - interoperability, portability and minimized vendor lock-in; detailing how each of them affects the benefits of PaaS adoption and how they can be supported by acquisition of capabilities.

CHAPTER 2 CONTEXT BUILDING

2.1 Introduction

This chapter is meant to further explain the motivations and challenges of flexibility and PaaS adoption, and differentiate between the potential solutions for a successful PaaS adoption case, drawing from the learnings of outsourcing literature. The chapter is structured as follows. In the first subchapter, I motivate the relevance of investigating capabilities with respect to the problems they can solve in cloud computing adoption and provide the reasoning for using flexibility as an umbrella term for interoperability, portability and vendor lock-in. The first subchapter also details these properties, explaining why they are relevant for PaaS adoption. The second chapter exemplifies three alternative solutions for PaaS adoption as different outsourcing arrangements, observing how they support or block effective flexibility in PaaS adoption. I then finish by emphasizing why the capability framework approach is suitable for describing how flexible PaaS adoption can be achieved.

2.2 PaaS adoption challenges

As shown in the introductory chapter, the cloud and PaaS market is volatile, with a broad range of shifting vendors and services, implying multiple solutions that are not necessarily interoperable with each other. But the mass of vendors to choose from is just one of many challenges businesses face today when initiating or expanding their cloud portfolios. Consequently, market reports in the past years have shown a changing list of cloud adoption and operation problems that adopters mention. Security has for a long time been the top worry of cloud adopters (RightScale, 2015) but is supplanted by lack of resources/Expertise in 2016, with 32% of respondents coining it the top challenge, followed by security with 29%, Compliance with 26% and others (RightScale, 2016). This lack of resources and expertise is said to aggravate due to the increased workloads being placed in the cloud, thereby requiring training of IT and development staff. This is a strong justification for the urgency and need of research in this field, because it underlines the criticality of having in-house skills and resources to manage cloud solutions.

Lack of skills and knowledge is an old problem in the new context of cloud. Many IT professionals were found to have only a superficial understanding of cloud computing and its benefits or challenges (Lin, 2012) and serious issues before deciding to adopt cloud services because of low IT maturity of the organization, legacy IT systems, and difficulty in integrating different service providers and business processes (El Gazzar, 2014). Moreover, capabilities are not only needed for managing the business and technical sides of cloud adoption, but also focus on orchestrating the supplier network (Kleinveld and Janssen, 2015). Thus, I argue that many of the cloud challenges today can be linked to an in-house lack of capability of managing cloud computing arrangements, therefore diminishing the potential benefits of cloud computing. In the following section I focus on the specific challenge that this research proposes to solve by using capabilities -- realizing flexibility in

PaaS adoption by treating three properties that compose flexibility: interoperability, portability and vendor lock-in.

2.2.1 Interoperability, portability and minimized vendor lock-in

This section explains the motivation for gaining flexibility with cloud, and the three concepts that influence flexibility. First, I introduce a visualization of how these concepts relate to each other on high level, in Figure 2-1. Second, I describe the motivations and challenges of attaining flexibility, the property that is influenced by the three concepts. Then, each of them is explained from a business perspective, followed by a short description of how standards act as a context factor to influence interoperability, portability and vendor lock-in.

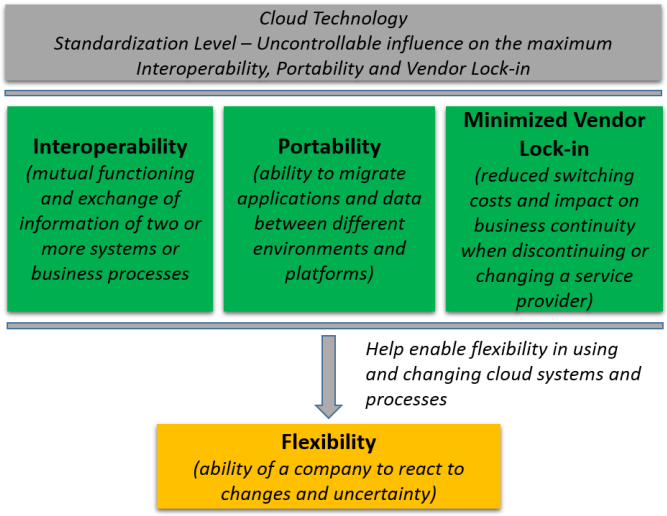

FIGURE 2-1. RELATIONSHIP BETWEEN FLEXIBILITY AND INTEROPERABILITY, PORTABILITY, VENDOR LOCK-IN AND CLOUD STANDARDS

2.2.1.1 Flexibility

This section's purpose is to describe the motivations and challenges of companies to achieve flexibility, while its definition and relationship to the solution are theorized in Chapter 3 - Theory building. I make this separation so that Chapter 2 can focus on underlining the challenges and the process of choosing from a range of potential solutions, and Chapter 3 can detail the solution chosen and theory that needs to be built around it.

As mentioned in the introduction, this thesis uses the evolutionary economics concept of flexibility as the variation of organizational performance in response to variation in the environment (Nelson and Winter, 2009). Flexibility is argued to be a characteristic required for survival in a volatile environment. In the PaaS context, flexibility represents the ability to react to changes in the IT and cloud market and technology environments, which are inherently volatile. Achieving flexibility[7] is reportedly the main driver for adoption of cloud

[7] Flexibility and Agility are used interchangeably in many studies and reports, issue recognized in the paper of Gong and Janssen, 2012; who differentiate between the two as flexibility being the ability to react and agility representing the speed of reaction. For further insights please read the article of Gong and Janssen, 2012.

computing services (Scribe Industry Report, 2015). The variation of organizational performance as called by Nelson and Winter, 2009, means that flexible businesses can react and take advantage of new business opportunities (Sharifi and Zhang, 1999), and design and deliver innovative products (Swafford, 2006). But it is dangerous to assume that flexibility is increased by simply replacing legacy with cloud technologies and services (Marston, 2011), so I try to reflect on it further in this thesis by understanding what can help build flexibility. I break flexibility down into three constituents that influence its success: interoperability, portability and vendor lock-in (CSCC, 2014). These factors are decisive in supporting the potential flexibility of an entire IT system or sets of business processes based on that IT system.

2.2.1.2 Vendor lock-in

One side of the problem with PaaS cloud adoption stemming from the lack of standards, market volatility and immense range and type of cloud-related needs and services is represented by vendor lock-in. Vendor lock-in is the situation in which a client organization's benefits from switching to another cloud provider that would offer a better service than the present one are overweighed by costs or efforts of switching (CSCC, 2014). While not all clients are concerned with vendor lock-in, some clients require high flexibility for developing and operating software applications. The main cause of vendor lock-in is a low level of standardization which makes migration difficult (CSCC, 2014). Other reasons for lock-in relate to non-technical aspects, such as the reluctance to change of users in their daily operation with PaaS platforms or PaaS-developed software, or high risks of disrupting business continuity. The existence of standards can only partially solve this latter problem, the bigger issue here being efforts and costs that need to be invested in change management. Lock-in does not occur only from a vendor perspective, but also from the perspective of employees, clients or partners who are locked-in with using a technology and processes they are familiar with. Political reasons for lock-in may also exist from employee's side, who fear that they will lose their jobs or be required significant changes in their roles (Marston, 2011).

2.2.1.3 Interoperability

Interoperability is the ability of two or more systems to mutually exchange and utilize information according to agreed-upon semantics, or more simply put: the degree to which systems or components can work together (CSCC, 2014). Most of the cases, the term is used in a technical sense, referring to the intercommunication of software applications, interfaces, databases, networks that can understand each other's messages, data formats, and authorization tokens (Zhang, 2013). Interoperability does not only refer to the digital communication and transmissions between systems. People must also be able to carry out their daily work in interoperating with each other based on systems that work on or are dependent of a PaaS platform, or are developed on the PaaS platform. This implies an organization or department-wide unification of policies, routines and rules for various business and operational processes. Gong and Janssen (2012) advocate the importance of ICT-enabled principles and standards for creating flexibility in a company or department, but do not explain the many context factors or capabilities needed to implement them for cloud and PaaS.

2.2.1.4 Portability

Portability indicates the capability to migrate an application or dataset from one system/environment to another while maintaining its usability (CSCC, 2014). In the context of cloud computing, portability can either refer to how easily can client-based applications and data sources be transitioned to cloud-based applications and data sources, or how easily can cloud-based applications be ported onto different cloud infrastructures and platforms (Clemons, 2011). Specifically for PaaS, an ideally portable application should be platform-independent, meaning that there are no data formats, interfaces, services and programming language-specific dependencies that work only on the platform the application is developed on (CSCC, 2014). Unfortunately this is rarely possible for vendor or open-source platforms, because application stacks that support development are diverse and do not use the same languages and formats (Pivotal, 2016). Moreover, portability challenges are most prominent for PaaS platforms due to a big differences in application environments and service availability provided by PaaS vendors. These differences require extensive re-engineering of customer code when moving between platforms (CSCC, 2014). Among solutions are increased utilization of open source PaaS platforms and containerization technologies that abstract the application from its development platform. These solutions require deeply technical capabilities in-house, due to lack of vendor support in the case of open-source platforms.

2.2.1.5 The role of standards

The subject of standards is significant due to the influence it has on facilitating interoperability and portability between solutions from different vendors (Lewis, 2013), and thereby on the flexibility of PaaS solutions to work with different vendor software or systems. PaaS cloud services suffer from low levels of portability and interoperability because the APIs and interfaces to access PaaS cloud services are not standardized. In this context, client organizations cannot rely on standards to mitigate the vendor lock-in problem (CSCC, 2014).

In the case of PaaS, on the on hand some vendors provide out-of-the-box capabilities and functionalities for user authentication, data storage, messaging and libraries that are tied to specific libraries and runtime environments such as Node.js, JAVA, Ruby, etc. The advantages for the user consist of value-added features and performance that are specific to the platform and its provider, but at the cost of decreased portability and interoperability. On the other hand, a PaaS with lower out-of-the-box functionality but more options for configuring interoperable and portable applications requires significant skills and effort for configuration and operation (Lewis, 2013). There is no good or bad choice, but rather it depends on the client's resources and goals for using the PaaS environment. Therefore, in the absence of universal standards, companies need to have the capability of assessing the impact of following diverse standards, by estimating future directions of technology and the market, and influence on their own assets and market offerings (Clemons, 2011).

To conclude this subchapter, I have introduced the main challenges in PaaS adoption that are focused on in this thesis, and motivated their relevance for ensuring flexibility in PaaS adoption. The next subchapter describes potential PaaS adoption directions, and how they treat the challenges mentioned with respect to flexibility.

2.3 Potential solutions to flexibility issues

As we have seen in the previous subchapter, interoperability, portability and vendor lock-in pose serious threats to how flexibility gains can be achieved by a company when utilizing PaaS services. This subchapter introduces the potential solutions to mitigate these problems described above. These solutions are based on variations of how companies usually treat sourcing arrangements (Lacity et. al., 1996), given that cloud is a particular form of outsourcing (Joha and Janssen, 2012). I present three alternative solutions for achieving the goals of PaaS adoption described in 1.2.3. These are total outsourcing, total in-sourcing, and selective sourcing (Lacity et al., 1996), as shown in Table 2-2. Finally, the last part of the subchapter brings supporting arguments for further research in capabilities and their structuring into a framework, as the desirable solution.

	Advantages	Drawbacks
Total Outsourcing	Vendor responsible of installation, integration, operation and maintenance (nearly a SaaS platform) End-to-end solution highly integrated with other offerings from vendor or partners.	High financial costs and maximum vendor lock-in. High risk of failure due to loss of control, alignment between business and IT strategy, and vendor service.
Total Insourcing	Maximum control over assets and processes and policies related to cloud and PaaS-based software functioning. Supports cloud excellence and becoming a cloud service provider. Flexibility to decide on standards, architecture, implementation.	Complacency and barriers for continuous improvement of the organization due to internal IT providing services. High capital expenditure and costs of hardware and software, significant skills and assets needed.
Selective Outsourcing	Best in leveraging competitive benefits of PaaS adoption (in-house development) while minimizing repetitive and non-core tasks (outsourced maintenance and operation). Trade-off that allows both reasonable flexibility and cost.	Complex and difficult to decide sourcing mix. Little to no methodologies due to high dependency on business case.

TABLE 2-1. ADVANTAGES AND DRAWBACKS OF DIFFERENT PAAS SOURCING SOLUTIONS

2.3.1 Total outsourcing

The first alternative to solve the flexibility problem with PaaS adoption is total outsourcing. This involves the outsourcing of everything needed for PaaS utilization. This is commonly known as a PaaS ecosystem, and is characteristic to long-term contracts with vendors that offer end-to-end solutions, and high integration with third party offerings (CSCC, 2014). This

solution involves throwing the flexibility issues into the vendor's backyard, and comes at a significant cost and almost maximum vendor lock-in because of the dependency on the provider. Also, a vendor switch is so expensive that it is very difficult to move to another vendor or in-house (Lacity et al., 1996. Thus, this solution's outcome is uncertain, as it is unknown how a vendor can ensure that the flexibility needs of the company can be met in time, and within the right service levels, with some capabilities still being necessary in-house, especially on the side of managing the vendor, aligning with him, and ensuring that service delivered is appropriate.

2.3.2 Total insourcing

This solution proposes that all IT and cloud related functions are built and serviced in-house. A particular case which is feasible for companies that through IT and cloud excellence want to become themselves cloud service providers (The Open Group, 2011). Flexibility in this case is completely in the hands of the company, and vendor lock-in exists only at the level of the software and hardware bought to support the PaaS platform. Considerable skills and resources that do not necessarily relate to the core business are required to successfully operate an exclusively in-house arrangement, and many of the benefits of PaaS are forfeited (Armbrust, 2009; CSCC, 2014).

2.3.3 Selective outsourcing

Selective outsourcing proposes that IT activities should be carefully selected for outsourcing, based on an evaluation of internal and external factors that can influence this decision (Lacity et al, 1996). This method proposes a careful assessment of vendors, activities to outsource (business), and technical considerations on in-house readiness and vendor-side technology to be considered. Activities that are core to the business should remain in house, but supporting non-competitive activities can be outsourced. With respect to satisfying the goals of flexibility in PaaS adoption, this approach proposes trade-offs for choosing where it is necessary to be flexible, by outsourcing the right activities with the right vendors, deciding this based on company requirements from the PaaS and on the current state of technology and culture of IT and cloud readiness in the company. However, despite the positive results of this approach to outsourcing, a methodology for choosing which skills and abilities are needed for implementing this direction is lacking for the case of PaaS adoption.

To have the ability to implement selective outsourcing, Feeny and Willcocks, 1998, argue that companies should retain capabilities that allow flexibility in four essential domains: business and IT vision, design of IT architecture, delivery of IS services, and IT governance. In the context of this thesis, cloud technologies and PaaS services are at the forefront of novel IT solutions, making them highly volatile. In the context of flexible adoption, capabilities ensure that its constituents: interoperability, portability, and minimized vendor lock-in, reach the levels desired by the organization, so that it remains flexible but also cost-efficient. This thesis intends to identify, categorize and explore the priority of such capabilities and how they can enable a successful selective outsourcing implementation of PaaS.

2.4 Chapter conclusion

This chapter has explored the challenges of flexibility and PaaS adoption with respect to several determinants of flexibility: interoperability, portability and vendor lock-in. These controllable factors, along with the uncontrollable standards in cloud computing factor determine how flexible a company can be in adopting and utilizing a novel PaaS service. Moreover, based on the argument that PaaS is a specific form of cloud outsourcing arrangement, I described the advantages and drawbacks of three types of sourcing arrangements with respect to flexible PaaS adoption. I concluded that selective outsourcing arrangement is the most appropriate for PaaS, in achieving desired levels of flexibility while avoiding extreme costs of acquiring too many capabilities or losing control by outsourcing most of them. I proposed a capability framework as a solution to describe the applied skills, knowledge and contexts required to attain flexible PaaS adoption. The following chapter builds theory around flexibility, capabilities and the context factors that influence the relevance of capabilities.

CHAPTER 3 THEORY BUILDING

3.1 Introduction

The previous chapter created the foundation for understanding the domain of research, described the motivations for researching this area, as well as offered some insights into the concepts of capabilities, flexibility and PaaS as an outsourcing arrangement, and how the problems of interoperability, portability and vendor lock-in with PaaS can be mitigated. This chapter establishes the theoretical foundation upon which the proposed solution relies.

First, I explain capabilities in cloud as a solution to the research problem. Afterwards, I explain how capabilities are used in frameworks, as decision support tools for relevant stakeholders. Then, I describe the concept of flexibility and propose how this organizational characteristic can be supported by specific sets of capabilities in certain contexts. Lastly, I explain that companies have different experience levels (or different readiness levels) with respect to cloud service adoption, a fundamental factor which determines cloud management domains to be of different priority. These points serve as the core specifications for building the capability framework; they are gathered through empirical data collection and analysis in the subsequent chapters.

3.2 Capability Theory in cloud adoption

Up until this point, capabilities were introduced from an IT perspective, as human-resource based skills that give the capacity of a team to execute task and activities that influence business performance (Feeny and Willcocks, 2006). The lack of capabilities with respect to cloud was found to be the primary concern of stakeholders involved in cloud adoption. More specifically, I stated that capabilities that support interoperability, portability and minimizing vendor lock-in enhance the flexibility of a company's cloud and PaaS arrangements. This subchapter starts by defining the concept of capabilities in IT and cloud management. Then, the four IT and cloud domains under which capabilities are categorized are mentioned. It follows to explain what frameworks are and how they can incorporate capabilities to create decision-making tools for business. Afterwards, I explain the cloud capability framework of Joha and Janssen, 2012, which stands as a model for building the PaaS flexibility capability framework in the thesis, and show why further detailing is needed for the case of PaaS-specific capabilities. These descriptions are made based on literature review that covered scientific articles on capabilities, flexibility, IT and Cloud adoption management, and PaaS.

3.2.1 Capabilities in organizational theory

This section establishes the concept and role of capabilities in organizations based on the articles of Grant, 1996; Teece, 1997; and Nelson and Winter, 2009. The capabilities of an organization include the set of specialized assets and repertoires of the organization's members to operate these assets. Moreover, capabilities contain the abilities and structures needed for decision making with respect to what tasks should be run, and what resources are required to support these activities. At the heart of capabilities lie individual skills of

organizational members. A skill is defined as the ability of an organizational member to execute a smooth sequence of coordinated behavior (steps) taken to fulfill certain objectives, given a certain context. Thus, capabilities are based on the skill and knowledge of people in the company, and how well they are supported by the company (decision making, assets) to use them. Especially with PaaS and cloud adoption which reflect unstable market conditions, knowledge is found to be the most strategically significant resource of the firm (Grant, 1996). Therefore, the value of IT technology resources depends on the existence and application of capabilities to meaningfully utilize the resources, but also adapt them to rapidly changing environments (Teece, 1997). This definition adds to the previous ones, mentioning how capabilities can support rebuilding competences for coping with volatile environments, such as cloud.

In conclusion, I state that capabilities: (1) include a set of human-resource based skills, that involve applying specialized knowledge within the firm in a coordinated way, to achieve certain goals within an organizational context and that (2) capabilities can support reconfiguring existing competencies, to address rapidly changing environments.

3.2.2 Application of capabilities in IT and Cloud Management

The concept of capabilities is applied in IT within a decisional framework for exploiting IT (Feeny and Willcocks, 1998 and 2006). They motivate capabilities as facilitators of IT exploitation, involving a mix of skills that are interpersonal, technical and business related. The drawback of their article is that the capabilities are quite general, and little advice for implementation is given. While the split of capabilities in different domains of IT is useful, it is not clear what “mix of interpersonal, technical and business skills” means in practice and how it could be achieved. However, this framework approach categorizing capabilities inspired a number of articles to go into more depth with how these capabilities can be applied in IT, such as cloud computing (Joha and Janssen, 2012), agile software development (Mercan, 2015), or IT outsourcing (Kleinveld and Janssen, 2015).

Moreover, it was argued that organizations can benefit from capabilities regardless of their business plan, strategy and other particularities (Feeny and Willcocks, 1998). However, this statement is hard to contradict because it is extremely general and with much space for interpretation depending on context. The difficult questions that remain is what mix of capabilities is more effective, depending on a firm’s context, which makes business, plan strategy and other particularities extremely important. As argued in (Kleinveld and Janssen, 2015), the limitations of such capability frameworks in most articles is that the capabilities defined are still too abstract and difficult to apply in practice, justifying further empirical research, and application in more specific case studies. Another complication which occurred since Feeny and Willcocks wrote about IT capabilities is that nowadays, most organizations are challenged by the complexity of sourcing arrangements due the past decade’s progress in outsourcing various IT services, including cloud computing technologies (cloud computing services being a particular form of IT outsourcing). These technological and market developments create more urgency for an even wider range of capabilities, either formed in-house, or partially ensured externally through a retained organization that manages outsourced functions (Kleinveld and Janssen, 2015).

The capability framework of Feeny and Willcocks (1998) has been verified in several articles (Willcocks & Feeny, 2006; Willcocks et al. 2006) and refined in (Joha and Janssen, 2012) for cloud governance, or (Kleinveld and Janssen, 2015) for IT-outsourcing orchestration. Thus, I consider there is sufficient evidence and sufficient fit between capability theory and my research objective, to ground my research into these articles. However, there is still enough space to challenge the weaknesses of these frameworks and attempt to create a more specific framework that creates understanding of what kinds of capabilities can achieve flexible PaaS adoption, especially because this emerging field is heavily unexplored.

3.2.3 Four capability domains of IT and cloud Management

The distinction of four areas of IT Management helps understand what roles and areas are responsible for acquiring and applying different capabilities. (Feeny and Willcocks, 1998; Joha and Janssen, 2012). These areas refer to (1) IT Governance, (2) Technical, (3) Business and (4) Supply. The IT Governance domain establishes IT's role within the business along with their responsibilities. The technical domain ensures that appropriate IT resources fulfill business requirements and requests. The business area manages business demand from IT and ensures alignment between business and IT for producing value. The supply area is tasked to manage and monitor supplier and partner relationships to ensure their quality and appropriate IT service delivery (Joha and Janssen, 2012). This distinction is used to categorize capabilities so that IT managers can more easily understand in what area they should invest for gaining skills, setting up policies, and driving change. The reason for using these domains is to offer more clarity on how to operationalize capabilities, splitting them between different functional areas in the organization. While the capability domains give some direction, a drawback is that in many cases capabilities cannot be contained in just one area, and that not all companies split their business in the same categories. This means that companies should be flexible in using such frameworks and adapt them on their organization, instead of taking them word for word.

To give more meaning to these domains and reduce ambiguity, I propose that cloud capabilities and domains have different priorities depending on organizational context factors. As stated in the research questions section, part of this research's scope is to understand an organizational context factor that is not included in the research by Joha and Janssen (2012). I refer here to the experience that companies have with cloud service adoption, or "cloud readiness", and its influence on the priority of PaaS-related capabilities. I will explain cloud readiness in sub chapter 3.4, as a simplified version of cloud maturity models, used for assessing the maturity of an organizations' structures, resources and skills with respect to an increasingly performant cloud utilization.

3.2.4 Frameworks in IT and capability frameworks

While the definition of capabilities and relevance for this research should be understood until this point, the *"framework"* concept and how it relates to capabilities and this research is still unclear. The framework concept is not explicitly defined in any of the capability framework articles (Feeny and Willcocks, 1998; Feeny and Willcocks, 2006; Joha and Janssen, 2012; Kleinveld and Janssen, 2015; Mercan, 2015). IT standards and definitions

glossary defines a framework as: “a real or conceptual structure intended to serve as a support or guide for the building of something that expands the structure into something useful.” (Rouse, 2015).

3.2.4.1 Capability frameworks

The core IS capability (Feeny and Willcocks, 1998 and 2006) and cloud governance frameworks (Joha and Janssen, 2012), depict capabilities supporting IT exploitation, and their categorization based on the domain of application they are under. The purpose of their frameworks is for deciding on, and developing of a company’s IS, IT and cloud professionals and managers, and for decisions around other necessary arrangements and resources required for sourcing and outsourcing transitions. Distilled from these articles are the following structural characteristics, usually contained in a capability framework (Table 3-1):

Characteristic	Description
Specification of capabilities	The capabilities required for IT or cloud transformation and exploitation projects. The capabilities are usually general so that they can be applied in a broad range of cases. One of the research contributions of the thesis is the specification of capabilities required for the goal of flexible PaaS adoption.
Advice on application	Explanations or prescriptive advice on how capabilities should be used, and in what moment of an IT/cloud transformation process or roadmap.
Categorization by domain or function	Capabilities are categorized based on directions that must be taken in account (business, technical, supply, governance), or based on functions responsible for them (IT architect, CEO, Project Manager, etc.)
Context Factors	Firm or industry-specific factors that influence the relevance of different capabilities and the priority of different domains that contain them. My thesis contributes to research by adding the factor of cloud readiness of firms as an influence to the domains and capabilities required for PaaS adoption.

TABLE 3-1. COMMON CAPABILITY FRAMEWORK CHARACTERISTICS

While the research contribution has been explained, the practical contribution can be depicted thorough a quote of one of the interviewees who has participated in a complex and successful cloud transformation journey with PostNL, the leading Dutch post and parcel delivery service that has adopted an all-cloud strategy:

> *“Such a framework can be very useful as a starting point and further reference point for companies that are considering PaaS adoption but do not have enough experience or resources to do so independently”*
>
> — IT Infrastructure Architect, PostNL

My thesis defines a framework as a decision support tool for helping cloud and PaaS stakeholders identify the capabilities they require for flexible PaaS adoption, given their company context. Capability frameworks can prove to be useful as waypoints, within a wider

IT transformation plan, to help companies identify where they are and what they need to do (in terms of acquiring skills and specialized knowledge) to progress towards goals.

3.2.5 A glimpse into PaaS-specific capabilities.

One of the research contributions of this thesis is to describe more in-depth capabilities that are applicable for PaaS adoption. Because scientific research on this subject is non-existent, I synthesized most capabilities from empirical data and from whitepapers and cloud-expert articles, that were written based on hands-on experience with cloud and PaaS adoption in organizations. I give a brief introduction to some of the PaaS capabilities to help exemplify them, followed by the next subchapters dealing with flexibility and cloud readiness.

One of the few sources that focus exclusively on PaaS (CSCC, 2015) acts as a practical reference for enterprise IT managers and architects to understand the needs for successful PaaS adoption. The capability sets that can be inferred from the paper are split between governance, business and technical areas. Among the business and governance capabilities, there are notable recommendations to plan for security, data regulation compliance and business continuity / service levels assurance considerations, exploring open-source solutions to mitigate lock-in, exit strategies in case of vendor failure or new opportunities arising, and acquiring change management capabilities and plans for PaaS-related changes in business and technical processes. With respect to technical capabilities, the authors recommend capabilities that help leverage PaaS advantages such as agile development, DevOps, development of cloud-native applications and SaaS software, and capabilities that ensure that PaaS is integrated successfully with existing IT architecture and systems - utilization of containerization services, utilization of microservices, PaaS integration (applications, services, data), and end-to-end application architecture redesign for cloud.

Another article by CSCC considers the interoperability and portability concerns and solutions in cloud computing (CSCC, 2014). The capabilities that can be drawn from this article are related to utilizing application environments (web server, database server, etc.) that are supported by different cloud providers, management of multiple cloud service integration, leverage SOA architecture and development and API utilization, development of interfaces between PaaS services and in-house systems, security issues with cloud service access of on premise APIs and data. Other articles (Mell, 2011; Hurwitz, 2010; Lewis, 2013) while still focusing on similar technical capabilities for adoption also underline some business, governance and supply considerations such as designing an IT architecture that promotes standards usage, ensuring successful cloud service orchestration for multiple cloud sourcing arrangements, implement policies and procedures for implementing and utilizing PaaS-related IT assets, monitor value provided by PaaS, monitor market and technology developments, etc.

3.2.6 Subchapter conclusions

Subchapter 3.2 defined the theoretical background of capabilities, which include a set of human-resource based, specialized skills, that involve applying specialized knowledge within the firm in a coordinated way, to achieve certain goals within an organizational context. Moreover, given the volatile cloud market environment, capabilities support reconfiguring

existing competencies, to address rapidly changing conditions. I also described how decision support tools named “capability frameworks” can be a reference point to help practitioners leverage capabilities for attaining specific goals in cloud transformation. The notion and motivation for using a framework, as well as common structural characteristics were described. Finally, capabilities for PaaS adoption that are mentioned in practitioner articles and white papers are briefly described, to have a preliminary understanding of what businesses currently require for PaaS adoption. The following section defines the second theoretical pillar of this research, flexibility with PaaS adoption.

3.3 Flexibility in PaaS adoption

This subchapter presents the second fundamental concept that acts as the main challenge that the capability framework solution is meant to solve: flexibility. In the context building chapter of this paper, I presented that when a company adopts cloud services, they must consider three key points (interoperability, portability and vendor lock-in) so that the cloud solution enhances the firm’s flexibility (and business agility) -- the principal goal for cloud computing adoption (Harvard Business Review, 2014; Scribe Industry Report, 2015). Therefore, this subchapter is organized around explaining how flexibility is defined within an organizational context, and supported by capabilities in PaaS service adoption.

3.3.1 Flexibility -- surviving and competing in a volatile environment

In the context of economic evolutionary theory, flexibility is seen as a key factor that ensures the survival of a company that operates in a volatile and uncertain environment (Nelson and Winter, 2009). Specifically in the IT domain, flexibility is the ability to adapt infrastructure, software applications and business processes for successful integration with novel cloud services (Gong and Janssen, 2012). An organization is flexible if they respond to variation in the environment with variation of internal performance. This means that the right capabilities have to be in place to facilitate flexibility for coping with novel challenges. While the market environment for different cloud adopting companies may not necessarily be volatile, the cloud and PaaS adoption environment is. This suggests that maintaining flexibility and openness to alternatives would be a wise strategy, until issues inherent to the technological and market landscapes of cloud are stabilized. Maintaining flexibility can be achieved by taking actions in the present that keep open a range of future choices and the paths created by these choices (Nelson and Winter, 2009).

A contribution to research of my thesis is operationalizing flexibility in cloud computing and in PaaS adoption, creating new understanding of how it can be applied. The integration of IT within the business has been time and time again coined as a major factor that determines the degree of success of IT adoption (Carr, 2003; Blumenstein, 2013), especially because IT remains a volatile field due to emergence of novel technologies. The case for cloud is the same as with IT - integration of cloud systems with non-cloud or other cloud systems and business processes remains paramount for cloud adoption success, and requires flexible systems, processes and organizational structures.

3.3.2 Flexibility and capabilities in PaaS adoption

The most difficult issue with flexibility, as I explained in the comparison between total outsourcing, total insourcing and selective outsourcing, is to achieve a balanced state where options are kept open, but at the same time processes are optimized, so that PaaS can become productive and easy to change at the same time. This section presents how gaining a broad range of internal capabilities that ensure interoperability, portability and minimum vendor lock-in with PaaS solutions can mitigate this challenge.

In the case of dynamic environments, capabilities are a solution to sustain flexibility and integration of cross-domain knowledge (Grant, 1996). Following the four cloud management domains division -- business, governance, supply and technical (Joha and Janssen, 2012; Feeny and Willcocks, 2006), I reinforce that companies should retain the capacity to regularly adjust their positioning with respect to business and IT vision, design of IT architecture, delivery of IS services, and IT governance. Thus, maintaining flexibility with respect to each of the domains described is done by acquiring capabilities that address each of them but at the same time facilitate knowledge transfer and collaboration between them. However, as pointed out earlier, research does not show how these capabilities help achieve flexibility in PaaS adoption cases. As I mentioned in the Context Building chapter, the degree of success for PaaS implementations is influenced by interoperability, portability and minimizing vendor lock-in. Figure 3-1 depicts how these traits of flexibility are enabled by gaining capabilities, and what these capabilities are, based on literature review (CSCC, 2014; CSCC, 2015; Di Martino, 2015) and interview responses.

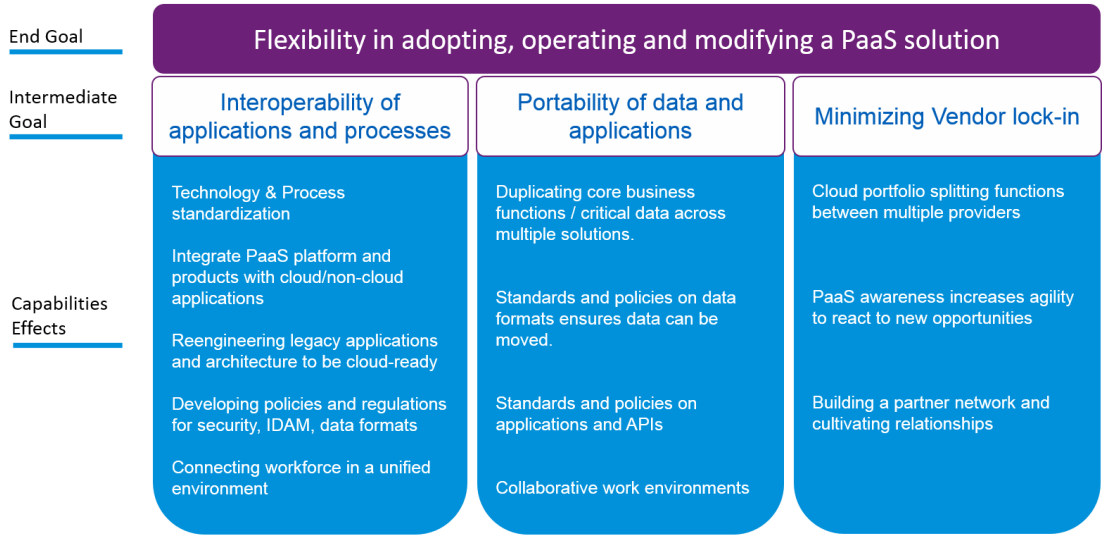

FIGURE 3-1. FLEXIBILITY COMPONENTS BREAKDOWN

As opposed to flexibility, which is quite abstract and difficult to operationalize, interoperability, portability and minimized vendor lock-in can be easily specified. For example, interoperability can refer to the collaboration between an application developed on the PaaS platform, and a local application for solving a specific task, and its corresponding capability may be technical programming skills for writing adapter code between the two applications, or cloud-architecture design capabilities to support communication between applications without adaptor code. To find out these capabilities, interviews were conducted to collect data, followed by its analysis with respect to the theoretical framework defined.

These steps are covered in the following two chapters, which deal with data collection and analysis. The next subchapter defines a third structural pillar for the capability framework: cloud readiness, an essential context factor that influences the relevance of certain type of capabilities.

3.4 Cloud readiness

There are critical aspects that affect the relevance of capabilities when applied in practice such as the desired cloud service and deployment models, cloud strategy, IT governance structure, and complexity of cloud sourcing landscape (Joha and Janssen, 2012). Thus, the right set of capabilities is for a specific company case depends on these variables in the least. My thesis focuses on cloud readiness as one of these factors, as can be seen in Figure 3-2:

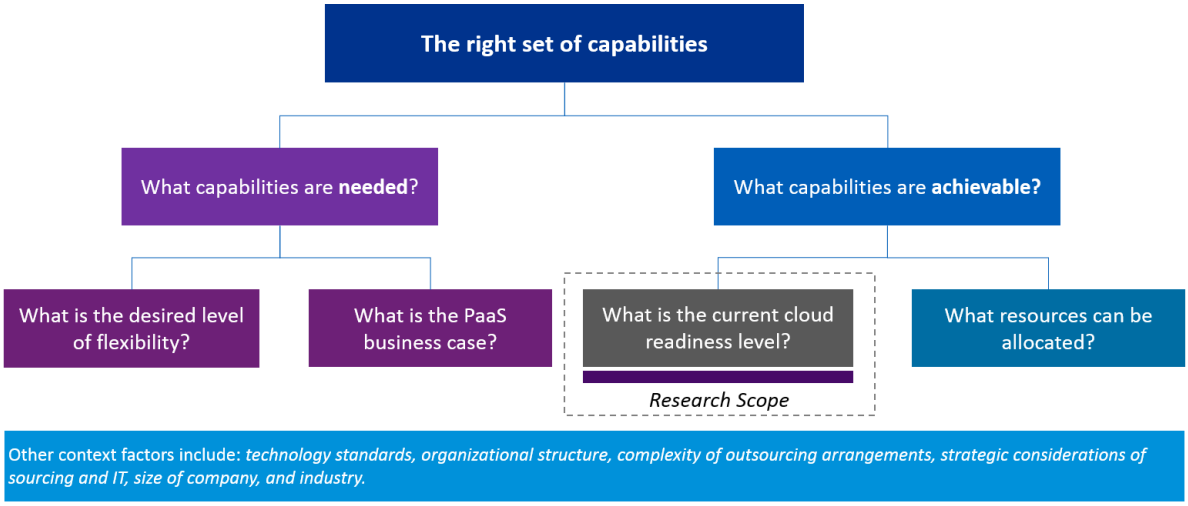

FIGURE 3-2. CONTEXT FACTORS FOR ACHIEVING CAPABILITIES

This subchapter explains the importance of this aspect, coining it “cloud readiness” in cloud service adoption, and describes how an assessment for readiness is conducted and how it can influence the relevance of different capabilities. Moreover, IT and cloud maturity models are explained as the methods standing at the basis of cloud readiness.

3.4.1 Why is cloud readiness relevant for PaaS adoption

Assessing cloud readiness is imperative in the case of large companies due to their higher risk and complexity of cloud adoption, and high integration needs between existing and novel systems (Loebbecke, 2011). Integration issues that need to be understood before adoption relate to data integration, process integration between applications and services, management capabilities for monitoring and controlling cloud services (including security and Identity and Access Management), and business/vendor management capabilities for usage reporting, invoicing and payments (CSCC, 2014). Thus, I define a company’s experience, assets and knowledge that support utilizing cloud and cloud-related services as their *cloud readiness* level. Cloud readiness represents how prepared a company is to adopt a certain cloud service, with respect to their current resources, determining the integration success of novel cloud services, within existing infrastructure, applications, processes and ways of working.

For this thesis, understanding cloud readiness / maturity is relevant because this step is a prerequisite for understanding what capabilities should and can be acquired. A cloud readiness assessment identifies the gap between current and desired situation with respect to skills, assets and roles needed to achieve a cloud-related objective. Figure 3-3 shows the steps usually taken in a cloud transformation roadmap (based on discussions with KPMG consultants), cloud maturity assessment being the preceding step to skill and resource identification. The following paragraphs delineate the theoretical foundation justifying a relationship between cloud maturity models and their influence on different sets of capabilities needed by a company. By sets of capabilities I mean the grouping of capabilities into the four domains of IT management, described in Joha and Janssen (2012).

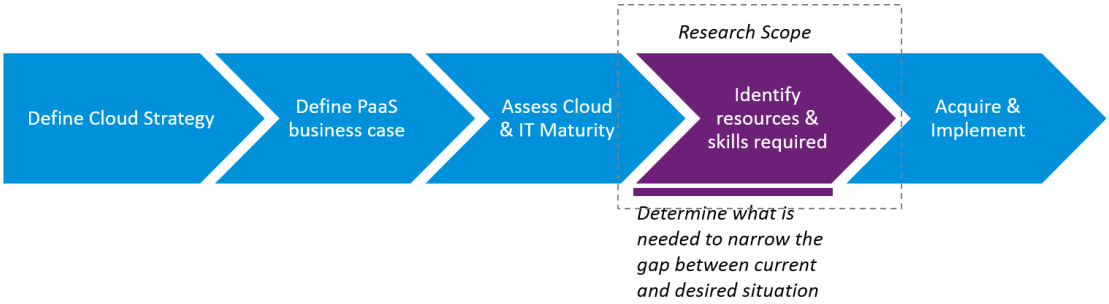

FIGURE 3-3. CLOUD TRANSFORMATION STEPS

3.4.2 Cloud maturity models

Cloud maturity models appeared based on the blueprints IT maturity models. The IT maturity models are highly applied in practice to establish baselines for planning, implementing and comparing against incremental stages of growth in IT service management and business alignment (ITIL, 2016), IT management and control (COBIT, 2007), or IT development (Nolan, 1973). Cloud maturity models are based on the same principle of categorizing a firm's "cloud organization" into several levels of maturity, each characterized by a set of attributes and capabilities of the firm needed to achieve a corresponding level. To build the cloud readiness categorization for this research, I utilize the cloud maturity model published by the Open Data Center Alliance (ODCA, 2016) due to its neutrality towards vendor-specific cloud services, and because the model does not differentiate levels between different cloud technologies, strategies or deployment models. The paper describes six cloud maturity levels described in Figure 3-44[8]**:**

[8] Cited from (ODCA, 2016) ©2015 Open Data Center Alliance, Inc. ALL RIGHTS RESERVED:

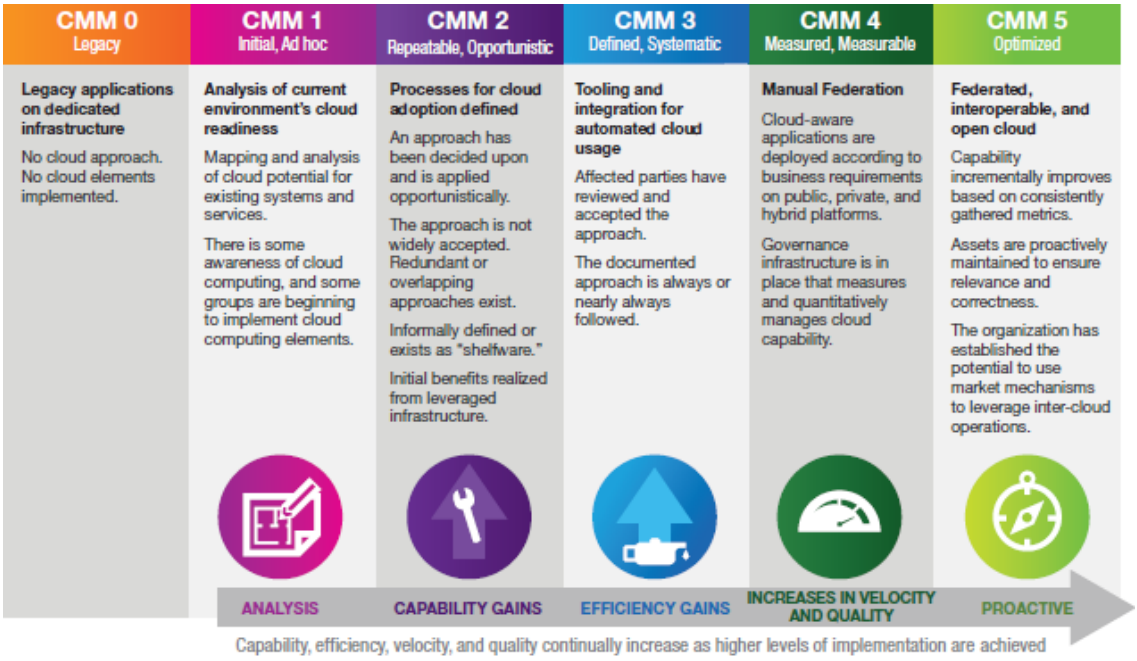

FIGURE 3-4. ODCA CLOUD MATURITY MODEL LEVELS (ODCA, 2016)

Each of the maturity levels described in Figure 3-44 represents a stage the adopting company is in on the road to optimized cloud utilization. Advancing through stages requires increased utilization of cloud, that translates into more knowledge and experience with how cloud solutions fit within company IT and enterprise architecture, and what capabilities are needed for improvement. Evidently, it is irrelevant for a company to want to acquire capabilities in, for example, leveraging inter-cloud operations between different systems if they currently have no cloud strategy or solutions implemented. An incremental approach is recommended to reach higher maturity levels that enable value creation with cloud, as high leaps towards adopting cloud have proved to be extremely risky and unsuccessful (NTT Communications, 2015). Based on these arguments, and the scientific argument found in Joha and Janssen (2012), I proceed to study what is the influence of being positioned in a certain cloud readiness level, on what capabilities and domains of IT management need to be considered. The following section describes how I use the cloud maturity model to specify a simplified assessment of three levels of cloud readiness.

3.4.3 Cloud readiness assessment for building the capability framework

Because the main scope of my thesis is not to confirm the application of cloud maturity models in practice, or to build theory in this area, I use a simplified version of the cloud maturity model to describe three levels that match three companies from whom empirical data is collected. I name this simplified version “cloud readiness” to differentiate it from its more complete cloud maturity counterpart. The companies were chosen based on their experience with cloud and PaaS on these three levels that I define as initial, intermediate and advanced. The basic level is meant to resemble the first two CMM levels from the ODCA model. A company in this tier has little to no cloud implementation experience and only now starts to consider a business case for cloud. PaaS may be specified within the business case,

but there is little to no technical or business experience of what PaaS can do. The intermediate level is similar to the next two CMM tiers, which explain that cloud and PaaS solutions are used in a siloed and opportunistic manner, without cross-organizational integration and governance, which only at this level start to be defined. The advanced level is in the lines of the final two stages of the CMM, where utilization of cloud and PaaS services are interoperable and leveraged to create value for the company and not just for siloed teams or departments. At this level, monitoring and orchestrating a significant number of cloud and non-cloud services and is essential. The levels and their ties to the ODCA cloud maturity levels will be described further in the Capability Framework Prototype chapter where the interview methodology and results are exposed.

3.4.4 Subchapter conclusion

In this subchapter, I introduced the need for assessing the cloud readiness of a company. Based on this need and on the theory built around the article of Joha and Janssen (2012), which states that different domains of capabilities are relevant in cloud computing arrangements contingent on context factors, I argue that cloud readiness can be used as a fundamental specification for building the PaaS capability framework. Data for establishing cloud readiness is collected in the next chapter, by interviewing cloud stakeholders from three companies with different experience levels with cloud and PaaS services.

3.5 Chapter conclusion

This chapter has set the theoretical grounds for building the solution to the research problem. The purpose of a company's acquisition of capabilities was defined gradually in an organizational, IT, cloud and PaaS adoption context. Afterwards, I explained how capabilities can be applied in practice in the context of a decision support framework for cloud and PaaS adoption. The concept of flexibility was defined as a desirable goal in the context of volatile market conditions. I motivated how interoperability, portability and minimized vendor lock-in are essential characteristics of flexibility in the context of PaaS adoption, and that they can be supported by acquiring specific sets of capabilities in certain contexts. Lastly, I introduced a context factor that influences the relevance of different sets of capabilities for achieving flexibility with PaaS. Cloud readiness, or the cloud-related experience, knowledge and assets of a company, was motivated as a fundamental factor which determines some cloud management domains to be of higher priority than others. The relationship between these concepts can be visualized in Figure 3-5:

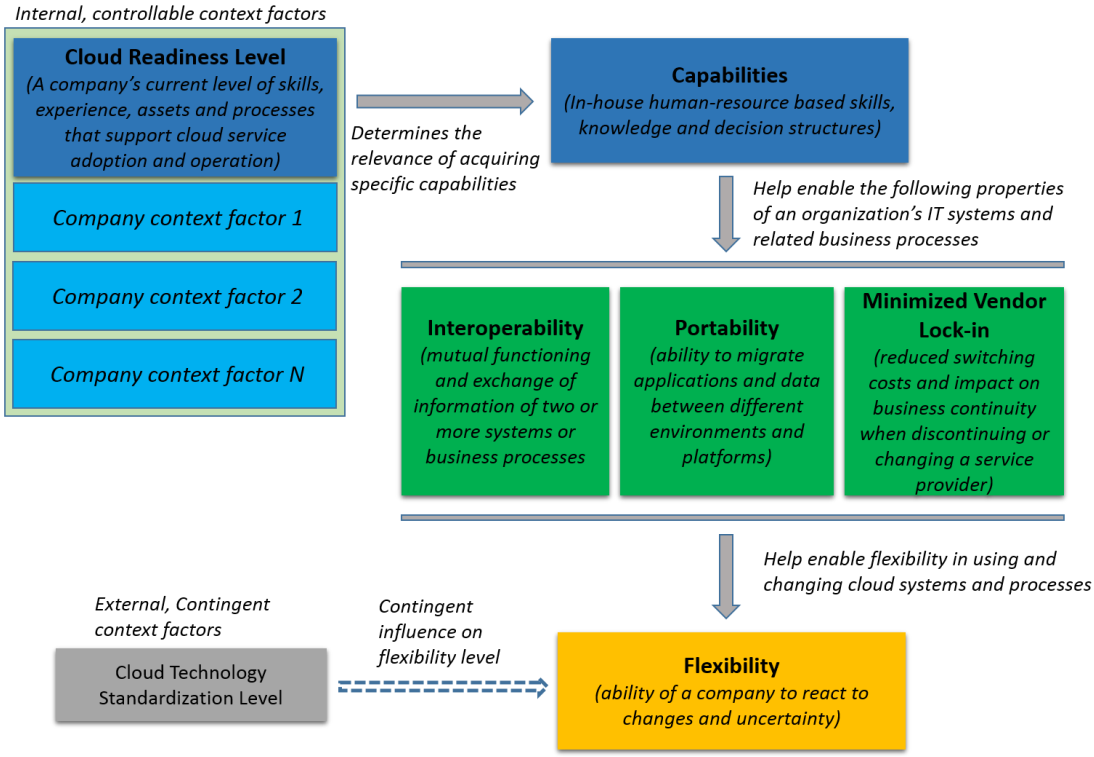

FIGURE 3-5. CORE CONCEPTS AND THEIR RELATIONSHIPS

These points serve as the core specifications for building the capability framework; they are gathered through empirical data collection and analysis in the following chapters. To present an overview of the main findings until this point, I present Table 3-22, where the fundamental research concepts that stand at the basis of the capability framework are explained.

Fundamental research concepts	Theoretical basis and description
Interoperability, Portability and minimized vendor lock-in	Flexibility-supporting properties to be considered, for a firm to be able to reconfigure existing competencies and address rapidly changing environments. These properties support integration between existing and novel PaaS-related systems, applications and processes, internal or external to the company (2.2.1. Interoperability, portability and minimized vendor lock-in) These properties were found to be important for ensuring flexibility of cloud integration and adoption, based on both practitioner whitepapers (Mell, 2011; CSCC, 2014; CSCC, 2016) and scientific articles (Lewis, 2013; Di Martino, 2015).
Capabilities in cloud and PaaS adoption	The set of human-resource based specialized skills and decision structures that involve applying specialized knowledge within the firm in a coordinated way, to achieve interoperability, portability and minimized vendor lock-in with PaaS adoption and operation. (3.2 Capability Theory). The necessity of capabilities is for successfully exploiting IT and cloud within an organization, and maintaining flexibility to address changes in the volatile market environment. Capabilities are the core components of the capability framework and will be arranged based on cloud readiness level and cloud management domain.

Fundamental research concepts	Theoretical basis and description
Flexibility in PaaS adoption	The characteristic describing a company's ability to react to changes and take advantage of opportunities through PaaS adoption (3.3 Flexibility in PaaS adoption*)*. Flexibility helps businesses adapt and exploit existing and novel PaaS applications, processes and systems. Flexibility is a higher-level goal which is formed of three component properties related to a PaaS solution: interoperability, portability and minimum vendor lock-in. In turn, these components are achieved through capabilities.
Four Capability domains of cloud management	Capabilities are split between four domains of cloud management that represent elementary directions that need to be followed for acquiring capabilities, based on the frameworks of Feeny and Willcocks (1998 and 2006) and Joha and Janssen (2012). The domains help distinguish between different categories of skills, roles and activities required for managing a PaaS solution - Business, Technical, Governance and Supply (3.2 Capability Theory). This categorization is a structural specification for the PaaS capability framework.
Cloud and PaaS readiness	A context factor of the cloud adopting company, that influences which capabilities can and should be acquired in practice, contingent to the firms' current experience, IT structures, skills and resources with cloud and PaaS services. A company's cloud readiness influences the priority that is assigned between the four capability domains (3.4 Cloud readiness). In the capability framework, I define three levels of cloud maturity, simplified from existing cloud assessment frameworks in practitioner literature (ODCA, 2016). This is the second structural specification for the PaaS capability framework, in combination with the capability domains.

TABLE 3-2. FUNDAMENTAL CONCEPTS FOR RESEARCH

CHAPTER 4 CAPABILITY FRAMEWORK

4.1 Introduction

The thesis has exposed the challenge of integrating PaaS solutions within the existing context of a client company, while remaining flexible with respect to the volatile cloud market and technology environment. I described the type of capabilities and context factors affecting their relevance, as specifications for building a capability framework. The framework is a decision support tool that helps IT management stakeholders in large companies identify and decide upon which capabilities they need to acquire to enable interoperability, portability and minimized vendor lock-in of PaaS solutions. The fundamentals for building such a framework were sketched in the previous chapter, while this chapter remains to collect empirical data, analyze it and shape it within the structure imposed.

First, I describe the methodology for the data collection in subchapter 4.2, explaining how the six semi-structured interviews were designed and conducted and what results were hoped to be obtained. Then, in subchapter 4.3, I explain how the data obtained was analyzed against the expected results, and how they can reflect the degrees of flexibility, cloud readiness and capabilities required by each of the three companies. Subchapter 4.4 follows by drawing the core capabilities for flexible PaaS adoption based on interview response analysis. In the same subchapter I explain how interoperability, portability and minimizing vendor lock-in are supported by the capabilities extracted. Afterwards, subchapter 4.5 distinguishes the cloud readiness level of each company based on their responses, discussing how clearly they fit into the assigned levels. Moreover, I argue which sets of capabilities and domains of cloud PaaS management are higher priority, depending on three levels of cloud readiness identified, and based on interview respondent's reported prioritization. Finally, the capability framework prototype is presented in subchapter 4.6, as a table that categorizes the capabilities identified by cloud readiness level, cloud management domain and priority of the domain based on readiness level. A detailed description of the interview protocol and responses is attached in the Annex.

4.2 Empirical Data collection - Semi-structured Interviews

Interviews have a paramount role in this research for creating more in-depth understanding of the subject and providing the data from which specifications for the capability framework are derived. They are especially valuable due to the scarcity of scientific research done in this field, requiring qualitative data to enhance understanding. Semi-structured interviews were chosen to maintain open-ended questions but keep focus on particular topics, so that respondents can both expand on their answer but at the same stay on track with the research scope. This subchapter details the goal of interviews, expected results, respondents' profiles, why they were chosen, the interview process and the limitations of data collection.

4.2.1 Interview objectives and respondent profiles

This section explains the main goals for conducting the interviews, and how these goals reflected on the choice of interview design. The goal of the interviews is to provide empirical evidence for the theorized relationships and concepts from the Theoretical framework chapter. The interviews are meant to cover a set of topics for understanding the core concepts of this thesis: (1) different levels of cloud and PaaS experience (or readiness), (2) relevance and potential issues with interoperability, portability and vendor lock-in when adopting a PaaS solution, (3) priority of the four domains of cloud management when adopting PaaS, (4) core capabilities for flexible cloud and PaaS adoption, and (5) feedback on the form, contents and applicability of the framework.

To cover these topics, six face-to-face interviews were conducted on site at three companies, chosen for their different expected levels of experience with cloud and PaaS implementations. Other significant criteria for selecting the respondent companies were intensive use of IT as an essential function for supporting core business processes, and large/corporate size of the company (a thousand and over employees) so that the chance they have complex IT landscapes with cloud, non-cloud and legacy systems and applications is increased. The companies are: one banking firm, one software development company - Exact Software, and one post and parcel delivery company - PostNL, and their corresponding cloud maturity levels have been assessed as low, intermediate and high. This assessment and the relation to different priorities assigned to capability domains based on interviews are discussed in subchapter 4.5.

The roles interviewed were: Corporate Infrastructure Manager, Software infrastructure and operations Manager, Software Automation Team Leader, IT and Enterprise Architect, Software Development and Operations Director, and Senior IT Consultant - Infrastructure and Architecture (responding on behalf of a client company). These diverse roles helped gain an in-depth understanding on various capabilities and priorities given to their domains. Respondent profiles within the company were sought so that they would cover aspects of all four domains of cloud management. Even if not all respondents have direct experience with PaaS technologies (three out of six do not have hands-on experience), all of them have knowledge on what PaaS is and how it could be used in the company on strategic, business and operational levels.

4.2.2 Respondent stake with respect to cloud and PaaS

To justify that the interviewees have the appropriate roles and knowledge to respond to cloud and PaaS-related questions, I draw Table 4-1. The table shows respondent's role in the company and stake in the cloud. A full transcript of the interview responses can be found in the **Annex.**

Company Cloud Readiness	Respondent Role	Stake in cloud
Advanced	IT and Enterprise	Full involvement in implementing cloud strategy. Designing network and application architecture

Company Cloud Readiness	Respondent Role	Stake in cloud
	Architect	for standardization, communication and interfacing between cloud and non-cloud component. Designing enterprise architecture to align and standardized cloud and non-cloud based processes, business and technology and involve partners.
Intermediate	Corporate Infrastructure Manager	Interest in cloud solutions (mostly on infrastructure side) and how to better serve the needs of business units while respecting budget constraints.
Intermediate	Development and Operations Director	Chief responsible of PaaS platform strategy for integrating existing SaaS development efforts of 35 development teams onto one cloud platform. Redesigning core application architecture towards microservices (based on PaaS) to facilitate continuous deployment of software.
Intermediate	Software Infrastructure and Operations Manager	Running the core business application (SaaS model), utilizing PaaS services for monitoring and application lifecycle management support. Running production environment PaaS.
Intermediate	Software QA Automation team leader	Software Test automation for SaaS application quality assurance. Vision of PaaS usage is for enabling deployment and QA integrated test automation capabilities for testing.
Initial	Senior IT Consultant - Infrastructure and Architecture	Creating SaaS & IaaS business case and strategy. No role at the moment in PaaS - Interested in risk, compliance and business cases for PaaS adoption.

TABLE 4-1 RESPONDENT STAKES IN CLOUD AND PAAS

The relevance of the respondents in answering questions on flexibility, capabilities and cloud readiness levels with respect to the four cloud management domains is warranted by their roles and stakes in cloud and PaaS. Also, respondents' role in all except one case (that of the Software QA Automation Team Leader) had knowledge and stakes in all domains of cloud management. This mention is made to emphasize that I focused to minimize variability of results with respect to respondents' positions, and explain different priority of capability domains based on company cloud maturity. However, I acknowledge that the different roles of respondents diminish the internal validity of claiming that a company's cloud readiness influences the priority they attach to different capability domains.

All respondents have technical knowledge of cloud and PaaS solutions, understanding the basic needs and challenges of achieving a technically interoperable and portable IT landscape. Moreover, not only do their roles imply understanding of these aspects, but they are dependent on how well interoperability and portability is achieved. With respect to governance and policy formulation, it goes hand-in-hand with the technical domain, as policies, responsibility and work methodologies must be followed to achieve the technical integration objectives on a cross-departmental level. Respondent's roles also involve business understanding and power to push the initiative of achieving flexibility with PaaS as a business priority. Last but not least, most roles have a stake in the supply area of PaaS, with respect to defining desired service levels, comparing costs of outsourcing with current costs, and exploring the cloud market for potential solutions. Thus, the respondents are relevant candidates for answering on the topics mentioned at the beginning of the chapter.

4.2.3 Interview design: strengths and weaknesses

Based on the roles mentioned in section 4.2.2, and the interview objectives underlined in section 4.2.1, the interview questionnaire was designed, following questionnaire design best practices (Sekaran, 2011) and based on the judgment of how well respondents are prepared to answer with respect to this novel field. Question funneling was meant to ask more general questions at the beginning of the interview, on the company and respondent's role and knowledge of cloud, followed by more in depth questions about flexibility, its properties, and capabilities to ensure them at the end of the interview. Questions were formulated to avoid bias on any capability or the priority on any of the four fields. Also, the questions were mostly formulated in a simple way, avoiding double-barreled formulations or using concepts that were confusing or new to the respondent. The choice of having a face-to-face interview was deliberately made due to the novelty and explorative character of the interview topics. The topic and research could be explained more easily, making sure that respondents understand the scope before proceeding with the interviews. Moreover, having the respondents engaged in a discussion left the chance to adapt some questions and clarify responses that were not fully understood at first answer attempt. Thus, the validity of data collected is increased in the face-to-face interviews, because of this interaction, which ensures that answers given are on point, and agreed upon by both respondent and interviewer.

However, despite the efforts to choose a structure that increases reliability and reproducibility, given the novel field and relatively reduced experience of respondents, there are obvious limitations to these characteristics on long-term. Due to rapid changes in the cloud market and technology, and the internal changes in perception of respondents with respect to this domain, reliability and reproducibility are inevitably weakened. Another disadvantage in the interview choice is related to the time and resources needed for arranging and conducting the interviews on-site at the respondent, which restricted the possibility to conduct more than the six interviews.

Therefore, I argue that validity of the data collection method and results is acceptable, so that conclusions can be drawn from the data found in this context. The contribution with

respect to previous studies is the increased focus on a particular area (flexible PaaS) and on an important context factor that is cloud readiness of adopting company.

4.2.4 Questionnaire topics and expected results

Following the guidelines mentioned, and based on the main objectives of the theoretical framework, I organized the questionnaire into seven core topic areas, each comprising of one or more questions. Each topic area is meant to either directly find specifications for the capability framework building, or support the context building and relevance of theoretical concepts at the foundations of the capability framework. While the full questionnaire structure is presented in the annex, Table 4-2 describes the topics, and how responses from each topic are expected to contribute to research and framework building.

Interview Topic	Relevance for framework building	Description of questions
Company's Cloud / PaaS Strategy	Identifies company goals for cloud and PaaS to start assessing cloud readiness.	Questions targeted at the strategic directions and business cases with respect to cloud and PaaS.
Cloud adoption readiness	Specification of different PaaS and cloud readiness levels of different companies based on existing context.	Questions focused to find the existing capabilities, resources and experience that companies have with cloud and PaaS service transformation.
Priority of Cloud Management Domain	Specifications for linking cloud readiness levels with different priorities assigned to cloud management domains	Questions targeted at how companies (with different cloud readiness levels) rank the four domains of cloud management.
PaaS preparation and operation	Helps understand the importance of preparation before adopting cloud.	This topic asks how companies prepare their IT systems, processes, resources and skills before PaaS adoption and maintain capabilities during operation.
Interoperability, Portability and Vendor Lock-in	Establishes the link between these factors, flexibility and capabilities.	New insights on the relevance, challenges and solutions with respect to interoperability, portability and vendor lock-in at PaaS and Cloud adoption.
Core Capabilities for flexible PaaS adoption	Specifying the core capabilities that are included in the framework.	Questions focused on the particular capabilities relevant for each company for flexible PaaS adoption.
Framework applicability	Specifies what additional characteristics the framework should have to be applicable in practice	Inquire about current and future characteristics of the framework for applicability and usefulness.

TABLE 4-2 INTERVIEW CONTRIBUTION TOWARDS TESTING HYPOTHESES AND PRODUCING NEW INSIGHTS

From Table 4-2, it can be seen that the interviews topics are useful for producing novel insights about how companies prepare and adopt PaaS, what cloud management domains they consider essential, and what capabilities support building interoperable, portable and vendor lock-in minimized PaaS application environments. Following the topics described above in order, the interview is conducted and responses written down. The experience of conducting the interviews is described in the following section.

4.2.4.1 Interview process, conclusions and reflection

After the respondent profiles and their corresponding companies were decided upon as described in section 4.2.1, a series of steps were taken for data collection. Six interviews were conducted in the context of the following steps, as can be seen in Figure 4-1:

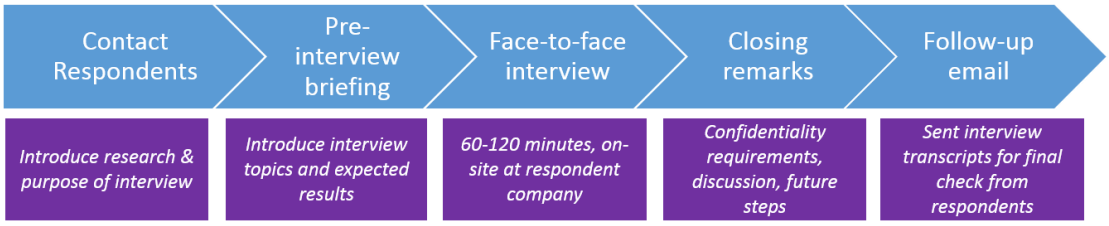

FIGURE 4-1. INTERVIEW PROCESS

Overall, the interview process went well, with participants openly discussing about the questions addressed. The expected benefits of the face-to-face interview and semi-structured questionnaires were well met, with respondents' emotions and reactions about the novel field of PaaS and the importance of flexibility being enlightening in combination with response content. Much enthusiasm was shown during the interviews about the subject, which despite being a factor that cannot be measured, reflects positive feedback about the interest in the subject. There were also limitations that do not relate to the interview process and questionnaire, but to the novelty of the field. Respondents, while enthusiastic, were at times hesitant about some subjects, especially on the part of how companies should prepare for flexible PaaS adoption. These results indicate that IT managers and employees have not yet shifted to a cloud mentality:

> *"Company culture and employee mentality are not yet cloud-ready";*
>
> *Software Development and Operations Director, Exact Software*
>
> *"Mentality is on its way to the cloud but not there yet (…). There are many restrictions related to compliance, and due to (the need for) business continuity of our live application."*
>
> *Infrastructure and Operations Manager, Exact Software*

This hesitance and uncertainty with respect to cloud reinforces the argument that there is a lack of understanding with respect to practices and resources needed to successfully integrate PaaS solutions. Following data collection is data analysis, where results were synthesized from the raw responses obtained. The next section explains the data analysis process.

4.3 Data analysis

This subchapter explains the methods and process of analyzing questionnaire data to produce results upon which specifications for the capability framework can be extracted. Methods for were drawn from "Research methods for business" book of U. Sekaran, 2006, where guidelines for analyzing qualitative data are described.

4.3.1 Data reduction and categorization

The first step in data analysis is data reduction, due to the large amount of unstructured data obtained from the interviews. The discussions could not always be written in an orderly way, so that the full focus could be accorded to the respondent. Data had to be categorized and rearranged so that responses match questions asked. The categories used for this reorganization were the same as the topic areas of the questionnaire, and can be found in Table 4-3 Data reduction and categorization results. First, the data was arranged for each interview in part, summarizing and ordering collected data into their corresponding questions and topics. The analysis of responses was done by comparing and summing up each interviewee's answer at question level, which represents the coding unit for data reduction used. This step ensures the match between question and response. Then, comparison between the data found from each question was done at topic level, checking that answers from different questions in the same topic. This step ensures that a certain topic is understood by adding up the responses of its subsequent questions.

The results of the data reduction and categorization steps mentioned above are compiled in a table, upon which conclusions can be drawn for creating the specifications for the capability framework. While the table is shown in full in the annex, its structure is presented here in Table 4-3 to understand how it supports the drawing of conclusions.

	Question 1	Question 2	Question N
Respondent 1	Answer 1.1.	Answer 1.2.	Answer 1.N.
Respondent 2	Answer 2.1.	Answer 2.2.	Answer 2.N.
Respondent N	Answer N.1.	Answer N.2.	Answer N.N.

TABLE 4-3 DATA REDUCTION AND CATEGORIZATION RESULTS

The conclusions that must be drawn from Table 4-3 Data reduction and categorization results represent the last step in the data analysis phase. The conclusions represent the specifications for building the capability framework and answering the research questions. I offer a brief description of these conclusions here as an end to this subchapter, introducing how they will be exposed in the following subchapters.

4.3.2 Data analysis conclusion

The first conclusion to draw from the empirical data collected is the relationship between capabilities in PaaS adoption and flexibility. This is done by referring to the table in which

empirical data is categorized, specifically looking at the interoperability, portability and vendor lock-in questions, and matching the data in these answers with the answers on core capabilities for supporting flexible PaaS adoption. This relationship is exposed in subchapter 4.4 Capabilities supporting flexible PaaS adoption. To achieve a reliable and valid match between the two concepts, relying on empirical answers only is not enough. I make the match with support from the literature and practitioner data exposed in the context building and theoretical framework chapters.

The second conclusion drawn from the data relates to the cloud readiness of each respondent company. The data analyzed in the questions that refer to each company's strategy with respect to cloud and PaaS, and the readiness from a technical and business standpoint to adopt PaaS. This data is compared to the characteristics of each cloud readiness level, based on theory on cloud maturity built in the theoretical framework chapter. If the empirical data matches with the characteristics of one of the cloud maturity levels (ODCA, 2016), then the respondent company can be categorized in the corresponding cloud readiness level. This conclusion allows me to formally separate each company based on different cloud readiness levels, a prerequisite for defining which capabilities correspond to each cloud readiness level. This relationship is exposed in section 4.5.1 Cloud readiness assessment.

Having exposed the cloud readiness levels of companies, the next conclusion based on empirical data explains how each company has different capability requirements, and assigns different priorities to cloud management domains, based on the identified cloud readiness. The data collected indicates the preference of each respondent company with respect to different cloud management domains and capabilities within these domains. Therefore, it remains only to expose what their preferences are and why, based directly on interview responses. This description is given in section 4.5.2 Cloud management domain prioritization.

Thus, the data analysis results operationalize the relationships between the three theoretical pillars (capabilities, flexibility and cloud readiness) upon which the capability framework is built. This subchapter has described the data analysis methods to achieve these ends, and the next subchapters will describe the results of the data analysis, followed by an evaluation of methods and data in Chapter 5 Evaluation.

4.4 Capabilities supporting flexible PaaS adoption

As argued until now, capabilities can be acquired to support interoperability, portability and minimized vendor lock-in with PaaS, thereby creating a flexible environment for PaaS and its dependencies. Based on these theoretical foundations and on empirical data obtained and analyzed, this subchapter operationalizes the relationships between identified capabilities and the factors that enable flexibility. First, I expose the PaaS-specific capabilities found from the data, and explain how they supports flexibility benefits. Afterwards, I detail how the flexibility attributes (interoperability, portability and minimized vendor lock-in) are enabled by capabilities. This is done through logically matching capabilities and flexibility needs mentioned in interviews, and based on what was found in practitioner whitepapers.

4.4.1 Capabilities' contribution to flexibility

All interview responses show that PaaS clouds are not explicitly mentioned as a priority in the IT strategic direction. I believe this is because PaaS-services are not yet well known and developed enough, but also because PaaS clouds are a means to an end, a tool to achieve certain business and strategic goals and not a goal by itself. PaaS is considered a key element to support development of applications, revitalizing IT architecture towards cloud, and supporting joint development of disparate software development teams. In line with this argument are responses from all accounts, stating that PaaS is used, or intends to be used for supporting development and monitoring of core applications, as is reflected by a few quotes from the interview responses:

> *"A PaaS platform may integrate development of 35 development teams spread around the world" and "support continuous delivery of our core application."*
>
> *Software Development and Operations Director, Exact Software*
>
> *"PaaS services will be used for monitoring, application development lifecycle and for operation" (of the core application).*
>
> *Software Infrastructure and Operations Manager, Exact Software*

The capabilities for cloud/PaaS flexibility can be found in Table 4-4**.** The table's goal is to: (1) describe the capabilities' contributions to enable flexibility, (2) state the parent capabilities from the Cloud capability framework of Joha and Janssen (2012), to show how the new capabilities extend and specify existing ones, and (3) categorize the core capabilities within their corresponding cloud management domains.

PaaS-specific Capabilities	Cloud Capabilities	Cloud Management Domains	Contribution to flexibility
Business-IT coordination for PaaS use case definition	IT project and Portfolio Management *and* Demand Management	Governance and Business	Communication between business (program managers) and engineering (architects) for discovering and implementing interoperability requirements (both process and application interoperability) and aligning business processes to be supported by PaaS capabilities.
Cloud-oriented workforce mentality	Cloud Leadership	Governance	Driving organizational mentality change towards working with cloud solutions, and having interoperable processes based on cloud / non-cloud resources
PaaS Financial control	Financial Control	Supply	Executive-level understanding and financial support for designing interoperable and portable systems and architectures for cloud and PaaS solutions

PaaS-specific Capabilities	Cloud Capabilities	Cloud Management Domains	Contribution to flexibility
PaaS championing	Cloud Leadership	Governance	Executive/Management level incentivizing of workforce and active driving of cloud/PaaS - adoption of new solutions and integration with existing ones
PaaS partner network management	Relationship Management	Business and Supply	Finding and maintaining relationships with PaaS providers and integrators to support the creation of a partner network.
PaaS portfolio risk distribution	Risk Management	Governance	Diversifying a portfolio of PaaS and related cloud/non-cloud solutions that lowers the risk and effects of vendor lock-in.
PaaS/Cloud policy enforcement	Risk & Compliance management	Governance and Supply	Designing organization wide policies and standards that must be respected when choosing and implementing PaaS solution. (eg: requirements for security, encryption, data privacy & regulation, etc.)
PaaS vendor service and product control and monitoring	Service management	Supply	Ensuring that vendors comply to standards, policies and service agreements. Ensuring vendors are up to date with standards and technologies enhancing interoperability and portability.
Cloud Architecture design and implementation	Architectural Design and Standards	Technical	Rebuilding or updating IT architecture so that it can incorporate new PaaS-enabled or collaborating technologies, applications and dependencies
Cloud/PaaS integration	Architectural Design and Standards OR Service Management (for outsourced integration case)	Technical (or Supply)	Development and configuration of integration software, interfaces and containerization usage to incorporate PaaS solutions and dependencies. (This capability can be part of the supply domain if integration of PaaS is outsourced)
Legacy to cloud migration	Application Lifecycle Management	Technical	Reengineering of legacy solutions to work based on or in collaboration with PaaS and cloud solutions.
PaaS Application Lifecycle Management	Application Lifecycle Management	Technical	Leveraging PaaS capabilities for development with collaborative and agile work methodologies.

PaaS-specific Capabilities	Cloud Capabilities	Cloud Management Domains	Contribution to flexibility
Cloud and Non-Cloud Technology Standardization	Architectural Standards *and* Compliance Management	Technical and governance	Development of principles and rules for technological standardization of IT (including PaaS) - data formats, communication protocols, interfaces, APIs, abstraction layers.
PaaS market and technology awareness	Cloud procurement	Supply	Keeping track and exploring new opportunities based on novel PaaS technologies or service offers to increase flexibility (by either changing or updating current PaaS solutions)

TABLE 4-4 FLEXIBLE PAAS ADOPTION CAPABILITIES AND THEIR DOMAINS

As we can see from Table 4-4, the newly stated capabilities specify more detailed activities that must be done by companies interested in adopting flexible PaaS solutions, as a particular cloud service model. These capabilities serve as the core specification for building the capability framework, and will be categorized in the following subchapters, based on cloud readiness domain and priority it demands from different cloud management levels.

As mentioned before, flexibility is a goal that is achieved through ensuring several properties of the systems and processes working with novel PaaS solutions - interoperability, portability and minimized vendor lock-in. Capabilities that enable these properties represent the skills, knowledge and methods, extracted from interview responses. This relationship can be viewed in Figure 4-2, while a more detailed effect of capabilities is added in Table 0.9 in the Annex.

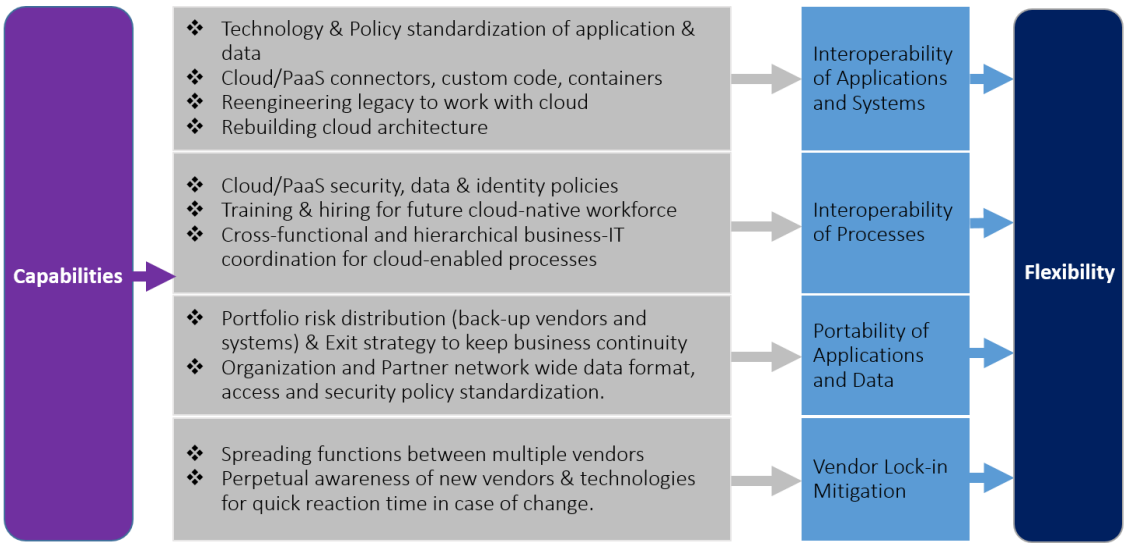

FIGURE 4-2. CAPABILITIES TO FLEXIBILITY MAP

In this subchapter, I have shown the fundamental findings on capabilities from interviews, and brought confirming arguments that these capabilities support interoperability, portability and vendor lock-in mitigation in PaaS adoption, so that flexibility can be achieved.

These lessons also give insights into what practitioners consider important when adopting PaaS. To further understand how these findings can be applied in practice, the following subchapter explains how different levels of cloud readiness in a company influence the priority they accord to different cloud management domains.

4.5 Prioritizing capability domains based on cloud readiness

The theory building section showed that a company's context is decisive for successfully integrating cloud and PaaS solutions from business and technical perspectives (Blumenstein, 2013). Thus, it is not enough to know which capabilities help towards crossing the finish line, a company must evaluate if capabilities can be acquired based on business and technology context factors, existing resources and skills, or the cloud readiness of a company. In this case, we are referring to the cloud readiness for integrating a new PaaS solution while taking in account flexibility targets. As explained in subchapter 3.4 Cloud readiness, a cloud maturity assessment exposes a company's cloud maturity, analyzing its current attributes and capabilities (ODCA, 2016), and a cloud readiness assessment is a simpler version that does not treat all factors included in the maturity assessment. This simplification is made because a full cloud maturity assessment is outside the scope and possibilities for this thesis.

Therefore, this subsection explains (1) each of the interview respondent's company readiness level based on questionnaire data, (2) the cloud management domains containing capabilities they considered as priority for flexible cloud/PaaS adoption, and (3) an explanation of why each company assigned different priorities because of their current cloud maturity.

4.5.1 Cloud readiness assessment

The companies were chosen based on preliminary assumptions of three different levels of cloud readiness (Initial, Intermediate and Advanced). A company that does not use cloud solutions in the PaaS area and does not have any strategic direction in this sense is categorized as within an "Initial" phase. An Intermediate level company has some experience with cloud and PaaS, and some strategic directions, but uses PaaS in a siloed and still experimental manner. The advanced level company utilizes PaaS to create value in an integrated way with other cloud and non-cloud solutions, with an aligned business and IT strategy. This choice of a simple yet robust cloud readiness assessment, intends to show that there are different capability needs for different levels of company experience with cloud, inviting future research into specifying more granular maturity levels and their corresponding capabilities. The assessment is done following the steps depicted in Figure 4-3:

FIGURE 4-3. STEPS FOR DETERMINING CLOUD READINESS

I first introduce the companies to create a brief context for their cloud readiness levels. For each level, I explain the company background, past progress and current plans with PaaS adoption, based on the interview responses analyzed.

> **PostNL - Advanced** cloud readiness. A remarkable example of a top performer in cloud adoption. As a private company that is the leader of mail and parcel delivery in the Netherlands, the company made a radical shift towards an all cloud strategy, completely redesigning enterprise and IT architecture, business processes based on IT, and their workforce towards a cloud-ready mentality. They have built a cloud partner network and enforced strict policies and standards inter and intra-organizationally for IT solutions with respect to service levels, security, data formats, identity and access management and integration principles. With tight, rule-based management and governance of their partner network and core business processes, they orchestrate a complex cloud-enabled business, which intends to ensure operational excellence, scalability and cost efficiency. Presently, they have no major challenges with cloud, except for managing and constantly updating their entire organization to market and technology changes.
>
> **Exact Software - Intermediate.** A company that develops ERP, partially marketed as SaaS. Their expertise in SaaS gives them some experience and knowledge with PaaS and IaaS. PaaS solutions are planned for the future, as support for developing their core SaaS application in a more distributed and cloud-native way. While cloud mentality does exist, it is siloed in departments and teams, as are also applications. Current efforts to mitigate these issues are done through increased virtualization of infrastructure resources, planning to redesign application architecture to host cloud-native applications and proposing bottom-up cloud initiatives that start from the technical levels. Inherent to their software engineering focus, but only now emerging, are efforts to empower engineers, as the main actors to identify and propose innovative technological solutions with PaaS.
>
> **Banking company - Initial.** A representative of the category of firms that still explore the business cases of cloud and are restricted by policies and data regulations to move fast into this domain. The company does not have experience with cloud and hire external parties to assist in finding a business case and identifying risks and possible barriers. Their current IT landscape consists of legacy systems that should partially be migrated to cloud. However, there are few technical skills and executive support for cloud transformation.

For each of the three companies, interviews included topics focused on the firm's current and planned experiences with cloud and PaaS. I analyze each company's response on readiness and compare characteristics with maturity levels based on the ODCA cloud

maturity model (ODCA, 2016). A detailed description of this comparison can be found in Table 0.10 in the Annex. Having categorized each company within a cloud readiness level, a relationship can be established between each level and the different priority of capability domains. The next step is to match the identified cloud readiness levels with cloud management domains that contain specific sets of capabilities as described in Subchapter *4.4* Capabilities supporting flexible PaaS adoption. For each firm level, I motivate why priorities were assigned as they were for the cloud management domains, based on the interview responses.

4.5.2 Cloud management domain prioritization

This section is tasked with describing how each company sees the four cloud management domains under which different capabilities are. The expectation is that depending on the readiness levels identified, each company will attribute different priorities to the management domains because they either do not have the capability or do not have the knowledge on how or why to invest in all of the domains.

4.5.2.1 Advanced cloud readiness level – PostNL

> *"It is extremely difficult to prioritize these domains, because they are all important and must be strongly interlinked to achieve the full benefits of cloud."*
>
> IT and Enterprise Architect, PostNL

As can be seen in the interview quote above, a company with advanced cloud readiness deems all domains of equal importance. This is because they are strongly interlinked and already work together. Such a company has both the knowledge and the capability to invest in all four domains. Based on the interview responses of the PostNL representative, the following characteristics are underlined.

The organization has successfully adopted cloud within most of its business units, having PaaS solutions well aligned with business needs and integrated with cross-departmental systems and processes. There are multiple cloud vendors and supporting partners that form a network for creating value. The business domain ensures that PaaS solutions and business needs are aligned with changing demand and supply options, within an IT strategy that drives the business. Governance ensures that control of core competitive functions supported by PaaS are kept in-house despite the large partner network. Capabilities ensure standardization and formalization of structures and procedures that rely on PaaS to improve coordination and interoperability of processes. The technical domain's paramount objective is to maintain the IT architecture and application landscape so they can support a wealth of solutions and stakeholders, which must communicate and work through integrated and interoperable channels. This area includes capabilities that guarantee optimal PaaS solutions usage to develop and operate applications. The supplier domain has the core responsibility to manage a high number of cloud vendors, integrators and other supporting actors in a well-functioning and supervised partner network. This requires excellent capabilities for PaaS partner network management, PaaS Vendor service and product control and monitoring, PaaS Market and Technology Awareness, and PaaS Financial Control. The advanced level companies are the only ones with such focus on the supplier domain.

4.5.2.2 Intermediate level – Exact Software

> *"Depends on the case of cloud adoption, but generally, would say the technical area is the most important and the others are equally important."*
>
> Corporate Infrastructure Manager, Exact Software

> *"Technical is the most important due to IT architecture, data security, and application design. Without cloud-ready application architecture, the vendor or business reasoning is irrelevant because cloud cannot be implemented."*
>
> Software Infrastructure and Operations Manager, Exact Software

The intermediate-level company indicated a strong emphasis on the technical domain, but also argued that it is highly dependent on the cloud adoption case and company context. This strengthens the assumptions that context factors are paramount for building any kind of advice for cloud transformation (such as the one built around capabilities in the thesis). Also, the companies at this level might not have sufficient knowledge and experience with cloud to consider managing a cloud-partner network, and neither do they have the cloud mentality of the company to support a full shift to cloud. How each of the four domains fares at this level is described as follows.

The business level maintains high priority - Business and strategy coordination with IT is essential for dictating the directions which PaaS can help support, and breaking the siloed cloud utilization that is not sustainable. IT & business alignment and requirement definition is key for understanding and delivering business needs. Excellent coordination is needed between IT and business to develop strong use cases for PaaS. Governance has lower priority than business, until a clear direction can indicate what policies, standards and regulations should be enforced across the company. However, governance is needed for cloud championing - pushing PaaS initiatives and change management, which interview respondents reported as paramount for changing the mentality of the workforce. Also, siloed efforts for standardization and role definition for PaaS management should be supported, but it is not yet at a cross-organizational level.

The technical level is of highest priority, due to the high number of capabilities that need to be gained in the case for PaaS flexibility as a company that found some business applications and direction for cloud, but needs to actually implement them. IT architecture must be redesigned and standardized so that the initial cloud and PaaS implementation can be leveraged. Application lifecycle management capabilities need to be changed to leverage PaaS and cloud development. Moreover, there is high pressure on engineers to explore and test these new technologies, and also expose their benefits to their managers so they can be understood from a business perspective. Lastly, engineers need to find solutions to migrate legacy solutions and integrate novel PaaS systems within the application landscape. This involves considerable capability needs in developing integration software, rebuilding applications so that they become cloud compliant, or writing novel cloud-native applications. The supply area is the least important. Identifying the right vendors is difficult without having clear requirements from business and clear specifications of what engineering can and cannot do. There is not yet the need to manage a partner network for cloud, but rather small groups of vendors (provider-integrator) that support the same

business function. Still, there are some capabilities that should be taken in account in terms of financials and PaaS market and technology awareness, so that experience can be gained about services available on the market.

4.5.2.3 Initial level

> *"Business is the most important, without a business case that fits strategic goals, there is no motivation to adopt PaaS." (…) "If a business case exists, and is unrestricted by policies, regulations, or strategy, technical architecture and application development skills are needed"*
>
> Senior IT Consultant - Infrastructure and Architecture, KPMG Netherlands

The initial level company places the business domain first due to a severe lack of experience with the other domains, and a strong need to justify filling this knowledge gap by finding a solid business case. Moreover, compliance and regulatory issues may block a cloud case from the start, before even having the need to consider investing in acquiring capabilities in any of the four domains. I judge that the PaaS capability framework would be particularly useful to initial cloud readiness companies, as they can use it in exploring and building a roadmap for cloud transformation.

Business domain capabilities are the top priority for building a viable business case for cloud, and drawing up the requirements needed to implement it. The beginning of a strategy needs to be formed above all else. Executive support needs to be gathered and visionary investments be planned. Governance has the same priority as supply, both being lower than business priority, because prior to business cases there is too little direction to work with. Preliminary efforts should be made for establishing who is responsible for future PaaS initiatives, what roles and rules should be defined, and what compliance and regulatory barriers may be faced for implementing the business case. Also, some capability should be gained in Risk and Compliance Management for evaluating the impact of business cases.

Technical level has the least priority because there is not yet anything to implement. Some efforts to gain basic PaaS and cloud understanding from technical perspectives should be made, and perhaps drawing up plans for technical experimentation with pilot projects. Supply also has an equivalent low priority with Governance, because vendors do not need to be monitored, contracted or orchestrated. PaaS market and technology awareness capability should exist for judging between alternate vendors, for building the business cases. Financial control should also be included as constraints to the business cases.

4.5.2.4 Discussion – Additional context factors for capability relevance

There are other factors that influence which capabilities are more prominent that have not been covered in this study but have emerged as important from the interview responses. First, sourcing strategy differentiates what capabilities are needed for in-house or outsourced development, business processes and services. The PostNL interview proved that an outsourcing-oriented strategy requires less technical capabilities but more supply and governance-related capabilities for controlling the partner network. Second, Strategic intent with cloud also determines the domains that should be invested in. For example, cost

cutting strategies demands increases supply capabilities for cloud financial control; new opportunity / market creating involves business domain capabilities for exploring potential use of cloud; operational excellence determines governance and technical areas to become prominent for increased integration, business continuity and service excellence. Third, data-related restrictions and regulations can block or seriously decrease the value of using cloud solutions, requiring extremely tight capabilities in cloud governance and technical domains, for security and privacy assurance. This applies especially to industries such as banking, insurance and government agencies. Fourth, Technology & Market developments are a contingent factor that might create more or less need for one or more of the capability domains. With PaaS supposedly becoming more mature and standardized in the future, fewer capabilities will be needed for technical integration and standardization.

4.5.3 Subchapter conclusions

In conclusion for this section, having explained cloud readiness as a more simple form of cloud maturity models (ODCA, 2016), I argued through interviews that each of the three cloud readiness levels imply different experience and knowledge with cloud services. Interviews with companies within the three levels were carried out, to find which of the four cloud management domains they consider of higher priority and why, for flexible PaaS adoption. Taking in account the interview responses and theory build with respect to cloud readiness and flexible PaaS adoption, I conclude that cloud readiness of a company influences the priority of cloud management domains to be focused for flexible PaaS adoption. Moreover, companies with lower cloud readiness may benefit more from the full extent of the capability framework for PaaS adoption, because the level of abstraction fits with initial exploratory phases of cloud transformation processes. Advanced readiness companies are already well versed with many of the capabilities, and use them in a more operational and applied way than this research can offer.

In addition, a relationship was established between a company's experience with cloud services and the priority awarded to cloud management domains. These contributions are explorative in nature, setting the context for future quantitative research and case studies, to strengthen the relationships and validate assumptions taking in account a broader range of context variables that influence them. The thesis continues with *Subchapter 4.6* Capability framework prototype, composing the practical deliverable that is the PaaS Capability Framework prototype.

4.6 Capability framework prototype

The PaaS Capability framework ties together the results of data collection, on the basis of the theoretical foundation. As explained in *3.2.4 Frameworks in IT and capability frameworks,* the deliverable is intended as a decision support tool for helping cloud decision makers within large companies understand the capability requirements for flexible PaaS adoption, given their current level of cloud readiness. Researchers can also use the deliverable as a starting point for investigating the context factors and capability needs of cloud adopting companies in more detail or in broader scope. This subchapter presents the

framework specifications and the framework itself, and offers a few pieces of advice to practitioners intending to use it.

4.6.1 Framework specifications

I restate the core specifications for building the flexible PaaS adoption capability framework, which were formulated in subchapters 4.4 and 4.5 as follows:

First of all, the framework specifies capabilities that support flexibility in PaaS adoption, within the four cloud management domains -- business, governance, supply and technical. The capabilities were derived from interview data analysis of what respondents claimed would be essential capabilities for supporting interoperable, portable and reduced vendor lock-in PaaS transformation. The categorization within the four management domains was done by following the model exposed in the theoretical foundation chapter, based on the capability frameworks of Feeny and Willcocks (1998 and 2006) and Joha and Janssen, 2012.

The second specification refers to a company's cloud readiness level determining different capabilities that are relevant for PaaS adopting companies. The company's cloud readiness level was motivated to be a decisive context factor for influencing what capabilities a company needs and is able to acquire, argument that is supported by empirical findings from interviews. The capabilities reported by respondents from the different companies are specified in the framework, each being set under one of the four domains.

Third, it was found that companies with different cloud readiness level perceive each of the four cloud management domains differently, with respect to how important they are for successful PaaS adoption. Data analysis results show that while cloud "advanced" companies assign equivalent priority and stress on the interdependence of all four cloud management domains, intermediate and initial level companies perceive business and technical domains as high priority, with various priorities assigned to the rest of the domains. The reason for this difference is that less experienced companies do not have the experience, resources or knowledge to invest in all domains equally at the same time, and must gradually build up a business case, technical capability, governance policies and structures and form a partner network.

4.6.2 Framework illustration

Based on the specifications described above, the flexible PaaS adoption capability framework portrayed in Table 4-5 shows which capabilities from the four cloud management domains are relevant for flexible PaaS adoption, depending on a company's cloud readiness level (domain differentiated by columns, cloud readiness differentiated by lines) and the priority of each cloud management domain with respect to cloud readiness (differentiated by color).

Cloud Readiness Levels	Cloud Management Domains*			
	Business	Governance	Technical	Supply
Initial	Business - IT coordination for PaaS use case definition	Role definition for cloud/PaaS strategy implementation	Legacy to cloud Migration	PaaS Market and Technology Awareness
		Risk and Compliance Management		PaaS Financial Control
Intermediate	Business - IT coordination for PaaS use case definition	PaaS Championing	Cloud Architecture design and implementation	PaaS Market and Technology Awareness
		Cloud/Non-Cloud Technology Standardization	PaaS Application Lifecycle Management	
		Cloud-oriented workforce mentality	Legacy to cloud Migration	PaaS Financial Control
			Cloud/PaaS integration	
Advanced	Value creation with cloud Partner Network	PaaS / Cloud policy enforcement	PaaS Application Lifecycle Management	PaaS Market and Technology Awareness
				PaaS Vendor service and product control and monitoring
	Business-IT coordination for PaaS value creation	PaaS portfolio risk distribution	Cloud Architecture and application landscape maintenance	PaaS Financial Control
				PaaS partner network management

*Domain Priority Scale	*Equivalent*	*Lowest*	*Low*	*Medium*	*High*

TABLE 4-5 PLATFORM AS A SERVICE CAPABILITY FRAMEWORK

4.6.3 Application advice for practitioners

The last section of this subchapter proposes how the framework should be applied in a practical context. This advice is drawn from observations made during the interviews and from the research on whitepapers on cloud adoption. The application advice is targeted towards stakeholders in cloud and PaaS transformation projects (client-side), who are interested in long-term flexibility of PaaS services.

The first step that should be taken prior to using this research and the framework is an assessment of the company strategy, goals, resources and skills that have any relation to cloud and PaaS services. Such an assessment could be done by following an IT maturity assessment as part of a wider service management improvement project. Specifically for the case of this thesis, a cloud readiness assessment should be conducted, as the ones proposed in the ODCA cloud maturity model (ODCA, 2016). Following this assessment, the readiness level should be identified by comparing against one of the three categories by referring to **Error! Reference source not found. Error! Reference source not found.**. Having the context of cloud readiness set, the framework could already be used to identify the capabilities corresponding to the cloud readiness line. Figure 4-4 briefly summarizes the steps that need to be taken to use the capability framework. As we have seen, it is advisable for companies with lower readiness levels to focus on business domain capabilities to ensure that cloud and PaaS services are beneficial and implementable. After gaining more experience of business domain capabilities, there should be technical focus on preparing systems, applications and architecture to function in a cloud environment. Finally, as we saw with PostNL, supply and governance capabilities become essential for extracting benefits from cloud implementations and keeping costs under control.

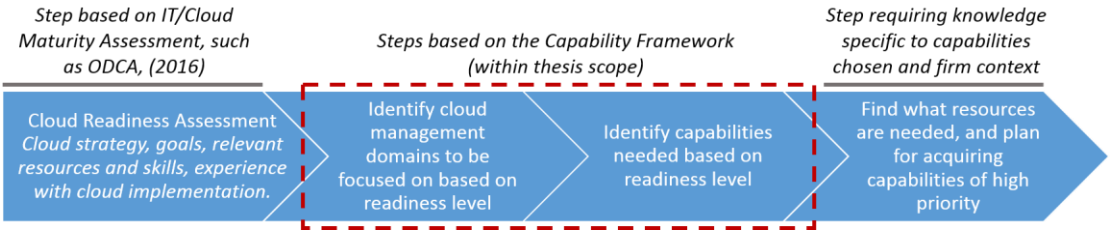

FIGURE 4-4. STEPS FOR IDENTIFYING CAPABILITIES FOR FLEXIBLE PAAS ADOPTION, BASED ON THE FRAMEWORK

For reviewing the meaning and effect of capabilities, an explanation is given in Table 4-4 Flexible PaaS adoption capabilities and their domains. For further understanding on what the capabilities mean for supporting interoperability, portability and minimized vendor lock-in, **Error! Reference source not found.** provides an explanation. Once the capabilities have been understood, the roles within the company, which might be responsible and knowledgeable about their acquisition, should be found. The first step would be to consult with stakeholders within the company that have roles in the cloud management domains or expertize with the capabilities indicated. Because such roles are usually not yet specialized in companies for managing capabilities with PaaS, this task might prove difficult, or even impossible without the aid of external help, such as parties mentioned in the thesis as cloud integrators, brokers and consultants.

4.7 Chapter Conclusions

This chapter described the methodology for designing, conducting and analyzing empirical data, based on a semi-structured interview approach, as well as discussed the main conclusions drawn from data analysis, defining the specifications for the deliverable of this thesis: the flexible PaaS capability framework. I have indicated the advantages and disadvantages of having the interviews for data collection, and the consequences of the volatile domain of PaaS clouds on validity, reliability and reproducibility of research. Then, I explained how the data was analyzed through reduction and categorization, so that specifications regarding flexibility, cloud readiness and supporting capabilities were extracted. The theoretical relationships between these concepts, established earlier in the thesis, were argued through the empirical data found. The data brought supporting evidence that specific types of capabilities support flexibility by ensuring interoperability, portability and minimized vendor lock-in of PaaS solutions. Moreover, the cloud readiness of companies to integrate PaaS solutions were evaluated as - Initial, Intermediate and Advanced, applied on the three respondent companies. This categorization was a prerequisite for showing that different cloud readiness levels determine different capabilities that are achievable and relevant. The final specification states that the cloud readiness also influences the priority firms assign to the four cloud management domains. Having these relationships supported empirically, they were considered as specifications for building the capability framework, which is the deliverable of this thesis incorporating and instrumentalizing the theories and relationships found. The capability framework prototype categorizes the capabilities identified by cloud readiness level, cloud management domain and priority of the domain based on readiness level. The next chapter discusses the possibilities and results of evaluating the framework ex-ante to its actual practical application, by judging how the process of building the framework was conducted.

CHAPTER 5 EVALUATION

5.1 Chapter Introduction

Given the practical orientation of the research, evaluation is an essential part to reflect if the entire research process and its deliverable are applicable and relevant to solve the research problem. However, due to the novelty of the research domain, and the lack of practical applications of similar capability frameworks, evaluation cannot follow any prescribed methodology. The goal of evaluation is to reflect on the research process and result (the capability framework deliverable) and assess them through the scientific quality criteria such as preciseness and clarity of research goals, purposiveness of goals for intended stakeholders, empirical validity and reliability of data and conclusions, rigorousness in deriving structural specifications from interview data. Both internal and external validity are only scarcely treated, because there was no opportunity and resources left to apply the framework in a real-life scenario. Therefore, a critical part remains for future research, to apply the framework in one or more real cloud adoption scenario, to assess if it can deliver the intended results (internal validity) and if it can be applied in other scenarios with similar results (external validity).

> *"Building such a framework to be applicable in practice is a difficult task because it (the application case) depends from company to company and from PaaS application to PaaS application"*
>
> *Application Infrastructure and Operations Manager, Exact Software*

I start this chapter by reflecting on possible evaluation methods that best fit the research in this thesis, by targeting evaluation activities on different stages followed in research. Afterwards, I explain how the evaluation is made for each stage, following standard scientific quality criteria (Sekaran, 2011) and guidelines for evaluating a practical deliverable in research (Hevner, 2004; Verschuren & Hartog, 2005) and reflect on the limitations for this type of evaluation.

5.2 Deciding how the evaluation should be made: reflection

5.2.1 The object of evaluation

Before the actual evaluation of the framework, guidelines must be chosen, depending on the characteristics and context of the object that is placed under evaluation. The object under study is not only the capability framework, but also the process underwent to define the objectives or goals for the deliverable, and the steps to achieve this goal – defining specifications for building the deliverable through data collection and analysis. A fundamental aspect of the capability framework is that it is meant to be useful for practical application. Utility and applicability go hand in hand to ensure the satisfaction of potential users (Verschuren & Hartog, 2005). However, if one is to evaluate these characteristics only at the end of the design process, it is highly probable that requirements have changed or the problem has changed, making parts or characteristics of the deliverable unfit to the new

context (Verschuren & Hartog, 2005). Especially in volatile environments, evaluation cannot be done only at the end of production.

5.2.2 Ex-ante and Ex-post evaluation

Evaluation can be differentiated between ex-ante, evaluation done all throughout the design process, and ex-post, evaluation done after the deliverable has an applicable form that can be tested in a "live" environment. Verschuren & Hartog (2005) argue that both types of evaluations are needed. This is not a new concept and does not restrict to IT deliverables. Evaluation of practical artifacts originates in the industrial design and engineering field, where evaluation comprised of assessing the design for building an artifact that fulfils a practical need, and evaluating the artifact itself, in its material form (Asimow, 1962). With the mostly dominating physical artefacts and products from decades ago, arguments favored ex-ante evaluation because of high costs to modify the design and product after it has been finished. Asimow (1962) argues that ex-ante evaluation assures the correctness of the designing process itself and includes guarantees that the resulting design is useful and relevant. This is done through gaining confidence (through evidence from literature and interviews) in the realization of concepts in practice. Alexander (1964) also endorses the ex-ante evaluation as more important than ex-post, as it can detect mistakes and needed changes while the artefact is not yet finished. Nevertheless, the deliverable of this thesis is an immaterial one, and can be corrected and adapted easily to the context it is in. Therefore, I argue that both ex-ante and ex-post evaluations are meaningful, but they cannot be exhaustive, and adjustments will certainly be needed depending on the case of application.

5.2.3 Evaluation based on design stage

Another distinction made by Verschuren & Hartog (2005) is between plan, process or product evaluation, based on what stage of design in the design cycle the deliverable is in. The plan evaluation is a logical, ethical and empirical check that the plan for design (in our case, the theoretical and empirical research and context building) is coherent and correctly carried out. The process evaluation targets the applicability of the framework as a whole to a specific context, and how this could be achieved. Process evaluation is made through empirical observations in a longitudinal case approach. Finally, product evaluation judges if the deliverable needs improvement based on the results of its application in a live case, where effects are observable and measurable.

5.2.4 Choice of evaluation method

The case of building a capability framework for flexible PaaS adoption is positioned within a highly volatile and unexplored context. This means that it is not appropriate to verify characteristics only at the end of design, when the deliverable emerges, due to the shifting nature of cloud technologies and service offerings and the diverse perspectives stakeholders have on PaaS adoption. Another reason that renders the ex-post evaluation difficult to execute is the time and resource limitations of this thesis; evaluation with a company that uses the framework would require a longitudinal study and strong ties with the target company. This implies that evaluation throughout the entire design process is

paramount for obtaining a relevant and usable deliverable (Hevner, 2004; Verschuren & Hartog, 2005). Thus, the choice of evaluation for this case is ex-ante, and the stage it applies to is plan evaluation, because the stage where empirical observations on a longitudinal case of application is not yet reached. The article of Verschuren & Hartog (2005) indicates useful evaluation guidelines that can be fitted for this thesis, for evaluating the research goals, the steps taken to achieve them by collecting empirical data and the specifications used for building the capability framework. By verifying these steps taken in research, I hope to partially prove the value of the prototype itself, in absence of an evaluation of the framework in a practical, applied context. The next subchapter presents the logical and empirical evaluation of the steps taken to design the prototype, as shown in Figure 5-1 shows the steps taken for evaluation.

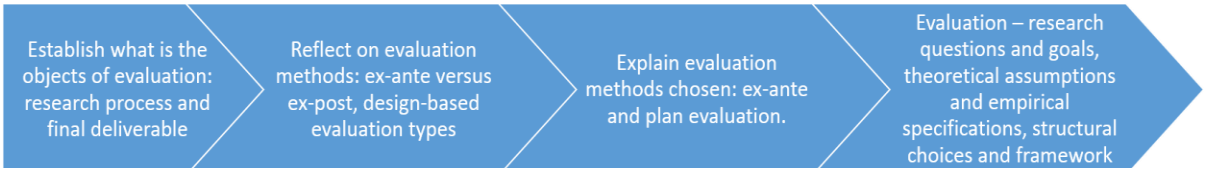

FIGURE 5-1. EVALUATION STEPS

5.3 Evaluation - reflection based on design cycle evaluation approach

5.3.1 Research questions and goals evaluation

The first step of evaluation relates to assessing if the problem and objectives defined for research are purposive, precise, rigorous, and that methodological guidelines for empirical research were followed in formulating goals. Thus, this section's unit of evaluation is the set of goals that the research and final deliverable intends to achieve. Goals in the case of this thesis are represented by the research objective and its' subsequent research questions, which are answered through theoretical and empirical evidence. I evaluate the formulation of the research objective and subsequent questions by treating three areas and hallmarks of scientific research based on the articles of Sekaran, (2011) and Verschuren & Hartog, (2005).

First, I assess if the involvement of a variety of stakeholders is balanced against the expected impact of the capability framework goals. This argument tests for the purposiveness and scope of goals to achieve the deliverable, given its target audience. I argue that a definite purpose was established from the beginning – to find a practical and scientifically grounded solution that can help PaaS adopters maintain flexible environments by integrating PaaS solutions, and preserving interoperability, portability and minimum vendor lock-in. A variety of stakeholders was sought for, in defining the problem, answering the interview questions and providing data for building the framework. Apart from direct users of the framework, thesis supervisors represent supporting stakeholders from both academic and business environment (TU Delft and KPMG Netherlands). The different cloud readiness of companies determined stakeholders to have various opinions on the problem, which covered some of the expected impact of the design. Moreover, writing the thesis within KPMG's team of

highly experienced IT and cloud consultants helped shape the thesis in a purposeful direction by asking the right questions and pursuing the right goals.

Second, I am critical about the preciseness and clarity of research objective and goals for providing a well-understood direction to conduct research and derive the specifications for building the framework. The research questions and sub questions are written such that the concepts, theories and practical components are clear, but at the same time leaving space for exploration. Scoping efforts were made towards the PaaS adoption domain, with specific interest on the challenges of interoperability, portability and vendor lock-in (all three coined as fundamental attribute that enable flexibility with PaaS). The concept of capabilities was used as a solution for these challenges, and the concept of a framework as a decision-making support tool to envelope and categorizes capabilities for practical application. The research questions and sub questions seek to find the relationships between capabilities, flexible PaaS adoption, and the priority of cloud management domains (that categorize capabilities) depending on company's experience with cloud (or cloud readiness). Thus, I argue that specifications for the final deliverable can clearly be delineated based on a rigorous theoretical foundation and empirical data collection and analysis, and act as the answers to the research questions throughout the paper.

Third, I underline the standard methodological guidelines for research that were followed in the formulation of goals, so that the study proves the quality of rigor. Standard methodological guidelines are the research methods that structured how the research questions were formulated and researched. First, a review of practitioner articles and market reports was conducted to define the practical problem and set the context. Afterwards a literature review was made of scientific articles relating to the practical problem identified, in order to understand how cloud adoption is a problem for scientific researchers in the field and similar fields. The knowledge gap was established based on these reviews, helping to narrow down towards the research objectives and subsequent research questions. A full description of methodology can be found in the Research approach subchapter, strengthening the argument that guidelines were followed.

5.3.2 Theoretical assumptions and empirical specifications evaluation

The second step of evaluation targets that the theoretical assumptions formed in the theory chapter and the empirical data collection and analysis. Standard criteria for evaluation are followed to check for validity, reliability, and verifiability of results. The criteria are applied on the theoretical assumptions that serve as a foundation for the empirical research steps, and on the empirical research steps themselves – data collection and analysis - carried out to find the user specifications with respect to the deliverable.

First, empirical validity refers to how empirical data collected corresponds to the theoretical assumptions and the data found in other contexts. Data from interview respondents on the importance of flexibility in PaaS adoption, and on the usefulness of the capabilities described to support it, matches with findings from literature and practitioner articles. The strongest argument in support of validity here comes from more researched fields of cloud adoption and IT outsourcing, where I observed similar issues and solutions in the literature review. Due to the emerging character of this research topic, it may be that maturation is a threat to

validity in the future, as technology and market developments might change how relevant this problem and its solution is.

Second, reliability of empirical results involves finding similar results when administering the same test or interview question in multiple instances. Many of the capabilities and issues with PaaS flexible adoption found through interviews repeated themselves from one respondent to the other, coming in different flavors depending on the respondent's role and context. These similar findings, despite diverse contexts, supports reliability of data. Verifiability of results refers to how easily the results sources and data can be verified to be from credible sources. The sources of empirical data are primary data sources collected through interviews, from cloud stakeholders in Dutch companies. The results in the thesis are based on the interview transcripts, which are available in the annex. Contacting the respondents is also possible upon request.

Third, specifications that regard functionality reflect what the framework should contain for it to be applicable and useful. The demands expressed in the interviews fit with the goals defined for the research: respondent's desired capabilities matched what I intended to find in the research objective and questions stage, and matched the capabilities discussed in literature and practitioner papers (thus strengthening empirical validity).

> *"The research should be applied after looking into a maturity level to evaluate the current capabilities of a company." (…) "The research would be very useful if complemented by a survey or significant quantitative data set from large market research companies (such as Gartner)."*
>
> *Development and Operations Director, Exact Software*

Regarding usability of the framework, most respondents reported that they do not usually follow structured guidelines in similar cases of cloud adoption, the reason for this being that there are yet no structured approaches in literature or practice. Three of the six respondents described that the framework would be useful as a starting point for considering PaaS adoption, but that the company and case of adoption would dictate how the framework would be applied. Moreover, they indicated that such a deliverable would be useful in combination with other cloud readiness or cloud transformation plans, as the ones conducted by external consulting service firms.

> *"Such a framework can be very useful as a starting point and further reference point for companies that are considering PaaS adoption but do not have enough experience or resources to do so independently."*
>
> *IT and Enterprise Architect, PostNL*

Fourth, considering context factors in which a deliverable is used influences its quality and internal validity (to be used for the purpose it was intended to), because it reduces the interference of unexpected or untreated factors. The context factors that affect the relevance of the deliverable, based on observations from scientific and practitioner literature, and argued through the empirical data collected, refer to the framework being useful for companies that are large, have core utilization of IT in their business, are interested in flexible PaaS adoption and have different levels of cloud readiness. However, I recognize (based on literature review results) that there are a wealth of other factors that

influence the needs and solutions companies might have for flexible PaaS adoption. The difficulty to account for the wealth of context factors, especially due to the changing nature of cloud computing and client companies, motivates why the deliverable is still kept at a conceptual level, not far from its predecessor frameworks (Joha and Janssen, 2012). The flexible PaaS capability framework treats only some of the specific characteristics of PaaS and flexibility, in order to differentiate it from general cloud adoption capabilities needed. Thus, I argue that context requirements are still an area which needs much more research, to better understand what factors influence PaaS adoption success and challenges.

5.3.3 Structural choices evaluation

The final evaluative step conducted in this chapter consists of assessing the quality of transition from the theoretical assumptions (based on the theoretical foundation) into structural specifications drawn from empirical data. Structural specifications in this thesis are the choice of capabilities, and the categorizations of capabilities based on cloud management domains and relevance for companies with different cloud readiness levels. This transition is done as a logical rather than empirical test (Verschuren & Hartog, 2005). The structure of the framework was based on the cloud governance capabilities framework of Joha and Janssen (2012), because the target audience and contents of the framework have many similarities. In addition to the Joha and Janssen (2012) framework, I make an arguably essential contribution to distinguish between the priorities of domains based on the client company's cloud readiness level, adding a logical dimension to the original structure. This structural characteristic is formed by first delineating the cloud readiness levels based on empirical data (through a simplified version of cloud assessment based on the model of (ODCA, 2016)), and then logically matching the levels with priorities reported by respondents from each company. The choice of which capabilities to include in the model from a larger set of capabilities found in literature is based on the empirical evidence (or the functional requirements relayed by respondents). Furthermore, I argue that since the framework should be incorporated within other more elaborate plans and practices for cloud adoption, the choice of structure is not an essential trait. Further research in this area could be beneficial for understanding how such a framework can be integrated within broader cloud adoption plans or IT service management frameworks such as ITIL or COBIT. Even though the contents are different, I argue that such research is meaningful to avoid reinventing the wheel by proposing a framework structure that overlaps with existing ones.

5.4 Chapter conclusions

This chapter touched the methods appropriate for evaluating the theoretical and empirical process of building the flexible PaaS adoption capability framework, and applied some of these methods based on the research evaluation guidelines from Sekaran, 2011 and Verschuren and Hartog, 2005. I motivated ex-ante evaluation of the deliverable and its design process, and acknowledged that further evaluation should be done on the assessment of the framework in a practical context, over a longer period of time. Research goals conceptualized in the research questions were assessed to be relevant and precise for defining what further steps are needed to form a theoretical basis and conduct empirical

collection and analysis of data. The theoretical assumptions and design specifications were evaluated, by referring to supporting existing literature and logically linking together the core results that answer the research questions. Standard criteria were used for evaluating the empirical data found from interviews and theoretical concepts from literature - internal and external validity, reliability, verifiability, and relevance of context factors that affect these specifications. Finally, the structural choices for building the framework underwent a logical evaluation, arguing that the choice of structure logically derived from the theoretical foundation and empirical findings. Despite lacking the further steps of evaluating the prototype in practice, the evaluation arguments are momentarily sufficient to support the relevance of future research to apply the framework and evaluate it in a live environment.

CHAPTER 6 CONCLUSIONS

6.1 Introduction

This thesis has presented the process and results of developing a decision support framework that helps large companies understand the capabilities needed for flexible PaaS adoption. The study made use of a suite of research methods for investigating the research context and problem area by analyzing practitioner and scientific papers, building the theoretical framework through a literature review of scientific articles, collecting and analyzing empirical evidence to build the capability framework specifications through semi-structured interviews, and evaluating the steps taken to attain the research objective, and the deliverable itself.

In this final chapter I reiterate the research flow and methods used, emphasizing on the core results of the thesis and their relevance for science and practice, referring to how the research questions were answered. I end by exposing the limitations of this research, and future directions for scientific research and applicability in practice.

6.2 Core results

The core results are presented by relating to the research objective and questions, and how they were accomplished. The objective of this thesis is to:

> *Increase understanding of the capabilities needed for flexible PaaS adoption.*

Considering that PaaS adoption challenges are myriad, I decided to focus on the issues of interoperability, portability and vendor lock-in with PaaS services, characteristics that contribute to a company's IT flexibility - one of the core reasons for cloud service adoption. Moreover, I focused on understanding what capabilities are needed, and how are they influenced by context factors, such as a firm's experience and resources with respect to cloud (cloud readiness).

I intended to achieve this objective by answering a set of research questions that yield meaningful results for both practical and scientific areas. In this sense, I chose to steer the research towards developing a practical decision support framework that helps PaaS transformation decision makers in companies with recommendations of what capabilities they should acquire depending on their firm's existing cloud readiness. The main research question was posed as:

> *What are the structure and contents of a capability framework that supports flexible PaaS adoption?*

The main research question sets the focus of capabilities for companies to be flexible in their PaaS adoption and transformation efforts. To answer the main research question, there are two major directions that were treated by proposing two research questions, Q1 and Q2.

> *Q1: How can capabilities, flexibility and cloud readiness be understood and related in the context of PaaS adoption?*

Q1 seeks to establish a theoretical foundation about capabilities, frameworks, and flexibility to understand and link them. Cloud readiness is introduced as an essential context factor, influencing how these concepts relate. Therefore, the theoretical foundation revolves around explaining flexibility as the challenge and goal desired by PaaS clients, capabilities as the solution, capability frameworks as the operationalization of the solution, and company cloud readiness as a context factor which distinguishes different cases in which different capabilities act as solutions. The first research question was further split into two sub questions.

> SQ1.1: What is the meaning and relationship between capabilities and flexibility in the context of PaaS services adoption?

The link between capabilities and flexibility was established by studying scientific articles and whitepapers exploring cloud and IT adoption. Flexibility was shown to be a competitive factor for companies operating or being supported by cloud services. Given the volatile environment of cloud and PaaS technologies and market, PaaS flexibility enables companies to operate in cloud environments while securing the ability to react to changing conditions. Based on practitioner whitepapers, I identified the factors that increase a firm's flexibility in cloud and PaaS. These properties are interoperability, portability and minimized vendor lock-in and they can be accomplished by acquiring in-house capabilities. Capabilities are specialized skills, knowledge and the decision making structures, required for a coordinated accomplishment of specific goals within a specific context. With this definition as a foundation, I looked into the role of capabilities within the context of cloud service adoption, finding that capabilities can support the successful adoption and exploitation of IT and cloud services. More specifically, I identified various technical and business capabilities support interoperability, portability and minimized vendor lock-in. Thus, a theoretical assumption was formed stating that specific capabilities contribute towards a firm's flexibility in PaaS adoption. For an overview of the relationship between capabilities, flexibility and its components, please check figures 3-1 and 3-3.

Having answered the first sub question, I concentrated on the cloud readiness, the context factor found to be decisive in influencing capabilities relevance.

> **SQ1.2:** Is cloud readiness a context factor that influences the relevance of capabilities for flexible PaaS adoption?

Based on literature review, I found that capabilities are relevant in different ways depending on their context of application within a cloud adopting company. The existing experience, skills, resources and structures for integrating cloud and PaaS solutions (or cloud readiness) were found as a decisive factor that contributes to the success or failure of adoption. In the case of this research, cloud readiness represents the level of preparedness of a company to adopt cloud solutions, so they can work together with, and be leveraged by existing company processes.

Therefore, by answering the two sub questions, capabilities, flexibility and cloud readiness are understood and the relationship between them theorized (as could be seen in 4-1), with the next step being to bring supporting evidence from empirical data collected. The relationships and concepts stand as the conceptual foundations of the capability framework deliverable. Concepts are operationalized specifications, by collecting and analyzing data

from interviews and building the capability framework. This task is fulfilled by answering the second research question and two of its sub questions.

> *Q2: What capabilities support flexible PaaS adoption, and can they be prioritized contingent to a firm's experience with cloud?*

The second research question intends to specify the actual capabilities that support flexible PaaS adoption, the core specification for the capability framework. In addition, the influence of cloud readiness on four domains of cloud management is studied. The methods for answering this question consist of empirical data collection through semi-structured interviews, conducted within three companies that were chosen based on their assumed difference in cloud readiness. The respondents selected from the companies had significant experience and stakes with cloud and PaaS-related initiatives and implementation within their companies. Upon analyzing the data obtained, I could answer to the following final research sub questions.

SQ2.1: What capabilities are core for supporting PaaS flexibility?

This question is answered using the interview responses and more high level capabilities found through literature review. A series of questions in the interviews lead to the specifications of capabilities for supporting PaaS. First, the concept of flexibility was explained to respondents with respect to its constituent properties – interoperability of applications and systems, portability of applications and data and minimizing vendor lock-in of PaaS solutions, and questions were asked about how each of these characteristics are relevant for PaaS adoption, and what issues should be solved in this respect. Afterwards followed the question inquiring about the capabilities that the company considers necessary to have in house to ensure these three attributes for flexible PaaS adoption. All respondents reported that each of the three characteristics are significant for PaaS adoption success, but they also mentioned that their significance is strongly related to the specific case of adoption. The capabilities reported were analyzed from the interview responses and categorized into the four cloud management domains, by logically comparing them with parent capabilities from the framework of Joha and Janssen (2012), thus setting the first core specification for the framework. The second and final research sub question targets the priority of focus on one or more of the four domains, depending on a firm's cloud readiness.

SQ2.2: Which of the four capability domains is higher priority, contingent to a firm's cloud readiness?

The first step taken to understand the relationship between cloud readiness and domain priority was to identify the cloud readiness level of each respondent firm. Questions were formulated and addressed to respondents on the cloud/PaaS strategic and business directions, and existing skills, assets and experience that would help cloud transformation. The answers to these questions were analyzed against cloud readiness characteristics based on a cloud maturity model (ODCA, 2016) found in literature. For the readiness assessment process, please check Figure 4-1. Thus, I determined that the initial level company (banking firm) had no experience with PaaS and had just started exploring business cases for cloud adoption. The advanced level company (Exact Software) had a siloed and still experimental way of using PaaS solutions, while the advanced level company (PostNL) were utilizing PaaS

within a fully integrated, organization-wide IT and enterprise architecture, reaping the benefits of cloud solutions leveraging the business.

Afterwards, further data was collected on the priority each company assigns to each of the four cloud management domains. Making the match between readiness level and priorities accorded, I drew the conclusions on how a company's readiness influences what they should invest in when adopting cloud, a major contribution of my thesis to research and practices.

First, with respect to the cloud-experienced company (or advanced level), they assigned equal priorities to all domains, as they all functioned together in an aligned, interdependent way. At this level, there was no need to focus on just one domain, and I argued that the deliverable of this thesis is the least useful for such companies, who already underwent cloud transformation. The intermediate level company assigned top priority for the technical domain, as they required capabilities to integrate PaaS solutions and adapt their existing systems to the cloud model. This level has a business case and requirements defined, so it must focus on technical architecture and implementation so that it can leverage novel PaaS solutions. However, they have not yet reached the level where they can build a partner network based on functional PaaS solutions and business processes. Finally, the initial level company considered business the top priority, for defining a business case and adoption strategy for cloud and PaaS solutions. I argue that it is highly recommendable for an inexperienced cloud adopter to invest heavily in business domain capabilities, to define a case that fits company strategic goals, and can support existing and new business processes. Moreover, the initial level company does not have the sufficient experience and knowledge to take on the other domains without a proper business case. Alternatively, after developing business capabilities, a company would need to gain technical capability to understand if cloud services can be matched with existing systems. Only afterwards should they pursue the other two domains of supply and governance of cloud services. These conclusions are backed up by the deliverable of this thesis (Table 7), the framework represented as a table containing the core capabilities for flexible PaaS adoption.

Finally, to underline the value of the capability framework, its building process was evaluated in an ex-ante manner, in lack of further possibilities and time to apply the framework in the context of a PaaS adopting firm. The evaluation took in account the relevance and precision of goals, the following of standard research methods, and the quality of the theoretical and empirical steps taken to create the specifications for the framework. The steps taken to design the framework followed a standard research flow, the assumptions and core concepts were well grounded in theoretical foundations and specified by practitioner literature and interview responses. The final deliverable took a form and contents that are easy to understand and recognize by practitioners in the field, and researchers knowledgeable of IT and cloud adoption fields. The practical and scientific relevance are further concluded in the next subchapter.

6.3 Scientific and practical relevance

6.3.1 Scientific relevance

The thesis brings its scientific contribution to the research domain of cloud adoption, proposing how acquiring specific capabilities can enhance the ability of a company to remain flexible in the volatile cloud and PaaS environments, from the points of view of governance, business, technology and supply. I argue that this contribution is much needed, because the current research landscape mostly explains the motivations for cloud adoption, only briefly touching how challenges with adoption from a client perspective can be mitigated. Also, there is a lack of depth in this research domain. Studies that treat how organizations should adapt their existing strategies, business models, processes, skills and resources are mostly done on high level, failing to provide actionable advices to practice when a specific cloud service model, such as PaaS, is adopted. Last but not least, this thesis adds the dimension of cloud readiness, showing it is an essential context factor to influence what a firm should focus on when adopting PaaS solutions. This context factor brings supporting evidence to the argument that it is not sufficient to enumerate capabilities needed for cloud transformation, but that they depend in a critical way on the preparedness of adopting firms, on business, governance, technical and supply levels.

The capability perspective of solving these issues that the thesis takes extends and complements existing research on how capabilities can support IT service exploitation (Feeny and Willcocks, 1998 and 2006), cloud service adoption and governance (Joha and Janssen, 2012) and orchestrating IT outsourcing arrangements (Kleinveld and Janssen, 2015). The understanding of capabilities as human resource based skills, knowledge and management structures is reinforced from the perspective of how this concept can support flexibility, a desirable property that companies are advised to acquire in a volatile market and technology environment such as cloud computing. Moreover, the thesis motivates the choice of developing a capability framework as a useful point of reference for both practitioners and researchers to understand the requirements needed to enable flexible PaaS adoption.

The added value over existing research of the PaaS capability framework is that it goes one step further to specify capabilities taking on the specific PaaS field, and focusing on the flexibility goal. This increased degree of specificity means that researchers can more easily use this research on real-life scenarios of cloud transformation, and judge if the capabilities are helpful or not, as opposed to previous research which illustrated capabilities to abstract and high level to be applied in practice. General capabilities specified until now, such as cloud leadership or financial control, are still valid, but they do not give much insight as to what a company should focus on, and in what situation. Therefore, this research offers a capability framework which is an excellent starting point for researchers to discuss and build their own theories about capabilities priorities contingent to context factors such as from what domain are capabilities from, or what cloud maturity do some capabilities fit to.

6.3.2 Practical relevance and applicability

As shown in the introductory and context building chapters of this thesis, despite high adoption rates of cloud computing, practitioners are still lacking an actionable framework which can guide them through the process of cloud and PaaS adoption. More specifically, PaaS seems to remain the most confusing cloud service model, creating an even more

urgent need for research in this field. Gaining in-house capabilities that increase skills and knowledge on cloud and PaaS adoption is a relevant solution to this challenge, especially because market reports show that lack of resources and expertise is reportedly the number one challenge that managers face when adopting and operating cloud solutions.

Compared to previous capability frameworks (Feeny and Willcocks, 2006; Joha and Janssen, 2012), the present one has increased applicability because it considers a specific cloud model (PaaS), a business goal (flexibility), and a context factor of influence (cloud readiness), despite being narrower in range of application. The flexibility of cloud-non/cloud integration has proven to be significant for business, as one of the factors that favors or blocks cloud service adoption from being successful. In the case of PaaS, both existing literature and interview responses showed that integration issues are enhanced by the lack of standards for data formats, communication protocols, security and identity access management, and others. Moreover, I saw that integration and switching services is difficult because PaaS vendors provide their services with customized functionalities and the dependencies that come with them. Thus, a company's lack of control over standards evolution and the development of PaaS market offerings almost forces the client company to gain capabilities for integrating a PaaS solution with existing systems, and keeping an acceptable level of vendor lock-in.

With respect to applicability of the framework, the capabilities are presented in a way that helps practitioners identify the context in which they could be applied. The cloud readiness level in the capability framework indicates what capabilities are desirable for each specific cloud readiness level, and further specifies what areas of focus should be seen as with high priority, among the four domains of business, governance, technical and supply. However, I acknowledge that the framework cannot be used as an independent entity for supporting PaaS adopters. A wider range of factors should be taken in account for understanding what capabilities are desirable and achievable by the client company, and a detailed approach on how these capabilities could be implemented within the company context would be required. In this sense, the capability framework could be used in combination with a broader, more widely known and more complete IT service management and governance frameworks, such as ITIL or COBIT. Moreover, in order to understand the capabilities that need to be acquired to reach a desired flexibility level, it is necessary that potential PaaS adopting company assess their current levels of IT and cloud readiness, also making use of maturity models or assessments from external service providers.

6.4 Limitations and future research

The last subchapter of this thesis discusses the limitations of this research with respect to the resources for reaching the final goal, the context of cloud computing as a changing environment, and the solution space of capabilities, flexibility and application within a framework for practical use. Moreover, future research is proposed to mitigate these limitations and expand the research in breadth and depth.

First of all, the limitations that are unrelated to the subject or research methods are the resource limitations for conducting this study. I perceive that the number of interviews and the quality and quantity of data gathered could have been much more targeted to the scope

of this research. A higher number of interviews targeted towards at least double the number of respondent companies would have increased the quality of data and results significantly, because presently the evidence of what capabilities are needed for each of the three cloud readiness levels is based on just one respondent company per level. I suspect that there might be undiscovered capabilities that may be relevant for flexible PaaS adoption, because of different contexts in which it is adopted. Thus, taking on further cases of PaaS adoption and observing if similar answers are given may significantly increase the reliability of data. Moreover, a longer time period and more in-depth relationships with companies would bring essential insights into the applicability of the framework in practice. As for now, while the process of research and designing the final deliverable was argued to be reliable, there is still little empirical evidence that the framework would be interpreted and used as intended. This limitation, combined with the previously mentioned limitation on the extent of interviews conducted could be relevant objectives for future research, based on the theoretical foundations of this thesis and the practical design of the capability framework.

Second of all, while the cloud and PaaS service domains are interesting to explore due to their volatility and wide range of application scenarios in practice, these characteristics make cloud-related challenges and solutions very slippery to contain and reach conclusions about. A recurring problem I have heard from most if not all interview respondents and other people discussed with was that a definition for PaaS has not yet been reached. A PaaS service can mean many things depending on the service bundle offered by a provider, or on the stack of requirements asked by a client. As indicated in the conclusions of several market research studies, challenges that practitioners experience with cloud services change yearly, as new technological or market solutions emerge for old problems (such as security issues which were surpassed in 2016 by expertise and knowledge issues), but at the same time new problems appear (for example, integration between multiple cloud vendors to provide a common application for the client). The consequences of this volatility forces firms to be flexible, and researchers to constantly challenge previous findings in this field. The direct impact of this aspect on this thesis is that the validity of findings might be threatened on long term, when there would be more efficient solutions of achieving flexibility other than gaining to wide a range of in-house capabilities. An example that would circumvent the utility of capabilities for adapting a company's IT systems to novel PaaS solutions would be the emergence of standards, at least used between several prominent PaaS providers. Thus, I believe it worthwhile to conduct future research on the open-standards and open-source PaaS technologies, and how they might be a significant enabler for enhancing flexibility in PaaS adoption.

Third of all, there are limitations with the solution choice itself, as a capability framework that supports decision making. A problem in general with specifying capabilities as solutions to IT adoption issues is that they are too abstract to be directly applied in practice (Kleinveld and Janssen, 2015) without significant interpreting of how the capabilities fit the context, what roles in the company can be made responsible of them and how they are actually acquired in practice. However, the reason for having the capabilities in a less-than operational state is to enhance the generalizability of findings. Especially given the changing nature of cloud technologies, it is highly probable that capabilities that are specific enough to be directly understood and applied in an operational context might not be valid in the

future, or in the present but in a different context. Therefore, a middle ground must be found with this type of solutions, to maintain a sufficient level of depth so that the capabilities are applicable without effort that surpasses benefits, while remaining high level enough so that they apply on multiple contexts. In any case, I argue that a practitioner wishing to apply such a capability framework is bound to invest significant efforts into translating capabilities into actionable decisions, because the context factors that are internal (firm-related) and external (technology and market related) can never be exhaustively included in a framework design. Thus I argue that future research should be done to understand how capability frameworks might be solutions for a greater number of contexts, but maintain a similar level of abstraction for the capabilities themselves, to maintain generalizability of findings given the volatile cloud context that is an inherent threat to validity, which cannot be resolved until cloud stabilizes.

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ANNEX

6.5 Interview Protocol

0. Briefing (pre-interview email / call): 20 minutes of call / reading by respondent.

- Introduce myself and my position (TU Delft / KPMG) and confidentiality possibilities.
- Introduce the potential respondent to the thesis topic, objectives and application in practice.
- Introduce the main concepts that will be discussed:
- PaaS adoption - basics, use cases, challenges.
- **Flexibility** in PaaS (Interoperability, Portability, Vendor lock-in avoidance).
- Organizational **capabilities** supporting flexibility.
- Capability **framework** and **categories** it targets (types of companies by cloud maturity, and domains of application within company).
- Ask if the goals and high-level contents of the interview are clear and relevant for the respondent.
- Explain how the framework can help respondent's organization in the future.
- If unclear, restate and explain.
- If irrelevant, ask for a different person that would be more comfortable with the subject.

1. Introduction (5-10 minutes)

Open talk to set the atmosphere, introducing myself and the purpose of my thesis, the scope of the interview, what I hope to find with the interview, and what confidentiality requirements the interviewee might have.

What I need to find out from you (broadly)

- Company's position on Cloud (**strategic**)
    - Innovative/Exploratory or Efficiency-driven/Exploiting
    - A broad assessment of Cloud maturity (business and technical)
- Cloud initiatives (**tactical**) involving PaaS Services
- Challenges in integrating PaaS, and priority (**operational**)
    - Interoperability of Applications, Teams, Business processes.
    - Portability of data and applications.
    - PaaS vendor lock-in - switching costs
- Organizational capabilities required to solve challenges contained in a framework.

Any additional Confidentiality issues.

2. Questions. (45-50 minutes)

This section addresses the main interview questions in a semi-structured manner. The respondent does not need to give a precise answer - it is open to discussion but within the boundaries of the subject. My responsibility is to steer the respondent on the right path to stay on subject.

I. Context building (10 min)

Topic 1. Your role within the company

Topic 2. Cloud Strategy and PaaS

Topic 3. Cloud maturity

Step II. PaaS adoption (10 min)

Step III. (15 min) Interoperability, Portability, Vendor lock-in (based on selected cases)

Step IV. Framework (10 min)

3. Follow-up questions & Closing remarks (5 min)

Final thanks and setting a potential follow-up discussion (call or email)

6.6 Interview questions

Q1 - Stake in cloud/PaaS strategy and implementation.
Q2. Strategic position of the company towards cloud/PaaS adoption.
Q3. How well is the company prepared to adopt cloud/PaaS on a technical level?
Q4. How well is the company prepared to adopt cloud/PaaS on a business / organizational level?
Q4. Rank the priority of the four domains of cloud management for successful PaaS/cloud adoption?
Q5. What use cases for PaaS are there within the company?
Q6. What preparation steps need to be taken for PaaS adoption?
Q7. How important is interoperability between applications, systems and business processes based on PaaS with other entities?
Q8. How important is portability of applications and data based on PaaS platforms?
Q9. How important is easily changing to another platform, with minimum switching effort (application, data, dependencies)?
Q10. What capabilities are core to have in-house for adopting and maintaining flexible PaaS application environments?
Q12. Would a framework categorizing capabilities by company cloud maturity and domain of application be useful? If yes, how would it be applied?

TABLE 0-1 INTERVIEW QUESTIONS

6.7 Interview responses

	IT and Enterprise Architect
Q1	Part of a team of architects, aligned with the CIO and CFO for translating the mission and vision into capabilities through IT architecture. Part of achieving the full-cloud scenario, where all clouds communicate, users collaborate, and applications interoperate in the cloud. Developing the network architecture for communication and interfacing between components.
Q2	Using technology, and cloud solutions to drive strategy and initiatives. Achieving a full-cloud scenario of integrated and standardized solutions, which align with business strategy. Moving towards a partner network rather than supply chain. Align and standardize processes, business and technology with partners.
Q3	It is now well prepared due to significant restructuring over the past years, which considered in advance the full cloud stack adoption. Enterprise and IT Architecture had to be completely redesigned, as well as underlying processes, roles and responsibilities, including a massive workforce restructuring. In short, the entire organization had to be restructured to fit the new strategy, needs and goals.
Q4	In the beginning and during the transformation process, there were problems with the discrepancy between operation and development requirements for software. Software developers (from outsourcing vendors) had to be aligned with our operation processes and needs
Q4	Extremely difficult to prioritize these domains, because they are all important and must be strongly interlinked to achieve the full benefits. Business and Governance are essential, for developing the business cases and rethinking policies and principles to guide cloud utilization and processes. Technically, there are a lot of preparations needed for moving to the cloud, starting from the IT architecture, and then considering Identity access management, security and the complicated technical implementation. The supplier network is also important. Suppliers have to be aligned and a partner network has to be created, so that a common understanding of cloud, its application, and objectives is reached. This requires parties who provide the PaaS platform, software application outsourcing who writes on the platform, and integration experts who help integrate data, user provisioning, Identity access management, etc.
Q5	Outsourced software being developed and operated on PaaS for different work areas. - Only core and non-commodity software is developed, utilizing external SaaS solutions covers the rest.

	IT and Enterprise Architect
Q6	Both technical and organizational preparations are needed beforehand. A business case and supporting architecture needs to justify and sustain platform as a service adoption. From a technical point of view, the types of desired authentication, data formats & transmission, interfaces, identity access management, integration principles, and networks, need to be established as a standard to be used across the entire organization for integration and interoperability purposes. From organizational point of view, a full partnership network needs to be able to support PaaS, and internally the roles, responsibilities and rules need to be clearly defined to dictate how PaaS is selected, run, integrated and monitored.
Q7	It is essential for any application developed on PaaS to integrate with all dependant applications around it, and support the underlying business processes that work on this stack of applications. For the new way of working as an event-based business, this integration is essential on all levels, such as files, messages, service calls, front/backend between applications.
Q8	In a fully integrated application environment, portability is not an issue because there is no motivation to port applications or data to different providers or environments. Different environments would have to be chosen such that they can handle the applications or data that wish to be ported.
Q9	In a well functioning partner environment, where applications are integrated and interoperable, switching is not preferable because it would incur massive costs. This makes vendor lock-in a huge problem due to financial reasons. To avoid vendor lock-in and have some protection, abstraction layers must be added (adapters, containerization), or open source technology should be used (which is costly in times of implementation and offers no guarantees for business continuity) However, for PostNL, they want to rely on providers to come up with a complete solution and do not want to bother with open source technologies or costly steps to avoid vendor lock-in.

	IT and Enterprise Architect
Q10	**Governance** Cloud-oriented / IT driven strategy building; Executive support (cloud championing at an organizational level). Financial support (strongly dependant on executive support); Coordination and management of the whole restructuring and adoption - communication between program managers and architects. Workforce that is in line with technology trends and can change with them (for example, app-based mentality). Development and operations integration and alignment. **Business (Demand)** Capability of transforming suppliers into service providers and aligning them with business. Strong relationship management - partners that are experts in the specific fields that the company wants to work in. Continuously adapting the whole partner network to new technology and trends so that legacy is avoided. Partner portfolio management for risk distribution and ensuring business continuity. **Supply** Requirement design for security, encryption, data privacy & regulation.; Monitoring capabilities of vendor service; Control of vendor service and product delivery; Strong contract development skills; Testing for cloud vendor maturity. **Technology** Flexible Cloud IT architecture design that can incorporate new technologies, applications and dependencies. Cloud/PaaS Integration strategy and implementation - people who can implement, configure and design integration principles between applications; Experience with integrating and running a PaaS environment (this can also be outsourced).; IT & Enterprise architecture design; Decoupling non-cloud applications and rebuilding interfaces.; Identity access management expertize Development of principles and rules for technological standardization (data formats, communication protocols, etc.) Expertize in data formats, communication protocols, interfacing; Abstraction layers design expertize and re-coding applications to ensure interoperability.
Q12	Such a framework can be very useful as a starting point and further reference point for companies that are considering PaaS adoption but do not have enough experience or resources to do so independently (or within their current partner network).

TABLE 0-2 INTERVIEW RESPONSES

	Corporate Infrastructure Manager
Q1	As corporate infrastructure manager, I ensure that the IT infrastructure is effective in serving the needs of different business units, and also efficient in maintaining the infrastructure so that it respects budget constraints. I am interested in using cloud solutions to have good connectivity between different infrastructure components and supporting any PaaS implementation with our own infrastructure.
Q2	Mainly IaaS related
Q3	First of all, at the moment the infrastructure works more efficiently in the current, hosted datacenter plus on-premise combination. We are not considering creating a PaaS environment ourselves, or using IaaS intensively in the near future. From my infrastructure and IT services point of view, we need to upgrade our architecture, ways of working and technology to a more virtualized and connected environment before we can use cloud efficiently. Also identity management is another step to be unified so significant change to cloud infrastructure/applications can be achieved.
Q4	We need more standardization and new governance methods for production environments and corporate infrastructure so they can be merged together and break the silos.
Q4	Depends on the case of cloud adoption, but generally, would say the technical area is the most important and the others are equally important. While we can't do anything about it, I think that cloud technologies still have to advance so that they achieve standardization and break the barriers between vendors, and maybe even converge to just a few dominating vendors.
Q5	Offering an environment for development, testing and operations teams to more easily deploy their software stack onto our infrastructure. I don't see a strong application of PaaS from a corporate infrastructure perspective. You should get more insights from our Software Development business unit.
Q6	Investing in upgrading in-house infrastructure and applications to be cloud ready and hiring people with experience in cloud technologies on different levels Hiring external consultants and intermediaries to help choose and implement the right PaaS solution
Q7	It is essential to have a cloud solution that is standardized and can be used with existing systems and infrastructure. This is one of the reasons for not considering to use PaaS yet from our perspective.

	Corporate Infrastructure Manager
Q8	Not relevant for respondent position.
Q9	Not relevant for respondent position.
Q10	The choice of a standardized cloud solution, this is not doable until cloud stabilizes more and vendors offer integration between solutions. Procedural understanding of how to integrate different business units in cloud while respecting each regulatory and access needs. Technical skills on API services/applications, microservices, virtualization, containers. A cloud-ready infrastructure and application architecture is essential Communication and joint governance of different business units interested in the PaaS solution (in our case, between production and IT administration). Financial and executive support for the initiatives (the capability here is actually the strategic interest and business understanding of executives about PaaS and the communication between them and the business units who want PaaS and are able to explain why they want it).
Q12	Not relevant for respondent's position.

TABLE 0-3 INTERVIEW RESPONSES

	Development and Operations Director
Q1	Role of keeping the company's core product (SaaS ERP software) up and running. Chief responsible of a PaaS platform strategy that can integrate the development efforts of 35 development teams spread around the world. Deciding the technical & business requirements from PaaS platforms to support microservice style development and continuous delivery of their core application.
Q2	Main strategic position towards cloud is SaaS as their core product. PaaS is not explicitly a strategic objective but it is a means to achieving microservice architecture for their core SaaS application. Interest to transform the current monolithic solution into a microservice based one (architectural style for continuously deployed systems consisting of many decoupled services that facilitate a modular approach of system building).
Q3	Core application needs to be rebuilt slowly from stateful and monolithic towards the next big cloud-ready version. Already some idea on running Azure and Rackspace for infrastructure cloud. The technical capabilities to rebuild exist but it takes time, especially since the application is live.
Q4	Culture and mentality not yet cloud-ready.
Q4	Technical is essential due to security and privacy of client data and applications, which are dealbreakers in PaaS adoption. Security should be considered from within the application and less vendor-reliant. IT Architecture is foundational for building a cloud-ready environment Deep knowledge needed for running PaaS platforms. Governance is also essential due to mentality to accept cloud and change in general. The most important thing is to empower developers to drive product design instead of marketing or non-technical people, who cannot keep up with quickly changing technical innovation trends. Greatest challenge is to change the culture and the people towards change, risk taking, failing and adapting. Another important governance aspect is risk management and compliance, especially when managing multiple cloud vendors. Too much chaos can lead to costly and misaligned cloud solutions. Business and Supply area not mentioned
Q5	Transform the current monolithic solution into a microservice based one (architectural style for continuously deployed systems consisting of many decoupled services that facilitate a modular approach of system building). Integrate SDLC work on core application from 35 distributed development teams to work in parallel on the same platform.

	Development and Operations Director
Q6	In-house technical skills for running a PaaS platform, working agile and designing a microservice architecture. Keep up-to-date with new tech as a team effort and based on a cultivated team mentality.
Q7	Important to be able to write custom code or applications that interconnects different environments and processes.
Q8	Important from the point of view of running company data on vendor datacenters.
Q9	Important to change to another vendor but difficult because PaaS vendors get users locked in with the functionalities they offer. However, for big systems/applications, vendor lock-in is unavoidable because they are stateful and legacy, and have too many dependencies to build a cloud infrastructure to work on.
Q10	Design Microservice and standardized Architecture Vendor management and diversifying cloud vendor portfolio to spread risk is a must, no one vendor can offer enough assurance. Strong supply and partner network for choosing and integrating PaaS and planning for alternatives to increase interop/port/reduce lock-in Privacy, Security and Compliance expertize are deal-breakers. Strong financial and executive support for PaaS initiatives if demanded by IT (this is a subset of business IT alignment). Company culture towards agility - biggest challenge is to obtain the resources and drive the mentality that preservers agile ways of working, applications, services, that can be easily changed from the inside. This will enable changes on the outside (vendor change). PaaS platform running skills can ensure that the company is not dependant on PaaS services and can more easily adapt code or create their own environment when wanting to switch providers or change product. Empowerment of developers to drive business. Building multi-disciplinary teams that consists of all roles needed to achieve a goal (release a software component, or try out a technology through pilot projects) and gradually increase customer satisfaction by incremental improvements.
Q12	My research should be applied after looking into a maturity level to evaluate the current capabilities of a company. The research would be very useful if complemented by a survey or significant quantitative data set from large market research companies (such as Gartner).

TABLE 0-4 INTERVIEW RESPONSES

	Software Infrastructure and Operations Manager
Q1	Running Exact Online, PaaS services for monitoring, ADLC process support (alerting, availability monitoring, etc.) and for production environment PaaS (Azure Service Bus) Deciding the technical & business requirements for PaaS for ADLC and operation of EOL.
Q2	PaaS as a contributor to the value of their SaaS core product
Q3	Technically, there needs to be more integration between production, operations and infrastructure, but some of the components for using cloud are there. The problem is more on the organizational culture and management side.
Q4	Mentality is on its way to the cloud but not yet there because of siloed development/operation/infra. Also there are many restrictions of compliance because of customer data, and due to business continuity of our live application.
Q4	Technical is the most important due to IT architecture, data security, and application design. Without cloud-ready application architecture, the vendor or business reasoning is irrelevant because cloud cannot be implemented. Governance is also essential due to risk and compliance, which is a make-or-break factor for adopting cloud. Manageability of customer data, compliance and security should be considered from the start. Also, cloud leadership and cultural changes are essential. DevOps/Continuous development which support cloud adoption and are in turn empowered by it are about cultural change rather than technology. Business Area - not mentioned. Supply Area SLAs should not be relied on, but rather applications should be tolerating of failure. Other areas are similar to outsourcing and regular service management, the big differences in cloud are in mentality and technology readiness (i.e. architecture)
Q5	From operations point of view, PaaS can offer better monitoring, ADLC process support, maintainability, faster development through use of PaaS APIs, increased customer-facing services through PaaS services.
Q6	In-house technical skills and de-siloed culture change for running a PaaS platform.
Q7	Important, interoperability should be increased from the application point of view.
Q8	The architecture and code should be written so that it works in different

	Software Infrastructure and Operations Manager
	environments, and not be tied to one or two platforms types.
Q9	It's essential to understand the degree of lock-in to determine what changes need to be made for switching providers. Very important is to have manageable customer data, so lock-in on that side should be minimal.
Q10	Cloud Application architects & developers designing scalable and cloud-native applications. Customer data security experts & compliance managers. Cloud application monitoring & proactive processes for maintaining a easily manageable, interoperable application Development / Operations (DevOps) collaboration for running a scalable, cloud-native application. Sets of requirements and best practices for developers in cloud-native ADLC. Awareness of cultural changes (CI, CD, DevOps) needed to adopt and maintain PaaS from technical and business people. Fault-tolerant application design due to cloud inherent volatility. Vendor management - distributing risk across several cloud vendors and never relying on just one vendor for operation.
Q12	Difficult task because it depends from company to company and from PaaS application to PaaS application

TABLE 0-5 INTERVIEW RESPONSES

Column1	Software QA Automation Engineer
Q1	No explicit role and responsibility within PaaS/Cloud. Writing and implementing automated test scripts for developers to run and deploy within the SDLC.
Q2	Not Applicable
Q3	For cloud adoption, constant updates in knowledge are needed about technical and vendor specific changes that occur. There are not yet enough technical skills or mentality needed for cloud but it is slowly growing.
Q4	Culture and mentality not yet cloud-ready. Closing the gap between operations and infrastructure is difficult because of this.
Q4	The most important domain is the Technical because good understanding of PaaS technical capabilities empowers engineers to decide the characteristics of the cloud and how it integrates with existing systems. Business needs can be fulfilled in similar way by different vendors and in different ways without the end user feeling it. Therefore, technical teams are responsible of the choice and implementation based on: (1) If PaaS users are interested in functionality alone, they don't care about customizing and configuring the PaaS, which implies that less tech skills are needed for running it but higher vendor lock-in and more difficulties to integrate it with other systems. (2) If PaaS users are interested in functionality and configurability, they will choose a vendor or range of vendors that offer more customizability, more freedom, less lock-in but much higher in-house effort for implementation in terms of technical skills.
Q5	Enabling stronger and more integrated automation capabilities for QA automated test designers and integration with development.
Q6	In-house technical skills for running a PaaS platform
Q7	Extremely important because development is not the only thing to do with PaaS. Operations and even infrastructure should be able to access the PaaS in some way for configuring, integrating with on-premise infrastructure, or using some APIs and functionality with their own systems and processes, which requires interoperability.
Q8	As long as the PaaS vendor provides the functions needed to accomplish goals with PaaS, portability is not a big issue.

Q9	If the PaaS platform gives a lot of freedom and integration capabilities with other systems, switching would not be needed, and if needed, it would be easy. As a user of PaaS, I don't care about the vendor as long as it gives me free hand to use it to fulfil my current and possible future needs. It's also not that difficult to switch in all cases, writing some custom code can adapt the application to another platform. However, the financial, regulation and risk control stakeholders might care from their perspectives because of complex contracting, compliance and vendor management considerations.
Q10	Company culture accepting urgency towards change across hierarchical levels. Tech & Business awareness of cloud technologies - encouragement from management, innovation time for exploring apart from daily tasks. Skilled IT engineers and architects that can respond to problems/needs by using novel, cloud technologies that are flexible to prevent future problems and be easily maintainable. Tech & Business roles that enjoy changes and can be spontaneous in finding solutions (PaaS/cloud)
Q12	No answer

TABLE 0-6 INTERVIEW RESPONSES

	Senior IT Consultant - Infrastructure and Architecture
Q1	Interest in risk, compliance and business cases for cloud and PaaS. Experience with SaaS but limited with PaaS adoption
Q2	Exploring cloud business cases and their potential benefits and costs.
Q3	A lot of applications are not cloud ready and it is often easier to configure applications to work on IaaS but more difficult to be operated on PaaS due to many dependencies that are not supported on cloud Applications strongly depend on databases, middleware, identity access management, which must be replatformed for cloud, which in many times is easier by re-writting the entire application, especially if dependancies are not supported (eg: Windows server 2003). People knowledgeable of Cloud/PaaS exist in companies but are deeply technical and worried about organizational changes required to adopt - Instead of running your own environment you monitor another one which requires different capabilities.
Q4	Most problems with risk & compliance, legal, procurement. Alignment of all these decisions and moving sensitive data to cloud providers is very underestimated and mostly done after adoption, which creates problems.
Q4	Business is the most important, without a business case that fits strategic goals, there is no motivation to adopt PaaS. Second is Governance for risk & compliance. If PaaS is blocked by restrictions, it's not worth considering it. Third is technical area. If a business case exists, and is unrestricted, the technical architecture and application development skills are needed. Plus, this has to be aligned with cloud strategy. Supplier area not mentioned
Q5	Migration of legacy applications into PaaS operation or new application development
Q6	Strategic selection of vendors and partners and doing a proof of concept. For core software applications, in-house development capabilities needed to be upgraded to work with cloud aspects through training or hiring.
Q7	Important because the application must work well in the full application landscape, if the whole application landscape is not fully migrated to the cloud.
Q8	Portability of data is essential and can be a deal-breaker and it is a big consideration especially when moving data to the cloud. Portability and avoiding vendor lock-in are also motivated by expensive licenses, to which companies do not want to get tied their development processes and applications to.

	Senior IT Consultant - Infrastructure and Architecture
Q9	It depends on the application, but usually the goal is to minimize lock-in and easily switch vendors because of fear of future developments, contract breaches, costs, etc.
Q10	Application development and its related activities needs to be strong in advance to be able to successfully and easily take advantage of working in the cloud. Target architecture design and principles for guiding development must exist in order to create a cloud-ready environment and applications. Readiness of architecture - clear architectural vision and knowing how to implement it for cloud. Support from management to make visionary investments. Strong business and technical capability to integrate PaaS within strategy, align with business, and consider exit strategies and risks so that change can be smooth in case of problems. Strong supplier/partner network and awareness of vendors to understand alternatives.
Q12	No answer

TABLE 0-7 INTERVIEW RESPONSES

6.8 Confidentiality requirements document

Confidentiality Requirements Document				
Name				
Company				
Position				
	Thesis and any Thesis-related documents (annex, thesis defense presentation)	Thesis and Thesis Annex Only	Thesis Annex Only	Hidden
Where can your name be mentioned?				
Where can the company name be mentioned				
Where can your position be mentioned				
Additional comments				
Please review the interview transcript below, and make any desired changes directly on the text using red color. Please add any other comments in the comment box above.				
Interview answers for each question				

TABLE 0-8 CONFIDENTIALITY REQUIREMENTS DOCUMENT

6.9 Supporting capabilities for each Flexibility attribute

Flexibility Attribute	Supporting Capability
Interoperability of applications and systems	(a) Technology standardization efforts in utilizing standard data formats, communication protocols, interfaces, APIs and abstraction layers between applications and services; (b) Cloud/PaaS integration efforts in development of integration software, utilizing containerization; (c) Reengineering of legacy applications and out of date systems to work in collaboration or based on PaaS solutions; (d) Cloud architecture design and implementation - rebuilding the IT architecture so that it can incorporate and sustain novel cloud technologies such as PaaS.
Interoperability of processes	(a) PaaS/cloud policy making for security, data policies and identity access management so that processes and users can work on common interfaces; (b) Cloud-oriented workforce mentality supports organizational change towards user collaboration on cloud-enabled processes (c) Business-IT Coordination for PaaS adoption and integration is essential for defining and implementing requirements on how applications and processes interoperate for higher business value.
Portability of applications and data	(a) PaaS portfolio risk distribution permits data and applications to be ported (at least to some extent) to other environment when the need arises. (b) Technology standardization - Standards and policies on data formats, access and security implemented organization-wide increases portability of data within the organization and partner network.
Vendor lock-in mitigation	(a) PaaS portfolio risk distribution can help reduce vendor lock-in effects by ensuring that an entire application or process is not fully dependent to just one provider, so that business continuity is not affected in case of an exit (b) PaaS Market and Technology awareness gives a company insights into how vendors and technologies evolve, so that the company can have a timely and planned reaction to change vendors if needed. (c) PaaS inclusion in partner network is another way of mitigating vendor lock-in by “embracing” it. Cultivating deep relationships with cloud vendors creates a mutual dependency, which changes the supplier’s status to partner.

TABLE 0.9 SUPPORTING CAPABILITIES FOR EACH FLEXIBILITY ATTRIBUTE

6.10 ODCA Cloud Maturity model compared to readiness

This table contains a detailed description of how the readiness assessment was made with support of the ODCA cloud maturity model, for each of the three respondent companies based on interviews. The first column indicates the respondent company, and their expected cloud readiness levels. The second column lists existing characteristics of the company with respect to their strategy and operation of cloud and PaaS solutions. The third column lists the matching cloud maturity model levels based on the ODCA model, stating what each level implies.

Table 0.10 frames each company's cloud readiness into three categories that I define for simplicity as Initial, Intermediate and Advanced. The interview responses from each company match with ODCA cloud maturity levels, justifying my simple classification into the three levels.

Company and level	Cloud/PaaS readiness characteristics based on questionnaire responses analysis	Correspondence to Cloud Maturity Level
PostNL (Advanced)	Utilizing technology and cloud solutions to drive strategy and initiatives. Full-cloud scenario with integrated, interoperable and standardized solutions aligned with business strategy. Standardized and aligned cloud partner network. Partner network-wide policies and standards for orchestration.	**CMM 5 - Optimized**. Federated, interoperable and open cloud. Automated application and service deployment, orchestration between multiple cloud systems and vendors, distributed data and process movement, and defined partner network and integration layers.
Exact Software (Intermediate)	Strategy implementation uses PaaS where needed for supporting SaaS development. Efforts initiated for PaaS usage to unite siloed development teams. Monolithic, legacy applications based on architecture that needs updates for cloud readiness. No technical integration between production, operations and development. Virtualization efforts underway for infrastructure and applications. No organization-wide policies and initiatives for standardization and governance of cloud landscape. Cloud culture and mentality incipient or siloed based on department (development, operations, and infrastructure).	**CMM 2 - Repeatable**, Opportunistic. Processes for cloud adoption defined. Strategy and approach decided upon and applied opportunistically. Redundant and overlapping approaches exist. Emergence of cloud aware apps. Adoption of private clouds with physical-to-virtual transformation of infrastructure and applications.
Banking Company (Initial)	Assessing risk, compliance and business value for potential cloud solutions. Applications not cloud ready, especially for PaaS, due to outdated dependencies (databases, middleware, etc.). Sensitive data, risk, compliance and legal aspects slowing down the process of planning for cloud. Mentality not cloud ready, no technical skills for working with cloud or PaaS development.	**CMM 0 /1. Legacy / Ad hoc** Applications on dedicated infrastructure / analysis of current environment's cloud readiness. No cloud strategy and implementation. Mapping and analysis of cloud potential for existing systems and services.

TABLE 0.10 COMPARISON BETWEEN READINESS LEVELS AND MATURITY LEVELS (ODCA, 2016)