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Abstract

Cloud computing is the fastest growing part of the IT industry and is a solution to effectively manage data. Cloud computing is an evolved form of traditional IT outsourcing and it has been identified that hidden cost are the largest bottleneck of IT outsourcing. In this research, hidden cost drivers at ten cloud migrations projects in the banking industry are examined. Hidden costs drivers during cloud migrations exist, and are a combination of tangible and intangible drivers. Findings of tangible hidden costs drivers are: managing dependencies, legislation, support from other departments, re-architect, and external contractors, internal resources, cloud training, cloud migration team and third party services. Intangible hidden costs drivers of a cloud migration are: business case construction, business continuity, cloud acceptance, cloud vendor, cost control, knowledge gap cloud, legacy applications, network, on-premise, retention, security and strategy.

Key words	Cloud migration, hidden costs drivers, corporate banks, cloud economics
Further information	

UNIVERSITY OF TURKU
Turku School of Economics

WHAT ARE THE HIDDEN COSTS DRIVERS OF CLOUD MIGRATIONS AT CORPORATE BANKS?

Master´s Thesis
ITEM

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Preface

This thesis is the final chapter of my double degree masters and my studies have been the happiest time of my life. This thesis was written in Finland and in The Netherlands. Many have contributed along the way and I wish to express my most sincere *gratitude* to them: First and foremost, this research was not possible without the relentless and unconditional support of my thesis supervisor Sandor Welfing, MBA. Dear Sandor, thank you for this great opportunity, your contribution, patience, encouragement and belief in this long research process. The in-depth discussions always provided me with new horizons. Ing. Niels Zegveld, I truly enjoyed working with you during our *quest* for cloud benefits management back in 2018. Even though this research was under the umbrella of IT Infrastructure, Erik and you showed the true spirit of being colleagues, you encouraged me along the way and contributed to this research with your valuable feedback and knowledge. Erik Jongsma Msc, I enjoyed our discussions we had about *hidden costs drivers* and your contribution in designing the data collection part is appreciated. Sandor, Niels and Erik, it was a pleasure and I am sure our paths will cross again in the future. Secondly, the contribution of ten corporate banks, without your invaluable support this research would not have been possible. You have given me your trust, time, support and true insights in the process of cloud migrations. I am convinced that this research will elevate your cloud computing journey. My thesis supervisor, Dr. Joris Hulstijn, I always enjoyed your lectures. Your passion and dedication for your students is rare. Your valuable feedback, even during your summer holiday clearly demonstrates your dedication to your students, thank you for your support and guidance. Dr. Martin Goossen, during the summer of 2018, you suggested to research the hidden costs drivers in cloud migrations, thank you and I always appreciated your guidance. Prof. Dr. Lex Bijlsma, thank you for always encouraging me, the valuable feedback, especially regarding the methodology part is very appreciated. Dr. Jaap Gordijn, your guidance and feedback during the final stages of my thesis are invaluable, I can always rely on you, thank you and I am looking forward to our academic journey (Ph.D). Dear mom, *education is freedom* is what you have taught me, you are an inspiration for me, with your strength and resilience. Last but not least, my biggest supporter: ir. Vincent Almering RC RT, your dedication and love means the world to me and you have been *very patient* with me during this journey which even extended to Finland for my 2nd masters degree. With the many discussions we had about my thesis, it truly contributed to this research process. I learned important lessons along the way that I would like to share:*"Never give up on your dreams"* and *"Don't let the opinions of people drown out your own inner voice"* Fadime Kaya, Eindhoven, August 2019

Summary

According to Forbes (2018) "every day 2.5 quintillion bytes of data are being generated and this is only increasing." Cloud computing is the fastest growing part of the IT industry and is a solution to effectively manage data. Amazon Web-services (AWS) and Microsoft Azure market their cloud business models and claim to lower the infrastructure costs with their "pay-per-use" utility model. These cloud computing services are increasing rapidly, however financial transparency regarding the value chain of cloud computing is lacking and can lead to hidden costs for companies when adopting cloud computing.

Cloud computing is an evolved form of traditional IT outsourcing. According to several research it has been identified that hidden cost is the largest bottleneck of IT outsourcing (Lacity et al 1995; Willcocks & Fitzgerald, 1994; Ward & Peppard, 2005). Cloud migrations are often an underestimated and complex processes which can lead to hidden costs. Prior migrating to cloud there should be a cost-benefit analysis applied and this analysis is an critical tool for IT managers to evaluate the migration decision (Tran et al., 2011). However, a known problem with building business cases is that it is usually inflated and too positive. A research conducted by Ward & Peppard (2005) found strong evidence, that only a few organizations could produce a justified business case for IT investments.

Constructing a business case, especially the impact and projecting costs are difficult to estimate. A consequence of hidden costs is that objectives are not achieved and can negatively impact firm performance (Larsen et al., 2013). This study examines the cloud migration process of ten international corporate banks, to determine if there are hidden costs drivers during a cloud migration. These identified hidden costs drivers have been verified and validated by a Delphi cloud expert panel. Hidden cost drivers excist and has been identified with this research.

Hidden costs drivers are a combination of tangible and intangible drivers. Tangible hidden costs drivers are: managing dependencies, legislation, support from other departments, re-architect, external contractors, internal resources, cloud training, cloud migration team and third party services. The intangible hidden costs drivers during cloud migration are: business case construction, business continuity, cloud acceptance, cloud vendor, cost control, knowledge gap cloud, legacy applications, network, on-premise, retention, security and strategy. It has been found in this research that many banks struggle with formulating and following up the business case for cloud migrations. The hidden cost drivers are the result of inflated business cases and can be prevented to a certain extent with a proper business case validation prior migration with certain cost theories such as total cost of ownership and function point analysis.

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1 Introduction

1.1 Cloud computing

According to Forbes (2018) "every day 2.5 quintillion bytes of data are being generated and this is only increasing." Especially with other emerging technologies such as Internet of Things, it is expected that the amount of data will only grow even further (Ahmet et al., 2017). These substantial amounts of data have to be governed and controlled and cloud computing technology is identified as a solution to manage increasing amounts of data (Hashem et al,. 2015). Cloud computing is redesigning the entire information technology industry and it is one of the fastest growing technologies within the IT industry (Dillon et al,. 2015 ; Sabahi, 2011). It is clear that cloud computing will be an increasingly growing part of companies. Cloud computing is an advanced form of IT sourcing and management should carefully analyze the underlying costs (Dhar, 2012; Clemons & Chen, 2011). State-of-the-art IT outsourcing companies emerged, such as Amazon Web Services and Microsoft Azure. These companies have created competitive innovative business models and entered the traditional outsourcing value chain (Dhar, 2012). Amazon Web services and Microsoft Azure have become the main competitors for the traditional outsourcing partners such as IBM. Amazon Web services is even the market leader in cloud computing. Cloud vendors are assertive with proposing efficient cloud operating & business models and claim to lower IT infrastructure costs (Dhar, 2012). Cloud computing and its services offered by Amazon and Azure are rapidly developing, however the financial transparency of their business models are lacking significantly and can lead to hidden costs (Dutta et al., 2013; Dignan, 2019). These cloud providers, often promise effective use of cloud services and market them as pay-per-use. Due to the attractiveness of the business model proposition of Amazon Web Services and Microsoft Azure, companies do not properly analyze their decision to migrate to cloud computing and consequently this poses increased risk such as hidden costs, vendor-lock-in and costs of cloud computing are often underestimated by the industry (Martens et al., 2012). Cloud migration is a key concern for many organizations and is often an underestimated process, which can lead to hidden costs (Pahl et al., 2013). Cloud migration is a multifaceted project with many factors involved, such as project management, digital transformation and effective cost control.

1.2 Hidden costs drivers

An important obstacle for cloud adoption at large enterprises is the lack of a clear migration process and its related costs (Tran et al., 2011). Enterprises are struggling with cloud migrations, which is related to their complex on-premise IT landscape (Beserra et al., 2012). Hidden cost is the biggest dilemma of IT outsourcing (Lacity et al., 1995; Willcocks & Fitzgerald 1994). In two studies hundreds of outsourcing contracts were analyzed and both studies concluded that hidden costs in outsourcing contracts are the biggest problem (Lacity et al., 1995; Willcocks & Fitzgerald 1994). Hidden costs of an outsourcing project can threaten the viability of a project (Barthelemy, 2003). Often, companies do not approach cloud computing objectively and are mainly focused on the expected benefits of cloud computing, which eventually leads to hidden costs (Martens et al., 2012; Dutta et al., 2013; Khajeh-Hosseini et al., 2011). The consequences of hidden costs can negatively effect firm performance (Larsen et al., 2013). Hidden costs has the consequence that strategic objectives are considerably undermined and not achieved (Dibbern et al., 2008; Reitzig & Wagner, 2010; Stringfellow et al., 2008). Hidden costs arise due to the lack of knowledge and the activities that come along with outsourcing (Aubert et al., 1998). Investigating hidden costs between the budget and actuals is important for succesfull execution of any project (Larsen et al., 2013). If cloud migration of a company is not addressed thoroughly, without business cases, it can lead to increased and hidden costs (Beserra et al., 2012). A cloud migration processes poses several risks, it requires planning, analysis and compatibility with the company's requirement and availability of IT systems should be maintained all times (Pahl et al., 2013).

1.3 Why do costs remain hidden?

Faced with complex business cases, decision makers struggle to estimate the actual costs of business case and find the correct variables (Larsen et al., 2013; Khajeh-Hosseini et al., 2012). Cloud vendors promise lower costs with their "pay-per-use" utility slogan, but fail to distinct which components are standard and which require re-work and changes which the company needs to pay for(Barreau, 2001). Costs are generally underestimated, due to a lack of understanding of the applications and what is required to make it work succesfully (Barreau, 2001). As a result that hidden costs remain unknown from the management (Larsen et al., 2013). From the vendor perspective, these costs can remain hidden and companies should not rely heavily on cloud vendors knowledge and remain their independence from the cloud vendors (Dutta et al., 2013). As software projects grow in size and importance it impacts the

increasing complexity of the project, which makes it difficult to predict the costs (Boehm et al., 2000). With IT projects, project managers tend to overestimate the potential savings and benefits over the costs (Barreau, 2001). A case study of cloud migrations, with Amazon as the cloud provider, revealed that cost effectiveness was achieved with cloud computing (Khajeh-Hosseini et al., 2010). However, a stakeholder analysis identified significant disadvantages to the benefits. Long term costs were volatile and to a certain extent vendor-lock occurred due to the diffusion of control and dependency at the cloud vendor (Khajeh-Hosseini et al., 2010). According to Kawatra and Kumar (2014) "cloud is a game-changing paradigm to acquire and leverage IT resources in the banking industry (Kawatra & Kumar, 2014)."

1.4 Conceptual model

Cloud services can be rarely used immediately as it requires customization depending business requirements, and positioning within the architecture and costs related to these alterations are often overlooked (Barreau, 2001). The objective of this study is to research hidden costs drivers of cloud migrations at ten corporate banks. How the ten banks are selected is elaborated in the data collection methodology section. This research will focus at cloud migration process, since there is a clear starting point, from on-premise to the target environment: cloud. During this process, many actors are involved and it has severe implications for the process, the organizations and the people. These all behave different in the relation with costs. One of the risks of an IT project is that the budget will exceed its budget (Remenyi & Sherwood-Smith, 1998). In this section, the notion of hidden costs drivers will be defined and this research is positioned with a conceptual model. Hidden costs drivers are defined in academic literature as:

- Un-anticipated costs of implementation (Dibbern et al., 2008; Reitzig & Wagner, 2010; Stringfellow et al., 2008;).
- Non-obvious cost of IT, which in fact may appear in another department or function as a result of computerization (Remenyi & Sherwood-Smith, 2001)
- Difference between the expected and actual costs (Larsen et al., 2013)

Tangible costs are measurable and intangible costs are difficult to budget and measure, both can result to an increased cost problem of an IT project (Remenyi & Sherwood-Smith 2001).

This leads to the definition of *hidden costs* of this research:

1. Tangible costs drivers that are over budget and can be measured
2. Intangible costs drivers that not have been budgeted

Figure 1 is the conceptual model of this research. The cloud migration of ten banks will be analyzed and decomposed to: tangible cost drivers and intangible costs drivers. The cost drivers in the research are quantitative. The data collection methodology section explains how this research is conducted.

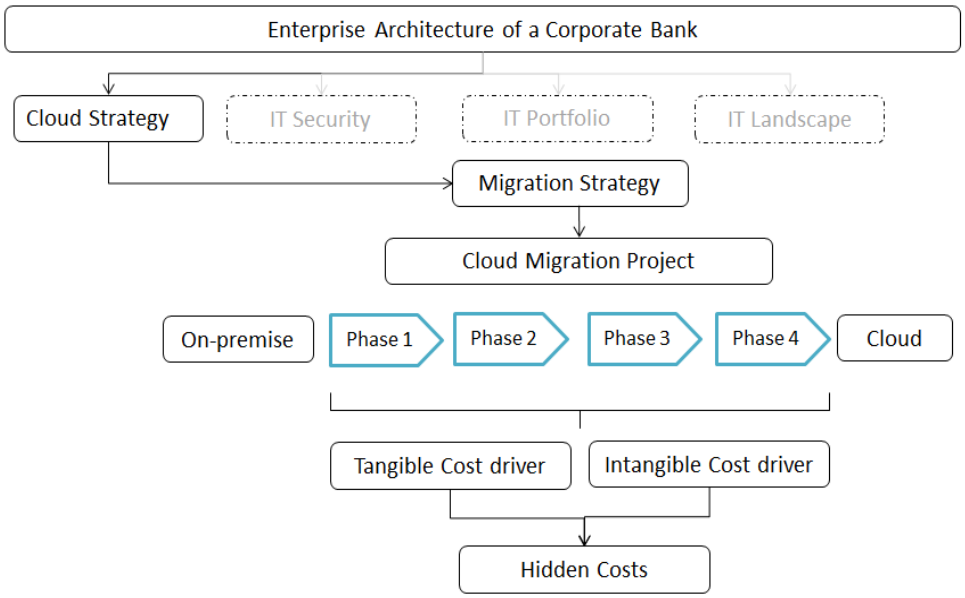

Figure 1: Conceptual model

1.5 Academic relevance

One of the largest barriers for enterprises to adopt cloud computing has been the lack of visibility regarding migration processes and its cost (Tran et al., 2011). A recent literature survey, analyzed 53 articles and identified a clear research gap regarding costs of cloud computing and a lack of a consistent body of research for cloud economics (Rosati et al., 2017; Gholami et al., 2016). A research conducted by the University in Dublin entails with a systematic review of current academic literature that cloud migration is an immature research field (Jamshidi et al., 2013). How to progress and execute cloud migration is an unanswered question for many organisations (Pahl et al., 2013). The research area of cloud migration hidden costs is immature and there is lack of academic papers regarding this subject (Rosati et al., 2017; Gholami et al., 2016; Jamshidi et al., 2013). There is literature regarding IT costs, outsourcing and cloud computing, however it is dispersed and this thesis integrates these research area's. To be able to integrate these research area a thorough knowledge regarding finance, cloud computing and project management is required. The writer of this thesis has seven years of experience in corporate finance and has relevant cloud computing experience at an international bank.

1.6 Corporate banking industry relevance

With the emergence of electronic data processing, banks relied on in-house application development, which we perceive today as legacy applications (Fub et al., 2007; Moormann, 1998). Legacy application in the banking industry, are historically built around services which are tightly coupled with complex dependencies (Chowdhury, 2003). Legacy applications is adding a layer of complexity to existing infrastructures and is an obstacle to efficiently organize the IT landscape of a bank (Fub et al., 2007). Large amounts of money are spent on IT and banks are expected to deliver all services to customers via online banking applications. Cloud computing projects are difficult to manage due to their dynamic nature (Walterbusch et al., 2013). During the exploratory phase of this research, several banks expressed their concerns and the difficulties experienced during cloud migrations. The banking industry, compared to other industries, is heavily regulated with demanding security requirements. Next to that, the banking industry has several IT challenges: infrastructure scalability, legacy applications and to build an enhanced customer experience based on data. Here below are quotes from IT managers that work in the banking sector to illustrate the hidden costs drivers problem:
"The move to public cloud is seen by most companies as inevitable and necessary to achieve their digital transformation goals due to the agility and new technology public cloud offers. However the migration and ongoing operation demands a mind-shift in how to manage costs, moving from a CapEx mindset to managing OpEx on a daily or even hourly basis. Beyond this, the migration to public cloud is rife with hidden costs that undermine even well-thought out business cases" - Sandor Welfing, IT Infrastructure Manager.

"As a bank we are a very cost driving organisation. We base our decision making on business requirements and return on business investment against the expected TCO of the IT system (application). For this we depend heavily on solid TCO business cases. Not having the full picture due to hidden costs can lead to incorrect decisions being made and a negative business case. From this thesis and learning's from other corporate banks we want to have a better understanding of the hidden costs of cloud migrations and the impact they have on the TCO of the IT Systems" - Niels Zegveld, Transition Manager.

2 Research methodology

2.1 Research approach

During my time at the cloud competence center of an international bank, I noticed that migration project are lengthy and require extensive time and budget from the organization. I wondered how other banks execute and approach their cloud migrations. With cloud and IT managers I had several discussions about cloud computing costs. This research took in total one year and started last year in summer 2018. The first six months of this study, were dedicated to research, to what extent corporate banks are involved with cloud computing and more specifically if they started with cloud migrations. In total 30 corporate banks were approached. Several banks indicated they did not started with cloud computing yet, and thus could not participate. The participating banks had strict rules regarding this research. Participation was only possible if I did not asked quantitative, financial data and that the research is guaranteed anonymous. When starting this research, I could not find any databases, descriptive nor structured data-sets regarding cloud migration costs. In profit and loss statements, these are accumulated as IT costs and not specified per category. As a consequence it is not possible to perform statistical research. Moreover, the type of information that is required for this research is highly classified and confidential. This aspect became clear that several did not want to participate due to confidentially reasons, even though I emphasized the anonymous aspect. Ten banks were willing to participate in this research. Since there are only a few banks involved in cloud migration in general and only ten were willing to participate, a survey would not yield usable results. Gathering quantitative data of ten banks was not possible due to classified information. The focus of this research is to obtain a deeper understanding of the underlying qualitative aspects of hidden costs drivers during cloud migration. An in-depth case study with multiple interviews fits this purpose. Khajeh-Hosseini et al. (2010) performed a case study regarding cloud migration and identified the case study approach as an effective method to investigate cloud migrations. Furthermore, a study regarding *"research agenda in cloud computing"* identified there are only are few case studies that focus solely on cloud migrations (Sriram & Khajeh-Hosseini, 2010; Tran et al., 2011). Pahl et al. (2013) studied cloud migrations in a case study setting with in-depth interviews and established a focus group of cloud migration experts. Furthermore, due to the nature of this research problem and the questions that are formulated to research hidden costs drivers, a qualitative case study design has the best fit. In figure 2 the research approach is summarized.

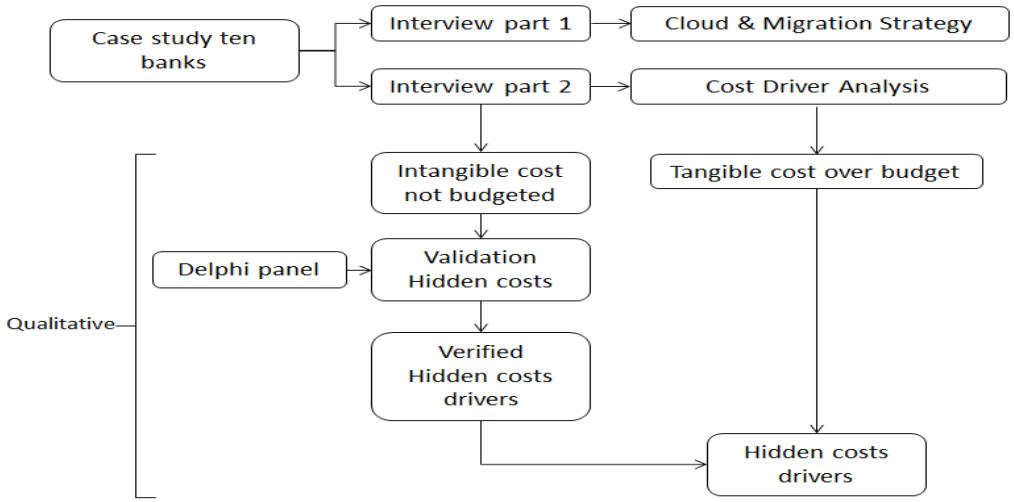

Figure 2: Research approach

2.2 Research questions

The main research question of this research is:

What are the hidden costs drivers of cloud migration at corporate banks?

To answer the research question the following sub-research questions are formulated:

1. What are the typical costs of a cloud migration?
2. Which tangible costs drivers in bank cloud migration projects are over budget?
3. What are intangible cost drivers of a cloud migration project?
4. Do cloud experts agree or disagree with the identified intangible costs drivers?

2.3 Data collection method

This section will explain how data collection is designed and constructed, how the ten banks are selected, design of the interviews is explained and

2.3.1 Ten case studies at corporate banks

Ten banks participated in this research and the interviewee's are Chief Information Officers, IT Directors, Cloud Managers and Cloud Enterprise Architects. Interviews are conducted confidential and the research output and analysis is formulated in such a manner that banks who contributed to this research are not recognizable. This was a prerequisite for the banks, otherwise the banks would not have participated. Several banks had to confirm with their compliance department first, in order to get approval for participation. Due to this reason, information about the background of the banks will not be mentioned in this research. In order

to select the banks for this research I specifically asked the question if the bank is currently in a cloud migration, if so, I requested a person who is knowledgeable about cloud economics, cloud and migration strategy. It was a crucial aspect to find the right persons, which was a challenge. Another complicating factor was that several banks confirmed participation and once the interview questions were sent prior the interview, they dropped out. These banks said they did not want to share this level of details. Hence from the total 30 banks approached, 10 agreed to contribute. Thirty banks were approached initially and several did not want to contribute due to confidential information, which not allowed to be shared and other banks were not involved with cloud computing.

2.3.2 Multiple interviews per bank

Data collection is realized with multiple interviews per bank. Every bank contributed at least four hours, this started from the initial contact, finding the right person for the interviews, planning the interview, sending the questions beforehand, preparation from the bank prior the interviews, conducting the interview and following up the interview to connect the dots. The interviews are constructed in an semi- structured format. The interviews are conducted via an anonymous Skype account. Skype is selected as the technology to conduct the interview as it offers the possibilities to share screen and record the audio. It is an useful technology as the participating banks are dispersed over the world. During the interviews, my screen was shared with the interview questions. During the interview they could see their answers and this contributed in high quality data collection. Seeing their answers on the screen contributed in constructing the answers to the questions as clear as possible. Furthermore, audio during the interview was recorded as well. Semi structured interviews allows direct control regarding the process flow and issues that occur during an interview can be clarified immediately. An intensive coding process has been executed to analyze the data thoroughly. The appendices are the result of a very detailed coding operation in order to derive the hidden costs over budget as part of interview 2.

1. First interview: Cloud & Migration strategy

The first interview will focus on identifying the cloud and migration journey with the angle of cloud strategy at ten corporate banks. The business objectives of the cloud journey and migration of legacy application are discussed. Especially the rationale behind the cloud and migration strategy selection and formulation is the main focus. How banks perceive cloud computing in their overall IT landscape is elaborated. Theory and practice are not always

aligned, therefore several control questions are formulated to research if the strategy is also followed in practice, in order to research what is causing the possible discrepancy between a theoretical formulated strategy and what is occurring in practice. To conclude there are questions formulated about cost control and the relation between costs and strategy. The interview question can be found in appendix A. Data collection from the first interview are discussed in the case study per bank in chapter 5 and it forms the basis for the verification and validation of the intangible hidden costs by the cloud expert panel. Next to the semi structured question, follow up questions during the interview occurred.

2. Second interview: Cost driver identification

Prior selecting the cost methodology to design the interviews, several interviews were conducted with IT managers. The purpose of these interviews was to discuss which method would fit serve the purpose of categorizing costs and designing the interview questions. During these interviews, the Technology Business Management framework Taxonomy (TBM) came up. The Technology Business Management (TBM) is a value-management framework and it is designed for controlling IT costs, aligning business & IT objectives and it provides a standard set of categories for costs related to information technology (Tucker, 2019). KPMG (2016) identified that TBM is a strong method to achieve cost transparency and integrating IT with Finance. Technology business management framework is applied to design the second interview, this to ensure that costs pool that occur during a cloud migration are covered. The TBM has several layers and the framework identifies the following costs pools: Internal labor, external labor, outside services, hardware and software. The second interview will focus on identifying which costs are overlooked, not budgeted or overspend regarding cloud migrations. These are questions that are formulated based on cost pools of the TBM framework, per question. Each question has *four sub questions* in order to identify the potential tangible hidden costs. Variances compared to budget regarding overspend are discussed with the interviewees. The rationale and explanations behind the deviations are direct quotes from the interviews. See appendix B for the second interview questions.

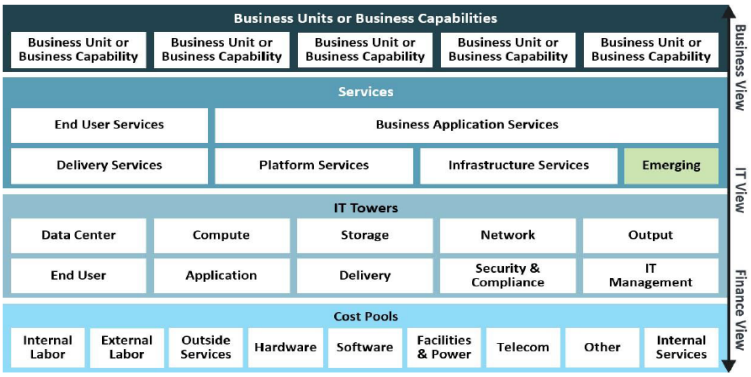

Figure 3: Technology Business Management Taxonomy
(Tucker, 2019)

Furthermore, each question in the interviews is designed to contain four sub questions. These four sub questions could only be answered with yes or no, and the last sub question, is an open question to explain the variances compared to the budget:

1. Yes/No
2. Was this budgeted?
3. Was it less, equal or more than the budget?
4. Rationale behind deviation, direct quotes from the bank

2.3.3 External validity

To increase the external validity of this research a Delphi cloud expert panel is established. It was a true challenge to find cloud expert that were willing to contribute to this research and are knowledgeable about cloud migration, cloud strategy, cloud economics within the banking industry. These cloud experts have a proven track-record in managing and overseeing cloud computing and are part of the cloud migration execution process and have more than 20 years of IT experience. The cloud experts work in the field of cloud migration in the banking sector, verified and validated the identified hidden costs with direct statements.

2.4 Research limitation

This research has potential limitations as could be expected since especially IT cost control, in the light of project management is a highly discussed research area. Data collected in this research is highly confidential and not easy accessible only ten case studies could be collected. This research is executed in the banking industry, which is a highly regulated industry compared to other industries and this is a limiting factor as well.

3 Cloud migration

This purpose of this section is to provide a literature overview of cloud computing, its mechanics and cloud computing vendors. Secondly, cloud & migration strategies are elaborated and how to approach and execute a cloud migration strategy.

3.1 Brief history of cloud computing

Cloud computing emerged during the 1950's and is known as the mainframe computing era. The desire to link computers that physical are not in the same area but still accessible by multiple end-users. Conceptualization of cloud computing started during Arpanet. During that time, four university computers were interconnected and these were fundamental steps for paving the road for cloud computing. In 1996, the term cloud computing was introduced, with a white paper, for the first time by the company Compaq. In the late 1990's the company salesforce was a true pioneer and was one of the first companies to develop SaaS (software-as-a-service), it offered business applications via the internet. With the emergence of web 2.0, cloud computing took off and was pivotal in establishing the foundation for cloud computing, as information sharing and collaboration over the internet accelerated. In 2006, Amazon created the subsidiary Amazon Web Services (AWS) and in 2008 Microsoft followed with Azure. Currently Amazon Web services and Microsoft Azure are the global leading vendors of public cloud computing. Google cloud and Alibaba are emerging but with significant lower market shares. According to a Goldman Sachs report, Amazon Web Services had a market-share in 2018 of 47% and Azure 22%. Amazon web services is currently heavily dominating the cloud industry as it was the first company to offer public cloud services. We have entered the cloud computing era and cloud computing is an evolvement of technology as IT solutions are delivered as a business model. It transforms an enterprise in its core, as services can be offered on a global and distributed level.

3.2 Mechanics of cloud computing

Cloud computing entails that applications and services are transferred and offered via the internet. This is done via hardware and software systems in the data-centers. It is specifically defined as public cloud computing when it is made available via pay-per-use by companies such as Amazon web services (AWS) and Microsoft Azure. Public cloud computing is offered as a service known as utility computing and is easily scalable and elastic. In a traditional infrastructure, applications are built on middle-ware, with cloud computing every layer is

offered as a service and made possible by virtualization. The stack is a layered architecture and is explained here:

1. SaaS: Able to access an application and the maintenance of that application will be taken care off by the application provider. Software such as : CRM and ERP.
2. PaaS: A platform is provided and the customer can develop applications without having to manage the infrastructure.
3. IaaS: Fully use of an external infrastructure

3.3 Cloud vendors

In the field of public cloud computing currently, there are three cloud vendors: Amazon web services known as EC2, Microsoft Azure and Google cloud. Amazon offers their own platform for virtual machines. Their dynamic deployment is easily implemented. It also supports state of the art distribution, cloud monitoring tools and load balancing. In order to use Microsoft Azure it is required to use their API to connect with their infrastructure. It offers significant features such as: unstructured data, table and drive storage, web and worker role. Microsoft Azure has a strong focus at software as a service. With Google Cloud the focus is on the code because it is a end to end managed platform that entirely abstracts the infrastructure. Their most known feature is mapreduce which makes it possible to run your own mapreduce algorithm. Google offers a platform rather than an IT infrastructure. Development and deployment facility for Python and is offered. Furthermore, interfacing is software programming based.

3.4 Cloud & migration strategy

Beserra et al. (2012) presents a systematic overview named "cloud workflow" which steps a company should take prior a cloud migration, which includes decision points, see figure 4. Cloud migration is the process of transforming the IT infrastructure into a fluid and agile IT infrastructure and it determines how applications are offered and developed (Pahl et al., 2013).

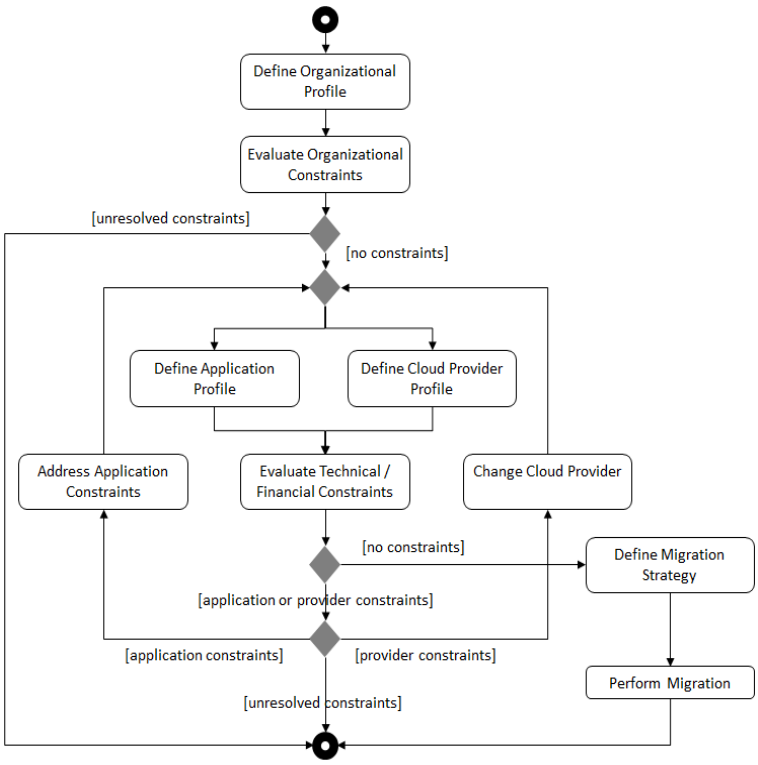

Figure 4: Cloud migration strategy

(Bessara et al., 2012)

The authors designed cloud workflow specifically for the purpose of cloud migration. Several factors have been identified that might impact cloud vendor selection and the migration process. In the paper it is clearly indicated that following cloud workflow will minimize initial migration costs and decrease the costs of managing the application after its deployment in the cloud (Beserra et al., 2012). The cloud workflow takes several steps into account for migration namely, cloud & migration strategy and executing of cloud migration. It is a clear, structured and relatively easy method to adopt for companies to gain insights in the costs that are associated with migration and their cloud execution process. It ensures that several hierarchical layers in an organization are aligned. The author strongly advises that given the immature nature of cloud technology, multiple migration strategies should be taken into account in order to have a flexible approach, since not every application can be silo-ed and might not benefit from the same approach. With the current digitizing world, scaling of technology is an important requirement. Virtualization and on-demand availability of applications which accessible from every device is an important requirement for companies, which can be achieved with cloud computing. Thus investing heavily in hardware does not sound as a logic business case. Migrating to cloud can yield beneficial returns if managed correctly. Companies usually choose for a hybrid strategy in which the on-premise environment co-exists with a cloud solu-

tion. The complexity of cloud migration managing both on-premise and cloud simultaneously. The migration process has several steps that can be distinguished with the stack: Saas, PaaS or IaaS. There are five cloud migration strategies identified (Zhou Zhou, 2014)

1. **Rehost:** is designed in such a way that applications are running in an Infrastructure-as-a-Service (IaaS) environment. Cloud is basically approached as a data-center and the benefits with this approach will not be reaped from cloud and is difficult to scale.

2. **Refactor:** Enables developers to re-use languages, code and container of the application and is application is as a result "cloud native". This might pose framework lock-in and is not loosely coupled.

3. **Revise:** Application will be altered extensively prior migration to cloud. The current code will be modified, this is the case for legacy applications/end of life application which can require revision. It is an expensive strategy and time consuming.

4. **Rebuild:** The existing code will not be used and is discarded. Application is usually re-build on a Platform-as-a-Service (PaaS) stack. Rebuilding ensures that capabilities and features of the cloud vendor can be taken into account to gain the full benefit of cloud.

5. **Replace:** The application is discontinued and replaced with a Software-as-a-Service (Saas) solution. Vendor lock in of the application can be a risk but it is an efficient solution in terms of time and costs.

The cloud migration framework, figure 5, identifies that each stack requires a different cloud migration process and approach (Pahl et al., 2013). Each stack has it own set of objectives and with this decomposed approach the migration process becomes more transparent for all actors involved in the migration process. Especially with PaaS and IaaS the migration process should start with a detailed costs and cashflow analysis of the application. As cloud migration will change the costing structure from OPEX to CAPEX, especially at IaaS and PaaS level. It has been identified that PaaS and IaaS, migration costs are underestimated and neglected (Pahl et al., 2013). The cloud migration process as proposed by Pahl et al. (2013) is not comprehensive as it does not take business case aspect into account, except for the PaaS stack, prior a cloud migration a sound business case should be formulated.

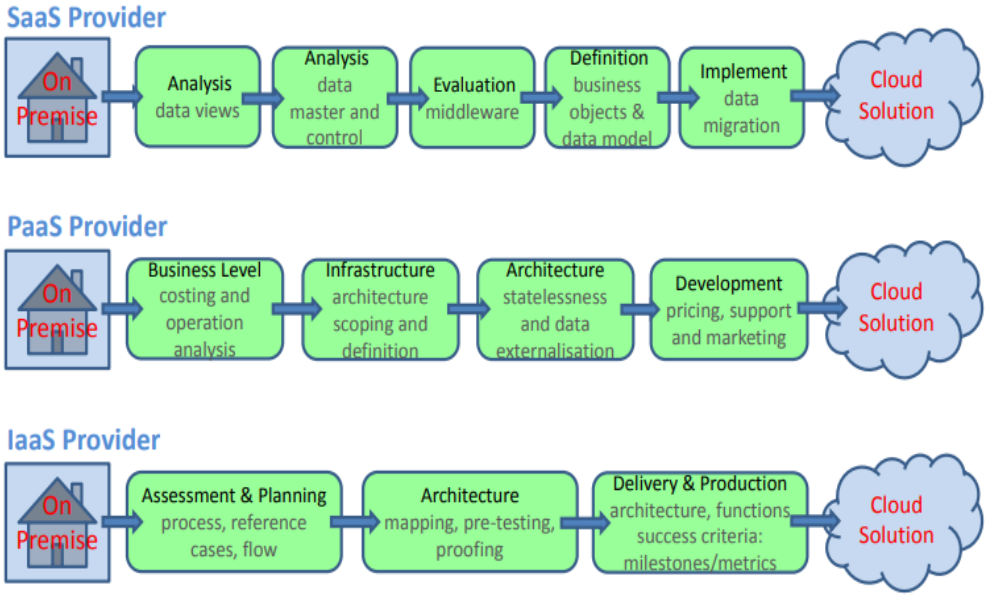

Figure 5: Cloud Migration process
(Pahl et al., 2013)

According to Tran et al (2013): "even though, cloud migration process is a one-time task, it is quite challenging and has an evident impact on the organization." The cloud migration strategy decides to a certain extent how a cloud migration project is approached and executed and should be aligned with the migration strategy. In essence, a cloud migration should be treated as a project, since the migration has a clear start and end point, namely on-premise to cloud (Marchewka, 2015).

4 Cost perspectives on cloud migration

A recent research concluded that enterprises spending more on cloud computing, but are struggling with cost control (Dignan, 2019). This is related that cloud adoption and deployment is still in an immature phase and it is difficult to construct balanced and correct projections. Finding the right balance between cost optimization and benefiting from cloud is a challenge and a grey area for many enterprises. in this section, several costs cost theories and perspectives regarding cloud migration will be elaborated. The main focus will be regarding theories that are used in information technology and with a split between tangible and intangible costs.

4.1 Cloud migration costs

Cloud computing is a complex project and contains several challenges for every organization that deals with cloud computing. Cloud migration costs are difficult to measure and to estimate, (Tak et al., 2001 & Tran et al., 2011). We start from the usual IT projects costs: (1) Operational costs (2) Direct labor cost(3) Indirect (labor) costs (4) Deployment costs (5) Systems development costs (Kroenke, 2008). Then the questions arises, how are these IT costs modelled within an organization? It depends on the size of a company. In small organizations IT costs are accumulated and treated as a general overhead costs. While in large organizations, IT costs are charged back to departments and teams. IT costs can be further specified to tangible and intangible costs. Tangible costs can be measured in costs: direct labor, hardware, sourcing. Intangible costs are complicated to measure and are related to loss of motivation, resistance against technology acceptance and knowledge gap. Tak et al. (2011) briefly mentions in their paper costs allocated to cloud migration should be decomposed to quantifiable, non quantifiable, direct and indirect costs to have the complete overview, see figure 6.

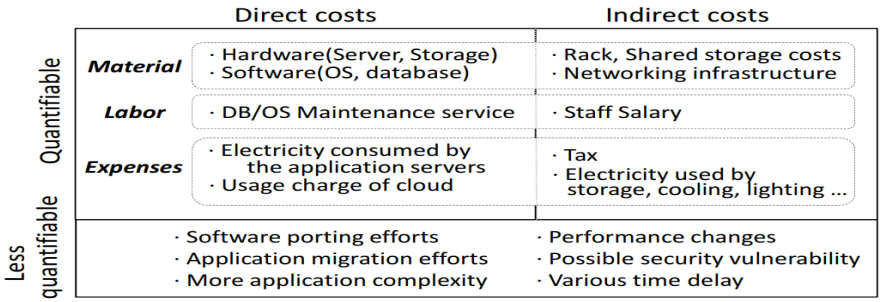

Figure 6: Cloud migration costs

(Tak et al., 2011)

The cloud taxonomy, figure 7, is a first step for companies to understand what the drivers for a cloud migration are and in order to measure the realized benefit and keeping track of the actual costs (Tran et al., 2011). The cloud taxonomy provides a solid basis of the requirements of a cloud migration project and should the basis in constructing the cloud migration business case. In order to prevent hidden costs, it is important understand how the taxonomy creates insights in what the required efforts are for the organization to execute the cloud migration (Tran et al., 2011). Cloud migration is related to software costs which includes, tangible, administrative and development costs. The most difficult costs to estimate in cloud migrations are costs in terms of "effort" that is required for the cloud migration (Tran et al., 2011).

Category	Task
Training & Learning Curve	Training on the existing application: Understand system environment, specifications and configurations
	Measure system's size and estimate system development efforts
	Training on the selected cloud platform: Understand its offerings and technologies used
	Identify any compatibility issues
	Training on third party tools: Identify and understand tools for data migration
Installation and Configuration	Set up development tools and environment
	Install and set up environment in IaaS Cloud
	Install third-party tools
Code Modification	Database connection
	Database operation query (if using NoSQL Cloud database)
	Any required modification for compatibility issues
Migration	Prepare database for migration
	Migrate the local database to Cloud database
	Prepare system for migration
	Migrate the application
Testing	Test if local system works with database in Cloud
	Test if system in Cloud works with database in Cloud
	Write test cases and test the functionality of the application in Cloud

Figure 7: Cloud migration taxonomy
(Tran et al., 2011)

4.2 Total cost of ownership

When discussing tangible and intangible costs, it starts with the theory about total cost of ownership (TCO). It is a theory that has been around since 1950, however it is still a relevant theory as it allows decision makers have total overview of costs behavior over time. Total cost of ownership is largely applied within the Information Technology TCO) industry. This theory

contributes to make informed financial decisions as it take the complete cost of an application starting from acquiring, developing and supporting until the application becomes end of life. It takes into account expected costs such as repair, service and insurance. To summarize, TCO consists of: direct, ongoing and indirect costs. TCO has a long history within the information technology field, authors Ellram and Siferd (1999) argue that TCO can be applied as a strategic cost management method, as it takes external effects into account. The authors strongly advise that suppliers performance should be part of a TCO calculation and its broad effects on the organization. For a successful cost management throughout the organization, strategy should be part of this goal. Cloud computing is advanced outsourcing as the environment were the applications are offered, updated and developed are the responsibility of the cloud vendor and these services should be assessed on a strategic level. TCO can be applied at every layer within the organization, starting at the strategic level towards the operational level, as described in figure 10. Every hierarchical layer within the organization has it own goals and objectives to achieve, this demonstrates versatility of TCO.

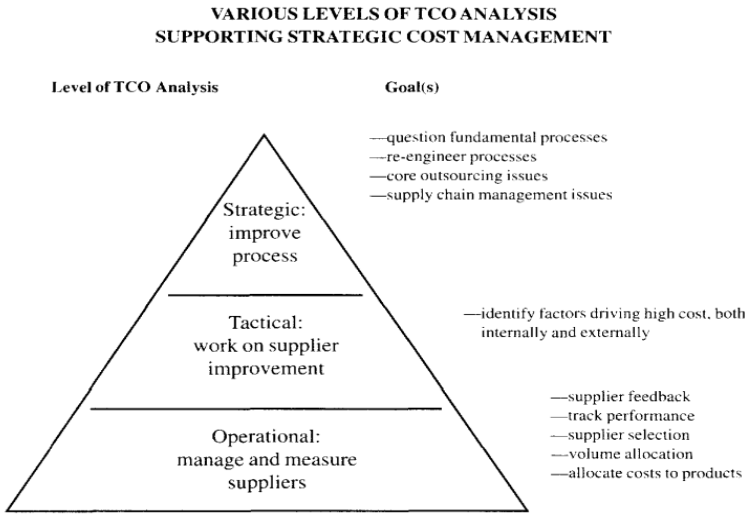

Figure 8: Level of TCO analysis
(Ellram & Sifer, 1999)

The formula for total cost of ownership is not straightforward and is defined as: the sum of all the costs occurred during the lifetime of the system (Mitra, 1999). Cost control should be lead by management. This will increase the use of TCO and enhancing that cost management should be executed at all layers of the organization. Critical decision making should be supported by TCO models as it takes the external environment and its effect at the organization. Due to this reason, TCO is part of strategic cost management. In a study, it has been found that applying TCO will increase awareness regarding (in)direct and hidden

costs in cloud adoption (Walterbusch et al., 2013).

4.3 Function point analysis

Early software requirements engineering is important and essential for cloud projects and its success (Tran et al., 2013). There are several models to estimate software complexity and size: lines of code, expert method, COCOMO II and function point analysis (Dillibabu & Krishnaiah, 2005). Function point analysis is an established software method for over thirty years(Orr & Reeves, 2000). Size and complexity of an IT project can be measured with function points (FPA) analysis. A case study, tested FPA as an approach with six cloud migration projects. This study proved that FPA is a reliable to estimate the size and the complexity of a cloud migration project (Tran et al., 2013). One function point equals 100 lines of code, 10.000 function points require 1 million lines of programming (Smits, 2018). The larger the system in terms of code, the more it will costs to develop (Smits, 2018).

4.4 Business case and costs

Marchewka et al. (2015) defines a business case as: "an analysis of the organizational value, feasibility, costs, benefits, priorities and risks of the project plan." A business case is intended for managing and aligning the stakeholders as well. As stakeholders all have a different interest, objectives and their power should not be underestimated. According to Nutt (2002) 50 % of the decisions fail because decision makers do not align with stakeholders. Thus a solid business cases, with involved stakeholders is a prerequisite for a successful cloud migration. A solid business case consists of the following (Ward & Peppard, 2005):

1. Project objectives
2. Business drivers
3. Risks
4. Feasibility
5. Identify structured benefits and owners
6. Expected organizational changes
7. Alternative scenario planning
8. Total costs of ownership (TCO)
9. IT & Business alignment and value creation
10. Commitment from business managers

Prior cloud migration, there should be a sound cost-benefit in place and this analysis is

a critical tool for IT managers to evaluate the migration decision (Tran et al., 2011). Cloud computing requires a solid business case which takes costs and benefits into account, in order to asses if an application is feasible for cloud migration. Cloud migration is not just an IT project, it has an impact on the organization and ownership of applications changes as well. Costs can be directly traced back to an application, which was not possible with on-premise, since on-premise deals with sunk costs, known as CAPital EXpenditure (CAPEX) while cloud is OPerating EXpenditure (OPEX). Costs are not treated as a lump-sum anymore and has a direct continuous effect in a cloud environment. Cloud computing is widely reported as utility, as cloud is "pay-per-use". Figure ten illustrates the impact of cloud computing at an organizational cost basis.

LET'S OUTLINE OUR OPTIONS:	**CAPEX** CAPITAL EXPENDITURE	**OPEX** OPERATING EXPENDITURE
DEFINITION	Funds spent on acquiring, upgrading or maintaining fixed assets like land, buildings and equipment	Expenses incurred through ordinary business activities such as sales, r ent, inventory costs, marketing, etc
WHEN PAID	Lump sum payment up front (or financed with extra costs)	Recurring monthly or annual payment
IN ACCOUNTING	Accounted for over a 3 to 10 - year lifespan as the asset depreciates	In the current month or year
TAX TREATMENT	Deducted over time as the asset depreciates	Deducted in the current tax year
LISTED AS	Depreciation, equipment or property	Operating cost/expense
EXAMPLE	Investing in a new data center	Software-as-a-Service Infrastructure-as-a-Service

Figure 9: Capex vs Opex

(Jovicic, 2018)

If an organization has an on-premise environment, with capital expenditure, it requires a full shift of thinking from the organization when it comes to cloud and a different costing model, namely operating expenditure. The accounting and tax departments will no longer have to record IT infra assets and depreciation in their books but they will see an additional IT OPEX line appearing in their general ledger. The additional benefit in that these costs will now scale with the usage and/or amount of users of the cloud service. Regarding scenario planning as part of a sound busines case, the following formulas can be applied to compare the alternatives, these formulas are suggested due to my experience in corporate finance for over seven years.

1. Payback period (years) = Orginal investment Amount ($) / Annual cash inflows ($)
2. Breakeven point (units) = Orginal investment amount ($) / Net profit margin per unit
3. Return on Investment (%) = Expected Return ($) / Orginal investment Amount ($)
4. Net Present Value (NPV)= -/- investment amount ($) + (Cash inflows ($) / Time Value)

These formulas can be applied also for the purpose to compare alternatives based on forecast figures, identifying potential benefits and extracting the net value. Objective benefits can be collected from the scenario planning as well. In order to understand the business case, an organization can start with a pilot first, to understand how the business case is performing in the practical world and compare the outcomes of the theoretical business case, to further refine the business case. An inflated business cases, can pose several hidden costs which are not depicted in the case. These hidden costs can be direct and indirectly.

4.5 Inflated business cases

A known problem with building business cases is that it is usually inflated and too positive. A research conducted by Ward & Peppard (2005) found strong evidence, that only a few organizations could produce a justified business case for IT investments. These organizations were concerned about identifying and measure the potential benefits of their business case, no accurate proof and evidence could be generated to support their investment (Ward & Peppard, 2005). Therefore, many business case were positively overstated to secure approval of the business case. Several other studies proved that IT investments do not deliver the projected benefits and the success is lower as 30% (Nelson, 2007; Procaccino et al., 2006; Royal Academy of engineering- London,2004; National audit office, 2006). In the study of Ward and Peppard, 96% of the respondents reported that a business case was required for approval of IT budget and spend (Ward & Peppard, 2005). Financial projects are a part of a business case, but it should not be the main focus, as these are all forecast figures and these can be easily modelled for a positive business case, which will lead to inflated business cases.

4.6 Conclusion literature and expected outcomes

In this section, the key findings for cloud migration costs derived from the literature study are summarized:

1. A consequence of hidden costs is that firm performance will be negatively effected and that strategic objectives are undermined and not achieved (Larsen et al., 2013; Dibbern et al., 2008; Reitzig Wagner, 2010; Stringfellow et al., 2008).
2. Following a clear cloud & migration strategy and a cloud taxonomy will minimize the initial migration costs (Beserra et al., 2012; Tran et al., 2011).
3. There are several cost theories to approach cloud migration, in a cloud computing study it has been found that the TCO method will increase awareness regarding (in)direct and hidden costs in cloud adoption (Walterbusch et al., 2013).
4. Function point Analysis (FPA) proved in a case study with six cloud migration projects that it is a reliable method to estimate size and complexity (Tran et al., 2013).
5. According to Nutt (2002) half of the decisions fail because decision makers fail to align with the stakeholders when preparing business cases.
6. A research conducted by Ward & Peppard (2005) found strong evidence, that only a few organizations could produce a justified business case for IT investments, and IT investments do not deliver the projected benefits and the success is lower than 30 % (Nelson, 2007; Procaccino et al., 2006; Royal Academy of engineering- London, 2004; National audit office, 2006).

Expected outcomes of the research questions based on theory:

The literature review implies that a thorough planning prior cloud migrations, with a clear strategy, migration planning in place and business case formulation can reduce unexpected and hidden costs. Furthermore it can increase the success rate of the project. However, I do not expect that banks will follow a theoretical framework in planning for a thorough cloud migrations. I do expect that the cloud strategy is decided based on business objectives. Also I expect that business case are used to a certain extent but costs overrun in complex projects are likely and hidden cost drivers will be found in this research. I also do not expect that the several methods proposed for estimating the costs of the business such as function point analysis or total cost of ownership are applied as a part of the business case. These methods are time consuming, difficult and not easy to gather the required data.

5 Case studies at ten international banks

In this section cloud and migration strategy will be discussed of ten corporate banks. The reasoning behind the cloud and migration strategy selection will be elaborated. A deep-dive regarding business objectives and decision making of the banks are analyzed and to what extent costs are a driver of the cloud strategy are elaborated. This section is based on the first interview regarding cloud and migration strategy, please see appendix A for the interview questions. An extensive coding is part of analyzing the collected data. In total 30 banks were approached for this cloud migration research. Several banks did not want to did not want to share this type of information due to classified information. Other banks could not participate as they are not involved with cloud computing. In total, ten banks were willing to contribute and are currently in their cloud computing journey.

5.1 Case study: Bank 1

The cloud journey of this bank started approximately six years ago with the private cloud initiative. Public cloud computing was established one year ago with Microsoft Azure as the cloud vendor. The cloud strategy is not completely clear yet, but it is aimed at private cloud first strategy. A deviance of this strategy is allowed if an application is not feasible for private cloud or if the required functionality is not available. This bank invested heavily in private cloud as public cloud, was not mature enough with their requirements for (eight years ago). The business objectives for cloud are: business agility, enabling functionalities, speed of development, agile deployment and availability. This bank indicated that costs are an integral part of the business objectives. Business cases for cloud have the following elements: business strategy, alignment with strategy, cost and ratio between costs and functionalities. In practice, the low cost solution is selected. This bank is struggling in comparing 'apples with apples' when defining the businesses case for cloud when comparing private with public cloud. There is no defined migration strategy yet, which is remarkable, since this bank is running their private cloud for many years. Cost control for this bank is also influenced by the maturity of the Devops teams, some teams are better in decision making (e.g. turn off applications which should not be available 24/7) than other teams.

5.2 Case study: Bank 2

This bank is following the multi-cloud strategy: on-premise, private and public cloud. The strategy is public cloud over private cloud. Amazon Web services and Azure are the public

cloud vendors. A dual vendor strategy is selected as it prefers to remain flexible and avoid vendor lock-in. Their cloud strategy is a part of their overarching sourcing strategy. As this banks perceives public cloud computing as outsourcing and with positioning within sourcing it emphasis the cost aspect. According to this bank legislation is lagging behind and there is no clear jurisprudence yet regarding cloud computing. Legislation and legal requirements with public cloud are complicated. This bank anticipates on changing requirements from regulators therefore a multi-cloud strategy is selected. It is a risk averse cloud strategy and IT portfolio is leading. The business objectives for this bank : improved time-to-market, flexibility and streamline internal and vendor management processes. Cloud strategy is so far in line with the actual execution of the migration. The main reason is that the bank did not had to enforce critical decisions regarding their applications. First, the least impact-full applications are migrated to the cloud first in order to increase the learning curve steadily. When knowledge of cloud migrations are at a comfortable level, the end of life applications will be assessed for a potential migration. This bank has a large IT cost component in their overall costing structure and costs are inherent for constructing the business case for cloud. It is acknowledged that cloud computing is not fully accepted yet by business partners and it is more risky than initially was assessed. This was addressed with data availability and data backups challenges. In terms of cost control, this bank has a clear cost management framework and variances compared to business case are carefully analyzed and managed.

5.3 Case study: Bank 3

This bank follows a public cloud first strategy, this to ensure that the IT organization has the same mind-set when it comes to cloud adoption. With every (IT) project this bank undertakes, public cloud should always be the preferred choice. Cloud computing is positioned at the forefront of their IT organization. This bank adopted a multi-cloud vendor strategy: Amazon web-services (AWS), Microsoft Azure and Google cloud. The reason for a multi cloud strategy is to fulfill requirements of the business, elevate vendors capabilities and each cloud vendor has a different purpose for the bank. AWS is mainly used for application hosting, MS Azure for geographical spread and presence and Google cloud for data analytics purpose. Part of the strategy is an exit scenario and vendor locking. The business objectives for cloud are: leveraging and increasing delivery of applications by using cloud elasticity and dynamic scaling. A flexible cloud consumption OPEX model has been adopted, this allows to have a higher value propositions of the business cases and limits on-premise expenditure. This bank aims for reducing dependencies and create maximum benefits of the cloud by

further simplifying the complexity of their on-premise architecture. This bank is critically analyzing their existing legacy structure and how to transform their legacy applications to cloud. Migration strategy is approached with rehost and rebuild strategy as a pilot, to test the migration with 30 applications. During this pilot, it will be assessed and evaluated what the best migration strategy is. With the migration strategy this bank aims to decompose the dependency of legacy applications and off the shelf applications, to simplify the migration. To further support the cloud strategy this banks has an external cloud hosting committee in place. Every application/workload that is intended for cloud migration needs to be assessed by the committee first. If the application is not supported by the strategy it will not be allowed to migrate. Costs are taken into account when discussing the migration strategy, there must be a cost benefit ratio when migrating to the cloud. Cost control and managing budgets for cloud, is the responsibility of the global cloud service team.

5.4 Case study: Bank 4

A multi-cloud strategy is followed: on-premise, private and public cloud with a dual vendor strategy: Amazon Web-services and Microsoft Azure. Their private cloud journey was seeded in 2013, at that time that was the intended target IT infrastructure environment. It is not the intention to further develop private cloud as it does not fulfill the requirements. It was evaluated that private cloud is lacking time-to-market and agility. Private cloud does not provide access to new technologies and it was expensive to develop these new technologies internally. Business objectives for public cloud strategy are: access new technologies, agility and time to market. When building business cases, it is difficult to compare benefits and cost of on-premise versus cloud. Public cloud also requires a different approach regarding security and compliance, this complicates comparability and the costs. Migration strategy is a mix of re-host, refactor, revise, rebuild and replace. A flexible migration strategy approach is selected as it wants to decide it per application Some years ago, this bank outsourced their full on-premise environment to an external vendor. This is a multi-year contract and it is the strict obligation to full-fill the term of this contract. Due to this reason, this bank is obliged to keep their on-premise environment for the next years to come. In practice it is difficult to manage the applications on the cloud, as it also deals with the on-premise vendor, this bank has several vendors for their on-premise and cloud environment. Especially the dependencies of applications emerged to be difficult during migrations. Every application that is an intended candidate for public cloud will be analyzed from a cost perspective. If there is no clear and traceable business case, the application will not be migrated. Cost control of cloud migration

is not approached via a total cost of ownership method as TCO is a difficult method and is not managed separately.

5.5 Case study: Bank 5

This bank pursues a public cloud first strategy with a dual vendor strategy, namely: Amazon Web-services and Microsoft Azure. A cloud first strategy entails that every new application should be "born" in the cloud. The rationale for a cloud first strategy is that full potential of cloud benefits can only be realized if most of the applications are running in the cloud. To achieve this objective, their on-premise environment will be decommissioned over a period of four years. Business objectives for cloud computing are: speed, agility and time to market. Costs are not the main driver, but it is a trade off and is depended per business case. This bank has an evident migration strategy: re-architect. With re-architect, the applications will end up as high as possible in the stack namely, Software-as-a-service (SAAS). With SAAS, the benefits from public cloud will utilized. The basis for this migration strategy is identified as gaining speed to accelerate cloud migrations. Every migration has a profound business case and the cost developments of the application for the next five years are taken into account. The overall cost development of cloud migration are monitored on a monthly basis. Cloud native tools offered by Amazon web-services and Microsoft Azure are also used for cost control. Furthermore forecasts are constructed in order to compare actuals with forecast.

5.6 Case study: Bank 6

Even though this bank started their cloud journey with a cloud first strategy, this was later on revoked and it is currently a hybrid strategy: private and public cloud. The reasoning for terminating the cloud first originated from the legacy applications and their core banking systems which are running on mainframe. During their internal strategy sessions, it became clear that if legacy applications will be migrated, it required heavily re-engineering and it will take several years to migrate and prepare these legacy applications. It was not a realistic business case as it would require the banks full capacity in terms of time, budget and personnel. It has been decided that for the next years the legacy applications will run on-premise. This bank follows a dual cloud vendor strategy, namely: Amazon web-services and Microsoft Azure. Multiple vendors are selected to avoid vendor lock in and maintain flexibility. This bank is not convinced that all applications should be migrated to cloud. Their data-centers perform well, are cost efficient and highly automatized. The business objectives for this bank are: agility,

innovation, access to new technologies, security, elasticity, availability and ecosystem enabling. The migration strategy of this bank is re-architecting, as the benefits of cloud will be realized best with this strategy in their view. There are some deviance's from this migration strategy if dependencies occur during the migration, those are usually related to legacy systems. When an application is end of life or requires a big update, this bank sees this as an opportunity to switch to a software-as-a-service solution. Per business case costs are evaluated with a comparison between private and public cloud.

5.7 Case study: Bank 7

This bank just started recently with cloud adoption, a hybrid strategy is adapted, on-premise and public cloud. Amazon Web-services is the sole provider. One of the drivers for cloud adoption is effective data management, access to new technologies, data analytics, increased computing power, time-to-market and agility. Currently, this is not being realized, since their data is fragmented. Concerning the legacy systems as these have been altered from time to time, it contains many layers of applications and thus a high level of dependencies. It is difficult managing these dependencies during cloud migration. Cloud migration adoption is slower than anticipated mainly due to regulation and GDPR. It requires consent from their end customers how and their data is stored. Retrieving consents from their customers is a time consuming process. Aligning stakeholders within the organization was inherently difficult. Costs are discussed with every business case for cloud migration. Business case formulation is an important method regarding costs insights and developments. The business case should be beneficial and in balance with the costs and time that is required. Migration strategy is currently aimed at a mix of all five strategies. Business case is leading in selecting the migration strategy which proposes the best fit with the application. Regarding the legacy information systems, it is currently discussed that all systems that reach an end of life cycle should be renewed. The many layers on the mainframe should be decomposed and simplified, that method of architecting (creating many layers) is not allowed anymore. There are key performance indicators defined regarding cost control and the development costs are analyzed per application.

5.8 Case study: Bank 8

This bank follows a hybrid cloud strategy: on-premise and public cloud, with Microsoft Azure as the sole cloud vendor. The strategy is cloud first, new applications will be developed in

public cloud. To a certain extent the cloud vendor do not fulfill requirements about privacy and data storage. A clear requirement from this bank is that data cannot be stored in the USA and should be stored in the European Union (EU). Their cloud journey was initiated several years ago as cloud vendors approached the bank with their cloud solutions. During the same time, vendors of applications, which are running on-premise, should reconsider cloud computing. It is an illusion to migrate all applications to the cloud, due to nature of the data and its sensitivity has been said. It has to be managed very carefully and not all data should migrated to the cloud. The business objectives for cloud adoption are: scalability, accelerate with the market, flexibility and agility. If the cloud vendor cannot guarantee the security to the banks standard, than even with a positive business case the application will not migrate to the cloud. The bank does not expect that the costs will be decreased with cloud adoption and costs reduction is not a driver for cloud adoption. Migration strategy is discussed per business case as their current IT landscape requires this and is diverse. Furthermore, the business has different requirement and is not possible to stick to a single approach regarding cloud migration. Cloud adoption has been slower than expected as the business selects what is known and safe, thus on-premise is selected over public cloud. Cloud cost control are embedded in the regular business processes and it not managed separately.

5.9 Case study: Bank 9

With their own data centers this banks opens up their environment for vendors who are providing applications. This bank is quite critical concerning cloud computing and how cloud can continuously deliver business value. Cloud computing was compared with outsourcing, it is the same level of approach. Business objectives for cloud adoption are: business continuity, access to new technologies and specific expertise. This bank is using cloud computing limited and public cloud is applied at only specific business cases. Cloud is used for creating new network components, creating new services and for additional capacity when required. Cost are an important driver for the business cases and every element of the business case should be translated into costs. In theory, a business case for cloud adoption can be made attractive, to make a realistic business case, the unexpected costs and extra costs charged by the cloud vendor should always be taken into account as well. This bank selected consciously a sole cloud provider, in order to enable full integration and interoperability without having to manage the complexity of multiple cloud vendors. Current existing infrastructure running on-premise will not be migrated and the migration strategy is replace. The cloud migration costs are controlled via business cases and it is overall managed within the business processes and

not separately. This banks experiences costs control as a big challenge, since cloud requires a different way of working from our internal teams, and discipline is required in actively managing the applications that run on the cloud.

5.10 Case study: Bank 10

This bank follows a hybrid cloud strategy: on-premise and public cloud with a dual vendor cloud strategy: Amazon web-services(AWS) and Microsoft Azure. The vision and general strategy for the cloud is at an immature phase. The current landscape, its functionalities and capabilities are not yet fully understood and several difficulties are experienced. The primary reason for a 'lack of control' of their current on-premise environment is that this bank worked for many years with external contractors with a consequence that the knowledge about their IT infrastructure was not maintained within the company. Some time ago this bank applied a rehost strategy to migrate on-premise to another on-premise environment (outsourced) and during this migration, even though it was not a cloud migration, quite some problems were experienced. This was the proof in the pudding that the bank needs to increase their knowledge about the current IT landscape in order to prepare thoroughly for cloud migrations. Reason for cloud adoption is: flexibility, pay per use and scalability. Scalability is an important business objectives driver for cloud adoption as their vision is to organize and manage their IT infrastructure more effectively. At present, this bank does not benefit from their current IT infrastructure set-up as many servers are idle and not used. This is partially related to the fact that this bank outsourced their on-premise environment, which did not worked out for them. With the legacy information systems, this bank does not know yet how to handle those and what happens if applications are turned off or even migrate them to the cloud. It was said: *"we don't dare to touch legacy information systems"*, migration strategy is based per business case and the application. Certain applications require re-architecting but the level of complexity is high and difficult to estimate the impacts on their IT infrastructure. It is not the aim to migrate all applications to the cloud, as the outsourced on-premise contract also prevents this. To further enhance the migration complexity of this bank, is that most of the applications are managed by the vendor of that application. This is causing to a large extent inflexibility and costs are increasing to make changes to applications.

5.11 Summary banks

All banks in their cloud journey have the following similarities with the research of Luftman & Derksen (2012) with the following business objectives for cloud computing:

1. Agility
2. Flexibility
3. Time-to-market
4. Access to new technologies

In the table here below, the ten case studies regarding cloud, migration strategy and cloud vendor selection is summarized:

	Cloud strategy			Migration strategy					Cloud Vendor		
	On-premise	Private	Public	Rehost	Refactor	Revise	Rebuild	Replace	Amazon	Azure	Google
Bank 1		X	X							X	
Bank 2	X	X	X	X	X	X	X	X	X	X	
Bank 3	X		X	X *(pilot phase)*					X	X	X
Bank 4	X	X	X	X	X	X	X	X	X	X	
Bank 5	X		X		X				X	X	
Bank 6	X	X	X		X				X	X	
Bank 7	X		X						X		
Bank 8	X		X	X	X	X	X	X		X	
Bank 9	X		X					X		X	
Bank 10	X		X	X *(pilot phase)*					X	X	

Figure 10: Cloud journey ten corporate banks

All banks have a cloud strategy in place, which in most cases is the hybrid strategy: on-premise and public cloud. Public cloud is selected at ten banks with the main motivation, access to new technologies. To develop these technologies internally would take many years, therefore public cloud is selected. Not every bank has formulated a migration strategy yet. There are several reasons for this: still in the starting phase, remain flexible with their approach due to changing business requirements and start with a pilot migration first to determine the migration strategy. Five out of ten banks have the re-factor migrations strategy. Re-factor is a cloud migration strategy usually selected for PaaS and for legacy application systems (Zhou Zhou, 2014). To gain the most benefits of public cloud, SaaS is the advised stack. Refactor is the most time and resource intensive migration strategy, but if done well the applications are full cloud native and are compatible with the cloud framework of the cloud vendors. Banks prefer to approach the migrations strategy flexible as it has been said that a specific

migration strategy does not fit all applications, especially not the legacy information systems. In general there is more emphasis on the cloud strategy than the migration strategy. It seems there is no overarching IT project management method for cloud migration and even though there are workloads defined (contains several applications) it is mostly approached case by case. Most of the legacy information systems are running on the mainframe (core banking infrastructure) and there is limited knowledge, regarding how to migrate legacy applications. They aim to migrate with the least impact-full systems first in order to gain experience with cloud migration. Some banks were dissecting and analyzing their legacy applications layer by layer in order to reduce the complexity. It seems that regulation and new developments such as GDPR is playing a role in the cloud strategy, one bank specifically selected a multi cloud strategy: on-premise, private and public cloud to act on changing requirements. Furthermore, what stood out is that two banks were still dealing with decisions made in the past that affects their migration to the cloud today. These banks have outsourced their on-premise (data-center) some years ago to an external vendor. This causes vendor lock-in for their on-premise environment. These are multiple year on-premise contracts and cannot be dissolved on the short run. Since their on-premise environment is outsourced, this causes difficulties in migrating their applications to the cloud. The drive for cloud migration clashes to a certain extent with the on-premise vendors objectives. Thus decisions made in the past, heavily influenced their current IT landscape and their cloud journey, as this is causing these two banks more effort, time and budget so manage two external outsourcing companies.

6 Tangible hidden cost identification per bank

In this section, data of ten corporate banks regarding cloud migrations will be analyzed on a detailed level. Tangible hidden costs drivers will be supported by direct quotes from the banks. Each question will have to be answered if the spend occurred, if it was budgeted, if it was less, equal or more than budget and an explanation of the variance. The cost drivers for the interview set-up, has its origins from the Technology Business management framework (TBM) as discussed in the research methodology section. The following cost drivers will be analyzed and discussed:

1. Managing dependencies spend
2. Legislation
3. Support other departments
4. External contractors spend
5. Re-architecture
6. Internal resources spend
7. Cloud training spend
8. Cloud migration team spend
9. Third party services for cloud migration spend

6.1 Analysis managing dependencies

Managing dependencies entails that if application A is migrated to the cloud, during migration it appears that application A has dependencies with application B. To solve this, it can be decided that application B should also be migrated or that even the migration of application A should be even reversed. Managing dependencies is the largest bottleneck for banks during cloud migration. Eight out of ten banks (80%) spent more than budgeted for managing dependencies on applications during cloud migrations. *"We have many isolated systems and we are not aware of our current landscape full capabilities and functionalities and the impact of migrations of certain applications yet as we are still struggling with our on-premise environment"* is a direct quote from one of the banks. Four banks explained that decomposing the application and its several components posed to be difficult during the migration. One bank clearly identified the cause for overspent occurred due to a lack of knowledge of their on-premise environment. They did not fully understood how their IT landscape is defined and understanding the purpose and capabilities of the applications. Another bank identified that changing business requirements during migration impacts managing dependencies as well.

Overspent regarding managing dependencies of applications is an indication to what extent banks have an in-depth knowledge about their on-premise environment, applications and what the quality of the business case is prior migration.

6.2 Analysis legislation

Legislation are laws that banks have to follow. Especially the banking industry is one of the highest regulated industries on a global stage. Seven out of ten banks (70 %) spend more than budgeted regarding legislation. Data storage, outsourcing the data of customers and privacy sensitive is an underestimated problem. Several banks indicated that the current processes of the regulators are strenuous and not clear in the requirements. Also due to changing requirements per region is making it difficult for banks to manage this process, on a global level, since most banks of this research have a worldwide presence. Also legislation on overarching levels such as the European Union is lacking and therefore every country has their own set of rules to a certain extent. For the future an impact is expected. Banks are struggle with the fact that the regulation changes and their requirements are not fully clear and are not sure what to expect in terms of reporting and auditing.

6.3 Analysis support required from other departments

Support required from are departments that are indirectly related to cloud migration such as risk, compliance and security departments. Six out of ten banks (60%) required more support than was budgeted. One bank did not even take into account that support from other departments was initially required and had no budget allocated. Only three banks were on budget, since it was clearly mentioned the departments build and invest into the relationship. One bank had no idea if a budget overrun was occurred. Moreover, these banks who did not have an overspent mentioned a close relationship with other departments, this also increases agility and effectiveness. Six banks that required more support than initially budgeted explained during migration they required support from the risk and security department. One bank openly mentioned that their risk department was not well attuned to their needs, requirements and this was creating a lag in the process of cloud migration. Limited knowledge from their risk department was causing delay in cloud migration. Several banks mentioned that security for cloud migration required more support than expected.

6.4 Analysis external contractors

External contractors are developers and consultants that are hired for their specific skill for a limited time. Five out of 10 banks (50%) spend more than budgeted on external contractors such as developers and consultants. None of the banks spend less than budget. Banks had an overspent due to several reasons. The required knowledge for cloud migration was not available internally. Two bank have their on-premise environment outsourced to an external vendor. Managing public cloud together with an outsourced on-premise environment did not do any favors for those banks and increased the dependency on these vendors. External contractors can be very expensive if not carefully managed, also to a certain extent the knowledge is not invested in-house. Hiring external contractors should always be a trade-off between knowledge preservation in-house and to manage the migration. From a project management perspective certain parts of the migration were not prepared well and the project had an overrun. Another bank had to support a changing business requirement and in order to fulfill this request, an external contractor had to be hired for that specific knowledge. Even though one bank is very keen on sustaining the knowledge internally, they still had to spend on external contractors regarding security and risk elements. External contractors should always be taken into account when preparing the business case of an application migration. The required knowledge required for that migration should be plotted against internal resources, this in order to predict better what to spend on external contractors and to what extent it is necessary to hire. Furthermore, overspending on external contractors is an indication how the process of migration is actually progressing. It clearly displays which areas are still lacking required knowledge, to be able to manage it internally without external contractors.

6.5 Analysis re-architecting

With re-architecting fundamental changes are made, such as changing the code of an application. Five out of ten banks (50 %) spend more on re-architecting applications, during migration. Two banks did not even budget for this occurrence, but were realistic about the possibility that it will occur. During migration it became clear that a certain solution was not offered by the cloud vendor and in order to full-fill the business requirement the bank had to re-architect. It seems that during cloud migration, banks are not fully aligned yet with the possibilities the cloud vendor offers. Two banks struggled with end of life applications and it became clear that re-architect of the application was necessary for the cloud migration. Again, complexity and underestimation of the cloud migration processes were given as reasons

for overspending.

6.6 Analysis internal resources

Internal resources are a key element in building the knowledge and gaining experience with cloud migrations. Internal resources are referred to internal personnel at the bank. Four out of ten banks (40%) spent more regarding internal resources compared to budget. Internal resources is the personnel that are employed internally by the bank. In all these four cases, budget was allocated for internal resources regarding cloud migration, but still there was overspent.For every bank that spend more than budget, it was due to the fact that budgets were too optimistic and there was a knowledge gap regarding cloud migration. Which was not known prior migration. Knowledge gap became clear during cloud migration at the four banks that had an overspent. Since cloud computing is a relative new technology there is a steep learning curve, which is reflected in the overspent compared to budget. One bank spend less than budgeted, but this was due to the fact that this bank is behind schedule of cloud migrations, which in the end will lead to more costs than budgeted. It is important that the process of internal resources assigned to the cloud migration project is reviewed and adapted. Also the reasons for the variances should be taken into account when preparing budget discussions. In this case overspent was caused mainly by the lack of knowledge and overestimation of their capabilities. Realistic budgeting and the available resources should be taken into account. Capabilities of the internal personnel should be taken into account when building the business case for cloud migration, to identify potential knowledge gap beforehand.

6.7 Analysis cloud training spend

Cloud training for internal personnel is a prerequisite as it requires a different way of managing applications compared to on-premise. Four out of 10 banks (40 %) spend more money than initially was budgeted for cloud training. At one bank, there was significantly less money spend on cloud training's compared to the available budget. Reason for this was a lack of interest from the internal personnel for the cloud training and it was not being advocated by the bank. Other bank spend more than expected as they said " we did not have the full picture" and underestimated what was required to certify their personnel. At one bank, cloud training had a positive take-off within the organization and whilst doing the training, their personnel recognized that the knowledge gap was even larger than anticipated and required cloud training. The developer of the applications becomes in a certain way also partially

together with the business part the 'owner' of that application, as cloud has the pay per use business model. While other banks plan carefully the required budgets upfront with their HR departments and are allowed generous budgets other bank have a limited budget for the purpose of training. Indirectly, the extent of budget that is spend on cloud training reports the pace of the expected cloud adoption progress.

6.8 Analysis spend on cloud migration team

Forming a cloud migration team is an essential part of sustaining the knowledge and offering support to teams. A central part of a companies cloud migration adoption. Most bank have a overarching cloud teams, where cloud migration is part of the team's objectives. These teams, have the helicopter view and support several teams who are in the process of cloud migration and adoption. Three out of ten banks (30 %) had an overspent on their budgets regarding constructing cloud migration teams. Complexity of cloud migration lead to teams being extended, it was more complicated than initially assumed. Complexity of the cloud migration and its adoption has been given as the main cause for the overspent in extending the cloud migration team. Cloud computing and migration is part of an enterprise wide project and it should not be treated as an isolated project. It requires that several teams across the organization work together in adopting cloud migration. A cloud migration team can facilitate this process and act as an internal consulting team enterprise wide. Furthermore, by working together and relying on an internal source of information can have positive effects on cloud migration and can create accountability. Cloud migration team is the corner stone of the overall cloud computing project and it effects business continuity.

6.9 Analysis third party services

A third party services is different than external contractors, as a third party services manages a process end to end. Two banks (20 %) spend more than expected due to lack of knowledge of cloud migration and its complexity. Two banks were in line with budget projections at external parties to execute and support them with cloud migration. Main reason for this is that the banks are focused on trying the build the knowledge internally and are not willing to spend large amounts on outsourcing the cloud migration execution end to end.

6.10 Identification hidden cost drivers overspending budget

In this section the hidden costs that are over budget are identified per cost driver category. The following cost category drivers had an overspent compared to budget than budgeted, sorted by the the category which had the most overspent and a summary of the complete view is elaborated in figure 12 and explained.

1. Managing dependencies (8 out of 10 banks overspent)
2. Legislation (7 out of 10 banks overspent)
3. Support from other departments (5 out of 10 banks overspent)
4. Re-architect (5 out of 10 banks overspent)
5. External contractors (5 out of 10 banks overspent)
6. Internal resources (4 out of 10 banks overspent)
7. Cloud training (4 out of 10 banks overspent)
8. Cloud migration team (3 out of 10 banks overspent)
9. Third party services (2 out of 10 banks overspent)

Was it less, equal or more than budget?	Internal resources	Cloud trainings	External Contractors	Cloud migration team	Support from other departments	3rd party services	Managing dependencies applications	Re-architect during migration	Legislation
Bank 1	Less	Less	Equal	n/a	More	More	More	Equal	Equal
Bank 2	Less	More	Equal	Equal	Equal	n/a	More	Equal	More
Bank 3	Less	Equal	More	Equal	Equal	More	n/a	n/a	N/a
Bank 4	Equal	Equal	More	More	More	Equal	equal	More	More
Bank 5	More	More	More	More	More	No	More	More	Equal
Bank 6	Equal	More	Equal	Equal	More	Equal	More	More	More
Bank 7	Equal	Equal	n/a	n/a	n/a	n/a	More	More	More
Bank 8	More	equal	Equal	More	More	No	More	More	More
Bank 9	More	equal	More	Equal	Equal	Equal	More	n/a	More
Bank 10	More	More	More	Equal	More	n/a	More	n/a	More

Figure 11: Hidden costs - overspend budget

1. Managing dependencies during cloud migration is the biggest bottleneck for banks and has the largest impact on cloud migrations as 80 % of the banks had an overspent compared to budget. Research revealed that dependency issues are often underestimated (Opara-Martins et al., 2013). Even Amazon Web Services which is market leader in cloud computing, strongly advises that dependencies of applications should be mapped and analyzed prior cloud migration (Varia, 2010).

2. The second hidden costs driver is legislation, as 70 % of the banks had an overspent compared to budget. This is clearly an item that is keeping all the banks occupied as data privacy regulation is currently an evolving process and not set in stone. This even lead to that one bank clearly selecting multi cloud strategy (on-premise, private and public cloud) in order to adopt quickly when new requirements regarding legislation arises. A recent study indicated that even though cloud computing offers certain benefits, it does increase the legal complexity exponentially (Duncan & Whittington, 2016; Pearson & Benameur,2010). Due to the dynamic nature of cloud and data globally dispersed it makes it inherently difficult to comply with regulators (Pearson & Benameur, 2010).
3. Thirdly, support required from other departments, during cloud migrations is the another hidden cost driver which caused an overspent at 50% of the banks. Elements such as risk and security required more support than expected. Cloud computing is challenging organizations as it requires a different way of working, and elements such as security was very well known and managed on-premise, while cloud computing requires a different approach. With cloud computing, the data is stored externally at cloud vendors. One bank mentioned, their risk department even slowed the adoption of cloud due to a lack of managing, providing the cloud teams with their requests.
4. External contractors reliance on cloud migration purposes is underestimated as well as 50 % of the banks spend more than the budget, One bank spend specifically on security and risk contractors due to a lack of internal knowledge. It is clear that cloud computing requires a new set of requirements and knowledge from an organization which has adopted cloud. The difficulty that lies here is that the IT profile is changing and required knowledge is not specifically IT related anymore. With cloud computing the IT department is emerging more to the forefront of a company and is more exposed. It requires knowledge regarding decomposing and analyzing applications, strategically analyzing their IT portfolio and landscape, especially how applications are intertwined, extensive knowledge about enterprise architecture and knowledge regarding security, finance, risk and legislation.

7 Delphi panel: Cloud experts validation of intangible hidden costs

In this section the intangible hidden costs drivers are synthesized based on the ten case studies at corporate banks and is based on their cloud migration execution process based on interview 1 and interview 2 per bank. The intangible hidden costs drivers are recorded based on direct quotes from the banks during the multiple interviews per bank.

7.1 Set up: Cloud expert validation

The hidden costs drivers have been verified with a Delphi cloud experts panel which consists of two cloud computing experts who have a proven track-record in managing and overseeing cloud migrations. The cloud experts have a solid knowledge about cloud economics and are part of a cloud migration execution process within their company and have more than twenty years IT experience. It was a challenge to find seasoned cloud experts who were willing to participate in this research and who are knowledgeable regarding: cloud strategy, cloud computing economics, cloud migration and building business cases. Both cloud experts provided their input separately, thus there was no influence from the researcher nor the other cloud experts during the validation process. The hidden costs are evaluated per driver with the underlying statements of the banks. A binary scale was used: the cloud experts could either *fully agree* or *fully disagree* with the statements. The binary scale is selected because it resulted in a mandatory clear answers and evoked underlying motivations of their selection (agree or disagree). The validated intangible hidden costs drivers will be analyzed in the next section.

7.2 Intangible hidden cost drivers

In this research the following intangible cost drivers have been identified, the cloud expert validation is integrated in table 1 below.

Identified intangible cost driver	**Verification Cloud Expert 1**	**Verification Cloud Expert 2**
Business case (10)	66 %	66%
Business continuity (1)	100 %	100 %
Cloud acceptance (4)	75 %	50 %
Cloud vendor (1)	0 %	100 %
Cost Control (4)	100 %	100 %
Knowledge gap (6)	100 %	66 %
Legacy applications (4)	100 %	75 %
Network (3)	66 %	33 %
On-premise (2)	100 %	50 %
Retention (2)	100 %	100 %
Security (3)	66 %	66 %
Strategy (6)	80 %	75 %

Table 1: Intangible hidden costs drivers validated by cloud experts

Business case

Business case construction is an important component in cloud migrations and cloud experts validated that if these are not clearly formulated and followed up it can cause hidden costs. *"There are too many variables, that would make the business case extremely complex and a project on it's own".* All banks define business case but seems to struggle with creating, validating and following up the business case. It is rarely being followed up if the estimated costs and benefits in the business case are actually realized. *"I believe we hardly ever check the original business case against the actuals. Most business cases are approved based on 'business benefits' that are not measured".* When creating the business case, essentially all banks experience issues with ensuring they compare "apples with apples" on-premise vs cloud. *"Actually, business cases are rare. Projects get started when they feel good and get 'sold' internally".* If business- IT alignment does not occur during business case construction, this can cause problems during cloud migration. *Business - IT alignment is causing slower migration, during migration the business required enhanced security, which was not covered in the business case.* For some bank the business requirements changed during cloud migration, these can be prevented with an accurate business case to a certain extent. *An ongoing discussion, different views of public vs private cloud, maintain vs manage, there is no clear figures both business cases (on-premise vs cloud)* There is also a lack of an standardized business case construction and method for almost all banks and is more an-hoc process. There are only two banks

who follow TCO method for business case construction. A governance structure should be followed, to ensure that a business case is formulated and discussed the cloud migration of an application.

Business continuity

Regarding business continuity, cloud migration should be a steady process and should not be approached with a big bang. The cloud expert fully agrees with avoiding a big bang as much as possible. One bank mentioned: *"Biggest danger: difficult to change IT, than for the long time they dont change, and then at once they approach it with a big bang. For continuity and in order to manage it, approach renew of applications on a continuity basis, not a big bang, that is a very risky operation."*

Cloud acceptance

For three banks, cloud acceptance of their internal personnel, especially from the business side is a challenge. At all these three banks it was mentioned that the business prefers on-premise environment over cloud computing - as on-premise environment is known and they know what to expect. If there is a resistance for cloud acceptance it will slow cloud adoption and migration. *Very slow cloud adoption from the people in the organization and this does not improve in migrating applications to the cloud, slow adoption.* During a business case construction the business should be involved early on to mitigate this risk as much as possible. One cloud expert added: *It requires a huge change in mindset and way of working to realize this shift*

Cloud vendor

For some banks it is not fully clear what the standardized services are that a cloud vendor offers beforehand. Also aligning with cloud vendors regarding their requirements prior migration was not done thoroughly which led to problems during migration. During migration it became clear that certain parts of the contract had to be re-negotiated to reach the level that the bank required. *Vendor management and the standard contracts they are offering did not fulfill our requirements. Cloud vendors offer standard contracts and they try to hold to what they offer in a standardized way as much as possible. It required a lot of effort, time and money to get the vendor to our requirements.* The cloud expert panel agreed to a certain extent, one cloud expert panel mentioned: *Correct, vendor contract management need to learn this business model first.* The other cloud expert explained that these hidden costs drivers can be prevented as the organization should stay in control*"mostly the vendor should not change but the customer should try to follow the standard offerings. That is the only way to benefit from standard services."*

Cost control

The cloud experts agreed fully that cost control is a hidden cost driver. One bank mentioned: *We have a good view, which kind of costs we can expect, but the level of costs is to a certain extent difficult to predict.* Feedback cloud expert: *most contracts are likely pre-payments to get better discounts, but companies rarely know how long it will take to use up the pre-paid amount.* I observed and noticed that only one bank had a clear cost management system in place and other banks don't analyze cloud migration costs separately and cloud computing costs are accumulated in the bigger picture of IT costs. It is an ad-hoc process if there variances occur. It requires a different way of thinking, as IT infra structure costs will be flexible. The cloud expert added: *Difference between OpEx management and CapEx management.* Cost control depends on the maturity of the devops team, very mature devops team they take it into account, less mature teams are not fully aware which costs can occur. One cloud expert concluded:

Knowledge gap

One bank explained that knowledge is a serious challenge *We are still learning, and level of experience within the industry is very low regarding cloud computing, the chance of hitting unexpected costs are high, because we are experiencing it for the first time.* and *Overall complexity of migration, no prior knowledge of how to do it.* These are direct statements from the banks regarding and indicates that cloud migration at these banks are still in early phases of maturity and is part of the learning curve. One cloud expert mentioned that "Not a lot of possibilities to compare with" - the cloud expert entails with this statement that cloud migration is a new process and is difficult to compare with other projects.

Legacy applications

We don't dare to touch legacy applications, this is a clear indication that this specific bank has no clue yet how to handle these kind of complex systems. Most of the banks started their cloud migrations with applications which has a low impact. In order to build and gain knowledge to prepare the cloud migration of critical legacy applications. *It is too expensive to migrate our mainframe applications, we don't have the capacity nor the budget to invest heavily in migrating mainframe applications. Return on investment, was not positive.* We will keep all our mainframe applications on-premise Many banks clearly indicated that they are very hesitant to touch critical/legacy applications and it is expected that there will always be a on-premise environment due to this reason. *"Outdated applications cause issues during cloud migration and especially dependencies on other applications."* One cloud expert mentioned *"I am convinced that all IT can be migrated, but I am also convinced that it will not happen." It*

is mostly politics. Some banks dont have a mainframe, so it is possible to run a bank without."

Network

We had to do major investments for our infrastructure and on a network level. The data volume between on-premise and cloud, we had not the capacity to support this and the migration itself as well. We just realized this during the migration when the network connectivity became very slow. While these are hidden costs, the cloud expert said that this can be easily prevented and is a result of "bad planning". The first migrations posed issues for many banks as well, as these are strenuous and it required a change in their networked offerings such as secure connections to cloud, set up a wider band width that can handle the enormous flow of data from on-premise to the cloud. One bank quoted: *We had to do major investments for our infrastructure and on a network level. The data volume between on-premise and cloud, we had not the capacity to support this and the migration itself as well. We just realized this during the migration when the network connectivity became very slow.*

On-premise

Insufficient knowledge about on-premise environment is leading to hidden cost drivers during cloud migration. *We have a lot of legacy systems and we don't know how to handle them, we have no clue what will happen if we migrate them to the cloud or shut them down.* Outdated IT infrastructure and limited knowledge of the current IT landscape implicates more difficulties during migration as the AS-is to-be environment should be aligned. Cloud experts were surprised that this is the situation at certain banks, that the current on-premise environment is not fully under control and this should be more mature prior migrating to the cloud.

Retention

Personnel management is an important factor in cloud migration, at some banks after their personnel received "cloud native trainings" they switched jobs and this knowledge was not utilized. The initial investment was not paid out as well in terms of knowledge preservation within the company. Cloud expert agreed fully and mentioned *I can imagine that trained staff leave the company if they perceive the progress is too slow. This is a real risk and companies need to work on retention plans. Our bank worked for many years with external contractors, they all left and the current internal personnel are all recently hired and we have very limited knowledge about the on-premise environment and our IT infrastructure, we are struggling highly with this.* Retention management in digital transformation is crucial to execute it successfully.

Security

Security from on premise to the cloud could not be guaranteed by the cloud vendor, we had to extend our firewall capacity and this causes hidden costs that was not known prior migration. One cloud expert commented with: *Agree but this is also something that shows lack of technical and security maturity, this is a given if you extend your network beyond your traditional borders.* One bank stated: *Level of security and risk is not at a comfortable level yet for us, in practice the cloud adoption is lower than expected and we choose for what we know and can rely upon (on-premise) due to risk and security reasons mainly*, whereas the cloud expert reacted with: *False dilemma, on-premise security is just as complex and costly, if you think you are safer on-premise you are lacking controls and security.* Both agreed that if security requirements is not fully known prior migration it can lead to hidden costs:

Strategy

It seems that several banks already started with cloud migrations while even the first initial cloud strategy and migrations strategy is not finalized or not even formulated yet. Cloud experts reacted that this can occur but only that this is only acceptable with SaaS solutions. If there are no clear guidelines and strategies beforehand this might lead to different migration strategies and not the intended outcome in the stack, with possible re-engineering to align with the migration, which can lead to hidden costs, since it was not agreed up-front.

8 Conclusion

The objective of this research is to identify the hidden costs drivers of cloud migrations based on ten case studies at corporate banks. Cloud adoption at corporate banks is in an early adoption phase. The ten corporate banks are currently building knowledge and expertise with cloud migration. The central research question: *What are the hidden costs drivers of cloud migrations at corporate banks* is divided into four sub-questions, the answers to the main and sub research questions are listed below. First the four sub research questions are answered and then follows the main research question.

8.1 Revisiting the research questions

1. What are the typical costs of a cloud migration?

Cloud migration projects has IT project management costs component structure, however these do not cover the cloud migrations fully. Cloud migrations are a complex IT project with unique project management costs features. The costs here below are identified based on academic literature for cloud migration:

- Training costs of personnel for cloud native
- Installation and configuration of their infrastructure
- Adopting the cloud framework of the vendor
- Change of code modifications
- Systems development costs
- Direct labor costs
- Operational costs
- Deployment of application costs

Migration costs as listed here above were used in combination with the technology business management framework to formulate and structure the interview questions for in identifying which costs are over budget.

2. Which tangible costs drivers in bank cloud migration projects are over budget?

The following cost drivers, have an overspent compared to budget and all ten banks had overspent compared to their budget on the cost categories as identified in the table below. Managing dependencies during cloud migration is the biggest bottleneck for banks and has the largest impact on cloud migrations as 80 % of the banks spent more than budget. When applications are identified for migration, it should be analyzed what the several layers of the application are prior migration, to mitigate these risks and dependencies at other applications. This also entails that current knowledge about their on-premise environment is lacking. Application dependencies during cloud migration, were only discovered to a certain extent during the migration and dependencies on other departments such as risk and security as well.

Cost category	**Banks overspend**
Managing dependencies applications	8 out of 10 banks
Legislation	7 out of 10 banks
Support from other department's	6 out of 10 banks
Re-architect during migration	5 out of 10 banks
External contractor	5 out of 10 banks
Internal resource (headcount)	4 out of 10 banks
Cloud training	4 out of 10 banks
Cloud migration team	3 out of 10 banks
External 3rd party for cloud migration support	2 out of 10 banks

Table 2: Costs drivers overspend compared to budget

3. What are intangible hidden cost drivers of a cloud migration project?

The following intangible hidden cost drivers have been identified based on case studies at ten banks and stated here below, these occurred during cloud migration at ten banks. These are all drivers that are hidden, because it influences the cloud migration negatively and are difficult to predict and are not budgeted.

- Business case
- Business continuity
- Cloud acceptance
- Cloud vendor
- Cost control
- Governance
- Knowledge gap
- Legacy applications
- Security
- Network
- On-premise
- Retention
- Strategy

4. Do cloud experts agree or disagree with the identified intangible costs drivers?

To increase the external validity of this research, a Delphi cloud expert panel was constructed to verify and validate the intangible cost drivers of a cloud migration. With every cost driver identification it is marked how many times it occurred. For example the business case cost driver has 10 underlying statements found during the interviews. Per cost driver category the cloud expert identified with a binary scale if it agreed or not agreed with the statement. To illustrate this with an example, in total there are 4 intangible cost drivers found for cost control and the table below, reported as *cost control (4)*. Overall cloud experts agreed on the identified intangible cost drivers on certain items, they did not agree and said it was the result of bad planning and can be easily avoided. Also network problems, can be avoided as cloud always requires an extensive network bandwidth than on-premise. Summary of the cloud experts validation is stated in table 3.

Identified intangible cost driver	Verification Cloud Expert 1	Verification Cloud Expert 2
Business case (10)	66 %	66%
Business continuity (1)	100 %	100 %
Cloud acceptance (4)	75 %	50 %
Cloud vendor (1)	0 %	100 %
Cost Control (4)	100 %	100 %
Dependency (4)	100 %	100 %
Knowledge gap (6)	100 %	66 %
Legacy applications (4)	100 %	75 %
Regulation (4)	33 %	66 %
Network (3)	66 %	33 %
On-premise (2)	100 %	50 %
Retention (2)	100 %	100 %
Security (3)	66 %	66 %
Strategy (6)	80 %	75 %

Table 3: Intangible hidden costs drivers validated by cloud experts

Main research question

What are the hidden costs drivers of cloud migrations at corporate banks?

Hidden costs drivers, during cloud migration exist and have been identified via a multiple interview approach (case study) at ten corporate banks. The hidden costs drivers exist and remained hidden as there are no proper business case construction prior a cloud migration. Cloud computing is a new technology and cannot be approached as a typical IT project, because it is not a typical IT project as cloud has unique features. Most banks do not manage cloud migration costs separately and the related cloud costs are accumulated.

- The largest bottleneck for tangible hidden cost drivers is that banks severely underestimate managing dependencies of applications during a cloud migration. Eight out of ten banks, spent more than budget to manage dependencies. Managing dependencies entails that if application A is migrated to the cloud, during migration it appears that application A has dependencies with application B. To solve this, it can be decided that application B should also be migrated or that even the migration of application A should be even reversed. It requires a lot of effort, time and budget to fix these dependencies of applications during migrations and is slowing down cloud migration.

- The largest bottleneck found in this research for intangible hidden cost driver is business case construction. Business case construction is an important for cloud migrations and cloud experts validated that if business cases are not clearly formulated and followed up, it can cause hidden costs. All banks define business case but struggle with creating, vali-

dating and following up. It is rarely being followed up if the estimated costs and benefits in the business case are actually realized. When creating the business case, essentially all banks experience issues with ensuring that the correct variables are constructed to compare on-premise with cloud. For some bank the business requirements even changed during cloud migration, these can be prevented with an accurate business case and a stakeholder analysis with decision makers, prior migration.

Hidden cost drivers are a combination of tangible & intangible drivers **Tangible hidden costs drivers that are over budget and can be measured:**

1. Managing dependencies applications
2. Legislation
3. Support from other department
4. Re-architect
5. External contractor
6. Internal resource
7. Cloud training
8. Cloud migration team
9. External third party services

Intangible hidden costs drivers:

1. Business case
2. Business continuity
3. Cloud acceptance
4. Cloud vendor
5. Cost control
6. Dependency
7. Governance
8. Knowledge gap
9. Legacy applications
10. Security
11. Network
12. On-premise
13. Regulation
14. Retention
15. Strategy

8.2 Aligning academic theory with findings

Academic literature provides several cost methods and strategies to prevent hidden costs drivers from occurring to a certain extent. Approaching cloud migrations with cost theories provides insight and early requirements can be formulated.

- Academic literature advocates for a clear cloud and migration strategy. Most banks have a mix of several migrations strategies, only two banks had a clear process of selecting the migration strategy, others banks opted for a mix of the five migration strategies. Two banks which have a clear migration strategy, are testing their migration strategy with a pilot phase, to see what actual works. In this pilot phase, applications will be migrated to cloud and tested with several migration strategies to see how it works in practice. Based on the results of this migration pilot, the migration strategy will be selected. Thus, it can be concluded that most of the banks don't follow academic literature in constructing a clear migration strategy. The general cloud strategy, such as selecting the cloud vendor has solid base why the cloud vendors are selected and are aligned with their business objectives they aim to achieve with cloud and is in line with academic literature.

- Academic literature regarding cost theories, proofs with several case studies that a clear cost theory approach prevents hidden costs to a certain extent. Total cost of ownership is being advocated in literature as a valid method to estimate cost and complexity of projects. However, in this research only two banks applied the total cost of ownership (TCO) method. Other banks did not applied TCO as it is a difficult method to apply and variables required for TCO analysis was not available to a certain extent.

- Business case construction is an important part of IT project management and can prevent hidden costs as well, as every aspect of the project is projected and aligned with decision makers and stakeholders. A known problem, as identified in literature that these are usually inflated. In this research, every bank prepared a business case prior migration. All banks, struggle in creating, validating and following up the business case. The business case is rarely being followed up if the estimated costs and benefits in the business case are actually realized. When creating the business case, essentially all banks experience issues with ensuring that correct variables are constructed to compare on-premise with cloud. Business case construction is also identified as the largest bottleneck regarding intangible hidden cost drivers in this research. Banks understand the

importance of business case construction, but fail to a certain extent in actually creating a sound and proper business with the correct variables.

8.3 Contributions

This research has a significant contribution because this type of detailed and precisely constructed information is not accessible across the banking industry and in academia regarding cloud migration costs. The data collection in this research is usually not accessible as it is highly confidential. This research created a direct insights in the cloud migration journey of ten corporate banks. It provides a direct benchmark for banks to compare their own cloud computing journey with other banks. Practitioners gain access to confidential information about how strategies are decided and formulated. Furthermore, the detailed level of decision making regarding cloud migrations and the evolvement of their costs drivers is a type of information that is not shared within the financial banking industry. Contributions are summarized below.

8.3.1 Contributions for academia

This research is the first step for identifying the hidden cost drivers during a cloud migration.

- Constructed hidden costs drivers for cloud migrations by integrating the research area's of: IT, Finance and Project management
- Building theory in cost control and insights for cloud migration
- Contribution to IT project management cost drivers for cloud migration
- Contribution to IT outsourcing theory specifically for cloud computing and cloud migration
- Contribution regarding inflated business cases in cloud computing
- Contribution which factors drive the selection of a cloud migration
- First step in forming a blueprint for cloud migrations with the angle of costs drivers
- Contribution to theory regarding hidden costs drivers

8.3.2 Contributions for practitioners

- Critical objective analysis of cloud migrations based on ten case studies
- Identification of bottlenecks during cloud migration from different perspectives
- Benchmark of ten corporate banks with insights that are usually difficult to gather
- Clear insights in how banks made decisions regarding cloud computing

- How to build a business case for cloud migration
- Able to make better estimated predictions for cloud migration budgets
- How decisions made in the past regarding on-premise IT landscape influences cloud migration
- Which cost drivers are difficult to predict for cloud migrations
- Which costs drivers are causing overspent at cloud migration budgets
- Learning's from other banks, such as testing the migration strategy first (pilot phase)
- Gained insight what the status is at other banks regarding legacy applications and cloud migration

8.4 Future research

This research is one of the first studies in identifying hidden costs drivers of a cloud migration in the banking industry. All ten banks in this research did not yet fully migrate their legacy applications to the cloud. It is a big question mark for banks how to migrate these legacy applications as these are mission critical of their core banking system. It would be interesting to research how banks approach the migration of legacy applications and what the hidden costs drivers are. This research can be replicated for other industries as well, as the banking industry is heavily regulated and specific legal requirements apply only for this industry. Furthermore, it would be interesting to extend this research for the pre- and post migration phase to have the full overview of cloud computing and its impact regarding cost drivers. Based on the hidden costs drivers of this research, a case study can be performed at an organization to further build the theory for cloud migration costs and drivers.

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Appendices

A Interview 1: Questions

No.	Category	Question
1.1	Introduction	What is your role in the cloud migration project?
1.2	Cloud strategy	What is your cloud strategy?
1.3	Cloud strategy	What are the business objectives /driver you are trying to reach with cloud?
1.4	Cloud strategy	Is this also the case in practice?
1.5	Cloud strategy	Are cost an integral part of the business objectives?
1.6	Migration strategy	What is your migration strategy? (rehost, refactor, revise, rebuild, replace)
1.7	Migration strategy	Why did you choose for this strategy?
1.8	Migration strategy	Is this also the case in practice?
1.9	Migration strategy	Does the migration strategy have a cost component driver?
1.10	Migration strategy	What are methods to control and gain insights in costs development of your cloud migration?

Table 4: First interview: Cloud & Migration strategy

B Interview 2: Questions

No.	Category	Question
2.1	Internal Labor	Did you assign internal resources to the cloud migration?
2.2	Internal Labor	Did you spend money on training personnel for becoming cloud native?
2.3	External Labor	Did you spend on contractors for the cloud migration?
2.4	Internal Services	Did you create a dedicated team for cloud migration?
2.5	Internal Services	Did you receive support from other departments for cloud migration? (e.g risk, security, and compliance)
2.6	Outside Services	Did you spend on services from 3rd party to execute the cloud migration?
2.7	Software	Did you spend on managing dependencies on other applications/components?
2.8	Delivery	Did you had to unexpectedly re-architect during migration?
2.9	Delivery	Did you changed your service level (SAAS, PAAS, IAAS) during migration?
2.10	Other	Did you spend money regarding legislation during migration?

Table 5: Second interview: Costs identification

B.1 Internal resources spend

In this subsection the following question *"Did you assign internal resources to the cloud migration?"* will be analyzed.

Bank	**Yes/No**	**Was it budgeted?**	**Was it less, equal or more than budget?**	**Rationale for the variances - Quotes from the interviewees**
1	Yes	Yes	Less	We are running behind schedule, the engineers need to finish other projects first prior they can start with the cloud migrations
2	Yes	Yes	Less	We have budgeted very conservatively and budgeted more than was required
3	Yes	Yes	Less	We are currently lagging behind with our cloud adoption mainly due to having to receive legal approval from many different regulators, since we operate in many countries. We need their consent first, prior we can migrate data to the cloud.
4	Yes	Yes	Equal	With our Devops transformation, we assign the internal resources per business case therefore we aim to stay in control
5	Yes	Yes	More	When we started we thought we would need a certain amount of resources, we miscalculated because we were too positive, Knowledge gap about change and cloud is the main reason for this
6	Yes	Yes	Equal	On target, important to manage it within the budget
7	Yes	Yes	Equal	We dont take a fixed approach to this, adjusted when required
8	Yes	Yes	More	Regarding the contracts with the public cloud provider was much more complicated than expected, initially, we did not received clear answers about how the data is stored, which data is stored and location of the data storage. To figure out all these questions took us quite some effort.
9	Yes	Yes	More	Large amount of internal effort required, we planned too optimistic, the requirement we have put upfront is imperfect and we learn by doing it. Also due to changing requirements, to facilitate that is expensive
10	Yes	Yes	More	We had some complex migrations and these issues that occurred are very time consuming

Table 6: Internal resources

B.2 Cloud training spend

Bank	Yes/No	Was it budgeted?	Was it less, equal or more than budget?	Rationale for the variances, direct quotes from the interviewees
1	Yes	Yes	Less	9 out of 10 times for training purposes, are not being spent, people are not aware they can take these training's and lack of involvement and interest for cloud.
2	Yes	Yes	More	Our internal personnel got very enthusiastic with the cloud training's and identified other knowledge gaps regarding cloud, such as security and on premise integration with cloud.
3	Yes	Yes	Equal	We paid upfront from cloud training's, these can be used unlimited (also licensing training's)
4	Yes	Yes	Equal	We align with our HR department about the training's budget we require and we make clear to them what we need, which is granted to us. Also it is quite a generous budget
5	Yes	Yes	More	We did not have the full picture when we started our cloud journey, we decided that all internal personal required certifications of their knowledge. This costs a lot of money
6	Yes	Yes	More	More required than anticipated
7	Yes	Yes	Equal	No comment
8	Yes	Yes	Equal	No comment
9	Yes	Yes	Equal	Easy to budget and we choose carefully the training's our personnel requires
10	Yes	Yes	More	We have very limited budgets, not very realistic budgets for what the personal requires in terms of sustaining cloud knowledge for training purposes and we are still building knowledge regarding cloud

Table 7: Cloud trainings

B.3 External contractors spend

Did you spend on contractors for the cloud migration?

Bank	**Yes/No**	**Was it budgeted?**	**Was it less, equal or more than budget?**	**Rationale for the variances, direct quotes from the interviewees**
1	Yes	Yes	Equal	No comment
2	Yes	Yes	Equal	We made a correct budget estimation and we want to promote internal resources above external resources
3	Yes	Yes	More	Expertise is difficult to come by, we do not have the knowledge in-house yet
4	Yes	Yes	More	Our internal IT is very limited because we have outsourced our IT to a great extent. The vendor we outsourced our internal IT to, refused to work with us on public cloud, since this vendor manages our on-premise environment. It was a conflict of interest for them. Therefore we had to seek other vendors for public cloud. We also had to manage peak loads, this is related to initial investment in public cloud and we expect this will diminish at some point.
5	Yes	Yes	More	We did not meet our targets and the contractors could not yet start since the database was not ready, we spend time waiting
6	Yes	Yes	Equal	We are critical how we spend regarding external labor and always prefer to execute it with internal resources
7	Yes	Not known	Not known	No comment
8	Yes	Yes	Equal	Currently very limited use of contractors
9	Yes	Yes	More	To facilitate changing business requirement we had to hire contractors
10	Yes	Yes	More	Even though we are currently focused at building knowledge internally and not very keen to hire externals we are dependant on risk and security matters from contractors

Table 8: External contractors

B.4 Cloud migration team

Did you created a dedicated team for cloud migration?

Bank	**Yes/No**	**Was it budgeted?**	**Was it less, equal or more than budget?**	**Rationale for the variances, direct quotes from the interviewees**
1	Yes	Yes	n/a	Dont know yet, we have just started building the team
2	Yes	Yes	Equal	No comment
3	Yes	Yes	More	No comment
4	Yes	Yes	More	The demand migration to the cloud was more than we initially thought, in order to deliver the service that was required and to meet the increased demand for cloud.
5	Yes	Yes	More	Due to limited knowledge we have, we required more staff than expected and budgeted for
6	Yes	Yes	Equal	We continuously check the feasibility and possible changing requirements of the business case and scale if required
7	Yes	Not known	Not known	No comment
8	Yes	Yes	More	Due to complexity of cloud technology, we extended the team. More complicated than we initially assumed
9	Yes	Yes	Equal	Part of a larger cloud computing team
10	Yes	Yes	Equal	Just started forming the teams

Table 9: Cloud migration team

B.5 Cloud migration support

Did you received support from other departments for cloud migration purposes, such as security and risk teams?

Bank	**Yes/No**	**Was it budgeted?**	**Was it less, equal or more than budget?**	**Rationale for the variances, direct quotes from the interviewees**
1	Yes	Yes	More	Start looking at functionalities you need, people are involved, you tend to understand how it works, new information from the vendor is on the table, another view, how things should be implemented. We required more support than expected.
2	Yes	Yes	Equal	We have made good estimations that we required support from other departments
3	Yes	Yes	Equal	Built a target operating model for 2019, so far it seems that the current resources function well and there is not yet a requirement for extending the team
4	Yes	Yes	More	Architecture became involved, to adopt services, which allowed portability between cloud providers: this was not taken into scope. Critical applications migrated to the cloud was quite complex from an IT security perspective and it required more work. For the critical applications it was also required to have an exit strategy, this is a requirement from regulations and this also required more work
5	Yes	Yes	More	There is a lag in the learning curve, because the risk department is not continuously evolved and with every risk assessment they need to re-start with learning with learning, it is not a continuous fluid process
6	Yes	Yes	More	Services were not fully mature enough and we underestimated it what was required in terms of security and risk
7	Yes	Not known	Not known	No comment
8	Yes	Yes	More	It was difficult to manage items such as security, as security is also an important element of the contract we have with the cloud vendor
9	Yes	Yes	Equal	We have a close relationship with our other departments and we are well adjusted to each other needs
10	Yes	No	More	We rely heavily on the risk and security departments. There is a general lack of knowledge in all departments regarding cloud and its migration challenges

Table 10: Support other departments

B.6 Third party spend cloud migration

Did you spend on services from 3rd party to execute the cloud migration?

Bank	**Yes/No**	**Was it budgeted?**	**Was it less, equal or more than budget?**	**Rationale for the variances, direct quotes from the interviewees**
1	Yes	Yes	More	Still in the learning curve and we don't have the knowledge yet required and we had to spend more on 3rd party for cloud migration purpose
2	No	No	n/a	Very much focused on developing the knowledge internally, hence also the reason why our headcount has not been decreased since our cloud adoption. We want to learn it the hard way and we accept the deep learning curve and don't want to depend on 3rd parties.
3	Yes	Yes	More	We had to take additional support from external party due to complexity of the cloud migration process
4	Yes	Yes	Equal	Able to financially structure our agreements, therefore in line with budget
5	Yes	Yes	Equal	Currently in line with the budget
6	Yes	Yes	Equal	Budget with the agile method and with every iteration we estimate what we need with the new situation and adjust the budget along the way
7	Yes	Not known	Not known	No comment
8	No	No	No	Not occured yet, since we are in the arly phase of cloud adoption
9	Yes	Yes	Equal	no comment
10	No	No	No	Does not fit our philosophy, focused on building the knowledge internally

Table 11: Third party spend

B.7 Managing dependencies of applications

Did you spend on managing dependencies on other applications/components?

Bank	**Yes/No**	**Was it budgeted?**	**Was it less, equal or more than budget?**	**Rationale for the variances, direct quotes from the interviewees**
1	Yes	Yes	More	Knowledge gap, while setting up the subscription it was more difficult than expected
2	Yes	Yes	More	We had delays in the set up of the "to be environment" due to dependency issues
3	No	Yes	Equal	Is taken into account and within budget, we did not migrated yet our critical applications to the cloud
4	Yes	Yes	Equal	Since our strategy is that we look at it case per case, we are able to control the and predict the
5	Yes	Yes	More	Currently in line with the budget
6	Yes	Yes	More	The first initial start for public cloud starts on premise and all your connection and dependencies are on premise and to decompose for the purpose of migration is a more complicated process than expected
7	Yes	Yes	More	Transfer the data to the cloud posed dependencies and it was more difficult than expected.
8	Yes	Yes	More	Integration's between on-premise and cloud and we had to decompose some applications due to dependencies. Cloud adoption in practice, is much slower than expected due these kind of complexities
9	Yes	Yes	More	Due to complexity and changing business requirements
10	Yes	No	More	We have many isolated systems and we are not aware of our current landscape full capabilities and functionalities and the impact of migrations of certain applications yet as we are still struggling with our on-premise environment

Table 12: Managing depedencies

B.8 Re-architect during migration

Did you had to re-architect unexpectedly during migration?

Bank	**Yes/No**	**Was it budgeted?**	**Was it less, equal or more than budget?**	**Rationale for the variances, direct quotes from the interviewees**
1	Yes	Yes	Equal	To a certain extent we had to re-architect during migration
2	Yes	Yes	Equal	In line with our expectations
3	No	Yes	Equal	Is taken into account and within budget, we did not migrated yet our critical applications to the cloud
4	Yes	Yes	More	On premise technologies that are available are clear but not yet with cloud technologies. For an application we had to change the NOSQL database during the migration to a relational database (SQL)
5	Yes	No	More	The solution was not suitable and application could not work, therefore we had to re-architect the application service
6	Yes	No	More	Certain components could not be guaranteed by the cloud provider and we had to re-architect during the migration to fullfill our own internal requirements to make sure it was secure
7	Yes	No	More	To manage complexity as on-premise and cloud are very different environment, especially for old applications
8	Yes	Yes	More	Difficult to find the balance, we know we have to re-architect, but what we come up with in theory does not necessarily work in practice
9	No	No	n/a	No comment
10	No	Yes	n/a	Did not occurred yet but we are very realistic that this will be happen

Table 13: Rearchitect

B.9 Legislation

Did you spend money regarding legislation during migration?

Bank	Yes/No	Was it budgeted?	Was it less, equal or more than budget?	Rationale for the variances, direct quotes from the interviewees
1	Yes	Yes	Equal	Compliance is an important matter, we are very keen regarding this and therefore budgeted realistic
2	Yes	Yes	More	Regulations regarding data privacy and storage at cloud vendors will have a big impact on cloud computing
3	Yes	Yes	Equal	We expect that we have spend large amounts to fulfill the regulations and to adopt to new regulations as we have a global presence worldwide
4	Yes	Yes	More	Regulatory requirements are changing and evolving, this required more attention than expected. Regulators require more insights and more reporting as time goes by
5	Yes	Yes	Equal	We have taken into account prior we started our migration, risk, compliance, vendor risk assessment. This was part of the risk strategy to take compliance assessment with the vendor as well prior the start
6	Yes	Yes	More	At the time when we went live with certain application in the cloud there was no yet an European regulation regarding public cloud computing, there was no backbone that we could rely on and we had to ask for approval at every local regulator regarding data storage and privacy of our customers
7	Yes	Yes	More	complexity arised due to regulations and public cloud
8	Yes	Yes	More	Legislation is not fully clear yet and we are struggling with adopting this with our IT and aligning requirement
9	Yes	Yes	More	Regulators require evidence and difficult to manage. Costs associated with audits and regulations higher than expected
10	Yes	Yes	More	In order to be compliant, it takes a huge efforts and we have a knowledge gap and it requires a new way of working and reporting

Table 14: Legislation spend