TU Delft Atos

MASTER THESIS

AN INTEGRAL FRAMEWORK FOR REALISING CONTROL DURING CLOUD TRANSITION

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An Integral Framework for Realising Control During Cloud Transition

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Preface

I'm finally at the destination and this thesis marks the end of my journey towards achieving a Master degree in Management of Technology at the Delft University of Technology. I feel extremely fortunate to not only have had the opportunity to pursue higher education but to have had the opportunity to excel at it and pursue my interests every step of the way.

I believe there would be no better opportunity than now to express my sincere gratitude to everyone who has paved the path for me and supported me along the way of pursuing a Master degree. I couldn't have done it without you and I hope to pay it forward.

Firstly, I would like to express my profound sense of obligation and gratitude to my first supervisor Prof.Marijn Janssen for his unparalleled encouragement and guidance. Thank you Prof.Marijn for all the constructive feedbacks from time to time which aided me in the best way possible. I would also like to extend my sincere thanks to my second supervisor Dr.Enno Schröder for patiently reviewing my work and providing me with valuable feedback and words of encouragement during every review.

I would like to express my wholehearted thanks to my manager at Atos, Mr.Maurits Douwes Dekker for the constant support, confidence and encouragement. I would also like to extend my cordial gratitude to Mr.Andre van Dalen for the pivotal support and for inspiring me with wonderful ideas during every conversation. I couldn't have asked for better mentors, thanks again both of you. My sincere thanks to Mr.Anton Zonneveld for taking me into Atos and introducing me to all these wonderful people. My gratitude to all my colleagues and the Interview participants from Atos who were kind enough to take part in my research and support me with their ingenious feedbacks.

I would also like to thank all my dearest friends in India. You have all always been an extended family to me and your love and support are what has brought me here. Thanks to my friends in Delft for making Delft feel like home and for being my pillars of strength during this adventure. Thanks to my grandparents and my family for their blessings, encouragement and love.

And finally thanks to my Mom and Dad. I know this was not just my dream but yours too. I'm here because you believed in me and no thanks could be enough to sum up to what you both have done for me. I dedicate this thesis to both of you.

Once again, Thanks to all of you. This journey would not have been possible without your support and encouragement. Looking forward to contributing to the world now, one step at a time.

Nivedha Sathyanarayanan

Delft, July 2021

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Executive Summary

Digitisation of businesses and keeping up with technological trends has become a pivotal factor for organisations to remain competent in the current market. Owing to the array of advantages that the Cloud offers many businesses have been moving towards cloud-based environments. A technological transition like Cloud adoption is often not restricted to a technological change but also influences every other aspect. Because of the agile nature of the process, it is often complex and convoluted.

Given the large spectrum of possibilities, multiple organisations and academic researchers over time have explored this line of interest to create generic frameworks to help companies move from on-premise to cloud. This scientific research was also directed towards creating a generic framework for cloud transition following a literature study.

The literature study showed that most of the existing scientific frameworks were context-dependent and directed towards managing a particular aspect or application. They were also limited only to the cloud adoption step and they disregarded all the steps before and after this process. The commercial frameworks on the other hand addressed all the different perspectives but had commercial elements in them which reduced transparency for the client and resulted in vendor lock-in situations. This research thus landed in a research gap that had significant scientific and practical relevance.

A need for companies to realise control during cloud transition was identified. This resulted in the research goal of this master thesis - ***"To develop an integral framework to assist companies in realising control while moving their applications to the cloud"***

Control is often subjective but here it is referred to as the transparency of the process and the client company's ability to steer it. Control and transparency can be achieved when the company has a detailed End-to-End strategy that clearly defines stakeholder responsibilities, addresses challenges and includes possible organisational measures for each step along the transition path. The integral framework is aimed to function as a generalised document integrating various aspects to help organisations plan end-to-end strategies and thus realise control.

The research was spread over a course of 25-weeks and was taken up in collaboration with Atos (Atos Netherlands B.V.), a multinational IT service and consulting company. The research involved interviewing experts from Atos who are experienced in Cloud transition process. About

9 interviewees participated in the design interviews and 5 experts were interviewed during the evaluation phase. Alongside this, scientific literature and grey literature (surveys) were studied to complete the research.

The various elements in this research and the main deliverable(s) are represented in the figure below.

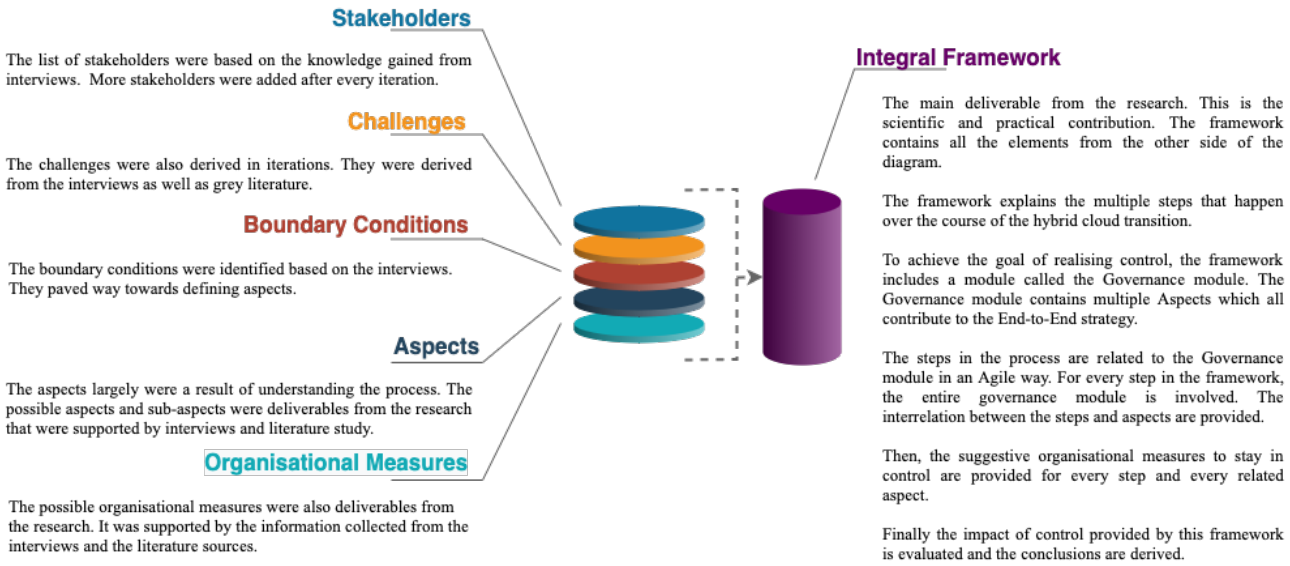

Figure 8 : Elements in the research contributing to the framework (Chapter 5).

The integral framework consists of a governance module that addresses 5 broad aspects required to formulate an End-to-End strategy. There are about 15 steps in the hybrid cloud transition and the process is agile. For every step in the critical path the governance module is considered. The possible challenges and boundary conditions are addressed and included in the framework design. A detailed steps and aspects based organisational measures list is made with best practice guidelines to increase transparency.

This was evaluated at the evaluation interviews where the impact of the framework was checked. The results were that the framework design was extensive and well-expressed. It was understood that the framework addresses most of the practical challenges the client organisations face while moving to a hybrid cloud. This in turn might improve the transparency of the process or allow the client companies to steer the process at ease. The results of the research showed that such an integral framework will be useful for the client companies in realising control but this however depends on the company and their subjective definition of control.

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Abbreviations and Translations

Table 1: Abbreviations and Translations

S.No	Acronyms	Abbreviations / Translations
1.	NIST	National Institute for Standards and Technologies
2.	IT	Information Technology
3.	CAGR	Compound Annual Growth Rate
4.	MoT	Management of Technology
5.	USD	United States Dollars
6.	B.V.	Besloten Vennootschap / Private Company
7.	RQ	Research Questions
8.	TOGAF	The Open Group Architecture Framework
9.	COBIT	Control Objectives for Information and Related Technologies
10.	ITIL	Information Technology Infrastructure Library
11.	TAM-TOE	Technology Acceptance Model – Technical Organisation Environment
12.	CCAF	Cloud Computing Adoption Framework
13.	FSaaS	Financial-Software-as-a-Service
14.	WBS	Work Breakdown Structure Framework
15.	DESMF	Department of Defence Enterprise Service Management Framework
16.	PaaS	Platform-as-a-Service
17.	IaaS	Infrastructure-as-a-service
18.	AWS CAF	Amazon Web Services Cloud Adoption Framework

S.No	Acronyms	Abbreviations / Translations
19.	WCGF	Weolcan Cloud Governance Framework
20.	ICT	Information Communication Technology
21.	CSP	Cloud Service Providers
22.	CIA	Confidentiality, Integrity and Availability
23.	IAM	Identity and Access Management
24.	GDPR	Global Data Protection Regulation
25.	DLP	Data Loss Protection
26.	SWOT	Strengths, Weaknesses, Opportunities and Threats
27.	CTO	Chief Technology Officer

1 Introduction

The process of moving to the cloud is a well-elaborated course of action that comprises multiple steps, various stakeholders involved and thus also has great complexity. This chapter briefs about the cloud computing process, various stakeholders involved, the need for frameworks and how they were developed, followed by the research objective and scope of this research.

1.1 Background

In pursuit of acquiring competitive advantage and ascendancy in terms of business agility, organisations across sectors have constantly been re-engineering and transitioning to breakthrough technologies. Digitisation of businesses and keeping up with technological advancements have become a key factor for organisations to remain competent and successful in current markets (Kobos, Malczynski, Walker, Borns, & Klise, 2018). Cloud computing systems are such a radical advancement that has emerged as one of the most preferred and rapidly expanding mega-trends this decade.

As defined by National Institute for Standards and Technologies (NIST), "Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." (Voss, 2010). In simple terms, Cloud computing simplifies sharing and storage of computing resources by enabling on-demand access from anywhere and at any time.

This breakthrough innovation has been revolutionising IT infrastructures and has facilitated accessibility from any part of the world. Cloud also provides an array of benefits like the flexibility to scale up or down, agility in business management, lower costs, lower maintenance, simple resource sharing capabilities, better security, etc. (Moore, 2015), all of which have motivated many businesses to move towards cloud-based applications.

1.1.1 Cloud transition process

Owing to the many benefits that the cloud offers, businesses across industries have been moving their resources to the cloud. Recent statistical research claim that about 90% of the businesses use or are expected to use the cloud in certain ways (EAGLE, 2019) and the global cloud computing market stature is expected to rise at a Compound Annual Growth Rate (CAGR) of 17.5% in the next five years (Research and Markets, 2020).

A technological transition, i.e., moving a company's resources and practices from one technology to another is not a straightforward one-step process.

Every organisation has its own aspiration and protracted strategy when it comes to taking up a technological transition like cloud adoption. However, these transitions are characterised by an array of decisions made during multiple instances throughout the process. From deciding the cost, governance, people management, time and resources a company can afford to, what cloud and how the migration can take place, etc. various key decisions are made (Kobos et al., 2018). The initially planned strategy has to be evaluated at each instance and iteratively modified.

The strategy is often influenced by various actors and factors. There are also certain boundary conditions that have to be fulfilled by the organisations to stay in control. This is even complicated in large organisations. For example, an IT transition does not only change the way the data processes but also the business operations and security governance in place. People have to additionally be educated on how to best use the new technology and the security plans as well have to be redrawn facilitating the new change. Similar changes have to be reflected across the organisation. Hence it requires extensive planning and well-defined strategies for the companies to stay in control.

1.1.2 Cloud adoption Frameworks

A framework in simple terms can be described as a collection of anything from implementation guidance in terms of instructive steps, development tools, middlewares, best practices guidelines, services that aid in management, creation, adoption or any functional operation of cloud applications (Scheier, 2012).

Early adopters of the cloud started with devising their own strategic plan for technological transition due to the lack of any standard mechanism and owing to the uniqueness of the companies. This caught the attention of a few researchers who started identifying why organisations are overwhelmed by questions while moving to the cloud and why can't a framework be created to keep them well informed. For example, the "Cloud Adoption Toolkit" by (Khajeh-Hosseini, Greenwood, Smith, & Sommerville, 2012) was one such early framework that was developed based on the idea of mapping tools and techniques to the concerns faced during cloud transition. Over the next few years, consequently, research broadened to areas to achieve tailored adoption frameworks to suit every perspective. For example, the research by (Chang, Walters,

& Wills, 2014) was a framework specifically created to tailor financial institutions moving to the cloud while the research by (Ahmadi, Nilashi, Shahmoradi, & Ibrahim, 2017) was designed for healthcare institutions moving to the cloud. These cloud adoption frameworks aim to act as advisory tools to assist companies in devising end-to-end strategies for the transition process. End-to-End strategies describe strategies that go from beginning to the end of a process covering all relevant aspects, actors and factors involved in the process.

1.2 Scientific Research gap

The frameworks in scientific literature were studied extensively and is included in section 3. The scientific frameworks progressed more towards creating context-specific frameworks like (Chang & Ramachandran, 2016; Kearns, 2018). This was followed by the trend where researchers worked towards creating generic or standardised frameworks like the (Open-Group, 2016; Gangwar, Date, & Ramaswamy, 2015). Though the researchers payed much attention to ensure applicability and increase efficiency, most of these frameworks lacked practical relevance and generalisability. For example, the TOGAF - Cloud Computing Governance Framework best fit only those companies which already follow standards by The Open Group.

Certain frameworks were also developed by cloud service providers and corporate organisations to assist their clients moving to cloud. These frameworks were well-structured and covered all the elements required. Yet, most of these frameworks had commercial motives or elements which reduced it's spectrum (Scheier, 2012; Amazon, 2020; Microsoft, 2020; Weolcan, 2021). Though these frameworks briefly describe every step, the platform products and services available are not explained to limit the client from comparing similar services provided by other CSPs. This lack in transparency pushes clients to a vendor lock-in situation.

A lot of possibilities for further study emerged through this literature study. The quest to create a standardised framework is still on, with multiple researchers across the globe still coming up with ways to improve previous studies. A key scientific gap which was identified through the literature review was that, most of these frameworks are limited to how the adoption happens and disregards all the correlative processes which happen before and after the adoption. This limits the control the client organisation has while moving into the cloud using these frameworks.

1.3 Practical Problem - Need for control

As explained in sub-chapter 1.1.1, Every organisation is in a need of a clear strategy that determines how they can stay in control during the technological transition. Control can be defined as the transparency of the process for the client companies, and them having the option to steer or influence the transition process at any given time. This is often complex criteria for organisations as control can only be achieved when all the correlated factors like people, business, operations, cost, time, etc. are managed efficiently and relevant decisions are taken with careful considerations.

Though there are well-documented studies on frameworks to assist in cloud adoption, there is no scientific research analysing the strategic planning during the cloud adoption which includes addressing multiple **challenges** and fulfilling the possible **boundary conditions**, all with the aim to help organisations **realise control** while moving their applications to cloud. This is the motivation for this study and is explained further in chapter 2.

1.3.1 Management of Technology Context

This socio-technological problem very well fits the context of ***Management of Technology*** Research as this scenario addresses a management problem that arises due to the adoption of new technology. The research is based on the idea that a technological transition is often not restricted to a technological change but also influences the other aspects of an organisation including business, cost, people, time and most importantly the control the organisation has. This research focuses on how organisations can use frameworks to improve the process and realise control during a technological transition like cloud adoption.

1.4 Research Objective

A further step in academic research would be to identify how organisations can form end-to-end strategies to realise control. This could be approached based on the potential challenges the organisations will have to tackle and the boundary conditions which they have to fulfil. Challenges are practical objections that might arise during the process of the cloud transition. Similarly, boundary conditions are referred to as prerequisites and the critical clauses to which the organisations have to conform. The main research question would therefore aim to identify how organisations can realise control (achieve transparency or have an option to steer) while moving to the cloud.

Thus the principal aim of this study will be to keenly investigate, perceive and evaluate the existing cloud adoption frameworks and identifying strategies in practice in organisational contexts. The primary focus will be on understanding how IT and business strategies are devised at organisations during cloud adoption, identifying the multiple factors, boundary conditions and challenges that hinder them from realising control. And devise a framework based on these research findings.

The goal of the research would be ***"To develop an integral framework to assist companies in realising control while moving their applications to the cloud"***. Control can be defined as the transparency of the process for the client companies, and them having the option to steer or influence the transition process at any given time. The framework will be aimed to function as a generalised document integrating various aspects, perspectives and contexts like cost, security, people, time, etc. to help organisations plan end-to-end strategies to stay in control when the applications are moved to the cloud, thereby making it an *"Integral framework"*.

1.5 Scope of the research

The idea to create a generalised framework that could work as a standard guide for organisations to move to the cloud is both complex and broad. Thus to streamline the research further and make it feasible to achieve in the span of 25 Weeks, the research is scoped.

Firstly only Large client organisations are to be considered while designing this framework, allowing modifications for scaling up or down in future. The cloud adoption process can be very costly, and thus not many small or medium companies prefer to take this transition at once. Therefore only large client organisations are to be considered while designing this framework. A large company typically has a size of more than 1000 employees with diverse teams and expertise, fully equipped IT, teams, Revenue roughly around $1 billion USD and has geographically dispersed presence (Sangoma, 2021).

For a large client company, there could be multiple teams and subject matter experts who collectively act as decision making authorities for various phases of cloud adoption. And thus, the time taken for end-to-end cloud adoption for a large company ranges between one to two years on average.

Secondly, the companies moving their applications only to the Hybrid cloud is chosen as this

is seen as a common trend lately. Recent statistics claim that 72% of the organisations prefer to move to hybrid or private cloud from on-premise and about 58% enterprise workloads are on or are expected to be on hybrid or private cloud (Casey, 2020). Hybrid clouds work as an agglomerate of private and public clouds and thus gives a lot of flexibility to move workloads between cloud solutions. The major advantage of hybrid cloud is that critical and sensitive information can be stored in private clouds while less critical information can be stored in public cloud thereby increasing agility and satisfying dynamic business requirements which are both very important especially for large organisations. Thus hybrid clouds basically containing one public cloud, one private cloud and with or without on-premise still in existence are considered as the target deployment model.

Control is the key aspect or motivation around which the framework is to be built. As defined already, control refers to the transparency of the process for the client companies and their ability to steer the process. This is because for a large company decision making and control is rather complex and involves multiple entities. Other aspects like Cost, Security, Operations, People, etc. are to be considered as complementary aspects which are mediated to achieve the goal of staying in control. The framework will work towards improving transparency of the process thereby allowing the client organisations to steer the process well. This is done by understanding the interrelation between the various phases of the cloud adoption process and the aspects of the framework from a helicopter view. Finally, an evaluation of the framework is done in terms of the impact it has on the control.

Finally, the research is taken up in collaboration with Atos (Atos Nederland BV), a multinational information technology service and consulting company. Atos is a pioneer in providing cloud adoption assistance among other services for multiple large and very large organisations. This research will be based on interviews of employees of Atos who have been taking up the Cloud adoption process from 2018 to - present. The specific years are considered to analyse the trends in decision making as well as challenges that companies undergo.

To increase generalisability, initial research will comprise existing survey reports and grey literature related to cloud adoption like organisations challenges during cloud adoption or motivations for organisations to move to the cloud, etc. taken by researchers or other organisations excluding Atos. A detailed literature study will also be done to use as a basis for building the framework. This is explained further in chapter 3.

2 Research Overview

This chapter elaborates on the research questions which this research intends to explore. It also describes the research methods which are used to observe, collect and evaluate data required to complete the intended research.

2.1 Research Questions

The identified knowledge gap explained in sub-chapter 1.4 has led to the following main research question : ***"How can organisations realise control while moving their applications to the cloud?"***

To better understand and create a framework for organisations to plan end-to-end strategies to stay in control, the following sub-research questions are identified.

- **RQ1 :** What major challenges do organisations tackle when moving to cloud?
- **RQ2 :** What are the required boundary conditions on a cloud to stay in control?
- **RQ3 :** What aspects should the framework include to achieve control in the cloud transition?
- **RQ4 :** What organisational measures need to be taken to stay in control?
- **RQ5 :** What impact will implementation of such a framework have on the control during cloud transition process in organisations?

The research follows the empirical research cycle which includes iterative development cycles because the process of cloud transformation is also often agile. The research strategy is devised based on this. The main research question is designed in a notion to improve the status quo. Control is defined as the transparency of the process for the client companies, and them having the option to steer or influence the transition process at any given time. This will be the key motivation around which the framework will be built.

The first sub-research question explores the possible challenges that organisations will have to tackle while taking up a technological transition like cloud adoption. Challenges are practical objections that might arise during the process of the cloud transition. Especially considering large organisations there could be a variety of challenges that arise at multiple stages during the cloud adoption process. The second sub-research question identifies the required boundary

conditions which have to be fulfilled by the organisations. Boundary conditions are referred to prerequisites and the critical clauses to which the organisations have to conform. This is important because if not, the hybrid cloud transition cannot be taken up.

The first two sub-questions will contribute to the selection of grey literature reports and will subsequently also be used to design initial interviews with company representatives. The collected data has to be analysed, compared and evaluated with existing frameworks in literature and this is served as input for the third research question.

The third sub-research question will illustrate the multiple aspects which have to be considered in order to create the integral framework, which in turn assists in realising control during cloud adoption. Following this, the fourth sub-research question will define the measures that organisations might have to take at each step to stay in control.

The framework will further be evaluated in terms of a process analysis based evaluation was devised which will include qualitative interviews of experts to understand if 'control' is effective when such a framework is implemented. Results from this will be used to answer the fifth and final sub-research question.

2.2 Research Strategies

To answer the research questions mentioned previously, a detailed research strategy is required. The research strategy is developed based on the empirical research cycle suggested by (van der Gaast, Koenders, & Post, 2019) as represented in figure 1.

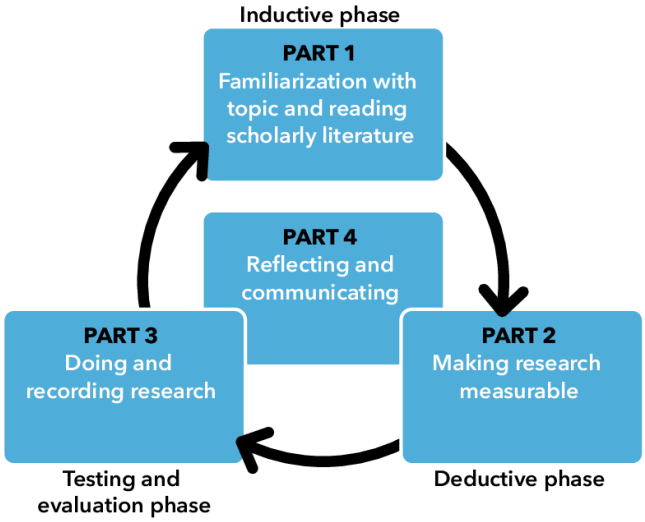

Figure 1: Empirical research cycle

(van der Gaast et al., 2019)

Because cloud transition is often agile and that it involves multiple steps, challenges and factors, the research study also was directed to follow the empirical circle. The inputs are observed, collected, analysed, interpreted and evaluated in cyclical phases. The main research question being a "How" question is designed in a notion to improve the status quo.

To ensure there's a broad understanding of the practical scenario during cloud adoption, the first two sub-questions required knowledge from the grey literature and from practical applications at organisational levels. Initially, a literature study was done including collecting relevant grey literature sources. These were used to formulate questions for the design interviews with Atos representatives. The information collected through grey literature and the design interviews contributed to answering the first two research questions. The collected data was then analysed, compared and evaluated with existing frameworks in literature (as summarised in appendix B) and this was served as input for the third research question.

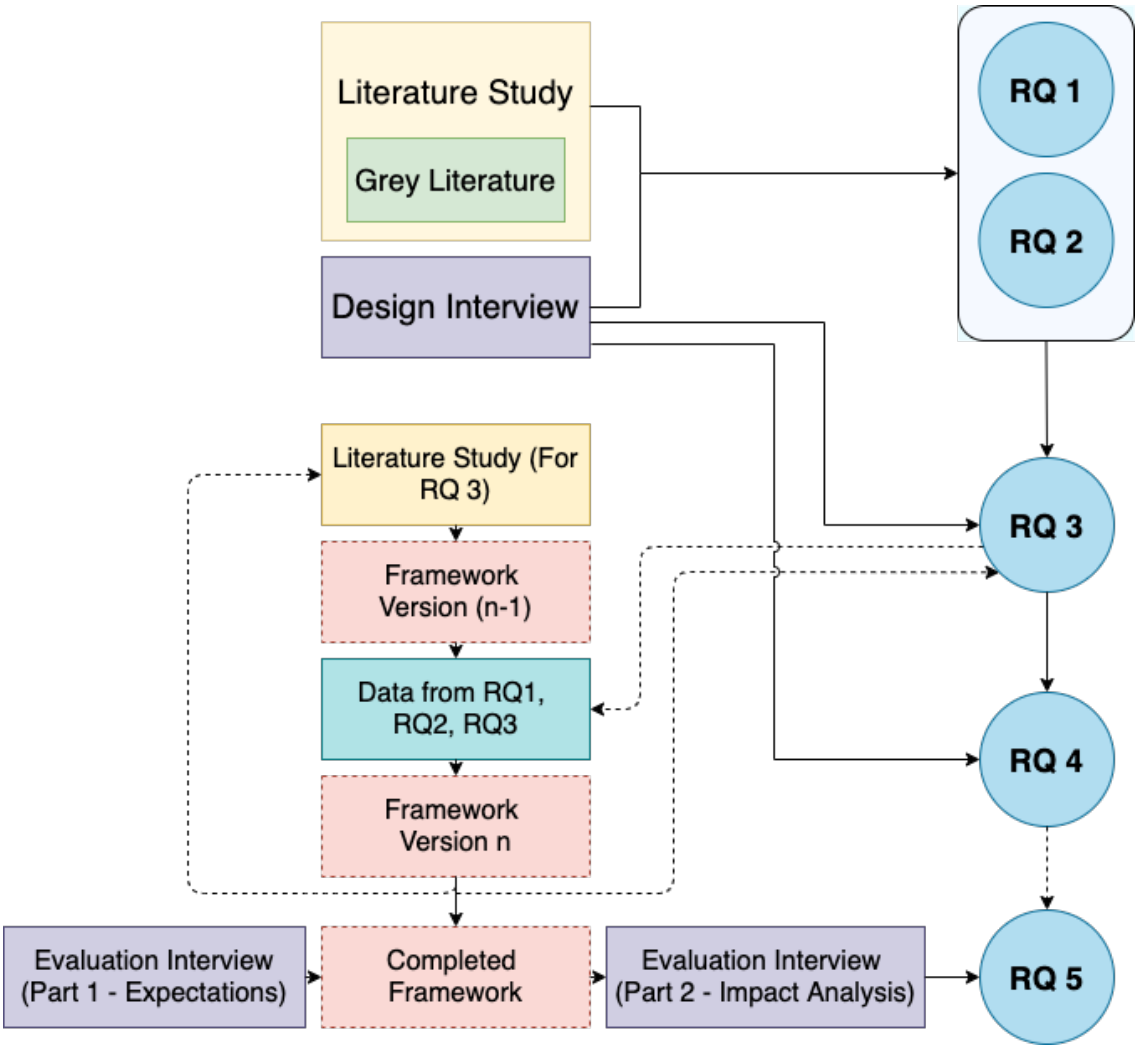

Figure 2: Research Strategies

The third research question owing to the aspects of the framework was also designed in an agile way with evaluation at planned intervals to improve the efficiency. Initially, a first version of the framework was designed based on existing theoretical frameworks and literature studies. This was then improved over further iterations based on design interviews and based on data from the first two research questions.

The fourth research question was then formulated based on the information collected from all the previous iterations and also from design interviews. Upon completion, the final framework was evaluated in terms of a process evaluation based interviews to understand the potential impact of the framework. Results from this were used to answer the fifth research question. These are all depicted in the figure 2.

2.3 Data Collection

Data required to carry out this research were collected from three sources - Grey Literature, i.e., Existing survey reports by other researchers and organisations (apart from Atos), interviewing subject-matter experts dealing with cloud adoption (Subject-matter experts and other stakeholders are explained in section 4.1) and based on studying available scientific literature (Briefed in section 3). As stated in sub-section 1.5, This research and the interview part of data collection were carried out only within the context of the company, Atos.

2.3.1 Grey Literature and Interview Combinations for Design

For answering sub-research questions one to three, triangulation of data was required. Existing questionnaire / survey reports by scientific researchers or other companies excluding Atos were collected to increase generalisability and to get a broad perspective required to answer the first few research questions.

Questionnaires in general are used to understand the opinions or preferences of people that often cannot be observed. It also helps in understanding how decision making happens or has happened in an organisational context during cloud adoption. A panel or cohort survey (by other researchers) was preferred for the same.

Alongside literature studies, surveys from various streamlines were collected to support the research at various iterations during the design phase. For example,

- The ones relating to challenges in cloud adoption - like the survey report by (Coles et al., 2015).

- Ones relating to the boundary conditions to be fulfilled by organisations - like the questionnaire by (Spadea, 2015).
- Ones relating to the measures taken by organisations moving to cloud - like the survey by (Davis, 2021).
- And other general surveys relating to cloud - like the survey on Cloud trends answered by 500 IT professionals by (Knorr Eric, 2020).

To understand the practical applicability of these data from the surveys and to take expert opinions on the gathered information, interviews in the context of the same topics were done with experts from Atos. About 9 subject-matter experts were interviewed in the design phase. The selection criteria and sampling process followed is explained below in 2.3.3. These interviewees contributed to different parts of the framework design depending on their expertise. For example, the security consultant (*(Interviewee 03-01)*) was helpful while addressing the security aspect exclusively in detail and in context with other aspects. The interviews were all be semi-structured and were tailored during the interview.

A framework was initially constructed based on data gathered from the literature studies. The process followed a cyclical flow as explained previously and thus was regularly evaluated against the data from the initial two sub-research questions and interviews, and improved at multiple instances. The process will be explained later in section 5.

2.3.2 Evaluation Interview

The fifth research question was included for evaluating the impact of the research framework and to understand if it helps companies in realising control. This was done in the form of interviews with two parts. The aim of these was to understand how organisational processes change when such a framework is implemented and evaluate it with real-time challenge cases at the companies to see if they can realise 'control' while moving to the cloud. The interviewees were initially presented with questions about general expectations from a cloud transition framework, then the final design is presented and later is followed by evaluative questions. This is explained further in 6.

The initial plan for the evaluation interview was to include 5-6 interviewees from the design phase and 3-4 new interviewees to get a fresh perspective. However, given the restricted timeline and unforeseen circumstances, the evaluation interviews were conducted with only 5 experts.

Three interviewees from the design phase and two new interviewees were included. Again, the participants were chosen according to their specific knowledge and experience handling multiple types of clients. The selection criteria for this as well is in the following sub-chapter. These interviews as well were semi-structured.

2.3.3 Sampling approach and Selection Criteria for Interviews

Sampling is the process of identifying a subset within the population to carry out the research. For this research, a non-probability based sampling was taken up as all of the interviewees were people associated with the company Atos at which the research is carried out. It involved subject-matter experts from the end of the service provider Atos, all of whom have necessarily been a part of at least 2 cloud adoption processes recently (In between 2018-2021), as stated in sub-chapter 1.5.

Atos is a global leader in providing IT-based services to its clients and an award-winning cloud partner. The company has a huge group of experts who have experience assisting large client organisations through cloud transitions. This is why employees of Atos were chosen as a part of the interview process.

As described already, the assisted cloud transition process involves multiple stakeholders. Thus, at various stages of this research, people from various backgrounds or job descriptions were selected to contribute to those specific parts. This is explained further in detail in section 4.1.

The first selection criteria for the design interviewees was that they either fall into the categories of subject matter experts, Lead architects, Managers or Consultants (As explained in section 4.1 and figure 4). The subject-matter experts are included in the study because they relate to more than one aspect and also understand how interdependent these aspects are. They also have experience using practical frameworks while preparing end-to-end strategies.

The second criteria were that they have experience handling at least 2 large clients and have knowledge about both the client companies and internal processes of the service provider.

The selection criteria for the evaluation phase was also the same, except a part of the selected interviewees were from the design phase while another part were new representatives. This was to get a fresh perspective. Overall, the research included ***14 interviewees***. The interviews were all be semi-structured and were tailored during the interview.

The major pitfall of this type of research is that it has low external validity and thus low generalisability. However, efforts like including surveys from external sources, etc. were taken to include diverse backgrounds of people/client organisations; thereby aiming to increase generalisability.

2.4 Data Analysis

Because the data collected was often Qualitative, manual analysis was required. However, to synthesise the information better, it was preferred to code the collected data. So the data analysis plan followed a structured procedure of data collection, coding and categorisation before the actual analysis was performed.

3 Literature Review

The size of the cloud computing and hosting market worldwide has been constantly increasing at an average rate of 13.18% a year between 2010-2020 according to recent statistics (Statista, 2021). The global cloud computing market stature is expected to rise at a Compound Annual Growth Rate (CAGR) of 17.5% in the next five years (Research and Markets, 2020). These statistical numbers indirectly mean that more and more organisations are moving their applications to the cloud or adopting cloud services for their operations and this trend is expected to grow for at least the next 5-10 years. This in turn also assures that it would be worthwhile exploring research studies in this field.

A recurring problem with the introduction and adoption of new technologies is that in many scenarios there's a gap between academic researchers and corporate organisations. While academic researches have high internal validity, research at organisations often have high external validity and generalisability as the cases of research are applied in a variety of contexts. In the last decade, many researchers from multiple disciplines and contexts have performed studies to create frameworks that assist companies in cloud adoption.

This literature research explores frameworks and studies developed at both academic and organisational levels and compares the studies to design standardised frameworks. The goal of this literature study is to understand the directions which have been explored and to identify gaps in the literature that can be researched further.

To increase efficiency and to derive meaningful conclusions theoretical frameworks were studied based on periods of publication instead of exploring frameworks concerning one direction or perspective like business, security risks, etc. This is elucidated in sub-chapter 3.1. Later a brief study was done on industry developed frameworks in sub-chapter 3.2. The inclusion and exclusion criteria for the literature review and the keywords search is included in appendix A.

3.1 Existing Theoretical frameworks

This sub-chapter includes studies done on academic and scientific literature which have contributed towards developing frameworks to assist cloud transition. As stated previously in Chapter 2, initially literature was studied based on context or perspectives but later consolidated based on the period of development to identify critical differences and similarities in

perspectives and methods used by researchers.

3.1.1 Frameworks developed between 2010 - 2013

A technological transition is not a straightforward one-step process. Research claim that during initial phases of cloud transition every organisation started with devising their own strategies. There were no standard mechanisms that assisted organisations in moving to the cloud and it was rather a unique journey for each organisation (Voss, 2010). This grabbed the attention of few researchers who started exploring this field of science in depth.

Concrete research with respect to developing a framework for cloud transition was only seen after 2010. As most of the researches before this period only owed to defining the cloud and its capabilities, organisations were overwhelmed by questions and the necessity to make multiple decisions over the entire period of transition. Organisations had to decide whether to stay on-premise or move to the cloud. Multiple actors and factors influenced these decisions and the primary step in creating a framework was assessing these factors.

(Ezzat, Zanfaly, & Kota, 2011) was one of the first few researchers to gather information about adopting cloud in multiple working fields. They derived a list of common and most important factors and aspects that support the adoption decision through surveying individuals. This was used to develop a cloud adoption framework tailored to unique business cases based on user perspectives and predefined factors. Though this framework had limited applicability as it does not address technical and organisational decisions to be made, it had a significant proposition about the user being the prime deciding factor in technological transition. Ultimately, the User's point of view was considered as metrics for evaluating the framework (Ezzat et al., 2011).

Another interesting research paradigm was the Cloud Adoption toolkit by (Khajeh-Hosseini et al., 2012). It was developed based on mapping tools and techniques to concerns. This research however had a different take when compared to (Ezzat et al., 2011). This prioritised cost as an important factor and had limitations with respect to the user concerns. Likewise, Another research by (Morgan & Conboy, 2013), classified the factors affecting cloud adoption into one of the three broad categories, namely, technological factors, organisational factors and environmental factors, together titled as TOE framework. This research however also identified the need to understand the perspective of people involved in such technological transition including psychological aspects, changing skill-sets and correlating this to frameworks in future.

Though all of these early researchers had slightly varying outlooks, most of their researches owed to identifying factors influencing decision making and incorporating them into a framework. But less importance was given to the actual migration of workloads, security constraints and unique environments of the organisations.

These studies however added empirical weight to support previous findings related to factors that were largely based on anecdotal pieces of evidence.

3.1.2 Frameworks developed between 2014 - 2017

Few researchers continued in the quest of creating a well-rounded cloud computing adoption framework. The Open Group, which is a pioneer in creating industrial worthy standards, strategies and certifications, for example, the TOGAF framework for Enterprise Architecture, etc. also worked on creating a Governance framework for Cloud adoption (Open-Group, 2016). They identified Cloud computing governance principles, roles, processes and metrics for applying governance to the adoption process. The aim of this was to create a framework not specific to a domain, geography, or any context and that which aligns with existing models and standards. This was a perfect framework for industries already using the open group standards like TOGAF, COBIT, ITIL, etc. as there was resistance to change due to path dependency and industries preferred choosing standards from the same group.

(Gangwar et al., 2015) proposed an extended technology acceptance model – technical – organisation – environment (TAM–TOE) framework for organisations collecting inspiration from the TOE framework by (Morgan & Conboy, 2013) and TAM framework. This framework deduced 12 variables that are relevant to the adoption of cloud-based on exploratory studies which were used to model a framework. In spite of being vast and extensive, this study was based on very low sample size and thus had low external validity. The research to build one standardised framework encompassing all the perspectives continued.

On the other hand, most of the researches around this period funnelled down and devised specific frameworks which were highly concentrated with applicability in a particular context. The most commonly addressed perspective in adoption frameworks was managing security and avoiding possible risk scenarios during cloud migration. This research by (Chang & Ramachandran, 2016) created a specific Cloud Computing Adoption Framework (CCAF) customised for securing cloud data. CCAF had a multi-layer security mechanism to provide fool-proof security but however did not address other factors like organisational and governance-based challenges

that come alongside the implementation of such a framework. This still inspired a lot more researchers to work on improving security and risk management in the cloud.

The same CCAF was addressed in the context of the financial domain where portability was demonstrated through a concept of Financial-Software-as-a-Service (FSaaS) (Chang et al., 2014). Many frameworks were developed to address cloud adoption with respect to specific domain or context; like creating a framework specifically for financial cloud (Chang et al., 2014) or hospitals and medical sectors (Ahmadi et al., 2017), etc. These researchers paid much attention to ensure applicability that they failed to address the technological procedures which were involved during migration and the strategic planning which is required. It also lacked generalisability since it was specific to a domain.

3.1.3 Frameworks developed between 2018 - 2021

Much like the previous period, few researchers still continued to develop ideal/standardised frameworks for cloud adoption, while others went on to develop context-specific frameworks, workload migration based frameworks, etc. But a common trend identified was that, many researchers combined previous studies in the literature to develop a much concrete framework.

Research by (Singh & Mansotra, 2019), is yet another attempt to create an integrated framework for Cloud migration. Despite being narrowed down (by geography and context) to the cloud adoption in Indian school education systems, this literature had put forth a strong suggestion to combine other common frameworks in literature like the TOE, TAM, HOT-fit and DOI framework with important constructs. Thus, even though this study had less generalisability due to a very narrow context, the study could be escalated with more constructs and variables in context implicitly. Another inclusion could also be identifying and reflecting the intentions of the decision-makers to adopt or disregard cloud-based systems.

Studies dived into further technicalities involved and literature was taken up addressing the migration of data which happens in line with adoption. (Kearns, 2018) study explains about devising workload migration plans to move to the cloud from a management perspective. This study combined 4 principal frameworks namely, Work Breakdown Structure (WBS) framework, IT Infrastructure Library (ITIL) framework, Department of Defence Enterprise Service Management Framework (DESMF) and Portfolio, Program, and Project Management Maturity Model (P3M3) frameworks to identify elements and device strategies for migration. This

research has a constructive impact on strategic planning thereby contributing to better performance, cost, timeliness, quality and the overall probability of success. This however yet again concentrates only on the migration or adoption process and disregards the required strategies before or after migration takes place.

Another study by (Ahmad, Naveed, & Hoda, 2019) integrates strategies and procedures in literature for cloud migration including commercial frameworks addressed in sub-chapter 3.2. This study groups the tasks in cloud migration into five phases and has identified five generic strategies. The five phases are Business Assessments, Technical Assessments, Migration Strategy, Migration Planning and Execution, and Monitoring and Optimisation. The five strategies include re-host, re-platform, repurchase, refactor and re-build of resources. The research postulates mapping workloads to business components suggesting that this will simplify the prioritisation process and will align with business strategies. This also opens various possibilities for further enhancement like automating mapping of business motives and technological goals, combining frameworks to predict organisational compatibility, and include control strategies for pre-and post-migration phases.

This trend to create a generic or standardised framework (by combining previous researches) is still continuing and is a potential track to follow. However, it is also identified that along with actors and factors like users, costs, technology, organisation, environment, etc. it is imperative to plan how the organisation will stay in control before, during and after the transition process.

3.2 Commercial and open-source frameworks

Leading corporations within the industry as well created frameworks to encourage their clients to move to the cloud. Frameworks specifically for operating at higher levels of the application called Platform-as-a-service (PaaS) frameworks and Infrastructure-as-a-service (IaaS) frameworks for working in network levels were invented. Few common examples for IaaS frameworks were OpenStack, Eucalyptus and Unbuntu Cloud infrastructure, and few popularly preferred PaaS frameworks were CloudFoundry by VMware and Red Hat's OpenShift. Most of these frameworks claimed to make cloud adoption and deployment easier and cheaper; however, they lacked flexibility and relevance to many. Additionally, these required special understanding and knowledge before implementation. They were also not open source and thus had restricted availability (Scheier, 2012).

This opened a pathway for open-source cloud frameworks which removed the commercial element to an extent, yet were developed by business organisations. Cloud service providers like Amazon AWS, Microsoft Azure and Google Cloud came up with their own open-source frameworks which supported companies moving to their cloud in planning strategies.

On contrary to specific frameworks in academic research, these frameworks panned out to address multiple perspectives. Amazon's AWS Cloud adoption framework (Amazon, 2020) addresses strategies from 6 different perspectives like Business, People, Governance, Platform, Security and Operations. All these strategies have their own capabilities, resources and roles defined. Similarly, Microsoft's Cloud Adoption Framework for Azure (Microsoft, 2020) classifies the adoption process into phases like Strategy, Plan, Ready, Migrate, Innovate, Govern, Manage and Organise, where each phase has a guideline or principle, benchmark assessment and best practices to assist their clients.

Weolcan is a Netherlands based digital transformation and cloud strategy company that has also been developing a standardised framework for Cloud governance called Weolcan Cloud Governance Framework(WCGF) (Weolcan, 2021). This framework is an amalgamation of other top industrial frameworks such as the previously stated Amazon AWS framework and theoretical frameworks including The Open Group Cloud Governance framework (explained in sub-chapter 3.1) and ITSM for the cloud. This framework was created to address the major challenge of cloud governance vs agility in the organisation, and thus has 4 knowledge bases including Strategy, transformation, migration and operation where maximum concentration is given to the strategy and operation phases.

Though these frameworks have remarkable advantages like high reliability, no limits on capacity, well-defined and instructive procedures, high business agility, etc. they also have certain disadvantages. Most of the limitations are because of the commercial elements which are still present. Clients do not see what a step in the framework offers and do not have relevant information to derive their own critical paths independently. This is because cloud service providers are not transparent about their strategies and product availability. This causes a major pitfall because it is impossible to standardise and the clients are forced to rely completely on third-party services. From the available resources, it could be inferred that few of these frameworks have a limitation of application to only their cloud services, few charge additional support/-training fees to acquire technical support and few services are not available globally though the

client has geographical presence, etc.

3.3 Criticisms and Takeaways from Existing Literature

Because this has been an active topic of research for the last decade, various researchers were exploring multiple perspectives in cloud adoption. Initial research had a few preeminent yet fundamental conclusions. User's point of view during multiple instances in the process of cloud adoption was identified as a viable metric to evaluate frameworks (Ezzat et al., 2011). The cost was identified as an important factor apart from technology, organisational and environmental (TOE) factors that could possibly influence decision making within organisations (Khajeh-Hosseini et al., 2012; Morgan & Conboy, 2013).

Research continued to create a standard framework to provide all-round guidance. While few pioneers in standard creation created their version of a standard cloud adoption framework, few researchers continued to create generalised frameworks by extending previous researches (Open-Group, 2016; Gangwar et al., 2015).

Consequently, Security and risk management was prioritised as a key constraint and research is still being devoted to enhance security in terms of prevention, detection, mitigation and governance (Chang & Ramachandran, 2016). Many context-specific frameworks to assist cloud adoption in particular domains were also identified (Chang et al., 2014; Ahmadi et al., 2017). Though these lacked generalisability, these had great operability.

A common trend was identified in further studies. Many researchers combined previous researches in literature to develop a much concrete framework. This created a constructive impact on strategic planning thereby contributing to better performance, cost, timeliness, quality and the overall probability of success in the process of cloud adoption (Singh & Mansotra, 2019). Frameworks to support intricate technological processes involved in cloud adoption like workload migration were also developed (Kearns, 2018). Other researchers identified the gap between academia and practice, and combined commercial and open-source frameworks created by R&D cells of top companies with academic literature to develop concrete frameworks (Ahmad et al., 2019). Though the researchers paid much attention to ensure applicability and increase efficiency, most of these frameworks lacked practicability.

The frameworks developed by cloud service providers and corporate organisations to assist their clients in moving to the cloud were extremely well-structured. Yet, most of these frameworks

had commercial motives or elements that reduced its spectrum (Scheier, 2012; Amazon, 2020; Microsoft, 2020; Weolcan, 2021). The corporate frameworks are often less transparent thus not allowing the clients to create their own critical path or forming their end-to-end strategies thereby curbing the control they have over the process.

All the literature studied along with the criticisms and key takeaways are further elaborated in the form of a table in Appendix B.

3.4 Conclusion

As explained in the previous sections, cloud adoption is not a straightforward process. Owing to the complexity involved in this process, multiple organisations and academic researchers over time have explored this line of interest to create frameworks to help companies decide between on-premise and cloud.

A lot of possibilities for further study emerged through this literature study. The quest to create a standardised framework is still on, with multiple researchers across the globe still coming up with ways to improve previous studies. Algorithms could be written to map business and technical goals, for analysis of alternatives during decision making, to predict organisational compatibility, etc. But another important aspect that was identified through the literature review was that, most of these frameworks are limited to how the adoption happens and disregards all the correlative processes which happen before and after the adoption.

Though there are well-documented studies on frameworks to assist in cloud adoption, there is no scientific research analysing the strategy planning for realising control during cloud adoption. These frameworks also do not address the possible challenges the companies face nor the boundary conditions that organisations are bound to satisfy while moving their applications to the cloud. This literature review set a path to continue research in this direction.

4 Preliminary Research

This chapter will give an overview of the initial study which was taken up alongside literature analysis for developing the framework. This preliminary research was done to answer research questions 1 and 2 which are often indispensable to create a cloud transition framework. The research was based on the information gathered from the studies of grey literature as well as the first set of design interviews. The first interview with *(Interviewee 01-01)* was very insightful in understanding the array of stakeholders involved during hybrid cloud transition. The next design interviews (With *Interviewees 01-01 till 09-01*) were useful in answering Research questions one and two in agile iterations.

4.1 Stakeholders

Owing to the complexity and agility involved in the cloud transition process, most large organisations prefer to seek assistance from service providers who have broad expertise in assisting their clients in cloud adoption. This is because in large organisations there are multiple teams responsible for each criterion and respective actors and factors influence the cloud adoption process at each stage. The service providers help their clients to understand why they need to move to the cloud, map their motivations and goals, prepare the cloud and move to the cloud, and finally also support them post the adoption process.

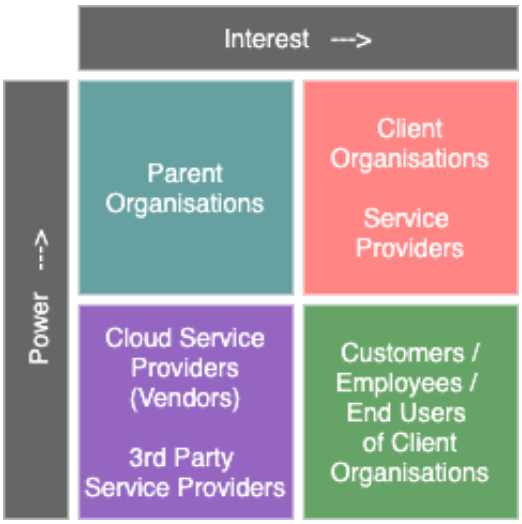

Figure 3: Power-Interest Grid of Stakeholders Involved

The companies moving to the cloud are referred to as Client Companies, while the company providing services are titled, Service Providers. These two encompass the major two stake-

holder categories as they have the most power and interest in this transition process. This is represented in the power-interest grid in figure 3.

External Stakeholders like the customers or employees who could be the end-users of the applications that are migrated to the cloud by the client have the lowest power but the highest interest. The clients could have parent organisations who might have high decision making powers in this application migration process. Finally, the third-party service providers / Cloud vendors fall into the last category where they have the least power or interest in this process. This is also depicted in the power-interest grid.

Because of the variety of stakeholders, there is also a contrast in viewpoints at various instances during a cloud transition process and that is why it is very important to understand the stakeholders. *(Interviewee 01-01)* added an example that, the client organisation might have aimed to cut costs by moving to the cloud, but in reality, cloud might cost them a lot more than what they are spending currently but could also pave way for more innovation, better security and a significant increase in the efficiency. The service provider is in a position to explain this to the clients and the clients have to understand this clearly. Every client might have a different motivation to move to cloud and the service providers are in a position to cater for this.

Though the figure 3 represents Service providers and Client Organisations as single entities, they encompass multiple stakeholders who are involved in this cloud transition process. This is represented in figure 4.

This diagram was derived based on the insights gained from Interview with *(Interviewee 01-01)* and using grey literature sources like the extensive report on Cloud Computing Market by (Markets and Markets, 2020).

The first group of stakeholders belong to the category of Service Providers. They are represented by the teal circle in the figure 4. A part of these stakeholders is also directly involved with clients (Overlapped part of the circles teal and red). The next group of stakeholders are from the client companies represented by the red circle and finally, the last group are the external stakeholders represented by the purple.

The stakeholders in the overlapped regions are usually teams that interact with multiple groups or contain members from more than one group. In this study, the interviewees were from this category of stakeholders. This group includes the subject matter experts, Lead architects and

Managers who often are the decision making authorities. This group collectively takes key decisions, ensures the cloud transition process is done smoothly and is also responsible for the organisation's control during the cloud adoption process. To facilitate this, and to assist organisations in the cloud transition process, frameworks are brought into the picture.

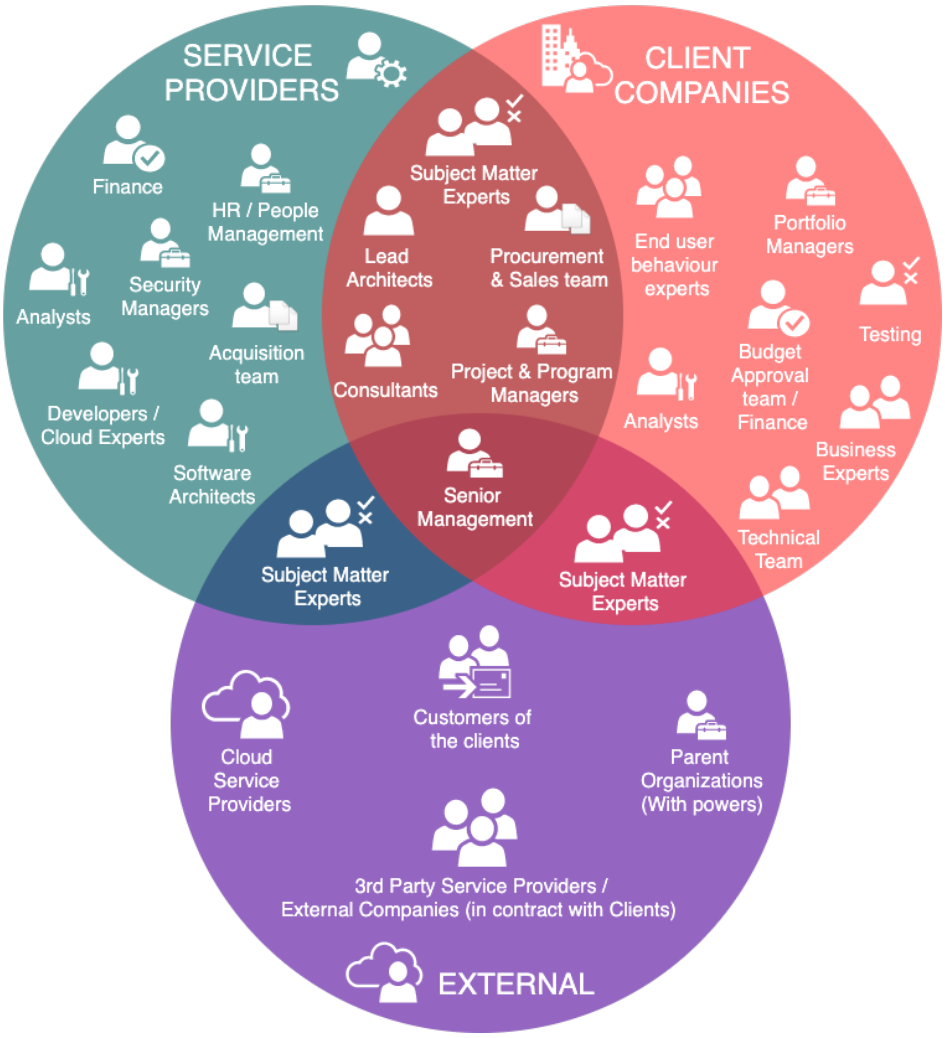

Figure 4: Stakeholders Involved in Assisted Cloud transition Process

The Subject Matter Experts are a team that encompasses technical, financial, people, security and business domain experts. This group is usually responsible for all key decisions from both client and service provider sides. The subject-matter experts are included in the study because they relate to more than one aspect and also understand how interdependent these aspects are. They also have experience using practical frameworks while preparing end-to-end strategies. The procurement and sales team deal with marketing and legal aspects of the process. The consultants help clients decide what best fits them while the lead architect from both sides plan and design the transition process. The Program / Project managers act as a communication

bridge between core teams on both sides and manage the entire process. Senior management like CXOs oversee and lead the process on the whole.

Internally, both clients and service providers have multiple teams including business analysts, architects, developers, end-user behaviour experts, finance team, acquisition teams, testing team, etc. and respective managers, who all play a role in this transition process. External stakeholders as stated already are also included in this figure 4.

4.2 Challenges Involved

As mentioned earlier, owing to the divergence in aspects and complications in the process of cloud adoption, organisations are bound to face an array of challenges while moving to cloud. Challenges are practical objections that might arise during the process of the cloud transition. The predicament could be while they define their motivations due to the uncertainties of providing an orchestrated configuration management post-transition.

The first research question is aimed at these challenges which are to be addressed by the framework in the course of the research.

RQ1 : What major challenges do organisations tackle when moving to cloud?

This section elaborates on the possible challenges which organisations will have to tackle while moving to cloud. As mentioned in chapter 2.2, this is derived from grey literature analysis and by interviewing professionals experienced in hybrid cloud transition.

The design interviews included questions relating to the commonly occurring organisational challenges which client companies face during cloud transition. The interviewees were also asked to share practical examples of these challenges. During the course of research iterations, about 18 challenges were identified and understood. They are listed below.

1. *Perception of cloud*

   The concept of cloud is very subjective and context-dependent. It is important but can be difficult for the client company to clearly define, scope and understand the cloud and the possibilities they are aiming to explore, especially if they prefer hybrid cloud. For example, Hybrid cloud could mean simultaneously hosting in more than one environment for one company, whereas for another company, it could be constantly switching between platforms. Both are correct and possible, but not feasible together. The client and the

service provider have to both understand which will best fit the client *(Interviewee 06-01)*.

2. *Fear of unknown*

   "Moving to cloud could mean moving out of their "comfort zone" to many organisations" *(Interviewee 02-01)*. This could be because of anything from having their systems hosted at a 3rd party service provider's location or not knowing how this could influence their organisational structures.

3. *Difference in motivations and conflict of goals*

   Every organisation might have its motivations to take up cloud transition. In large organisations it also becomes important for every department within, to stay on the same page. There could be a clash of opinions or interest mismatch between IT and Business teams or a "Not invented here" syndrome, all of which could be a challenge for the organisation. For example, the senior management would have to be convinced this hybrid cloud transition process to be a cost-saving step or an investment but the IT teams would think of this to be a mobility optimisation step which could be costly. These are two very different goals and might also be conflicting. Cloud transition could be either but often need not be both.

4. *Prioritising tasks and balancing benefits & costs*

   "Cloud could be costlier when not managed right" *(Interviewee 02-01)*. Having a clear financial strategy could also be a difficult challenge. For example, Organisations might have to create a strategy to prioritise the activities based on which brings higher value or return on investment, or which might have higher maintenance costs upon moving to the cloud in future. This could be a challenge given the uncertainties.

5. *Dealing with diversity vs Standardisation*

   Moving into a hybrid cloud environment includes an additional challenge of dealing with diversity. Orchestrating multiple platforms and presenting the system as a single interface to the end-user could be a challenging criterion. Similarly, the new process should also not deviate too much from what the company stands for and thus standardisation adds up to the list. For Example, striking a balance in ICT Expertise and ICT Heritage of the company, scalability and compatibility of existing portfolios, impact regarding redundant infrastructures, etc.

6. *Organisational culture and Absorptive capacity*

   People happen to be an important part of any technological transition. This digital transition becomes demanding if the inherent organisational culture does not allow a change and if people are not open to comprehend new ventures. For example, few countries or companies might have employee unions which might also have a say on the transition process. People's openness to new ventures also play a key role. These cultural aspects can be a limitations while taking up the cloud transition *(Interviewee 07-01)*.

7. *Inter-dependency between processes*

   The processes could be highly correlated and their relationship with other aspects could lead to a complex challenge. Companies might have a challenge in defining agility and flexibility during the transition. For example, Cloud adoption might drive a decision to change the business model. Such an action might entail a restructuring of the entire business so that it reflects the new business model.

8. *Fragmentation of responsibilities between multiple stakeholders*

   As explained already in the previous chapter 4.1, defining clear responsibilities, the procedures to deal with Decision making, ensuring accountability, etc. could be a challenge.

9. *Issues related to inter- and intra-organisational dependence*

   Client companies opting for service by service providers will also have the challenge to deal with inter-and intra-organisational dependencies. "Dependency on service providers is a huge challenge for clients migrating to third party clouds" *(Interviewee 04-01)*. "As a client, you lose flexibility when you prefer standard services provided by CSPs, this is a challenge in itself" *(Interviewee 09-01)*.

   For example, while attempting to use services from third-party CSPs there could be difficulties in finding out the real state of functionalities provided by them.

10. *Management of Data*

    "Managing Data is always a challenge". *(Interviewee 08-01)*. Being able to comprehend big data characteristics, evaluating the data and information architectures and transferring them without any impact on Information Quality could be a laborious yet crucial task.

11. *Skill management*

    Ensuring technical and domain-specific expertise is available is a major challenge in recent times. So is maintaining a stable relationship between employees, management and clients. A recent survey claims that 86% of its participants feel - A shortage of qualified talent will slow down cloud projects and 63% of them feel it is difficult to find a qualified cloud engineer (Logicworks, 2020).

12. *Maintaining Ambidexterity*

    Constantly innovating to adapt to changes yet making sure the existing systems are efficiently delivering services could be a challenge especially while in a large organisation where there is a lot of space for innovation *(Interviewee 05-01; Interviewee 03-01)*.

13. *Risk Evaluation and Preparedness*

    Identifying potential risks and preparing a mitigation strategy is a critical part of any digital transition. Moving to a new system opens up a lot of probable vulnerabilities all of which have to be addressed.

14. *Privacy and Security*

    Recent statistics claim that about 73% of companies consider security as a major challenge while moving to cloud (Coles et al., 2015). Secure storage and retrieval of data as well as ensuring the data is available and accessible to authorised users is an uncompromising factor. Also, it could be a demanding task to ensure all regional and global security laws have been adhered to.

15. *Analysis of Market Dynamics, Influence of competitors and Social responsibilities*

    In a large company, a digital venture also depends on its competitors and the market. There is a challenge in choosing their timing of entry based on existing market and peer statures.

16. *Sustainability in Planning*

    The process of cloud transition could extend over a long period. Having a strategy planned that is sustainable enough throughout the process and still allowing the clients to have an option to influence might be a challenging task. For example, "The critical paths are

defined way before the actual transition starts. Though it is agile, it should not become irrelevant before the process ends *(Interviewee 08-01)*".

17. *Legal and Compliance issues*

    For client organisations taking up third party services, there could be legal and compliance-based challenges in bidding and contracting phases due to the uncertainties involved.

18. *Geographical delineation*

    Hosting in a cloud system could itself mean that the servers can be in a location different from the client's. For a large organisation, there are even more chances for the practices within the organisation to be geographically dispersed and the hosted servers to be in another part of the globe. This brings in new challenges related to ensuring the efficiency and security of the system.

The challenges organisations tend to face are not limited to this list but is often more and that is why it is crucial to have a framework that prompts a structure for governance.

4.3 Boundary Conditions

The organisations are obligated to satisfy certain boundary conditions during the process of cloud migration. Boundary conditions are referred to prerequisites and the critical clauses to which the organisations have to conform. These boundary conditions also help organisations determine their IT and Business strategies and drive them towards achieving the overall objective of realising control. The second research question aims to answer this.

RQ2 : What are the required boundary conditions on a cloud to stay in control?

After understanding the cloud transition process, it was understood how imperative these boundary conditions were. First, the boundary conditions were noted based on studies from the literature. Following this in the next few iterations, conditions were derived based on the interviews with experts. Interviewees were asked about possible go and no-go scenarios during practical cloud transition processes. From their answers it was understood that there were few conditional parameters which cannot be skipped and these were noted. The resulted conditions were all very broad but few of these boundary conditions had similarities while few were contrasting. In the next iteration, based on the similarities and inter-dependencies, the

boundary conditions were grouped. Finally, the 5 groups of boundary conditions were all given suitable titles. They are as follows.

- **GROUP 1 - Organisational Conditions**

  These boundary conditions define how organisations will have to manage their goals and direct the process of the cloud transition. Satisfying these will land in a set of drivers for the process.

  1. The client companies should have their motivations drawn clearly at the start of the process. (This is a key boundary condition because, without the motivations the critical paths or end-to-end strategies cannot be devised. In turn, control cannot be achieved.)
  2. Existing portfolios and processes are recorded for reference.
  3. The fragmentation of responsibilities and services should be bounded legally.
  4. Business requirements and IT requirements are consistent among all stakeholders.

- **GROUP 2 - Financial Conditions**

  These boundary conditions help organisations assess their financial capabilities and their market statures. And help them decide what is affordable for them and what is not.

  1. A structured financial possibilities and limitations should be present.
  2. A prioritisation list on possible expenditures has to be drawn.

- A synchronised cost measure has to be selected.

- **GROUP 3 - Data and Security based conditions**

  This group of boundary conditions owe to the security constraints which the organisations are bound to fulfil. Obliging to this will ensure the systems are private, accessible, available and intact.

  1. The data transferred to the cloud should be confidential at any instance.
  2. The data/application should be available for every certified user throughout irrespective of the process of transition.
  3. The Integrity of data cannot be compromised.

4. The existing portfolios of the client company should be traceable.
5. At every instance during the process of cloud transition the client should have an option to steer the process.

- **GROUP 4 - People based conditions**

  This array of conditions related to the stakeholders and people involved during cloud transition. Managing people is one of the most difficult challenges as explained already in the previous chapter (Logicworks, 2020). Fulfilling these conditions will ensure there is no skill shortage.

  1. The primary stakeholders should be educated about the process.
  2. The skill requirement for this hybrid cloud transition process must be predicted, analysed and confirmed

- **GROUP 5 - Technical Operation and Performance based conditions**

  The last group of conditions related to the operational processes and the platforms as such and abiding by it will lead to better performance.

  1. The new infrastructure should be compatible with the existing ICT portfolio of the company.
  2. The final hybrid cloud system should be orchestrated and managed as a well-round system.
  3. The process of transition should be standardised and independent of geographical delineation.
  4. Interfaces used by end users should be generic and unambiguous.

These groups and the similarities between the conditions within each group are explored further in the next chapter 6.

5 Design & Development of the Framework

Given the agile nature of the cloud adoption process, the complexities involved in designing an integral framework as well increased. The design and development of the framework was streamlined based on the research strategies as mentioned in chapter 2.2. The result of the initial literature studies and interviews did not only answer research questions 1 and 2 but also helped uncovering a huge research gap.

To create an integral framework that helps client companies in realising control while moving to cloud, it was important to understand how control can be achieved.

To achieve control what was required was a clear End-to-End strategy. The End-to-End strategy should convey the following.

- Draw the critical path with all possible steps which the client has to take to move into the hybrid cloud.
- The strategy should address the potential challenges the organisations might face in these steps while moving to the cloud.
- The go or no-go conditions or boundary conditions should be fulfilled along the way.
- Understand what actors and factors might influence decision making at each step.
- Identify possible organisational measure to ensure the process is transparent to the client companies.

Following this approach, the research was taken up in iterations. At the end of first iteration a design was made solely based on literature studies and grey literature. According to these theoretical approaches of the cloud transition process, the factors influencing control or the governance module is brought into picture only in the beginning during research and analysis, and later during the feedback phase. This is explained in figure 5. This also considers the case of hybrid cloud but is not far along the concept.

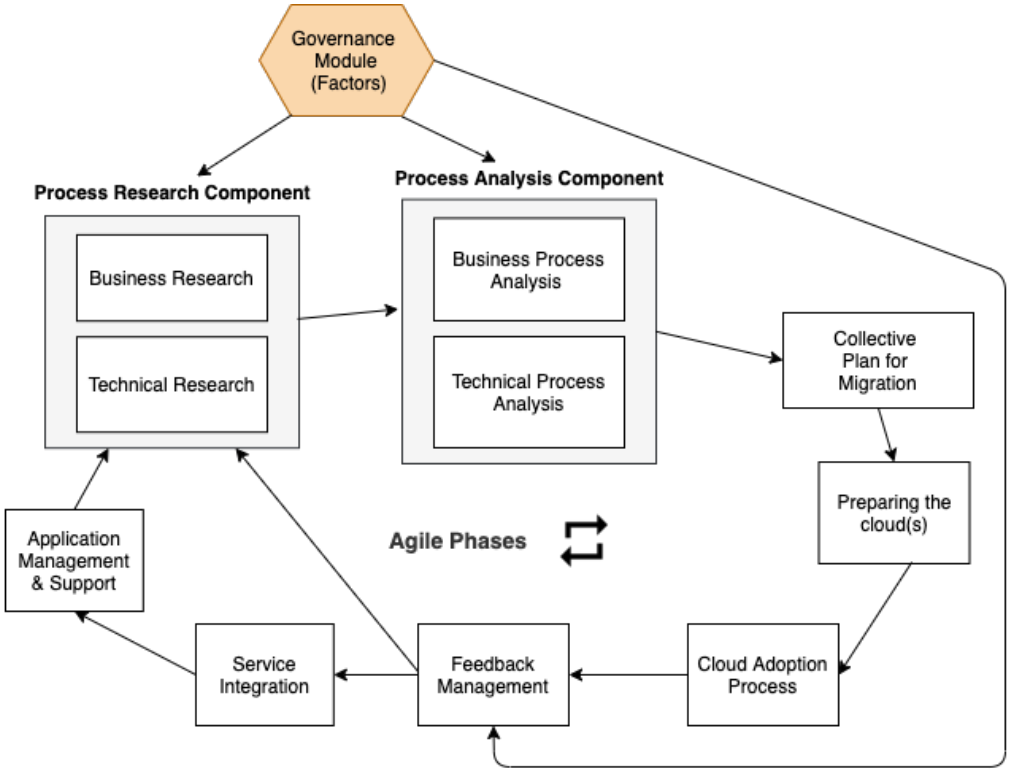

Figure 5: Theoretical definition of Hybrid Cloud Transition Process

But in an organisational context, this is not the case. Client organisations have multiple instances during the process where multiple actors, factors and perspectives are taken into consideration while decision making and this shapes the entire process of moving into cloud for the company. Especially in large companies, the steps as well are not as simple as what theory claims them to be, but rather extensively branched and agile. Moving into hybrid cloud brings in further requirements like orchestration and infrastructure management which would not have been considered otherwise. Thus there is a significant research gap which was identified between the theoretical understanding and practical implementation of hybrid cloud at an organisational level. This is because the Governance as a module is not just factors influencing decision making but often has many segments to it.

Further iterations were made including every detail involved bringing the framework closer to what is in practice. To understand the practical implementations, initially the governance module was explored. This was followed by the steps and finally efforts were taken to understand how the governance module was characterised within the steps and how it later shapes the framework.

5.1 Design Interviews

The design phase of research involved interviews of experts from ATOS who have experience assisting their large clients in the hybrid cloud transition process. Nine interviewees participated in this detailed design interviews. The interview protocol and the participants list is included in appendix C and E.

The interview questions were divided into 4 phases. Initially the questions were focused to understand the background and expertise of the interviewees. To get a broad perspective interviewees were chosen depending upon the sector of work they do in the cloud adoption process.

This was followed by questions to understand practical challenges that organisations face while moving to cloud and similarly the boundary conditions that have to be satisfied. This was constituted a major part of the research as it helped in answering RQ1 and RQ2. These are explained further in this section below.

The next set of questions were asked to get an overview about the multiple aspects, factors and perspectives in the hybrid cloud transition process. Then the latest iteration of the framework was presented and collectively the framework was designed.

The final set of questions were asked to get further feedback or points of improvement.

5.2 Governance of the process

As mentioned already, Governance of the cloud transition process is not just related to the factors influencing decision making, but involves multiple actors, factors and perspectives. Given the constraint, client companies realising control over the process becomes a substantial challenge. To realise control or to achieve transparency of the process and having the option to steer or influence the process, the companies have to devise their own End-to-End strategies.

These End-to-End Strategies are conclusively a combination of Business and IT strategies but are not just limited to one. This is because, a digital transition like cloud adoption is not just a technological change for a client company but often also influences the business operations. For example, the senior management would always want a strong business suite or case to drive the technical transition because they'd want to understand what kinds of returns will this investment bring back and how long would it take for the company to do this. Whereas the IT

strategies would just be planned having technology as priority. Thus in a stage where Business strategies and IT strategies have to be married, multiple aspects like Cost, Operations, People and Resources, Security, etc. comes into picture.

Now reconsidering the challenges and conditions explained in chapter 4, it brings light on the fact that though these challenges and conditions contributed to determining either the Business or IT strategies they were all highly interdependent. However, as distributed in the boundary conditions sub chapter, they had certain similarities and certain differences which lead to classifying them under 5 groups. These 5 classifications were explored further in context to the framework design.

5.3 Aspects of the framework

Considering the interrelation between various challenges and boundary conditions, and in what way they can be used in determining end-to-end strategies, they were grouped into 5 groups. From the 5 groups it was understood that the Organisational drivers, the financial aspect, the security constrains, the people involved and the operations were the categories which were considered during the research phases. While presenting this to the interviewees in further iterations, it was identified that in practice, these 5 categories were broad but often represents a group of decision influencing criteria under their title. It was also understood that these combination of actors and factors are involved at every step of the cloud transition process and not just in the research and feedback phases.

Based on this understanding, these 5 broad groups or categories were then termed as **Aspects** as they dive into specific areas where guidance can be given to, uncover potential challenges and improve processes with the overall objective of realising control.

This was explored as a part of answering the research question 3.

RQ3 : What aspects should the framework include to achieve control in the cloud transition?

The 5 aspects elaborate on the distinct functionalities related to the stakeholders, their technical or business capabilities and responsibilities owned by them. The 5 broad aspects are Business and IT Drivers, Security, Cost, People and Resources and finally Platforms and Operations. These aspects will help an organisation envision their strategies by providing an overview of multiple actors, factors and perspectives which all are a part of the cloud migration process

and helps in determining control. These aspects are also important while the service provider defines critical paths for the client companies.

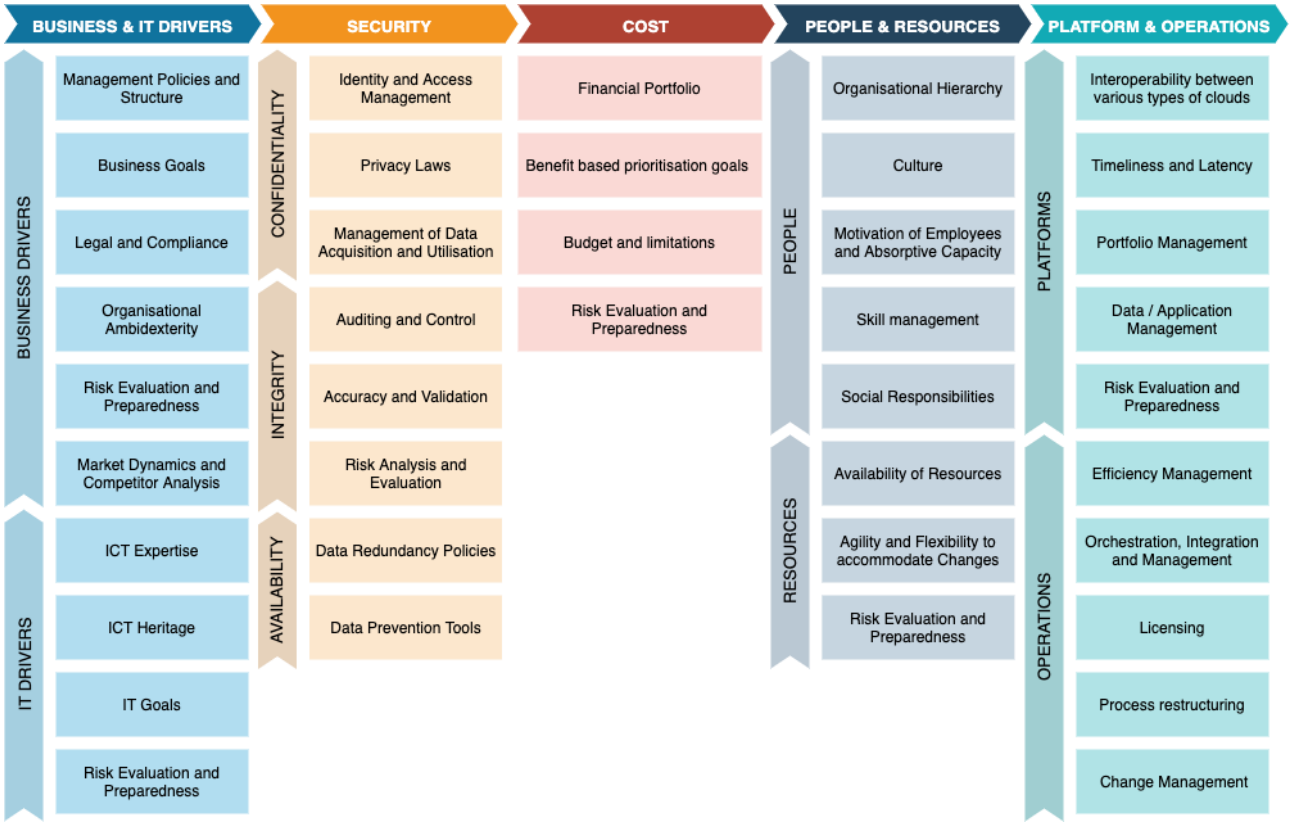

Figure 6: Multiple aspects of the framework

These 5 aspects encapsulate an array of functionalities (or sub-aspects) within each of them. Based on the understanding of the practical sides of these aspects, these sub-aspects were derived. Iteratively, they were also discussed at design interviews and were improved further.

The multiple aspects and their sub-aspects are depicted in the figure 6 and are explained further in detail.

5.3.1 Business and IT Drivers

The first aspect of Business and IT Drivers comprises of all the indispensable functionalities that conclusively drives the company. This is an important aspect because this helps the companies define and manage their motivations in context with the underlying principles and policies of the company.

1. **Business Drivers**

   The Business Drivers are related to the functional sphere of the company.

(a) Management policies and structure

The organisation's Management policies refers to the core values and beliefs of the company. This could also relate to how the company was formed, what the company strives to achieve and how they drive towards achieving this goal. The structure refers to the distribution of supervision and the operational flow with the company.

(b) Business goals

The Business goals are the objectives which the company strives to achieve within a limited span of time. They are clearly defined actions directing decision making at later stages.

(c) Legal and Compliance

The legal and compliance sub-aspect refers to the legally bound rules and regulations within the company and those laws the company is subjected to follow. The corporate legal departments generally monitor and implement these regulations continuously.

(d) Organisational Ambidexterity

The company has a certain set of goals to achieve and also certain demand to meet. The capability of the organisation to facilitate new changes without hindering the existing processes is a key goal.

(e) Risk Evaluation and Preparedness

"Risk management is an important sub-aspect within the context of business drivers as a technological change might have a great influence on the business and making sure the company is prepared to accommodate changes is an important factor" *(Interviewee 05-01; Interviewee 03-01).*

(f) Market Dynamics and Competitor Analysis

The timing of entry, how the current market looks like, how the market will be while the transition is complete, will this technological transition have an influence on the market performance of the company, how would the competitors react for this initiative are few of the questions which companies have to think about during the

initial research step. This aids the company in planning a business strategy in the long run.

2. IT Drivers

   The IT Drivers refers to the IT strategies and IT prospects of the company.

   (a) ICT Expertise

   The ICT Expertise relates to the availability of skills, products, systems and resources within the company. The existing IT structure and the capabilities of the company is an essential aspect while taking up a technological transition like cloud adoption.

   (b) ICT Heritage

   The ICT Heritage refers to the history and information on past digital ventures that the company has taken. "This gives an idea about how the company has managed to maintain it's functioning even during the change process" *(Interviewee 05-01)*. It also gives clarity about the IT related decision making route taken previously.

   (c) IT Goals

   IT Goals refers to the IT target which the company wants to achieve. These are characterised by the ICT Expertise and ICT heritage as well.

   (d) Risk Evaluation and Preparedness Risk evaluation is also a part of the IT drivers sub-aspect as it is crucial to be prepared to tackle technological risks as well. This is because if IT risks are not managed well it might cause an halt to the entire process.

5.3.2 Security

Security becomes a crucial factor while moving to a new environment especially if the landscape is a hybrid cloud. Multiple issues like integrating various systems and still ensuring availability, or ensuring privacy of end users, or complying with local and global privacy laws, etc. all become critical challenges. That is why Security is included as one of the broad aspects in this framework.

1. Confidentiality

   Confidentiality is one of the modules of the CIA triad. This aspects drives towards

ensuring that only authorised users have access to the systems during and after the cloud transition process (Fruhlinger, 2020).

(a) Identity and Access Management

The Identity and Access Management (IAM) sub-aspect relates to the monitoring and managing access to the systems during and after the process of hybrid transition.

(b) Privacy Laws

Privacy Laws are regional and global laws that are formulated by global bodies to standardise security measures and ensure security wise control for everybody. About 120 countries now have their own data protection and management laws which significantly influences the working of any company (Coos, 2021). For a large client company that has global presence or geographically dispersed existence, there is a need to ensure that all the local and global laws are checked. For example, for a European company or a company functioning within the European Union, it is mandatory to abide by the Global Data Protection Regulation 2016/679 (GDPR) *(Interviewee 02-01)*.

(c) Management of Data Acquisition and Utilisation

Data becomes an integral part of any digital transition. Ensuring there is a standard protocol for data acquisition and utilisation eases the process and facilitates the process of mapping strategies.

2. Integrity

Integrity of the CIA triad refers to the correctness of the data or application. It refers to protecting the data from improper or irrelevant modifications (Fruhlinger, 2020).

(a) Auditing and Control

Auditing and control refers to checking if the digital transition has a governance policy in place and also having a control plan to manage it over time.

(b) Accuracy and Validation

This sub-aspects relate to verification and validation where the verification process checks if it is the accurate data and the validation checks if the data is correct.

(c) Risk Analysis and Evaluation

A security wise Risk analysis plan is mandatory for the organisations. Having a preventive, detective and responsive risk management module is crucial aspect.

3. Availability

Availability refers to ensuring that the authorised users always have access to the systems. While transitioning to new platforms there might be instances where the system becomes unreachable. This could also affect the functioning of the company. The availability aspect cannot be jeopardised and efforts have to be taken to avoid downtime.

(a) Data Redundancy Policies

Maybe having multiple backups could be an alternative to avoid downtime. But this can lead to extra cost and also the challenge of ensuring consistency of data across all additional copies. The data redundancy policies of the company as well as regional and global laws have to be considered.

(b) Data Prevention Tools

Data Loss Prevention (DLP) software can be included to ensure availability. These software applications performs content inspection as well as contextual analysis. This should also be considered while planning the strategies well in advance.

5.3.3 Cost

Managing financial expenses is a key business challenge for any company. The management often expects the money spent to be a financial investment with returns and that it should align with the other strategies the company comes up with. This is why cost / financial aspect is an important part of the End-to-End strategies.

1. Financial Portfolio

The financial portfolio refers to the market stature and details of invested assets of the company. This is an important sub-aspect which drives the organisations towards deciding on their financial capabilities and investment goals.

2. Benefit based prioritisation goals

Every investment comes with certain returns or benefits. These could be fiscal returns or

value-based returns like performance outcomes or agility outcomes. Another important sub-aspect during strategy planning is to prioritise goals based on the benefits and costs. For example, "A company might expect the payback period for the investment on cloud migration to be a maximum of 18 months. For such a company the plan has to be made in such a way that this request is accommodated" *(Interviewee 02-01)*.

3. Budget and limitations

   Budget refers to the process of creating a financial plan based on the estimation of income and expenditures for a given span of time. This is vital for organisations while taking up a digital transition to understand and set a limit on financial spending. Companies might also create a specific financial plan / budget to confine money outflow during every step of the process.

4. Risk Evaluation and Preparedness

   Risk analysis helps companies in foreseeing financial risks and prepares them to avoid financial losses. That is why this is included as a sub-aspect within the Cost aspect.

5.3.4 People and Resources

People (or stakeholders) and the resource capabilities of an organisation is an important factor that influences strategy making process within a company. Ultimately, it is people who characterise the process and thus making sure every relevant stakeholder is well informed and is on board is a primary step during cloud migration. This is why, People and Resources are included as an aspect in the End-to-End strategies.

1. People

   People or stakeholders are individuals or teams who are involved in the process of hybrid cloud adoption. Detailed explanation on the stakeholders involved was provided already in sub-chapter 4.1.

   (a) Organisational Hierarchy

   Organisational hierarchy refers to the decision making structure within the company. But this also relates to the extent to which the people / teams involved can voice their perspectives. Managing this efficiently is a challenge on it's own.

(b) Culture

The values, beliefs, expectations and practices within the company are collectively titled as the organisational culture. It is important that the culture in the organisation pushes people to be open towards change and learning which comes along with digital transitions.

(c) Motivation of Employees and Absorptive Capacity

The employees or any primary stakeholders have to be enthusiastic about the technological change. This is an important factor under consideration. For example, In countries like France where employees could have employee unions, it is integral to get consent from the unions as well while deciding on a change invoking venture. Absorptive capacity refers to the learning capabilities of the employees. This is also important sub-aspect that drives decision making.

(d) Skill management

Skill management refers to bridging the gap between the skill requirement and skill availability. This has to be planned for the whole cloud transition process.

(e) Social Responsibilities

The organisations usually have corporate social responsibilities which is often tied up with the people within the organisations. The digital venture should not hinder these in any ways.

2. Resources

Resources refers to tangible and intangible assets of the organisation. This facilitates the organisations to work and drives them towards reaching their goals. This might include the properties, technical systems, equipment, etc.

(a) Availability of Resources

Ensuring that the required amount of resources are available to the stakeholders is an important sub-aspect under consideration.

(b) Agility and Flexibility to accommodate Changes

While taking up a digital transformation like hybrid cloud transformation the tech-

nology could be modified to a great extent. Making sure that the systems or resources are still capable to facilitate these changes is a primary aspect to deal with.

(c) Risk Evaluation and Preparedness

The organisations might face technical uncertainties which might influence the requirements in resource capabilities without a warning. This if not tend to immediately might cause delay or financial loss. The organisations have to be prepared to avert these risks.

5.3.5 Platforms and Operations

Operations management has become a separate division by itself in many large organisations. This part of the company specifically facilitates change and organisational management. Platforms refers to the target landscape and it's capabilities as well as existing technical architectures within the company.

1. Platforms

   Managing multiple platforms and making sure a synchronised performance is delivered throughout the process is another primary case to address while moving to hybrid cloud.

   (a) Interoperability between various types of clouds

   A hybrid cloud might conclusively contain more than one type of platform or infrastructure. It is imperative to ensure that the communication between these systems is cohesive at any instance in time. The interfaces have to be designed in such a way that this requirement is focused.

   (b) Timeliness and Latency

   "While having multiple landscapes, timeliness or the factor of having data delivered from and to the correct system, in the right time is a key aspect" *(Interviewee 06-01)*. Possibilities of time delays or latency have to be taken into account while designing the infrastructure.

   (c) Portfolio Management

   In a hybrid cloud environment there could be multiple types of infrastructures. Ease of planning and management of the ICT portfolios in each platforms, also happens

to be a deciding factor while moving to hybrid cloud.

(d) Data / Application Management

The landing zones or target platforms should be able to support the application or data moved to hybrid cloud. They should also be compatible with the existing systems.

(e) Risk Evaluation and Preparedness

Preparing to face ICT related risks is yet another important aspect which otherwise could also cause time delays and financial losses.

2. Operations

Operations refers to the functional management involved during the process.

(a) Efficiency Management

The efficiency management module helps in planning the strategies on the whole. The goal of this perspective is to achieve effective and efficient process with the available resources. Using six-sigma or Lean methodologies is a common practice within organisations to reduce waste. Also technically there could be unnecessary data and applications which the organisations could get rid off during the technical transitions. This is considered in this sub-aspect.

(b) Orchestration, Integration and Management

In a hybrid cloud environment, orchestration and integration could be a significant challenge as explained in sub-chapter 4.2. Defining what data is going to be stored in what part of the hybrid cloud and creating an orchestration plan to provide a single system overview to the end user is an important sub-aspect in strategy making.

(c) Licensing

Licensing and Managing multiple parts of the hybrid cloud is an important Infrastructure management step to be ensured of.

(d) Process restructuring

"Process restructuring can be a secondary response during hybrid cloud transition" *(Interviewee 01-01)*. Having a clear follow-up strategy to ensure the restructuring

is smooth is also a sub-aspect during the formulation of strategies.

(e) Change Management

Change is in-evident during technological transition. Having a change management plan like the 7R's plan can be very effective (Wilson, 2020).

All of these sub-aspects finally led to Five broad aspects which could aid in the strategy making process during cloud adoption. This conclusively answers the third research question.

5.4 Framework Design

As explained in the previous chapter, a governance module considering the various aspects which could also conclusively lead to deciding End-to-End Business and IT strategies was derived at the end of the second iteration. Following this, information from various interviews during the design phase were considered and the steps involved in the hybrid cloud transition process was elaborated.

Subsequently, at the end of the third iteration, a detailed process considering all the agile steps were included. The fourth iteration involved drawing an order and completing the framework design.

The framework as defined already, can be a collection of anything from implementation guidance in terms of instructive steps, development tools, middlewares, best practices guidelines, services that aid in management, creation, adoption or any functional operation of cloud applications (Scheier, 2012).

The final integral framework design is a collection of instructive steps and best practice guidelines for hybrid cloud transition to help companies realise control.

The multiple elements in the research and how it has contributed towards the final framework is explained in the figure 7. The stakeholders, challenges and boundary conditions from the previous section 4 and the aspects from this section are all contributing factors for this research design. The main deliverable of this research is the integral framework. However this framework encompasses all the elements from the research as it collectively creates a solution to realise control.

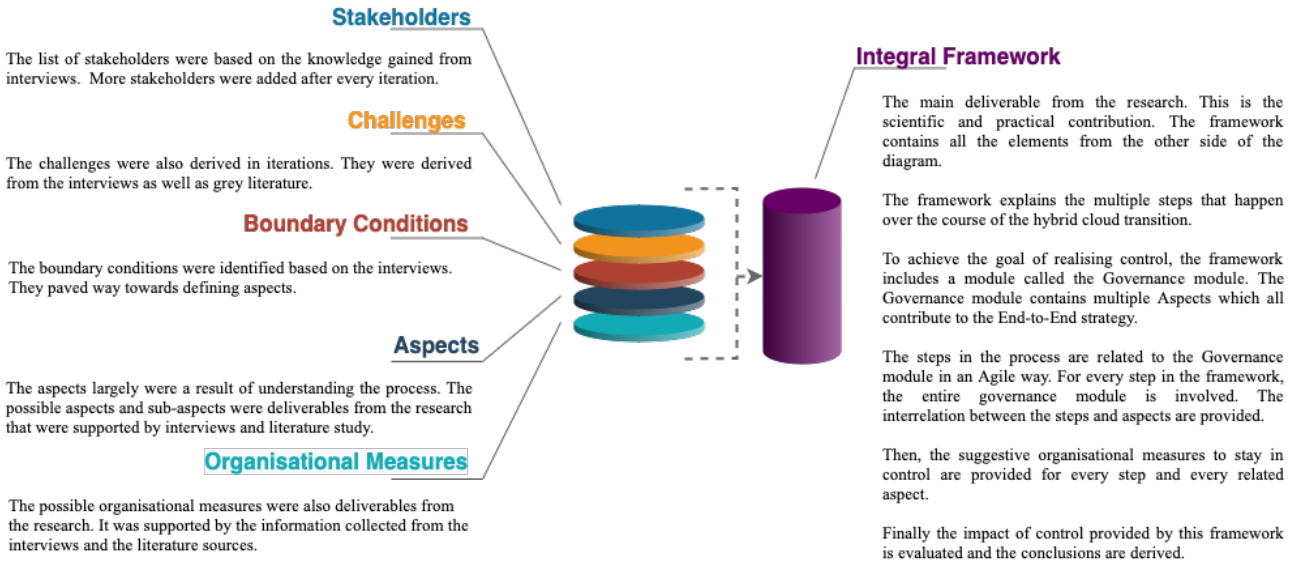

Figure 7: Elements in the research contributing to the framework

The final integral framework design consists of three parts.

- The following figure 8 is the first part of the framework design.

  This elaborates on the various steps in hybrid cloud adoption and how the governance module is interconnected with every step unlike the theoretical expectations.

- The second part is the sub-chapters 5.4.1 and 5.4.2 which brings much more details on how the steps and aspects are interconnected.

  For every step, the relevant aspects which can be involved in strategy making are marked.

- The last part of the framework is the instructive steps or possible organisational measures which could be taken to realise control. This is explained in sub-chapter 5.5.

  Here as well, for every step and relevant aspect, the possible organisational measures are listed. This conclusively helps in making concrete decisions and also to decide on End-to-End strategies.

The figure 8 is a visual representation of the entire framework as it shows how the multiple steps and aspects are connected through agile loops.

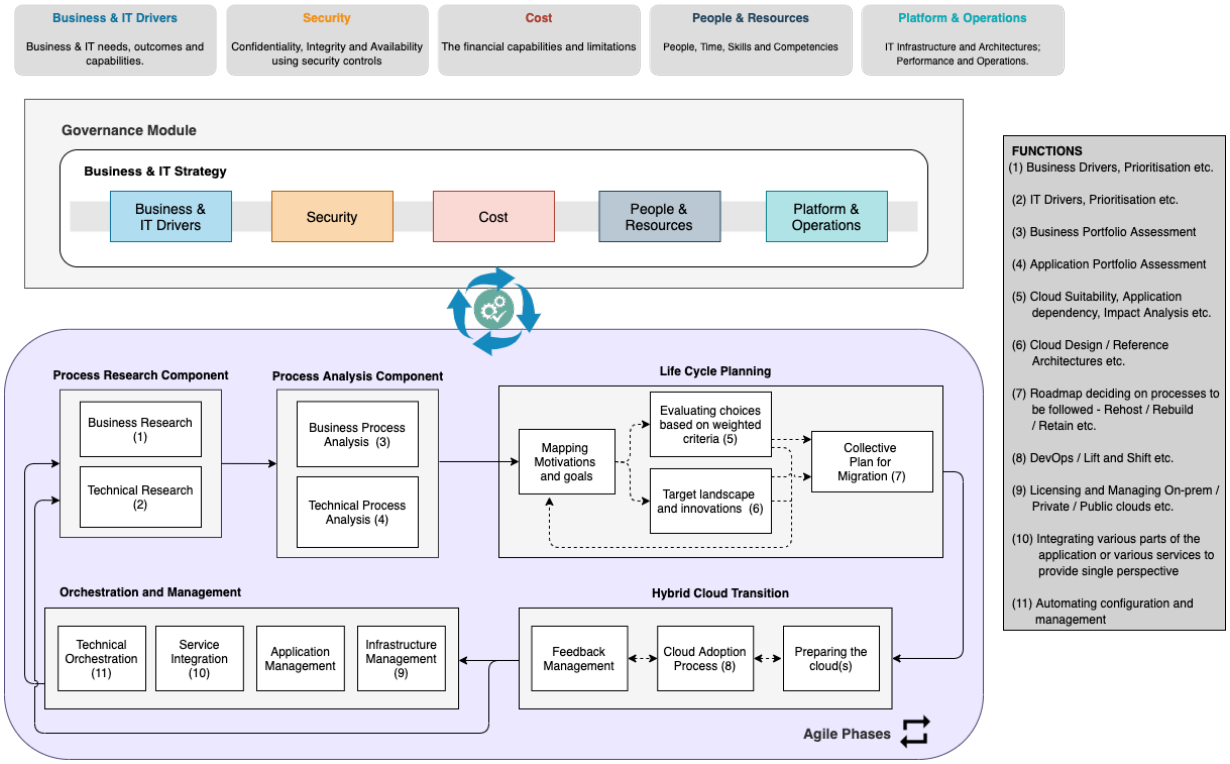

Figure 8: Design of the integral framework

The cloud transition process is not as simple as how theoretical definition portrays it to be. It includes multiple steps which are all agile and it is iteratively repeated in multiple phases or waves. In reality, the governance module as explained earlier comes into picture in every step of the transition process. This is explored further aiming to bring in much more transparency to the process thereby bringing in more control for the client companies.

5.4.1 Functional steps in the Hybrid Cloud Transition

The long iterative and agile process of cloud transition consists of about 15 steps as represented in the figure 8.

Upon making a decision on moving to cloud, the client company approaches the service providers to assist them in the process of cloud adoption. The following steps are taken up together by both the parties with the mission of transitioning into hybrid cloud.

The first module is the Process Research component which consists of two steps namely, Business Research and Technical Research. The overall goal of this module is to understand the client company, it's drivers and goals, and answer questions like why are they moving to cloud, how or what type of hybrid cloud could fit them, how long would it take for them to move to cloud, what does it do to the security statures, how much can the company fund for this, etc.

The Business Research is done to acquire maximum knowledge on the business perspectives involved in the process. It might include steps to understand business needs and for recommending relevant solutions. The Technical Research step is included to do a through technical study which might facilitate in defining the IT needs and goals for the company to take up hybrid cloud transition.

The next module is the Process Analysis Component which also consists of two steps namely, Business Process Analysis and Technical Process Analysis. This component is used to analyse the functional processes and evaluate the existing system to come up with achievable targets. The Business Process Analysis part includes steps like Demand vs Availability analysis, SWOT analysis, End Usage analysis, Market analysis, risk analysis, etc. The Technical Process Analysis part similarly evaluates the technical systems to come up with relevant achievable solutions. This could include steps like technology forecasting, technology assessment and technology foresight as explained by (Nazarko, 2017).

The third module is the Life Cycle Planning module. The Collective Plan for Migration is not born out of the Analysis component as theoretical definition claims it to be. In practice, organisations have a set of goals and motivations which are realised after the research and analysis components. The collective plan for migration is fetched by mapping the motivations into goals. But this also contains two steps in between. First the companies are provided with multiple choices at each stage during the migration process. The companies will have to choose between these choices. The first step is where the choices are evaluated based on weighted criteria. Simultaneously, the organisations will look for chances to innovate. Therefore there is also a step where these organisations identify target landscapes and innovate accordingly. These together maps the motivations and goals leading to the collective plan for migration.

The next module is the Hybrid Cloud Transition process. This consists of three broad steps. First is Preparing the cloud for migration, followed by the Cloud migration process as such and finally a Feedback management module. The first step of Preparing the Cloud consists of multiple sub-steps like prioritising workloads, performing any necessary refactoring, reviewing application's resource allocations, etc. (Downs, 2021). The next step is the long and detailed cloud migration process. This should go ahead smoothly as long as the company sticks with the planned strategies. However there should always be a risk analysis strategy in standby to takeover in case if the migration does not go as per plan. The next step is the Feedback

module. It is important for companies to take feedbacks and reiterate to ensure precision in the rendered solutions.

The final module of Orchestration and Management is included specifically in the hybrid cloud transition process owing to the diversity in the platforms and the necessity of the system to provide an orchestrated performance to the end users. This consists of four steps which could all be done sequentially or simultaneously. The first step as per the diagram is the Infrastructure Management. This could involve functional steps like licensing, data centre hosting, IT Risk mitigation and planning, server management, network management, etc. The next step of Application management consists of functional processes to manage the data and applications involved. Frameworks like the ITIL Application Management Lifecycle can be used to take up this process (Zitek, 2014). The next step in the diagram is the Service Integration. In a hybrid cloud environment there could be more than one platform where the applications are hosted. There is a need to ensure that the end-user gets a single perspective of the entire system or service. To do this, the various parts of the hybrid cloud have to be integrated well. The last step involved is the Technical orchestration. This involves functional steps like configuration management, automating multiple tasks to ensure there is a cohesive process flow, provisioning dependencies, etc.

As explained already these steps are all agile and happens in iterations called as phases or waves. The governance module is a part of every step and the Business and IT based End-to-End strategies are formulated depending on this.

5.4.2 Mapping the functional steps to the aspects

As explained in the previous chapter, the governance module is a part of every step during the cloud transition.

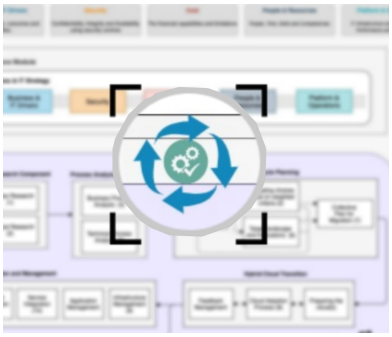

Figure 9: Zoomed-in view of the framework

The curved blue arrows with the check sign in figure 9 signifies the agile inclusion of the governance module in all the steps. The following table shows the how the multiple aspects are taken into consideration at each functional step and shows the relation between them.

Table 2: Mapping between Process steps and Governance aspects

Governance aspects / Process Steps	Business & IT Drivers	Security	Cost	People & Resources	Platform & Operations
Business research	✅		✅	✅	
Technical research	✅	✅		✅	✅
Business Process Analysis	✅			✅	✅
Technical Process Analysis	✅	✅		✅	✅
Mapping motivations and goals	✅	✅	✅	✅	✅
Evaluating choices based on weighted criteria	✅	✅	✅	✅	✅
Target landscape and innovations	✅			✅	✅
Collective plan for Migration	✅	✅	✅	✅	✅
Preparing the cloud(s)		✅		✅	✅
Cloud Adoption Process	✅	✅		✅	✅
Feedback Management	✅	✅	✅	✅	✅
Infrastructure Management	✅			✅	✅
Application Management			✅	✅	✅
Service Integration		✅		✅	✅
Technical Orchestration		✅		✅	✅

This table was formulated based on the interviews and literature studies. The table is studied in the following way - "The Business Research function involves the Business IT drivers, Cost and People &Resources aspects". Similarly for every step, the relevant It can be derived from the table that every modular component (or cumulative set of steps) includes all the aspects within the governance module.

5.5 Organisational measures

The fourth research question was to identify what suggestive organisational measures should the client companies take during the hybrid cloud transition process in order to realise control.

RQ4 : What organisational measures need to be taken to stay in control?

Therefore the following table is made by including the suggestive organisational measures which could increase transparency during the process.

For every step in the hybrid cloud transition process and for every related aspect as explained in sub-chapter 5.4.2, the possible measures are included.

In step 1 about **Business Research**, the relevant suggestive organisational measures and the stakeholders are as follows.

- **Relevant Stakeholders** - Subject Matter Experts, End-user behaviour experts, Strategy Team, Consultants, Lead Architect, Sales and Procurement teams, Bidding and Finance team, Business Experts, Program and Project Managers and Senior Management
- **Business and IT Drivers**
  - Understand the goals of the company.
  - Determine the motivations for moving into the cloud. For example : Cost savings or Reduction in vendor or technical complexities or Optimisation of internal operations or Increasing business agility, etc.
  - Reiterate existing Business Portfolios of relevant teams.
  - Check for legal and compliance constraints.
  - Competitor and market analysis has to be done.
- **Cost**
  - Financial standings of the company must be defined.
  - Budget allocation for this process should be stated using algorithmic usage-based cost models.
  - Tolerance limits should also be considered.

  - Analyse Enterprise cost optimisation policies.
  - Draw up legal bindings based upon analysis.
  - Create a benefit realisation document to understand value / cost based return on investments.
  - Understand what are the most important costs inherent processes in this business model
  - Define cost metrics.

- People and Resources
  - Availability of skills and resources should be checked.
  - Stakeholders directly involved should be briefed on the process.
  - Opinions from the stakeholders should be considered.
  - Identify corporate social responsibilities to be fulfilled or those that can be influenced by this process of restructuring.

Similarly for every step, and for every related aspect, a detailed organisational measures list is made. This includes all the best practice guidelines and suggestive measures to draw a critical path or End-to-End strategy. **This is included in appendix F.**

This organisational measures along with the framework design collectively works towards improving transparency of the process and increasing control.

6 Evaluation and Impact Analysis

This section elaborates on the results of the evaluation process of the framework. The evaluation and impact analysis related interviews were carried out with the overall goal to understand the practical relevance of such a framework and to evaluate if the framework achieves it's objective of improving transparency or control.

6.1 Evaluation Process Design

The final research question RQ5 was to understand the impact of implementing such a framework in practice.

RQ5 : What impact will implementation of such a framework have on the control during cloud transition process in organisations?

Thus an evaluation phase was outlined with a goal to explore the practical applicability of this framework and the impact it could potentially have in an organisational context. "On an average a hybrid cloud transition process might extend to about one year for a large company" *(Interviewee 08-01)*. Thus it was understood that the practical implementation of this framework was unattainable given the restricted time span of this research.

The practical implementation of the framework for a large company migrating to a hybrid cloud and later evaluating its impact on control might take about a year or even more. This was beyond the possibilities of this thesis research. Therefore given the short period, a process analysis based evaluation plan was devised which included qualitative interviews of experts.

To improve the quality of the evaluation and to get new perspectives, two interviewees from the design phase and three new interviewees participated in this segment of research. Detailed information on the evaluation protocol is in appendix D and appendix E. All the 5 interviewees were specialists in hybrid cloud transition with experience and knowledge in existing commercial cloud adoption frameworks.

Initially after giving an overview of the research, questions were asked to understand the interviewee's knowledge and expectations on a cloud transition framework. The interviewees were then asked if control was an actual challenge at organisations and were asked to provide relevant examples of practical challenges.

After this, the final framework design was presented and evaluative questions were asked to ex-

plore it's practical applicability, gaps for improvement, limitations, etc. of the framework. The practical challenges which the interviewees came up with were checked against the framework and the interviewee was asked how different the scenario would have been if they were given this framework during such moments of crisis. This helped in comprehending the practical applicability as well as limitations of the framework.

6.2 Impact of the Integral framework

The integral framework was aimed to serve as a single document integrating multiple aspects, actors and factors with the goal of helping client companies to manage control.

The impact an integral framework could have over the cloud transition process is assessed in this context using three dimensions, namely, the practical relevance in addressing challenges, the extent to which it is ensuring control and finally the limitations and weaknesses of the framework. This is represented in the figure 10. These three dimensions conclusively facilitates the research by assessing if the framework satisfies it's purpose and derives the possible impacts the framework could have in practice.

Figure 10: Impact Analysis of the Integral Framework

6.2.1 Practical relevance in addressing challenges

As explained in the previous section, the evaluation interview commenced with understanding the interviewee's expectations from the framework along with practical challenges their clients undergo while moving to cloud.

To better understand this the first set of questions were about few (possible) practical challenges

the clients of the interviewee's have faced while moving to cloud. The interviewees presented few example cases out of which the two most interesting cases are presented below.

CASE 1 by *Interviewee 05-02*

(Interviewee 05-02) came up with the following case where the client company had three major challenges while the course of the transition. The first challenge was that the business team had the drive to move to cloud hoping that it would save cost but the IT team was not in the same page.

The point raised by the IT team was that as much as the process of moving to cloud would open up improvement opportunities like reducing infrastructure and increasing flexibility, this might remove the roles of the multiple system administrators, infrastructure architects and engineers who are working on maintaining the current on-premise environment. This also means that the company might have to find a relevant roles for a large number of people and that this might have to be taken through employees unions or work councils. The issue was addressed by claiming that these employees will be given training and development on cloud skills and will be employed in the migration process. This led to the new challenge of the increasing the absorptive capacity and motivation of the employees to learn a new skill. The cost advantage reduced here with spending on reorganising and restructuring.

After this, during the transition process, the management team allocated the entire responsibility of acquiring additional capacity for workloads to the cloud developers. Because there were no gatekeepers in between to approve, the costs increased beyond the planned budget and the cost advantage minimised steeply. After about 25% of the adoption only 60-70% of the planned cost advantage was remaining and later to ensure this is maintained a financial manager was allocated to the process."

In this case, though the client company took relevant measures and tackled these challenges, it had an effect on the monetary benefits the company should have reaped.

CASE 2 by *Interviewee 11-01*

Another interesting case was given by *(Interviewee 11-01)* where the client company had two major challenges. The first challenge was that the clients had difficulties understanding hybrid cloud. The company believed their data was very specific and the state of that particular application they had was highly confidential. They therefore felt trusting one third party source

was not satisfactory and rather pictured that it would be better to shift between multiple clouds like AWS, Azure and private clouds consecutively to ensure security. However the actual goal of the company was just to securely store the application and also clear irrelevant data while moving that particular application to cloud which they did not realise until they took help from the service providers. Possible strategy here could be to improve the Identity and Access Management strategies and the security postures instead of switching between 3 types of clouds. This was not considered directly.

The next challenge they had was that the application was developed in a particular language and there were compatibility issues with moving those workloads to a public cloud. Flexibility and standardisation was the issue they had to address. To resolve this the company had to do a last minute in-house technical up-gradation first and then move the application to cloud which was not in the initial plan.

Practical Relevance

To check the practical relevance of the framework in addressing challenges, the framework was evaluated against these challenges.

Going back to the designed integral framework, a broad range of challenges and boundary conditions were considered before the aspects of the framework was determined. From Case 1, the first challenge of IT and business teams not sharing the same motivation and having to get the approval of work councils, the second challenge of increasing absorptive capacity and motivation of the employees and the third challenge of difficulty in managing budgets; were all addressed in the framework. In sub-chapter 4.2, Challenge 3, 4, 6 and 9 highlight the same practical challenges and the framework design included organisational measures to overcome this in the sub-chapter 5.5.

Similarly, for Case 2, the first challenge of unclear definitions of cloud and the second challenge of them dealing with flexibility and standardisation were also addressed in the framework. Challenges 1, 2 and 4 in sub-chapter 4.2 explain the same issues.

For this case, had the client company implemented process steps according to the designed integral framework, these challenges could have been avoided. In the organisational measures sub-chapter 5.5, the first challenge of unclear definitions of cloud is addressed as a Business driver aspect in the business research and business analysis steps. The second challenge of

flexibility vs standardisation would have been identified in the technical research step and the collective plan would have included the option to explore multiple opportunities instead of going with the last minute costlier operation of in-house development. This means that these challenge could have been avoided if the framework was in place. This confirms that the framework is practically relevant and addresses challenges.

6.2.2 Ensuring Control

The goal of this entire research was to help client companies realise control while moving into cloud. Thus the framework will have the necessary impact only if it ensures controls or transparency for the clients.

Questions were asked to the interviewees to understand from their perspectives if the framework might increase control. Various answers were given by the interviewees depending upon their perception of the framework and their experience.

Interviewee 02-02 simply felt that "This depends on every client company and what they want". Interviewee added that "The clients cannot aim to achieve absolute transparency of every step in the future as there are always multiple choice, and companies have their own preferences".

Interviewee 05-02 and *Interviewee 10-01* both felt this framework brings a lot of clarity on the processes and the steps as it clearly defines the challenges and measures to take in order to avoid these challenges at each stage.

Interviewee 11-01 added that "The framework considers a lot of attention points. But for it to practically ensure control the users have to understand how to best use it. This is because in practice companies don't plan out every detail. This would very useful to avoid constitutional challenges but not entirely assure control".

Interviewee 12-01 stated that "Most of the parts are still aligned with what an organisation could think of, but not sure if it is a clear yes or no. Control is a tricky challenge and this addresses practical issues well"

Conclusively, it was understood that the framework does not ensure control but might help companies realise it by addressing critical points of consideration. This is the goal of the research question and the framework does seems to be inclined towards this objective. However it depends from context to context and might require practical implementation to check if the

framework actually ensures control.

6.2.3 Limitations and Weaknesses of the framework

The practical limitations and weaknesses of the framework greatly define the impact the framework could have during real time implementations.The final set of questions in the evaluation interview was to understand points of improvements in the integral framework.

One major limitation of the framework was put forth by *Interviewee 02-02*. In the attempt to dive into details and ensuring that so many challenges are tackled, the resultant integral framework has multiple extensive steps. Though using such a framework would mean that the risks of failing could be avoided, people might still venture on their own as it might seem laborious to do all the tasks.

Another limitation was discussed during the interview with *Interviewee 10-01* who had a suggestion about the role distribution among stakeholders in the organisational measures part of the framework in the sub-chapter 5.5. "A huge list of Stakeholders are allocated for each step. Practically maintaining so many people could be difficult. Introducing a 'COACH' for the whole process could be better for steering the whole process. This could be the SCRUM Manager or a Subject-Matter Expert".

Interviewee 11-01 added that because this is a data driven process, there is a need to ensure that the relevant data is available. Without which the practical implementation of the framework can be decimated. The same interviewee added another point that many companies might be interested in open-source products. The whole step of exploring on availability of these products and equipping them is missed in the framework. This could be useful for the technical teams.

6.2.4 Results of the Evaluation

As explained, the impact of the integral framework is understood here by evaluating based on three components, how well the framework addresses the practical challenges, how well does it ensures control for the client companies and does it have any limitations.

Though the results of the evaluation interviews were positive overall, this brought in a lot of clarity about practical implementations. Firstly, the framework design is extensive and well-expressed. The framework addresses most of the practical challenges the client organisations face while moving to hybrid cloud. The framework might help companies in realising control

but this depends on the company and their subjective definition of control. The framework has certain limitations but these have to be addressed while practically applying the framework rather than in the design itself. Therefore, it can be concluded that the framework might have an affirmative impact on the hybrid cloud transition process when applied practically.

7 Conclusion and Discussions

This chapter presents the conclusions of the research obtained while addressing the main research objective and the sub-research questions. The scientific and practical contributions of this research will also be highlighted in this chapter. This is followed by recommendations for further work in academic and business contexts. Also, the practical limitations of the research is included. Finally, this chapter is concluded with the reflection in regards to the MoT master programme and on the personal journey taken during the course of this research.

7.1 Conclusion

A technological transition like Cloud adoption is often not restricted to a technological change but also influences the other aspects of an organisation including business, cost, people, operations and platforms. Because of the agile nature of the process, organisations are bound to plan end-to-end strategies that must work throughout the adoption process. The decisions made during these instances are often irreversible or costly. And larger the organisation, the more convoluted is this process. Therefore, such companies take the help from external service providers who have the expertise in assisting their clients in cloud adoption.

Owing to the complexity involved in cloud transition process, multiple organisations and academic researchers over time have explored this line of interest to create generic frameworks to help companies move from on-premise to cloud. This scientific research also aimed to create an integral framework to assist companies in cloud adoption.

The goal of the research was ***"To develop an integral framework to assist companies in realising control while moving their applications to the cloud"***.

Control was defined as, the transparency of the process for the client companies, or them having the option to steer or influence the transition process at any given time. The intended framework had to function as a generalised document integrating various aspects, perspectives and contexts like cost, security, people, time, etc. to help organisations plan end-to-end strategies to stay in control when their applications are moved to cloud, thereby making it an *"Integral framework"*.

This was approached using a structured method to answer the main research question - ***"How can organisations realise control while moving their applications to the cloud?"***

To better understand and create a framework for organisations to plan end-to-end strategies to stay in control, the following sub-research questions were identified and explored. The research involved multiple interviews at the design and evaluation stages where experts from ATOS were interviewed. This brought a lot of clarity on practical side of cloud transition process.

RQ1 : What major challenges do organisations tackle when moving to cloud?

The first sub-research question was intended to explore the possible challenges which organisations will have to tackle while taking up a technological transition like cloud adoption. Especially considering a large organisations there could be a variety of challenges which arise at multiple stages during cloud adoption process. This was addressed by triangulating data from scientific literature, grey literature and from the interviews of experts from ATOS. About 18 challenges were derived and all of this was carried forward in the notion to address the main research goal.

The second sub-research question was intended to identify the required boundary conditions which has to be fulfilled by the organisations.

RQ2 : What are the required boundary conditions on a cloud to stay in control?

This question as well was approached by combining literature studies and interviews. About 17 boundary conditions were identified and they were later categorised into 5 groups based on the similarities and characteristics they shared. These groups were pursued and explored in later stages of the research.

RQ3 : What aspects should the framework include to achieve control in the cloud transition?

The third research question explored further on the idea about introducing a separate governance model and the aspects in should contain to devise an End-to-End strategy which in turn increases transparency of the process. The collected data from the first two research questions including the interviews were analysed, compared and evaluated with existing frameworks in literature. Looking at the interrelation between various challenges and boundary conditions, and in what way they can be used in determining end-to-end strategies, they were grouped into 5 groups. This served as input for the third research question.

These 5 broad groups or categories were termed as **Aspects** as they dived into the specific

areas where guidance can be given, potential challenges could be uncovered and processes can be improved with the overall objective of realising control.

These 5 aspects elaborated on the distinct functionalities related to the stakeholders, their technical or business capabilities and responsibilities owned by them. The 5 broad aspects were Business and IT Drivers, Security, Cost, People and Resources and finally Platforms and Operations. These aspects were aimed to help organisations in envisioning their strategies by providing an overview of multiple actors, factors and perspectives which all are a part of the cloud migration process.

From this the framework was designed and developed. The research included a detailed study on the various steps involved in hybrid cloud transition and defined every step and sub-steps. After which, for each step in the process (in the agile iterations in terms of phases or waves), the relevant aspects in the governance module were mapped and explained.

RQ4 : What organisational measures need to be taken to stay in control?

The next research question was included to define the measures which organisations might have to take at each step in order to realise control. This research question as well included triangulated data from literature and interviews. But the information was processed and suggestive measures were provided.

For every step in the process and for every related aspect, the best practices guidelines or possible organisations measures to improve stability and transparency were included.

RQ5 : What impact will implementation of such a framework have on the control during cloud transition process in organisations?

The last and final research question was included to understand the impact of such a framework during a cloud transition process. Thus an evaluation phase including interviews was planned with a goal to explore the practical applicability of this framework and the impact it could potentially have in an organisational context. The impact an integral framework could have over the cloud transition process was assessed in this context using three dimensions, namely, the practical relevance in addressing challenges, the extent to which it is ensuring control and finally the limitations and weaknesses of the framework. These three dimensions conclusively facilitated the research by assessing if the framework satisfies it's purpose and derives the possible impacts the framework could have in practice. The results of the evaluation interviews

were positive overall, this brought in a lot of clarity about practical implementations and weaknesses of the framework.

Conclusion

Thus the research and development of the integral framework was found to be a cohesive and detailed inclusion of the 5 practical aspects including Business and IT drivers, Cost, Security, People and Resources and Platforms and Operations. Based on the insights gained during the research, it can be concluded that the framework might have an affirmative impact on the hybrid cloud transition process when applied practically and will improve the control for client companies. This was concluded based on the following discussions.

The integral framework consists of a governance module which addresses 5 broad aspects required to formulate an End-to-End strategy. There are about 15 steps in the hybrid cloud transition and the process is agile. Not just during research and feedback states but for every step the governance module is considered. The possible challenges and boundary conditions are addressed and included in the framework design. A detailed steps and aspects based organisational measures list is made with best practice guidelines to increase transparency.

This was evaluated at the evaluation interviews where the impact of the framework was checked. The results were that the framework design was extensive and well-expressed. It was understood that the framework addresses most of the practical challenges the client organisations face while moving to hybrid cloud. This in turn might improve the transparency of the process or allow the client companies to steer the process at ease. The results of the research showed that such an integral framework will be useful for the client companies in realising control but this however depends on the company and their subjective definition of control.

7.2 Scientific and Practical Contributions

The current research sits very well in both Academic and Business contexts. The initial literature study resulted on the research gap because though there are well-documented studies on frameworks to assist in cloud adoption, most of these frameworks are limited to how the adoption happens and disregards all the correlative processes which happen before and after the adoption. There was no scientific research analysing the **strategy planning for realising control** during the cloud adoption. The existing frameworks also did not address the **possible challenges** the companies might face nor the **boundary conditions** which organisations are

bound to satisfy while moving their applications to cloud.

The commercial and open source business frameworks however had remarkable advantages like high reliability, no limits on capacity, well-defined and instructive procedures, high business agility, etc. but they also had a certain disadvantages. Most of the limitations were because of the commercial elements which were still present. There was also a pitfall because it was impossible to standardise and the clients are forced to rely completely on third-party services. This also limits the control the clients have over the process.

In practice it was identified that companies rather take gamble and go ahead with steps with less or no strategies and often learn through experiences. The End-to-End strategy planning to decide the critical path is done based on experiences and thus has much more chances of failing. They might assume frameworks to be a hectic and convoluted process for them to follow and therefore there might always be hesitance. Also most of the frameworks list on what has to be done but hardly defines operative measures. The frameworks again are aligned towards a specific cloud service provider and often becomes impractical for hybrid cloud. There is also difficulties in allocating responsibilities among stakeholders.

The research addresses almost all of the issues and tries to bridge the gap between science and practice. The scientific contribution of this research is developing an **integral framework specifically for realising control**. The research aims to **create a generic "Integral framework"**, combining multiple aspects like Business & IT drivers, Security, Costs, Platforms & Operations, and People & Resources. The governance module with the detailed analysis on the 5 aspects, the interrelation between the steps and aspects, and finally the organisational measures for every step, are all specific contributions that escalates scientific research and brings it closer to what is in practice.

The practical contribution is creating a best practice guideline that addresses on **"What to do and How to do"** for every step in the Hybrid cloud adoption process. The critical path or End-to-End strategy can be derived much easily. Also because there is very little inter-dependency between the steps and aspects, the steps could be carried out in an agile way. The framework includes a standard glossary and shared semantics which could be easily understood and accepted by the industry professionals. This framework can be used by Cloud advisory teams, Cloud strategy teams, Bidding and Procurement teams, and also by subject matter experts while planning an End-to-End strategy. Thus this framework could work as

a standardised framework to improve process transparency at organisational contexts thereby having a strong practical use.

7.3 Limitations in the Research

The limitations of the framework were explained in detail in the previous section 6.2.3. It was understood that frameworks, in general, depends on the context to which it is applied to and the company which implements it. It also requires motivated stakeholders to implement it. All of which are limitations to practical application. Control as well has subjective definitions. Though this framework has an affirmative contribution, this framework might not be a standalone solution at every company and in every situation to realise control. This is one of the major limitations of this research.

The next set of limitations is related to the fact that the research was coped extensively to ensure it is completed within the span of 25 weeks. Firstly only Large client organisations were considered while designing this framework. Though the framework allows modifications for scaling up or down in future, it is difficult to scale down these processes. In small companies, there might be less stakeholders and less complicated processes. So multiple steps could be redundant to them. For a very large organisation, much more steps will have to be included and thus practical relevance of this framework might be reduced in that context.

Secondly, the companies moving their applications only to Hybrid cloud was chosen as this was seen as a common trend lately. Though Hybrid clouds work as an agglomerate of private and public clouds, the hybrid clouds had much more process steps including orchestration and management. These might not be the case while hosting in a virtual private cloud or a public cloud.

Finally, the research was taken up in collaboration with ATOS and thus the research only included interviews of employees of ATOS who have been taking up Cloud adoption process from 2018 - present. The specific years were also considered to analyse the trends in decision making as well as challenges that companies undergo.

This is another limitation because the research now has low external validity and thus low generalisability. Though efforts were taken to include grey literature and other scientific sources to increase generalisability, given the aim to build an integral framework that could work a single standardised document, having low generalisability could be a possible weakness.

7.4 Further Recommendations

Next steps in this research direction would be to extend this framework in such a way that it works efficiently at any business and technical contexts. For example, extending the framework to plan a strategy to move to public and private clouds as well. And similarly make it work irrespective of the company size. This can be done allowing the users to create critical strategies by selecting just parts of the framework that is relevant to them. This however depends on the skills of the employees.

On the other hand, scaling down the framework could also be a direction of the research. The interesting part about a standardised framework is that, parts of the framework can be separated and these could also be individual points of exploration themselves. For example, the cost aspects can be derived from the framework to understand operating expenses of Capital expenditures and Operational expenditures involved during hybrid cloud transition.

At the organisational level, the next steps would be to try practical implementation of this framework. The impact of the framework can then be understood using practical indicators for control and transparency. The suggestion of including a COACH or a committee for evaluating and ensuring control can also be useful in such circumstances.

Another interesting direction of research to explore could be to automate strategy planning measures using advanced technologies. For example, Using Artificial Intelligence (AI) and knowledge graphs to map multiple steps and compare relevant paths to choose the best fit strategy for the companies based on this Integral framework.

7.5 Reflection

This section presents the relevance of this thesis with the MoT Programme and also briefs about the personal reflection of the researcher.

7.5.1 In alignment with MoT Programme

The master thesis is in accordance to the Master of Science degree in Management of Technology (MoT) at Delft University of Technology. The MoT programme is a perfect amalgamation of technology and business spheres. The programme is designed in such a way that it allows to acquire advanced management and technical skills and comprehend technology as a corporate resource. I procured a competing edge in the technology management domains and intensified my knowledge through the well-framed MoT curriculum.

The digital innovations like Cloud transition are not just related to the IT portfolio of a company but often also with the Business strategies like Cost, People and Resources, Operations and Platforms, etc. This is a well defined technology management problem. The multidisciplinary aspects of this thesis was what drove me towards pursuing this research.

Every aspect in the framework is in alignment with a course in the multifaceted MoT programme or the specialisations I pursued. The Cost aspects addressed the knowledge gained from the Financial Management course, the Security aspect included portions from the Cyber Risk Management course, The People aspect included lessons learnt from Leadership and Technology Management, the Business Drivers aspects were based on the knowledge I acquired from courses like Technology, Strategy and Entrepreneurship, Digital Business Process Management, Emerging and Breakthrough technologies, etc. Finally the Platforms and Operations aspect was based on the knowledge from the I and C Architecture Design course. The learning's acquired from these courses set a great basis for my research. Thus, the research was a reflection of the acquired skills and exhaustive learning provided by the curriculum of the MoT program.

7.5.2 Personal Reflection

Though throughout the course of my Master programme, I had lots of opportunities to work on interdisciplinary projects where I enjoyed bringing out my entrepreneurial side, this research period was one of the few instances where I had the utmost freedom to explore and steer the direction of the research. The challenge however was that to ensure not to delineate too much and have a clear structure during the course of the research.

I learnt how to take up a qualitative study at an organisational context. I learned to be a self-starter, to take initiatives to prepare, schedule and conduct interviews. Fortunately, I had very supportive people around me who guided me in the right direction. Though many people were enthusiastic about participating in my interviews the challenge was to get their availability. There were many unprecedented delays which reflected on the time schedule of the research. I however learnt to accommodate and work in a dynamic environment and under pressure.

In terms of the technical aspects, though I had primitive knowledge on cloud, I had very less knowledge on cloud transition frameworks. This research was an interesting venture to learn about multiple cloud adoption frameworks in science and in practice at organisational contexts. I took up a few supplementary courses provided to ATOS employees to learn more about the

process operations and functional aspects of cloud and how it is practically applied. All these helped me gain exhaustive knowledge on various spheres of businesses and technologies revolving around cloud.

The research thus was a great chance for me to learn few interpersonal as well as technical skills and grow further as an individual.

References

Ahmad, N., Naveed, Q. N., & Hoda, N. (2019, 1). Strategy and procedures for Migration to the Cloud Computing. In *2018 ieee 5th international conference on engineering technologies and applied sciences, icetas 2018.* Institute of Electrical and Electronics Engineers Inc. doi: 10.1109/ICETAS.2018.8629101

Ahmadi, H., Nilashi, M., Shahmoradi, L., & Ibrahim, O. (2017, 2). Hospital Information System adoption: Expert perspectives on an adoption framework for Malaysian public hospitals. *Computers in Human Behavior*, *67*, 161–189. doi: 10.1016/j.chb.2016.10.023

Amazon. (2020). *AWS Cloud Adoption Framework.* Retrieved from https://aws.amazon.com/professional-services/CAF/

Casey, K. (2020, 7). *Hybrid cloud by the numbers, 2020: 10 stats to see | The Enterprisers Project.* Retrieved from https://enterprisersproject.com/article/2020/7/hybrid-cloud-10-statistics

Chang, V., & Ramachandran, M. (2016, 1). Towards Achieving Data Security with the Cloud Computing Adoption Framework. *IEEE Transactions on Services Computing*, *9*(1), 138–151. doi: 10.1109/TSC.2015.2491281

Chang, V., Walters, R. J., & Wills, G. (2014, 3). Financial Clouds and modelling offered by Cloud Computing Adoption Framework. *Nova Publishers*. Retrieved from http://eprints.soton.ac.uk/id/eprint/358252

Coles, C., Yeoh, J., Guanco, F., Mishra, E., Santos, L., & Scoboria, E. K. (2015). *CLOUD ADOPTION PRACTICES & PRIORITIES SURVEY REPORT* (Tech. Rep.). Cloud Security Alliance. Retrieved from https://cloudsecurityalliance.org/research/surveys/

Coos, A. (2021). *Data Protection Legislation Around the World in 2021 | Endpoint Protector.* Retrieved from https://www.endpointprotector.com/blog/data-protection-legislation-around-the-world/

Davis, Z. (2021). *Cloud Strategy Survey | Measures and Motivations.* Retrieved from https://www.research.net/r/X3NP5GL

Downs, K. (2021, 2). *Preparing to Adopt the Cloud: A 10-Step Cloud Migration Checklist.* Retrieved from https://newrelic.com/blog/best-practices/cloud-migration-checklist

EAGLE, L. (2019, 1). *Going Hybrid - Demand for Cloud and Managed Services across Asia-*

Pacific by LIAM EAGLE (Tech. Rep.). VMWare | 451 Research | Black and White Papers. Retrieved from https://www.ntt.com/en/about-us/press-releases/news/article/2019/0117_2.html

Ezzat, E. M., Zanfaly, D. S., & Kota, M. M. (2011). Fly over clouds or drive through the crowd: A cloud adoption framework. In *Proceedings of the 2011 international conference and workshop on the current trends in information technology, ctit'11* (pp. 6–11). doi: 10.1109/CTIT.2011.6107942

Fruhlinger, J. (2020). *The CIA triad: Definition, components and examples | CSO Online.* Retrieved from https://www.csoonline.com/article/3519908/the-cia-triad-definition-components-and-examples.html

Gangwar, H., Date, H., & Ramaswamy, R. (2015, 8). Developing a Cloud-Computing Adoption Framework. *Global Business Review*, *16*(4), 632–651. Retrieved from http://journals.sagepub.com/doi/10.1177/0972150915581108 doi: 10.1177/0972150915581108

Kearns, D. K. (2018, 1). *Planning & Management Methods for Migration to a Cloud Environment* (Tech. Rep.). MITRE Corporation. Retrieved from https://www.mitre.org/publications/technical-papers/planning-management-methods-for-migration-to-a-cloud-environment

Khajeh-Hosseini, A., Greenwood, D., Smith, J. W., & Sommerville, I. (2012, 4). The Cloud Adoption Toolkit: Supporting cloud adoption decisions in the enterprise. *Software - Practice and Experience*, *42*(4), 447–465. Retrieved from https://onlinelibrary.wiley.com/doi/full/10.1002/spe.1072https://onlinelibrary.wiley.com/doi/abs/10.1002/spe.1072https://onlinelibrary.wiley.com/doi/10.1002/spe.1072 doi: 10.1002/spe.1072

Knorr Eric. (2020). *The 2020 IDG Cloud Computing Survey | InfoWorld.* Retrieved from https://www.infoworld.com/article/3561269/the-2020-idg-cloud-computing-survey.html

Kobos, P. H., Malczynski, L. A., Walker, L. T. N., Borns, D. J., & Klise, G. T. (2018, 12). Timing is everything: A technology transition framework for regulatory and market readiness levels. *Technological Forecasting and Social Change*, *137*, 211–225. doi: 10.1016/j.techfore.2018.07.052

Logicworks. (2020). *Challenges of Cloud Transformation Survey Report 2020* (Tech. Rep.). Logicworks. Retrieved from www.logicworks.com

Markets and Markets. (2020, 7). *Cloud Computing Market Size, Share and Global Market Forecast to 2025 | COVID-19 Impact Analysis | MarketsandMarkets* (Tech. Rep.). Markets and Markets. Retrieved from https://www.marketsandmarkets.com/Market-Reports/cloud-computing-market-234.html

Microsoft. (2020). *Microsoft Cloud Adoption Framework for Azure - Cloud Adoption Framework | Microsoft Docs.* Retrieved from https://docs.microsoft.com/en-us/azure/cloud-adoption-framework/

Moore, W. (2015). *10 Benefits of Cloud Adoption for Your Enterprise - Invensis Technologies.* Retrieved from https://www.invensis.net/blog/10-benefits-of-cloud-adoption-for-your-enterprise/

Morgan, L. L., & Conboy, K. (2013, 1). FACTORS AFFECTING THE ADOPTION OF CLOUD COMPUTING: AN EXPLORATORY STUDY. ECIS 2013 - Proceedings of the 21st European Conference on Information Systems. Retrieved from https://www.researchgate.net/publication/289401874_Factors_affecting_the_adoption_of_cloud_computing_An_exploratory_study

Nazarko, [U+FFFD] (2017). Future-Oriented Technology Assessment. In *Research gate* (Vol. 182, pp. 504–509). Elsevier Ltd. Retrieved from https://www.researchgate.net/publication/316231781_Future-Oriented_Technology_Assessment doi: 10.1016/j.proeng.2017.03.144

Open-Group, T. (2016). *Cloud Computing Governance Framework – Cloud Computing Governance (Informative).* Retrieved from http://www.opengroup.org/cloud/gov_snapshot/p3.htm

Research and Markets. (2020). *Cloud Computing Industry to Grow from $371.4 Billion in 2020 to $832.1 Billion by 2025, at a CAGR of 17.5%.* Retrieved from https://www.globenewswire.com/news-release/2020/08/21/2081841/0/en/Cloud-Computing-Industry-to-Grow-from-371-4-Billion-in-2020-to-832-1-Billion-by-2025-at-a-CAGR-of-17-5.html

Sangoma. (2021, 2). *SMB, SME, and Large Enterprise: Business Size Classification Matters.* Retrieved from https://www.sangoma.com/articles/smb-sme-large-enterprise-size-business-matters/

Scheier, R. L. (2012). *Open-source cloud frameworks: A work in progress | Computerworld.* Retrieved from https://www.computerworld.com/article/2503804/open-source-cloud

-frameworks--a-work-in-progress.html

Singh, J., & Mansotra, V. (2019, 4). Towards Development of an Integrated Cloud-Computing Adoption Framework-A Case of Indian School Education System. *International Journal of Innovation and Technology Management*, *16*(2). doi: 10.1142/S0219877019500160

Spadea, K. (2015). *50 Questions You Must Ask Before Engaging In Cloud Computing Services | CIO.* Retrieved from https://www.cio.com/article/2897736/50-questions-you-must-ask-before-engaging-in-cloud-computing-services.html

Statista, R. (2021). • *Global hosting and cloud computing market 2010-2020 | Statista.* Retrieved from https://www.statista.com/statistics/500541/worldwide-hosting-and-cloud-computing-market/

van der Gaast, K., Koenders, L., & Post, G. (2019). *Academic Skills for Interdisciplinary Studies.* Amsterdam University Press. doi: 10.2307/j.ctvkwnn1t

Voss, A. (2010, 11). *Cloud computing It's a journey* (Tech. Rep.). HP EMEA International Expertise Team. Retrieved from https://www.itapa.sk/data/att/628.pdf doi: Pg.5

Weolcan. (2021). *The Weolcan Cloud Governance Framework.* Retrieved from https://governance.weolcan.eu/

Wilson, F. (2020, 12). *Your Go-To Guide to the 7 R's of Change Management - nTask.* Retrieved from https://www.ntaskmanager.com/blog/7-rs-of-change-management/

Zitek, N. (2014). *ITIL Application Management Lifecycle – within IT Service Lifecycle.* Retrieved from https://advisera.com/20000academy/blog/2014/03/18/itil-application-management-lifecycle-within-service-lifecycle/

Appendices

Appendix A Search Description and Selection Criteria for Literature Review

Selection Criteria :

The exploratory literature study was performed by way of a structured keyword search using Google Scholar search engine, Science Direct website (Elsevier), IEEE Xplore for scientific study and Google search engine for statistical data and corporate information available to general public.

Initially the search was done in Google Scholar search engine and after toning down, a certain topics of interests were searched in other websites like Science Direct and IEEE Xplore to get further information.

Table 3: Keywords searched

Keywords	Synonyms
Cloud	Cloud computing, Cloud technology, On-demand resources, Distributed computing, Public cloud, Private Cloud, Hybrid Cloud, Enterprise cloud, Infrastructure-as-a-service cloud (IaaS), Software-as-a-service cloud (SaaS), Platform-as-a-service cloud (PaaS)
Adoption	Migration, Selection, Transfer, Deployment, Transition
Framework	Model, Steps, Instructions, Guidelines, Principles, Foundations
Technological transition	Technological innovations, Trajectories, Technological paradigms, Regimes
Control	Regulation, Governance, Supervision, Restriction, Authority, Administration
Security	Data security, Confidentiality, Integrity, Availability, Safety, Risk
Factors	Determinants, Aspects, Cause, Circumstance, Element, Constituent, Instrument, Component
Actor	User, Consumer, Person, Employee,

Table 7 describes the words used in the keyword search. The multiple search engines generated a large amount of literature studies, and thus it was imperative to be specific. Initial search resulted in about 361 papers. The keywords listed were combined to get meaningful search

results. Initially broader terms like technological transition, cloud computing, cloud adoption framework were used which were later narrowed down by security framework, cloud control framework, actors and factors in cloud adoption, etc. Later results resulted in an average of 20-30 papers in each period.

Table 8 describes how scientific studies were included and excluded as a part of the review process. These criteria were set to limit and sort the studies in literature. Since the research in this line of interest has been done for a long time, it was critical to decide the criteria properly so that important studies aren't missed.

From the long-listed search results identified initially, first filtering criteria applied was the language and the research type. Then the period and technology helped streamline the search. Literature written in English with frameworks developed after 2010 were only reviewed.

Because this resulted in still a large number to skim through, technology and research field was included in the criteria. Frameworks related only to cloud adoption were considered. Artificial intelligence based frameworks like trust management in cloud, 3D model testing in cloud, etc. were not explored. This yielded about 30 papers in each period frame.

To specify even further the settings and purpose of the frameworks were defined and repetitive results were ignored. If there were 2 papers following same framework where one was the updates / refined version of another, then the most recent one was chosen and the previously existing literature was dropped. It was interesting to see that, few studies in early years did not progress, while few latest studies took inspiration from or combined existing literature to create a completely modified framework. This patterns were analysed and studies were chosen accordingly. This resulted in about 15-20 papers in each period, out of which an average of 5 studies were chosen after reading and understanding based on unique propositions.

Table 4: Inclusion and Exclusion Criteria

Question Component	Inclusion Criteria	Exclusion Criteria
Technology	Cloud adoption frameworks	Other Cloud Frameworks
Setting and Purpose	• Context specific and non-specific frameworks • Multi-dimensional frameworks • Both commercial and open-source frameworks • Factors and Actors in cloud adoption • Challenges in cloud adoption • Decision making	• Single-dimensional frameworks • Mathematical frameworks
Period	2010 till 2021 (Most recent study / Unique proposition with respect to a topic)	Before 2010
Research Type	Journals, Articles, Conference proceedings, Books, Statistical data, Websites	Patented documents, Original documents (Interview texts, recordings, etc.)
Language	English	All other languages
Research Field	Cloud Computing, Organisation and Business, Cyber Security, Strategy management	Distributed Networks, Mathematics, Artificial intelligence

Alongside scientific documents like Journals, books and conference proceedings, etc. websites of cloud service providers and legitimate sources for statistical data were also referred to support the study.

Because the literature analysis was an agile process, a lot of time was spent reading and understanding and then deciding if the study was in-line to the direction interested. Overtime, the keywords search and the inclusion criteria were refined to ensure all relevant literature were studied.

Appendix B Summary of Research Findings

Table 5: Summary of Research Findings

Study by	Year	Framework Name	Type	Description / Goal	Evaluation	Key takeaway
Ezzat et. all	2011	Fly over clouds or drive through the crowd: A cloud adoption framework	Theoretical	A list of common and most important factors and aspects that support the adoption decision were derived through surveying individuals. Framework was tailored to unique business cases based on user perspectives and predefined factors.	Had limited applicability as it does not address technical and organisational decisions to be made. Significant proposition about user being the prime deciding factor in technological transition	User's point of view was considered as a metric for evaluating the framework.
Khajeh-Hosseini et. all	2012	The Cloud Adoption Toolkit: Supporting cloud adoption decisions in the enterprise.	Theoretical	Developed based on mapping tools and techniques to concerns. This prioritised cost as an important factor and had limitations with respect to the user concerns	Limited concerns were given to user perspectives. Other factors were not given considerable value.	Cost is an important factor while deciding on moving to cloud from on-prem.
Morgan et. all	2013	Factors Affecting The Adoption Of Cloud Computing: An Exploratory Study	Theoretical	Classified the factors affecting cloud adoption to one of the three broad categories, namely, technological factors, organisational factors and environmental factors, together titled as TOE framework.	Identified the need to understand the perspective of people involved in such technological transition including psychological aspects, changing skill-sets and correlating this to frameworks in future.	Factors fit in one of the three broad categories, technological, organisational and environmental. Perspectives of people should be considered.
The Open Group	2016	Cloud Computing Governance Framework	Theoretical and/or Open Source	The aim of this was to create a framework not specific to a domain, geography, or any context and that which aligns with existing models and standards.	Identified Cloud computing governance principles, roles, processes and metrics for applying governance on the adoption process. Best fit for organisations already following standards by The Open Group.	Governance Principles, Roles, Processes and Metrics are also important for cloud adoption.
Gangawar et. all	2015	Developing a Cloud - Computing Adoption Framework	Theoretical and Combination of multiple frameworks	Extended technology acceptance model – technical– organisation – environment (TAM–TOE) framework for organisations and Technology Acceptance Model (TAM) framework. Deduced 12 variables which are relevant to adoption of cloud based on exploratory studies.	In spite of being vast and extensive, this study was based on a very low sample size and thus had low external validity.	12 variables relevant to cloud adoption.
Chang and Ramachandran	2016	Towards Achieving Data Security with the Cloud Com-puting Adoption Framework.	Theoretical and Context specific	Customised for securing cloud data. Had a multi-layer security mechanism to provide fool-proof security	Extensive analysis on security and risk constraints, explaining why security is an important perspective. Did not address other factors like organisational and governance based challenges that come alongside implementation of such a framework.	Security and Risk management are important perspectives.
Chang et. all	2014	Financial Clouds and modelling offered by CloudComputing Adoption Framework.	Theoretical and Domain specific	Customised for financial domain where portability was demon-strated through a concept of Financial-Software-as-a-Service (FSaaS).	Solved unique problems relevant to specific domains. High Operability but low generalisability.	Every organisation is unique. At times, organisations might need specific services which others might not need.
Ahmadi et. all	2017	Hospital Information System adoption: Expert perspectives on an adoption framework for Malaysian public hospitals	Theoretical and Domain specific	Specifically tailored framework for Hospital Information systems in Malaysia. Exploratory study to understand perspectives.	Solved unique problems relevant to specific domains. High Operability but low generalisability.	Every organisation is unique. At times, organisations might need specific services which others might not need.
Singh and Mansotra	2019	Towards Development of an Integrated CloudComputing Adoption Framework - A Case of Indian School Education System	Theoretical and Combination of multiple frameworks	Combine other common frameworks in literature like the TOE, TAM, HOT-fit and DOI framework with important constructs.	Even though this study had less generalisability due to very narrow context, the study could be escalated with more constructs and variables in context.	Multiple frameworks can be combined to get a more structured and versatile framework.

Study by	Year	Framework Name	Type	Description / Goal	Evaluation	Key takeaway
Kearns	2018	Planning & Management Methods for Migration to a Cloud Environment	Theoretical and Combination of multiple frameworks	Explains about devising workload migration plans to move to the cloud from a management perspective. This study combined 4 principal frameworks namely, Work Breakdown Structure (WBS) framework, IT Infrastructure Library (ITIL) framework, Department of Defence Enterprise Service Management Framework (DESMF) and Portfolio, Program, and Project Management Maturity Model (P3M3) frameworks to identify elements and device strategies for migration.	This research has a constructive impact on strategic planning thereby contributing to better performance, cost, timeliness, quality and the overall probability of success. This however concentrates only on the migration or adoption process and disregards the required strategies before or after migration takes place.	Strategic planning is necessary while moving work-loads to the cloud.
Ahmad et. all	2019	Strategy and procedures for Migration to the Cloud Computing	Theoretical and Combination of multiple frameworks	Combines theoretical and commercial frameworks in practice. Groups the tasks in cloud migration into five phases and has identified five generic strategies. The research postulates mapping workloads to business components suggesting that this will simplify the prioritisation process and will align with business strategies.	High practicability as it maps business motives with technical goals. Opens up multiple research opportunities.	It is important to map business motives with technical requirements. Can combine theoretical and commercial frameworks to bridge the gap between academia and industry.
Scheier	2012	Open-source cloud frameworks: A work in progress	Commercial	Study on various IaaS and PaaS frameworks developed by multiple organisations.	Many of these frameworks had restricted availability, lacked flexibility and required special understanding and knowledge for implementation.	Need for a standardised or generalised framework for cloud adoption, which is possibly open-source with no / less commercial elements.
Amazon	2020	AWS Cloud adoption framework	Commercial	Addresses strategies from 6 different perspectives like Business, People, Governance, Platform, Security and Operations.All these strategies have their own capabilities, resources and roles defined	Remarkable advantages like high reliability, no limits on capacity, well-defined and instructive procedures, high business agility, etc. Have a limitation of application to only their cloud services, few charge an additional support / training fees to acquire technical support and few services are not available globally though the client has geographical presence, etc.	Though the industry developed standards are highly efficient, they still have commercial elements which could be a discouraging factor for a few clients trying to move to cloud.
Microsoft	2020	Cloud Adoption Framework for Azure	Commercial	Classifies the adoption process into phaseslike Strategy, Plan, Ready, Migrate, Innovate, Govern, Manage and Organise, where each phase has a guideline or principle, benchmark assessment and best practices to assist their clients.	Remarkable advantages like high reliability, no limits on capacity, well-defined and instructive procedures, high business agility, etc. Have a limitation of application to only their cloud services, few charge an additional support / training fees to acquire technical support and few services are not available globally though the client has geographical presence, etc.	Though the industry developed standards are highly efficient, they still have commercial elements which could be a discouraging factor for a few clients trying to move to cloud.
Weolcan	2021	Weolcan Cloud Governance Framework (WCGF)	Commercial and / or Open Source	Combines AWS framework, The Open Group Cloud Governance framework and ITSM for cloud. 4 knowledge bases namely Strategy, transformation, migration and operation.	Address the major challenge of cloud governance vs agility in organisation.	There is often a tradeoff between governing cloud / planning on control strategies and business agility. Balancing it is important.

Appendix C Interview Protocol - Design and Development

INTERVIEW PROTOCOL

The following general set-up was used to ask interview questions. Since the interview is semi-structured, the real question asked by respondents may vary depending on the flow of the interview, but it will still comply with the protocol.

Before the Interview, a one page description of the project and the presentation slides for the interview is sent via email before the date of interview.

1. Introduction

a. Interviewer introduction
b. Research background and goal of the interview session are introduced using a presentation
c. Explain confidentiality terms and ask for consent on writing down discussions of the interview

2. Personal

a. Fills up a form alongwith the interviewee to understand what modules of the framework are relevant to them.
    i. Form Contents - Date of Interview / Medium of Interview / Job Role & Company of the Interviewee / Job Description of the Interviewee / Aspects relevant to them / Additional Information.
b. The questions concerning the role and responsibilities of the professional within the organization.
    i. Could you briefly describe your position in the company? Role and responsibilities?
    ii. How long have you been involved in the hybrid cloud transition?
    iii. Could you tell me a bit more about your team and type of services you provide your clients with?

3. Challenges and Boundary Conditions

a. These types of questions are used to better understand the client companies that these service providers assist.
    i. Do you have experience handling large client organisations moving to the cloud and What's your role in this?
    ii. What in your opinion is the major challenge that an organisation faces during hybrid cloud adoption?
    iii. Any examples of a challenge tacked recently by your clients? How was it solved?
    iv. What defines control to you? Is that a challenge practically?
    v. What is the aspect wise boundary condition to ensure clients have control over the process?
    vi. At what instance would you think the clients are in clear control of the process?
    vii. Who (Or which team) within the company ensures this is done?

4. Framework Design

a. Better Understanding of the multiple aspects involved during transition (Also - Presents Draft Version to the Interviewee)
   i. What do you think is the major aspect to be concentrated during cloud transition?
   ii. What drives this aspect?
   iii. How would we define control within this aspect? Are the defined boundary conditions enough or practically does it involve some other process?
   iv. What are the Go / No Go conditions for this aspect?
   v. How is this aspect related to the multiple steps explained?

b. Better understanding of the multiple steps involved during transition (Also - Presents Draft Version to the Interviewee)
   i. Basic evaluation of the design - Check if any absolute steps are missed
   ii. How does the organizational structure of the team and collaboration look like for this step?
   iii. What are some common standards, policies and Governance processes?
   iv. How does planning and structuring take place? How agile are these processes?
   v. How does the multiple aspects reflect in the steps done?
   vi. What are the Green / Yellow / Red flags for these steps under each given aspect? How is it practically checked?
   vii. How does the organizational structure of the team and collaboration look like?
   viii. Share some examples about the common end-to-end Control strategies
   ix. Any evaluative suggestions on the framework.

5. Further Discussion
   a. Ask for suggestions on the interviewing technique
   b. Ask about practical relevance of such a framework when completed
   c. Ask if the interviewee can continue to participate in future to evaluate the final design / to do impact analysis of the framework.

Appendix D Interview Protocol - Evaluation and Impact Analysis

INTERVIEW PROTOCOL - Evaluation phase

The following general set-up will be used to evaluate the framework. The evaluation will include an Interview and will be conducted as a Process-based Evaluation Workshop. Since the interview is *semi-structured*, the *real questions asked to the respondents may vary* depending on the flow of the interview, but it will still comply with the protocol.

A one page description of the project and the presentation slides for the interview is sent via email before the date of interview.

1. Introduction

a. Interviewer introduction
b. Research background, goal of the interview session and brief description of the framework are all introduced using a presentation
c. Explain confidentiality terms and ask for consent on writing down discussions of the interview

2. Personal

a. Fill up a form alongwith the interviewee to understand what modules of the framework are relevant to them.
    i. Form Contents - Date of Interview / Medium of Interview / Job Role & Company of the Interviewee / Job Description of the Interviewee / Aspects relevant to them / Additional Information.
b. The questions concerning the role and responsibilities of the professional within the organization.
    i. Could you briefly describe your position in the company? Role and responsibilities?
    ii. Do you have experience handling large client organisations moving to the cloud and What's your role in this?
    iii. Could you tell me a bit more about your team and the type of services you provide your clients with?
    iv. Any examples of a challenge tackled recently by your clients? How was it solved?

3. Expectations

a. These types of questions are used to better understand the interviewer's perspectives and knowledge in cloud transition frameworks.
    i. Define control to the interviewee. And ask : Is that a practical challenge?
    ii. What do you expect from a cloud transition framework? (or) Which issues should an integral framework for cloud transition address?
    iii. Can you give me a practical example of a challenge you (or your clients) faced during hybrid cloud adoption? (Or give an example case study)

4. Explain the final version of the Framework

5. Evaluation questions

a. Will this framework be practically relevant and useful in addressing challenges during cloud transition?
b. Based on your experience, do you think this framework might have solved an issue which was encountered previously? (Based on the example provided by the interviewee or example case study)
c. Do you think that certain elements are missing or could be improved further?
d. Will this framework improve the transparency the client company has over the cloud transition process?
e. What are the limitations and weaknesses of such a framework?
f. Do you have any further evaluative suggestions on the framework.

6. Closing the interview

Appendix E List of Interviews

Table 6: Interviews - Design & Development

Interview Code (Interviewee No - Interview No)	Date of Interview (DD/MM/YYYY)	Medium of Interview	Job Role & Company	Job Description	Relevant Aspects
01-01	26/02/2021	Video Conference	Senior Solutions Architect, Atos Netherlands	Responsible for designing and delivering solutions to clients	Business & IT Drivers, Security, People & Resources, Operations & Platforms
02-01	16/04/2021	Video Conference	Bid Manager, Atos Netherlands	Organisation of all aspects of a bid	Business & IT Drivers, Cost, Security, People & Resources, Operations & Platforms, OTHERS - Legal and Compliance ; Communication
03-01	20/04/2021	Video Conference	Security Consultant, Atos Netherlands	Implementation of Security Services (Identity & Access Management) for Clients	Security, People & Resources, Operations & Platforms
04-01	22/04/2021	Video Conference	Unit Manager & Service Delivery Manager, Atos Netherlands	Responsible for delivery of end-to-end security services	Cost, Security, People & Resources, Operations & Platforms
05-01	26/04/2021	Video Conference	CTO & Head of Digital strategy, Atos Germany	Management of multiple functions within the organisation	Business & IT Drivers, Cost, Security, People & Resources, Operations & Platforms, OTHERS - Legal and Compliance
06-01	27/04/2021	Video Conference	Principal Consultant & Delivery Manager, Atos | Syntel India	Complete ownership of the delivery - End-to-end services	Business & IT Drivers, Cost, Security, People & Resources, Operations & Platforms, OTHERS - Quality and Audits
07-01	29/04/2021	Video Conference	Solutions Manager, Atos Netherlands	Responsible for providing cloud based solutions & services to clients	Business & IT Drivers, Cost, People & Resources, Operations & Platforms
08-01	29/04/2021	Video Conference	Head of Cloud Advisory, Atos Netherlands	Management of cloud advisory services	Business & IT Drivers, Cost, Security, People & Resources, Operations & Platforms
09-01	03/05/2021	Video Conference	Service Delivery Manager, Atos Netherlands	Operational contact, responsibilities for specific services between Atos and Clients	Business & IT Drivers, Cost, Security, People & Resources, Operations & Platforms

Table 7: Interviews - Evaluation & Impact Analysis

Interview Code (Interviewee No - Interview No)	Date of Interview (DD/MM/YYYY)	Medium of Interview	Job Role & Company	Job Description	Relevant Aspects
02-02	04/06/2021	Video Conference	Bid Manager, Atos Netherlands	Organisation of all aspects of a bid	Business & IT Drivers, Cost, Security, People & Resources, Operations & Platforms, OTHERS - Legal and Compliance ; Communication
05-02	02/06/2021	Video Conference	CTO & Head of Digital strategy, Atos Germany	Management of multiple functions within the organisation	Business & IT Drivers, Cost, Security, People & Resources, Operations & Platforms, OTHERS - Legal and Compliance
10-01	07/06/2021	Video Conference	Senior Consultant, Cloud Advisory Services, Atos | Syntel, Netherlands	Functional Expert on Cloud platforms.	Business & IT Drivers, Cost, People & Resources, Operations & Platforms
11-01	11/06/2021	Video Conference	Solutions Manager, Cloud Strategy & Operations, Atos Netherlands	Managing Cloud RFP process for potential customers.	Business & IT Drivers, Cost, Security, Operations & Platforms
12-01	08/06/2021	Video Conference	Client Executive Partner, Atos Netherlands	Translating client requirements to technical experts.	Business & IT Drivers, Cost, Security, People & Resources, Operations & Platforms

Appendix F Organisational Measures

Table 8: Organisational measures

Governance aspects	Functional Steps	Stakeholders Involved
Step 1 : Business research		
Business & IT Drivers	- Understand the goals of the company. - Determine the motivations for moving into the cloud. For example : • Cost savings, • Reduction in vendor or technical complexities, • Optimization of internal operations, • Increasing business agility, • Preparing for new technical capabilities, • Scaling to meet market or geographic demands, etc. - Reiterate existing Business Portfolios of relevant teams. - Check for legal and compliance constraints. - Competitor and market analysis has to be done.	Subject Matter Experts, End-user behaviour experts, Strategy Team, Consultants, Lead Architect, Sales and Procurement teams, Bidding and Finance team, Business Experts, Program and Project Managers and Senior Management
Cost	- Financial standings of the company must be defined. - Budget allocation for this process should be stated using algorithmic usage-based cost models. - Tolerance limits should also be considered. - Analyze Enterprise cost optimization policies. - Draw up legal bindings based upon analysis. - Create a benefit realization document to understand value / cost based return on investments. - Understand what are the most important costs inherent processes in this business model	
People & Resources	- Availability of skills and resources should be checked. - Stakeholders directly involved should be briefed on the process. - Opinions from the stakeholders should be considered. - Identify corporate social responsibilities to be fulfilled or those that can be influenced by this process of restructuring.	
Step 2 : Technical research		
Business & IT Drivers	- Understand the current state from a programmatic or data-driven approach. - Create an inventory for existing systems. - Define scenarios. Whether it is to create a new application on cloud or transferring existing data to cloud or both. - Discover and gather data to enable all assessment activities.	Subject Matter Experts, End-user behaviour experts, Security and Data Management Teams, Consultants, Lead Architect, IT Solutions teams, Program and Project Managers and Senior Management
Security	- Understand already established essential security practices. - Identify existing compliance models within which the current environment operates. - Identify how a governance model for security based can be established.	
People & Resources	- Learn about the knowledge capabilities of the stakeholders. - Understand existing IT goals, IT heritage and culture towards transition.	
Platforms & Operations	- Understand how visible and transparent the operations of this application are. - Define the systems and describe the architectural standards. - Understand existing ICT architectures and ICT heritage. - Access the technical abilities to support business goals and objectives - Plan a provisioning infrastructure in the cloud to focus on aligning services. - Identify how the hybrid cloud is going to be structured and how the data division is going to be planned given the dispersed environment.	
Step 3 : Business Process Analysis		
Business & IT Drivers	- Management portfolios, policies and structures have to be understood. - Facilitate organisational ambidexterity. - Plan how the tasks can be prioritised.	Subject Matter Experts, End-user

Governance aspects	Functional Steps	Stakeholders Involved
	- Estimate the fiscal outcomes, performance outcomes, agility outcomes and value based outcomes. Define objectives, motivations and drivers related to each. This will help organisations in pitching their idea as a business case with a technical case that leads to better organisational value. - Understand Business Risks and create a risk management plan to prevent potential risks, estimate their impacts and the change in value or cost based returns in occurrence of these risks. - Analyse sustainability goals and reevaluate the plan. - Use customer analytics data to understand how businesses will change if this technological transition is taken up.	behaviour experts, Consultants, Lead Architect, IT Solutions teams, Program and Project Managers.
People & Resources	- Identify motivations of the employees and their absorptive capacities. - Stakeholder definitions and role allocation for this process. - Plan how incentives should be managed for the employees that will retain the employed experts during the process of transition. - Enable an organisational change management team to devote into personal management during this technological transition.	
Platforms & Operations	- Identify operational redundancies and understand how effectiveness can be improved. - Understand existing Change and transformation strategies.	
Step 4 : Technical Process Analysis		
Business & IT Drivers	- Validate the business case by using data about the current state environment - Prioritization - perform quantitative analysis of that data and a deep qualitative assessment of the highest priority workloads. - Check how the ICT heritage will influence the direction of the process. - Understand technical benefits for the current goals.	Subject Matter Experts, End-user behaviour experts, Consultants, Lead Architect, IT Solutions teams, Security and Data Management Teams, Program and Project Managers.
Security	- Evaluate Security of new and existing workloads. - Evaluate confidentiality and privacy measures in place. - Check compliance with local and global privacy laws for each part of the hybrid cloud. - Analyse directive security measures in place and determine their efficiencies.	
People & Resources	- Facilitate training programs and learning modules to nurture skills in existing employees.	
Platforms & Operations	- Defining levels of hosting hierarchy - Classify – Workloads, Stakeholders, Business units and Operational heads. - Define what data is going to be stored in what part of the hybrid cloud and create an orchestration plan to provide a single system overview to the end user. - Understand existing naming and tagging standards . - IT Assets to be deployed to the cloud, which will support multiple workloads have to be determined. - Solutions to support these workloads will have to be labelled as solutions and stored carefully. - They'll be grouped according to application categories and will have shared landing spaces. - Perform compliance analysis alongside the naming and tagging process.	
Step 5 : Mapping motivations and goals		
Business & IT Drivers	- Make a business case / report as a document. - Pursue an Incremental rationalization: Streamline assessment efforts to focus on a qualitative analysis of all assets, possibly even to support the business case. Then add a deep qualitative analysis for the first few workloads to be migrated. - Capture desired business outcomes and map it with expected deliverables. - Also use gathered data to map technical requirements to deliverables. - Business Value Consensus - Efforts to ensure business value alignment at each release of each innovation. - Also consider the geographical delineation of the hosting services provided by the	Strategy Team, Consultants, Lead Architect, Managers and other primary stakeholders from service

<table>
<tr><th>Governance aspects</th><th>Functional Steps</th><th>Stakeholders Involved</th></tr>
<tr><td></td><td>cloud service providers before deciding which parts of the hybrid cloud are externally hosted.</td><td rowspan="5">providers.</td></tr>
<tr><td>Security</td><td>- Create a plan to bridge the gap between security aspirations and current security postures.</td></tr>
<tr><td>Cost</td><td>- Understand which key resources / key activities are most expensive and which are important.
- Plan how the fiscal and value based returns can be improved.
- Determine how much financial input will be necessary to choose between the exorbitant, absolute and necessity in terms of people, platforms and resources.
- Determine costs to facilitate innovation.</td></tr>
<tr><td>People & Resources</td><td>- Align Stakeholders with respect to technical motivations and portfolios.
- Quickly evaluate required and existing skills to better understand what skill requirements should be addressed.
- Compare the availability of resources to what is required and try to plan the need.</td></tr>
<tr><td>Platforms & Operations</td><td>- Depending upon the technical considerations, facilitate changes that drive towards a targeted platform and optimize operations to catalyze it.</td></tr>
<tr><td colspan="3">Step 6 : Evaluating choices based on weighted criteria</td></tr>
<tr><td>Business & IT Drivers
Security
Cost
People & Resources
Platforms & Operations</td><td>- Depending upon all of these aspects, choices are to be made. Every step might have multiple choices and every choice might lead the company to a different path. Allocating weights or values to these choices and evaluating these choices based on weighted criteria might improve the quality of the process.</td><td>Strategy teams, Subject Matter Experts, Managers, Analysts, Architects, End User Behaviour Experts and Senior Management.</td></tr>
<tr><td colspan="3">Step 7 : Target landscape and innovations</td></tr>
<tr><td>Business & IT Drivers
People & Resources
Platforms & Operations</td><td>- Example Innovation Scenarios - Via Microsoft Azure Cloud Adoption Framework (Microsoft , 2020).
 

- Similarly innovative steps related to the application management or data management or the process management, etc. can be included depending upon the</td><td>Strategy Team, Consultants, Lead Architect, Managers and other primary stakeholders from service providers.</td></tr>
</table>

Governance aspects	Functional Steps	Stakeholders Involved
	motivation and drivers of the company. - Given the hybrid cloud case, there is a lot more space to facilitate innovation and it can start from also choosing the target landscapes. These are not just characterised by the platforms and operations but also depending upon the people, business and IT drivers.	
Step 8 : Collective plan for Migration		
Business & IT Drivers	- Create a motivation and data-driven strategy plan. - Choose how the process is taken up. Example which rationalization strategy is chosen - Rehost, Refactor, Re-architect, Rebuild or Replace. - Estimate timelines / Create a SCRUM / AGILE Plan. - Review rationalization decisions to refine adoption path decisions: migrate or innovate. - Draw Service Level Agreements (SLAs).	Strategy Team, Consultants, Lead Architect, Managers and other primary stakeholders.
Security	- Finalize Plan on improving security posture for every part of the hybrid cloud. - Learn best practices for addressing common network security issues based on capabilities.	
Cost	- Consider cost optimization ways. - Provide a qualitative plan to improve fiscal outcomes, performance outcomes, agility outcomes and value based outcomes. - Identify in what intervals the payment for the hosting services at external cloud service providers must be done and create a cash outflow plan accordingly. - Sign legal contracts with agreed terms on budget and time allocations.	
People & Resources	- Have a clear strategy on people management. - Map people to capabilities. - Create a skill readiness plan, identify gaps and find ways to amend it.	
Platforms & Operations	- Have a clear data division plan for the hybrid cloud storage along with its geographical delineation and technical constraints. - Creating a digital estate and plan on workload alignments. - Choose the networking services, tools, and architectures that will support the organization's workload, governance, and connectivity requirements. - Plan virtual networks based on your isolation, connectivity, and location requirements. - Create storyboards and allocate tasks to teams. - Confirm that all prerequisite steps have been completed. - Prioritize workloads and Identify which assets are required to support them. - Establish iterations and release plans. - Establish clear timelines.	
Step 9 : Preparing the cloud(s)		
Security	- Manage security of every part of the hybrid cloud. - Ensure every part of the hybrid cloud has a Preventive, Detective and Responsive Security measures set up. - Use cloud to manage security as well (Usage of security services by third party service providers is also an option). - Create a vulnerability management plan to avoid unhealthy frictions. - Enable fine-grained and group-based access management for resources organized around user roles.	Security - Architects, Managers and their teams.
People & Resources	- Make sure responsibilities are fragmented between multiple stakeholders and check if the skill and resources requirements are managed. - Make sure people are familiar with the tools, practices and processes. - Ensure employees are motivated and have high absorptive capacities.	HR, Managers and their teams.
Platforms & Operations	- Design user stories. - Create a landing zone to host the workloads that you plan to build in or migrate to the cloud	Systems, Solutions, Platforms and

Governance aspects	Functional Steps	Stakeholders Involved
	- Establish a code-based starting point for the environment. - Meet the platform requirements of the cloud adoption plan by expanding the first landing zone. - Validate landing zone modifications against best practices to ensure the proper configuration of your current and future landing zones. - Define a cloud operating model to ensure consistency across the adoption efforts.	Operations - Architects, Consultants, Managers and their teams.
Step 10 : Cloud Adoption Process		
Business & IT Drivers	- Stick to the migration plan and strategies determined previously. - Business Drivers, IT Drivers aspects should form a major part of the storyboarding process. These help bring in a structure in the adoption steps as such.	Security, Systems, Solutions, Platforms and Operations - Analysts, Engineers, Architects, Managers and their teams.
Security	- The Security aspect should also form a part of the user storyboarding process and helps set realistic security goals to complete in each wave / phase.	
People & Resources	- Consistently keep up with skill management.	
Platforms & Operations	- For every sprint, review user story and check if implementation was sufficient. - Deploy migration infrastructure initially. - Access workloads, deploy workloads and release workloads in waves or phases based on Agile / SCRUM plan. - Use process improvement methodologies to evaluate and measure various aspects of migration. - Have an infrastructure and orchestration management systems set up given the hybrid cloud nature. This can be evaluated post the first wave of migration.	
Step 11 : Feedback Management		
Business & IT Drivers	- Given the hybrid cloud environment the complexities and challenges could be even more. Consistently get feedback from Subject matter experts and End-User behaviour experts during the process. - Risk evaluation has to be done and systems have to be prepared to mitigate them as soon as possible.	Subject Matter Experts, End-user behaviour experts, Security, Systems, Solutions, Platforms and Operations - Analysts, Engineers, Architects, Managers and their teams.
Security		
Cost		
People & Resources		
Platforms & Operations		
Step 12 : Infrastructure Management		
Business & IT Drivers	- Licensing and Managing multiple parts of the hybrid cloud is an important IT driver to be ensured of.	Systems, Solutions, Platforms and Operations - Architects, Consultants, Managers and their teams.
People & Resources	- Availability and usage of resources have to be checked at each wave / phase.	
Platforms & Operations	- Given the hybrid landscape of the system, ensuring the infrastructural ability to fulfil the designated task as initially planned is a primary measure to be taken after every wave / phase. - Process restructuring has to be done if the intended infrastructure isn't available.	
Step 13 : Application Management		
Cost	- Ensure hosting these applications doesn't cost beyond the actual plan as it is easy to go overboard in the hybrid cloud due to less transparency.	Systems, Solutions,

Governance aspects	Functional Steps	Stakeholders Involved
People & Resources	- Resources to ensure proper functioning of the application also have to be verified.	Platforms and Operations - Architects, Consultants, Managers and their teams.
Platforms & Operations	- Reiterating whether the applications (Data and portfolio wise) are moved to the right part of the hybrid cloud as per the plan is another important constraint to be verified. - Risk management has to be done at every interval. - Application change and transfer management is also a crucial step to be considered during hybrid cloud adoption.	
Step 14 : Service Integration		
Security	- Integrating security measures at multiple environments within the hybrid cloud can be a challenging task but it has to be verified at each wave / phase. - Data redundancy policies have to be verified.	Systems, Solutions, Platforms and Operations - Architects, Consultants, Managers and their teams.
People & Resources	- Agility of the process should not hinder the system from providing a single perspective. This should be mapped with the resource management activities.	
Platforms & Operations	- Manage efficiency of the multiple hostling sources. - Integrating various parts of the application and various services to provide a single perspective to the end user.	
Step 15 : Technical Orchestration		
Security	- Management of data, acquisition and utilisation has to be reiterated. - Identity and access has to be managed. - Regular auditing has to be performed for control management. - Accuracy and validation checks has to be performed.	Systems, Solutions, Platforms and Operations - Architects, Consultants, Managers and their teams.
People & Resources	- Availability of resources have to be checked. - Agility and flexibility of resources to accommodate change must be verified.	
Platforms & Operations	- Automate configuration and management. - Efficiency of the systems have to be verified and improved after each phase. - Timeliness and latency of data transfer should be verified. - Interoperability between various types of clouds must be ensured. - Risks should be evaluated and mitigated at every wave / phase.	