LAPPEENRANTA-LAHTI UNIVERSITY OF TECHNOLOGY LUT
School of Engineering Science
Degree Programme in Industrial Engineering and Management

Markus Heinonen

DEFINING A PUBLIC CLOUD PERFORMANCE MANAGEMENT FRAMEWORK FOR BUSINESS

Examiners: Docent, D.Sc. Juhani Ukko
D.Sc. Mina Nasiri

ABSTRACT

Lappeenranta-Lahti University of Technology LUT
School of Engineering Science
Degree Programme in Industrial Engineering and Management

Markus Heinonen

Defining a Public Cloud Performance Management Framework for Business

Master's thesis
2021
122 pages, 16 figures, 19 tables and 4 appendices
Examiners: Docent, D.Sc. Juhani Ukko and D.Sc. Mina Nasiri

Keywords: Public cloud, performance management, business, strategy map

The objective of this study was to define a public cloud performance management framework for business, which would provide the case company's customers a foundation of knowledge for starting and developing their organization's public cloud performance management. The public cloud performance management framework defined in this study consist of the most important public cloud performance measures (objectives, critical success factors, and key performance indicators) from the business perspective, which are defined for the public cloud utilization areas defined by the case company (Data on Cloud, Infrastructure Modernization, and Application Modernization).

A collection of relevant knowledge and best practice was researched and gathered to support the defining of the public cloud performance management framework. The knowledge and best practice collected for this study consists of the basics of cloud computing and public cloud technologies to provide adequate context for understanding for the substance, combined with performance management fundamentals and its most proven concepts.

The definition of the public cloud performance management framework was performed based on the inputs received from case company experts in the form of interviews, and the knowledge and best practice researched for this study. As an addition, a strategy map was constructed to illustrate the value created by public cloud performance management for the business.

As a result of the study, a complete public cloud performance management framework for business was built, along with a public cloud performance management strategy map. The public cloud performance management framework for business provides a foundation of knowledge regarding public cloud performance management, which organizations can use to start and develop their organization's public cloud performance management practices. The strategy map illustrates the value created for business by the public cloud performance management, and it supports the message, that public cloud performance management brings significant benefits for the business, which can be recognized on the organization's strategic level.

TIIVISTELMÄ

Lappeenrannan-Lahden teknillinen yliopisto LUT
School of Engineering Science
Tuotantotalouden koulutusohjelma

Markus Heinonen

Julkisen pilven suorituskyvyn johtamisen viitekehyksen määrittely liiketoiminnalle

Diplomityö
2021
122 sivua, 16 kuvaa, 19 taulukkoa ja 4 liitettä
Tarkastajat: Dosentti, TkT. Juhani Ukko ja TkT. Mina Nasiri

Avainsanat: Julkinen pilvi, suorituskyvyn johtaminen, liiketoiminta, strategiakartta

Tämän tutkimuksen tavoitteena oli määrittää julkisen pilven suorituskyvyn johtamisen viitekehys liiketoiminnalle, joka loisi vahvan pohjan case-yrityksen asiakkaille heidän julkisen pilven suorituskyvyn johtamisen perustamiseksi, sekä kehittämiseksi omissa organisaatioissaan. Tässä diplomityössä määritelty julkisen pilven suorituskyvyn johtamisen viitekehys koostuu tärkeimmistä julkisen pilven suorituskyvyn osa-alueista (tavoitteet, kriittiset menestystekijät, sekä avainmittarit eli KPI:t) liiketoiminnan näkökulmasta, jotka ovat määritelty case-yrityksen määrittelemille julkisen pilven käyttöalueille (Data on Cloud, Infrastructure Modernization, sekä Application Modernization).

Julkisen pilven suorituskyvyn johtamisen viitekehyksen rakentamisen tukemiseksi tutkittiin ja kerättiin kokoelma asiaankuuluvaa teoriaa sekä parhaita käytäntöjä. Teoriat ja parhaat käytännöt koostuvat pilvilaskennan sekä julkisen pilven teknologian perusperiaatteet, antaen kontekstia sekä auttaen ymmärtämään diplomityössä käsiteltävää substanssia, sekä suorituskyvyn johtamisen perusteet ja parhaiksi todetut konseptit.

Julkisen pilven suorituskyvyn johtamisen viitekehyksen määrittely tehtiin yhdistämällä case-yrityksen asiantuntijahaastatteluista saadut oivallukset, sekä työtä varten kerätty asiaankuuluva teoria ja parhaat käytännöt. Viitekehyksen lisäksi luotiin strategiakartta havainnollistamaan julkisen pilven suorituskyvyn johtamisen tuottamaa arvoa liiketoiminnalle.

Tutkimuksen tuloksena rakennettiin kokonaisvaltainen julkisen pilven suorituskyvyn johtamisen viitekehys liiketoiminnalle, sekä lisänä julkisen pilven suorituskyvyn johtamisen strategiakartta. Julkisen pilven suorituskyvyn johtamisen viitekehys antaa vahvan pohjan julkisen pilven suorituskyvyn johtamiseen, jota yritykset voivat käyttää heidän oman organisaationsa julkisen pilven suorituskyvyn johtamisen käytäntöjen perustamiseen sekä kehittämiseen. Strategiakartta havainnollistaa julkisen pilven suorituskyvyn johtamisen liiketoiminnalle tuottaman arvon, vahvistaen samalla, että julkisen pilven suorituskyvyn johtaminen tuo huomattavia hyötyjä liiketoiminnalle, jotka pystytään tunnistamaan yrityksen strategisella tasolla.

ACKNOWLEDGEMENTS

I would like to express my humble thanks to the many people who helped and supported me through this journey.

Juhani Ukko, for overseeing this work and for the excellent insights you always provided. I have learned so much along the process.

Mina Nasiri, for supporting and examining this work.

Sakari Hyppänen, Pavel Haimi, Minna Joensuu, Hanna Heiskanen, Jyrki Martti, Mika Nurmi, Niclas Broman, and Markus Sipilä, for supporting me in constructing this study, and for your enthusiasm, expertise, and inputs. It is a privilege to call you my colleagues.

My family and friends, for always inspiring and supporting me. Also, apologizing for not having as much time to spend with you as I would have wanted during this journey. Thank you for understanding and for encouraging me, nevertheless.

My classmates, for all the shared moments in class. We had so much fun along the way, it was a pleasure to connect with so many people with similar ambitions in life and professionally. Hope to see you soon!

Looking forward towards the new adventures.

10.6.2021
Markus Heinonen

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

This research focuses on establishing a business-oriented public cloud performance management framework for managing public cloud performance in business organizations. The knowledge created in this research is aimed for organizations utilizing or planning to utilize public cloud in their business and IT functions, as well as for other professionals who are focused on public cloud from the performance aspect in their work. The main goal of this research is to define a business-oriented performance management framework for the case company's customers for managing public cloud performance. This consists of defining the most important objectives, critical success factors (CSFs), and key performance indicators (KPIs) for public cloud. This knowledge can be used by business organizations to manage their public cloud performance.

The case company provides public cloud capabilities and expertise for their customers and has experienced public cloud experts working in the company. This study was conducted because there was no suitable performance management framework or best practice available that would be ready-to-use. The challenge that customers currently have is that they have a need to understand public cloud performance management better in order to reach the full potential with the public cloud and more effectively realize the value which is available.

Most public cloud performance management frameworks available focus strongly on the technical aspect of managing public cloud technology, and the business aspects of managing public cloud performance are left for the business organizations to define themselves. From these frameworks it is not clear how the public cloud performance in different areas impact the business and its ability to create value. This study focuses on defining a performance management framework which consist of the most important objectives, critical success factors (CSFs), and key performance indicators (KPIs) from the business perspective and how does the performance of different public cloud areas impact the business. The results of this study were formed based on interviews and collaboration with the case company public cloud experts.

1.1 Research objectives and scope

Public cloud consists of different utilization areas, which are the areas where public cloud capabilities are used to create business value. The case company has defined three main utilization areas which are: Data on Cloud, Infrastructure Modernization, and Application Modernization. The public cloud performance management framework is defined for these three public cloud utilization areas. Public cloud performance management framework for business provides a business-oriented public cloud performance management framework, which can be used as a foundation for starting and developing public cloud performance management in an organization. This is performed by establishing a public cloud performance management framework which consists of: *1. Objectives for the public cloud utilization areas. 2. Critical success factors (CSFs) for the public cloud utilization areas. 3. Key performance indicators (KPIs) for the public cloud utilization areas.*

The research questions defined for this study: *1. What are the objectives for managing public cloud performance in the public cloud utilization areas? 2. What are the critical success factors (CSFs) for managing public cloud performance in the public cloud utilization areas? 3. What are the key performance indicators (KPIs) for managing public cloud performance in the public cloud utilization areas?*

The objective of this study is to define a public cloud performance management framework which consists of the most important aspects from the business perspective. The main goal is to provide a sound and logical framework which is easy to understand for business and provides a foundation of knowledge for public cloud performance management.

This study does not focus on gathering a collection of all possible, feasible, and suitable performance measures and management aspects into one body, because the best practice with performance management systems is that the focus should be on the most important performance measures in order to create a high quality and value performance management system. Having too many performance measures compromises the focus of the performance management framework and the quality of the outcome.

This study presents the most important objectives, critical success indicators (CSFs), and key performance indicators (KPIs) for managing public cloud performance, which can be used as a foundation for starting and developing public cloud performance. As an addition, to provide a strategic and high-level perspective on the value created by effective public cloud performance management, a public cloud performance management strategy map is presented.

1.2 Research method

This research is conducted as a case study. Case study is a comprehensive research on a subject which is conducted in a real-world environment. (Saunders M. et al. 2009) The study consists of two main sections, the theoretical and empirical sections. The subject of this case study is defining a public cloud performance management framework for business.

The theoretical section focuses on reviewing the existing literature relevant for the study. The case focuses strongly on developing best practice regarding public cloud and performance management, and these were the main subjects researched and gathered for the theoretical section. The theoretical section starts with an introduction to cloud computing and public cloud technology. This is followed by a collection of performance management concepts and best practices: How to define performance, how to manage performance, definition of critical success factors (CSFs), definition of performance measures and key performance indicators (KPIs), the balanced scorecard (BSC) framework, and the strategy map framework. In order to achieve the best possible outcome, the research on existing literature is performed thoroughly and the material selection for this study is performed carefully.

The empirical section focuses on solving the challenge defined by the case company with the best practice and concepts researched and gathered in the theoretical section, supported by the case company expert interviews. The empirical section starts with the case company's introduction to the case and the challenge (defining a public cloud performance management framework for business). This is followed by case company defining the public cloud utilization areas where the challenges are to be solved (Data on Cloud, Infrastructure Modernization, and Application Modernization). After this, it is defined how the challenges in the public cloud

utilization areas are solved using the knowledge gained from the theoretical section and with the support of the case company experts. After the definition work for the empirical section has been concluded, the focus shift to solving the challenge: defining performance management framework for each public cloud utilization area based on the case company expert interviews, and in addition, defining a strategy map to visualize strategic aspect of the public cloud performance. This is also be performed based on the case company expert interviews. In order to achieve the best possible outcome, the definition of the challenge done by the case company is performed clearly and solving of the challenge is performed in a structured and efficient manner. The focus is on ensuring that all relevant information required for forming the finalized versions is taken into account, and the case company experts' knowledge is used to provide the optimal solution for the challenge defined.

After the empirical section, the results of the study are presented. The performance management framework for each public cloud utilization area (Data on Cloud, Infrastructure Modernization, and Application Modernization) are shown, with an additional strategy map to form a complete body of knowledge based on the insights gained within this study.

1.3 Research structure

The study divides into eight chapters and each of them have their own purpose in forming the complete study. The chapters of the study, including each of their inputs and outputs, are illustrated in figure 1 below. The details of the research structure are elaborated after the figure.

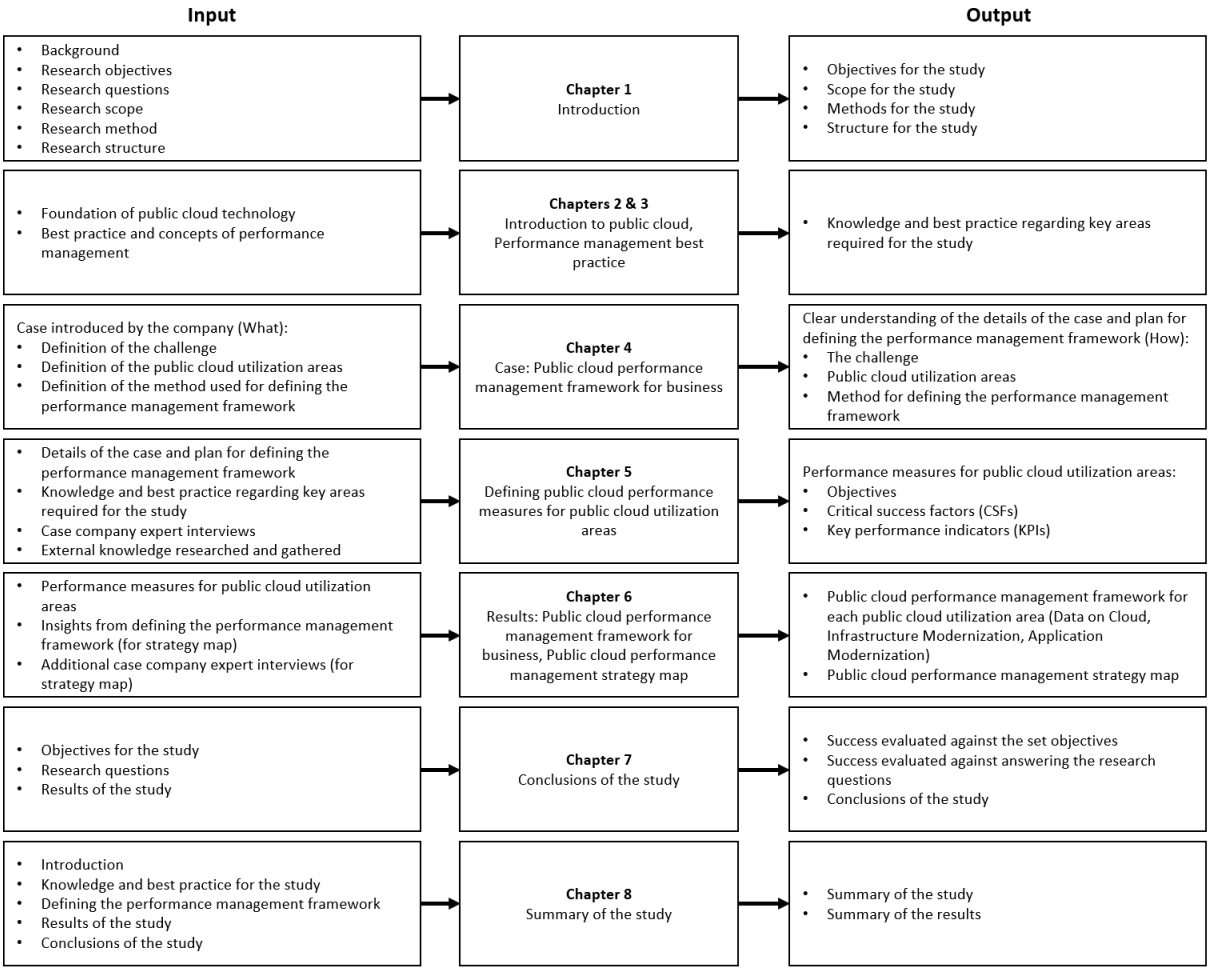


Figure 1. Research structure for public cloud performance management framework for business

The study begins with the introduction (chapter 1), which focuses on forming the foundation for the study. The introduction produced the objectives for the study, scope for the study, methods for the study, and structure for the study. In the beginning, the research questions are defined for the study which aim to determine the nature of the study, and the objectives and results which the results should address.

The introduction is followed by the theoretical section (chapters 2 and 3), which focuses on forming the knowledge and best practice regarding key areas required for the study. This consists of researching and gathering the knowledge foundation regarding public cloud technology, and best practice and concepts of performance management from the available literature.

After this, the case is introduced by the case company (chapter 4). The focus of this is to form a clear understanding regarding the details of the case, and plan for defining the public cloud performance management framework for business. The case company defines the challenge, the public cloud utilization areas, and the methods to be used for defining the performance management framework.

This is followed by the actual work of defining the public cloud performance measures for public cloud utilization areas (chapter 5), which is performed by combining the details of the case and plan for defining the performance management framework (defined in chapter 4), using the knowledge and best practice regarding key areas required for the study (defined in chapter 3), and performing the case company expert interviews to provide insights for building the performance management framework. The case company interviews and the work of defining the performance management framework is supported by researched and gathered external knowledge. The process of forming the public cloud performance management framework is described in detail in chapter 4.3 (Method for defining the performance management framework). As a result, this section provides the most important performance measures identified for the public cloud utilization areas (objectives, critical success factors, and key performance indicators) which are used to construct the final public cloud performance management framework in the following chapter.

The following chapter presents the results of the study (chapter 6). This includes presenting the public cloud performance management framework for each public cloud utilization area (Data on Cloud, Infrastructure Modernization, and Application Modernization), which were constructed based on the insights formed in chapter 5. In this chapter, also the public cloud performance management strategy map is presented, which was formed based on the same insights of chapter 5, with were supplemented by additional case company expert interviews to form the final version.

Towards the end, the conclusions of the study (chapter 7) are presented. The conclusions focus on evaluating the success of the study by comparing the results to the objectives which were set in the beginning of the study, as well as comparing the results to research questions which

were set to see if these were answered to by the study. In this section, the general conclusions and insights gained from the study are also presented.

In the final section, the summary of the study (chapter 8), summarizes the entire study into one chapter. The summary forms an overview of the study and the results, and presents the main points and insights of the study.

2 CLOUD COMPUTING AND PUBLIC CLOUD

This chapter introduces the basics of cloud computing and public cloud to provide an adequate base of understanding for the public cloud technology and how public cloud is utilized in business to create value. The introduction to cloud computing provides context for this study and gives a short induction regarding the substance (cloud computing and public cloud technology) addressed in this study combined with performance management.

This chapter consists of the following sub-chapters: *1. Introduction to cloud computing*, which introduces the basics of the cloud computing technology (public cloud is a cloud type among private cloud, hybrid cloud, and community cloud types). *2. The definition of cloud computing and differences between cloud types,* which describes what is the actual definition of cloud computing and what are the most important differences between different cloud types. *3. The benefits of public cloud*, highlighting the main benefits of the public cloud for the business. *4. The challenges of public cloud*, highlighting the main challenges of the public cloud for the business.

2.1 Introduction to cloud computing

Cloud computing is a technology advancement that has evolved the use of information systems from conventional physical computer hardware to virtual technology services. (Ratten. 2014) The accelerated adoption and development of cloud computing usage has been enabled by its dynamic and modern nature. (Stein S. et al. 2013) The utilization of information and communication technology (ICT) can create opportunities for business to compete in the market, and it has provided significant advancements and means for small and medium-sized enterprises (SMEs) to challenge bigger organizations. (Bayo-Moriones A., Lera-Lopez F. 2007) E-mail, office tools and other cloud-based end-user applications have become a key part of daily business operations, creating new possibilities, and building new capabilities, but also generating new obstacles for stakeholders. (Alshamaila Y. et al. 2013) Cloud computing capabilities offer end-users reliability and flexible access to data stored on servers. (Gray A. 2013) Cloud computing capabilities enable organizations to scale their business operations

conveniently. (Berman S. et al. 2012) It also offers a solution in the digital era that is suitable from the economic perspective. (Sultan N. 2013) Cloud computing is fundamentally changing how the IT services are delivered and this has a significant impact on the ICT landscape. (Srinivasan S., Getov V. 2011) Organizations are able to utilize cloud computing technology to achieve more flexibility and cost-effectiveness which results in organizations' employees to have more efficient and higher-level scalability on information systems. (Ratten V. 2012) Cloud computing technology support cost-savings by externalizing information system maintenance and by providing fast and efficient technology applications without high initial investments used for establishing hardware or software resources. (Karakas F., Manisaligil A. 2012)

Cloud computing is enabled by having a vast number of computers connected to each other using a communication network (e.g. Internet), comparable to utility computing (Carroll M. et al. 2010) Cloud computing is equivalent for shared computing over a network and is defined as the ability to operate an application or program on several computers simultaneously. Cloud computing evolves the IT landscape in today's business. (Prasad M. et al. 2012) In the IT environments operated with the former standard, the software, hardware, and networking devices demand experts for deploying and maintaining the IT services. (Thinkstrategies. 2002) Cloud computing is characterized as the new way of computing where virtualized resources are provided to the consumer as services over a network. Cloud computing also efficiently moderates the need of advanced hand-held devices for running mobile applications. (Prasad M. et al. 2012) Cloud computing can be defined as a model for enabling ever-present, easy-to-use, on-demand network access to a shared pool of configurable computing resources that can be quickly provisioned and released with low management and service provider efforts. (NIST. 2011) Cloud computing is described as a group of immaterial services which are accessible from anywhere using a mobile device equipped with a network connection (Erdogmus H. 2009) Cloud computing is seen as a form of parallel and distributed system made of a group of connected and virtualized computers which are dynamically provisioned and shown as a single or many unified computing resources based on service level agreements (SLAs) which are created through negotiations between the service consumer and the service provider. (Buyya R. et al. 2008) Cloud computing offers a network access to software, development platforms, processing power, and storage. The cloud computing technology has already been developed for decades. In the 1990s, the cloud computing technology was developed by leading IT

companies such as Google, Microsoft, and Amazon. A diverse set of cloud computing services are utilized by different types of users. For end-users the most important services consist of cloud-based email systems such as Gmail, and office applications such as Microsoft Office Online. The developers on the other hand are able to run their programs on the cloud using Google App Engine and Windows Azure. Organizations can utilize the cloud computing services to store their vast amounts of data on remote servers such as Microsoft Azure and Amazon EC2. (Liu W., Cai H. 2013)

2.2 The definition of cloud computing and differences between cloud types

Public cloud is a type of cloud computing in which computing resources, such as storage capacity, applications and virtual machines, are made publicly available using an internet connection. Public cloud enables organizations to scale and share computing resources in a way that would not be possible for a single organization to achieve by themselves. (Citrix. 2021) The definition of cloud computing is, according to U.S. Department of Commerce's National Institute of Standards and Technology (NIST. 2011) , as following: "Cloud computing is a model for enabling ubiquitous, 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. This cloud model is composed of five essential characteristics, three service models, and four deployment models."

The five essential characteristics of cloud computing, according to NIST (2011) are: *1. On-demand self-service.* A service user is able to provision computing resources, such as processing power and storage capacity, when required automatically without the need of human interaction with each service provider. *2. Broad network access.* Computing resources are reachable over the network and can be accessed through different devices, such as smart phones, laptops and workstations. *3. Resource pooling.* Utilizing a multi-tenant model, the service provider's computing resources are pooled to serve multiple service users simultaneously. Different types of computing resources can be automatically assigned and reassigned depending on the service user demand. Service user is focused on consuming the computing resources and has no control

or visibility regarding the exact location of the resource providing assets. *4. Rapid elasticity.* Computing resources can be elastically shared making fast service scaling possible in order to react to fast changes in demand. From service user point of view, computing resources are always available, and the quantity of resources can be scaled up or down instantly. *5. Measured service.* By metering the cloud service and the use computing resources, systems are able to automatically control and optimize the use of resources for the service consumers. The usage of computing resources can be analyzed by both the service provider and the service user providing transparency regarding the utilized service. (NIST. 2011)

The three essential service models of cloud computing, according to NIST (2011) are: *1. Software as a Service (SaaS).* The computing resources are provided to the service user by using service provider's applications on a cloud infrastructure. The application can be accessed from different devices, such as web browser or application interface. In SaaS model, the service user does not manage or control the underlying cloud infrastructure (including network, servers, operating systems, storage etc.) that is used to provide the service. *2. Platform as a Service (PaaS).* The computing resources are provided to the service user by deploying user-created or acquired applications onto the cloud infrastructure. Deployed applications are created by using programming, libraries, services and tools that are supported by the service provider. In PaaS model, the service user has control over the deployed applications. *3. Infrastructure as a Service (IaaS).* The computing resources are provided to the service user by provisioning fundamental capabilities, such as processing power, storage, and networks, for the service user. Service user is then able to deploy and run arbitrary software, including operating systems and applications. In IaaS model, the service user has control over the operating systems, storage and deployed applications. (NIST. 2011)

The four essential deployment models of cloud computing, according to NIST (2011) are: *1. Private cloud.* The cloud infrastructure is shared for exclusive use for a single organization including multiple service users, such as business units, utilizing the provided computing resources. Private cloud can be managed and operated by the organization itself or by a third-party service provider. It can also exist on or off premises. *2. Community cloud.* The cloud infrastructure is shared for exclusive use for a specific community with multiple service users sharing same concerns, such as mission, security requirements, policy, and compliance.

Community cloud can be managed and operated by one or more of the organizations in the community or by a third-party service provider. It can also exist on or off premises. *3. Public cloud.* The cloud infrastructure is shared for open use for the general public. Public cloud can be managed and operated by a business, academic, or government organization. It exists on the premises of the cloud provider. *4. Hybrid cloud.* The cloud infrastructure built based on two or more distinct cloud infrastructures (private cloud, community cloud, or public cloud) that remain unique but are connected to each other by technology enabling data transfer and application integration. (NIST. 2011) The table 1. below illustrates the differences, strengths and challenges regarding different cloud types discussed above.

Table 1. Comparison between different cloud types (Nag A. 2015)

Parameters/ Cloud type	**Private cloud**	**Community cloud**	**Public cloud**	**Hybrid cloud**
Description	Built on existing private infrastructure.	Built with different types of cloud to meet the mutual needs of several organizations.	Built to offer services for public users.	Built on a combination of private and public cloud types.
Scalability	Limited	Limited	Very high	Very high
Reliability	Very high	Very high	Medium	Medium to high
Security	Very high	High	Depends on service provider	High
Performance	High	Very high	Low to medium	High
Cost	Very high	High	Low	High

As it is concluded in the table 1. above by Amitava Nag in his article *"Cloud computing: A paradigm shift in IT infrastructure"* (2015), we can see why in the public cloud type has increased its appeal in many growing business organizations and other organizations which have increasing need for highly scalable cloud computing resources with a reasonable cost. This study strongly focuses on the public cloud type and how its advantages can be applied to the case company's customer needs.

2.3 The benefits of public cloud

With growing competition in a highly complex market, businesses are forced to find new ways to work more efficiently, build new products and services more rapidly, and implement substantial changes instantly. Public cloud can be recognized as one of the tools to establish a stronger technological backbone to support an organization with demanding digital and IT performance requirements, but want to achieve this with a reasonable cost. The benefits of the public cloud, according to Hentsu (2020) are following: *1. Scalability.* Public cloud's capability for scaling allows organizations to instantly increase or decrease the amount of cloud computing resources in use according to changing demand. *2. Big service providers work for you.* Big service providers are investing to the development of the public cloud service and solutions to find better ways to serve organizations' needs and reduce the amount of disruptions in the service. This means that the technologies, tools, and software are constantly updated. The organization itself can focus on production, development, and testing. *3. Fast and simple setup.* Switching to public cloud demands a careful and methodical approach, but the process can be completed in a very short time compared to other solutions. For example, the deployment and configuration can be handled remotely in most cases by the service provider. *4. Cost-effectiveness.* The cost benefits of public cloud are obtained from different aspects of the service. Firstly, organization's own staff is not required to manage technical aspects of the service, such bandwidth, hardware, and application improvement. With public cloud system these are responsibilities of the service provider. Secondly, there are little to no initial investments required to get public cloud up and running. And thirdly, pay-as-you-go model where payments are made monthly or annually, based on the use of cloud computing resources. *5. Business continuity and resilience.* Public cloud offers different ways to keep applications up-to-date and future-proof organizations' business. As one example, certain legacy applications can be migrated to the cloud to ensure business continuity. *6. Swift data recovery.* With multiple infrastructures available within the public cloud, difficulties are effectively reduced when deploying disaster recovery plan. There is a small risk for a significant data loss, and organizations do not have to use time to transfer backup data from own servers to recover the lost data after a disaster. With public cloud this process is mostly automated, enabling fast data recovery. *7. Lower workload for IT staff.* This is related to the cost-effectiveness aspect of the public cloud. Organizations typically have enormous budgets for computing costs, and IT

personnel who require continuous training and education in order to succeed in their work. IT professionals are in most cases hard to find and they are typically very expensive. Utilizing public cloud allows cloud management and cloud-related services to be handled externally, and organization's own personnel can focus on core business. *8. Agility.* Public cloud offers a response for the dynamic digital market demands. It is able to easily provision resources, process complex workloads, and manage enormous datasets. Agility is one of the primary focus areas in public cloud utilization. Public cloud is able to reduce technical challenges and enable organizations to focus on quality and efficiency of their operations. *9. Geographical flexibility and global presence.* Public cloud service providers have a growing network of servers, network bandwidth, and IT resources enabling cloud infrastructure to be available globally. Public cloud providers also provide servers in a certain geographical location for customers, who have specific demands on where the data has to be stored geographically. (Hentsu. 2020)

The benefits of public cloud act as one of the key decision criteria for the case company's customers, when deciding on whether the public cloud would be the most suitable computing model for their needs. Their relevance for this study is also high. Certain benefits are ones that the case company's customers need to measure, in order to ensure that the desired benefits of the public cloud are realized in their organization.

2.4 The challenges of public cloud

While public cloud has been rapidly developing in the recent years, it has its own weaknesses and is not the perfect solution for every organization. The cons of the public cloud are, according to Sharma A. (2019) following: *1. Security.* Security is one of the most critical disadvantages in public cloud. In the public cloud computing model organizations transition their systems and data to a hardware managed by a third party. This means that the third party will be responsible for the security. Also, as the public cloud is a large-scale function with an extensive reach, it is also considered as a high value attack target by hackers. *2. Privacy.* The public cloud platform is shared between multiple organizations, which means that hundreds of organizations' data could be stored on the same server. There are highly advanced mechanisms in place that create virtual barriers between different organizations' data, but there is still a risk

that an organization or an outsider would be able to access data that they weren't authorized to. *3. Pay-Per-Use Unpredictability.* Pay-per-use cost model lets organizations utilizing public cloud to take advantage of low prices to access a powerful infrastructure. The easy access and availability of the resources may lead to costs to rise to unexpected levels if there is a sudden growth in application use. (Sharma A. 2019)

In addition, there are challenges that cloud adopters see in cloud computing in general, which also relate to public cloud, and have slowed down the cloud adoption. Rountree D., Castrillo I. (2014, p. 13-17) describe the following challenges that are holding back cloud adoption in their book: *1. Ambiguity.* One of the main reasons which slow down cloud adoption is the lack of understanding regarding what cloud is and what does it offer. This lack of understanding creates caution and makes it harder to commit to a new way of utilizing computing resources. Most commonly the caution is around hidden costs that might emerge along with the cloud adoption and operation, as well as lack of control, integration issues, and security concerns. All of these issues can be managed with a suitable cloud provider. For that reason, it is important to understand what to look in a cloud provider and what to expect from a one, in order to get answers to the concerns raised regarding cloud, and in order to mitigate the risks related to it. *2. Concerns over maturity.* Organizations also have concerns regarding the maturity of the cloud and cloud service providers. There are many new service providers entering the growing cloud market, but many of the new players are simply not able to meet most of the organizations' needs. New service providers need some time to understand what the customers need, what kind of service levels they require, and what kind of support do customers need for their cloud services. *3. Services aren't robust enough.* Many of the cloud solutions provided by cloud service providers are not solid enough to meet the customer needs. Many of the public cloud services can be very specific and some service providers are only able to offer a solution that is not adequate for the specified purpose. An organization might need 24/7 availability for a critical service or application, but there might not be a service provider who would be able to offer that to a customer. *4. Service level agreements (SLAs).* Many service providers are not developed enough in the way of being able to offer effective SLAs. Certain service providers do not provide SLAs at all. Other service providers provide SLAs that do not offer adequate service levels for the organizations' needs. However, if your organization is facing technical limitations when trying to reach a certain availability level, it is possible that the service

provider would be facing the exact same limitations as the organization. *5. Integration.* Integrations are a key aspect to consider when purchasing services from public service providers. As you will not be owning the actual systems utilized by service providers, you might not have a direct access to the systems. In this case, interfaces have to be defined and provided in order to have access and allow integrations to your other systems. This could include both application integrations and data integrations. *6. Data integration.* When data is integrated and reporting is performed between cloud-based and on-premise systems, it can get very expensive easily. If you have to move large amounts of data from one location to another utilizing bandwidth provided by the cloud service, this will most certainly affect the cost of the service. In this case it is important to find the possibilities for data transfer which would be a suitable option also from the cost perspective. *7. Application/service integration.* In some cases, the web interface offered by service providers is not adequate by itself. Your organization might be using an application that needs to utilize the service provider's interfaces to solve this problem. Many service providers provide application programming interfaces (APIs) to access this functionality. *8. Ownership of Data.* This is related to the privacy challenge (#2) described in the public cloud challenges chapter above. One of the main questions is that who owns the data in a cloud setting? Your organization might have generated the data, but it is now located in a premise owned by an external service provider. Does your organization still own the data? When considering questions related to data ownership, it is important to assess your organizations requirements regarding this subject and discuss the possible specifications in detail with the service provider when choosing one. *9. Auditing.* The possibilities for good auditing can differ between different cloud environments. Your organization might not have direct access to the systems and applications you need to audit if the cloud environment has been implemented in a certain way. The service provider might be able to offer your organization access to the required logs by exporting them, or by providing your organization an application interface. *10. Legal and compliance issues.* When cloud implementations are performed, there is a significant amount of legal and compliance details to be considered. For example, same regulations apply differently in Europe and North America. It is important to ensure that the juridical details of your organization's cloud operations are thoroughly considered, and your business is secured from this point of view. *11. Multi-tenancy.* In terms of multi-tenancy, there must be great caution when different organizations are utilizing the same systems. Security details must always be well planned in order for this setup to work. *12. Lack*

of customization. A certain customization limit can be reached when sharing applications and systems with other organizations. With certain setups, it might not be possible to make changes to the systems without affecting other organizations using the same environment. As your service provider might be offering the service for thousands of customers, supporting high customizability for each organization would get very expensive over time. *13. Technology challenges.* Cloud technologies have been developed over a long time, but there is still a lot of room for further development. For example, it might not be standards or best practices defined for every action related to the cloud. Solving certain problems might require external help and training for your staff. *14. Scale out.* Most commonly, commodity equipment is utilized for cloud environments' infrastructure. This means in many cases, that in order to add capacity, it is needed to scale out instead of scaling up. This could cause a growing load on datacenters and growing environment related costs generated by power and cooling resources. *15. Corporate policies.* If your organization's previous setup has consisted of internal solutions, your organization's procedures and policies might need to be updated for enabling cloud environments as a viable option. For example, policies are needed to define what can be taken into the cloud environment, and what cannot be taken because of a certain risk. It is also a good practice to define policies which describe what is required from the service providers. *16. Flexibility after cloud environment has been chosen.* When making a decision regarding a cloud environment, this could be very limiting from the future perspective. It is recommended to consider, what would you be able to do if you are not satisfied with the service provider, and how hard would it actually be to change service providers. One important concern is also to consider how would it be possible to move your data to another provider if this would be required. This could be so expensive that it would be practically impossible to perform. (Rountree D., Castrillo I. 2014)

The challenges of public cloud also act as one of the key decision criteria for the case company's customer, whether they should or should not adopt the public cloud computing model to replace or support the current one. Certain challenges described above can pose critical risks for the case company's customer. If it is decided that the public cloud computing model will be implemented, the challenges need to be measured, in order to control the risks related to the challenges.

3 MANAGING PERFORMANCE IN AN ORGANIZATION

This chapter presents the foundational knowledge and best practice regarding performance management. The knowledge and best practice researched and gathered are used to form a base of understanding which can be used for creating a performance management framework in this study.

This chapter consists of the following sub-chapters: *1. Defining performance,* elaborating the term "performance" itself and defines what is "performance". *2. Managing performance*, introducing the basics of performance management in an organizational context. *3. Critical success factors (CSFs)*, presenting the definition of critical success factor and what critical success factors are used for. *4. Performance measures and key performance indicators (KPIs)*, going through different kind of performance measures used in an organizational and business context, and the definition of key performance indicators and what they are used for. *5. The process of defining objective-oriented KPIs*, introducing how KPIs are defined so that they are linked to organizations objectives, and goes through the method to achieve this used in this study (top-down CSF/KPI framework, Jahangirian M. et al. 2017). *6. The balanced scorecard (BSC)*, presenting the basics of one of the most famous performance management systems developed by Kaplan, R. & Norton, D. (1998). *7. Strategy map*, introducing the basics of strategy map, a tool for mapping how organization's objectives produce value and the desired outcomes, also developed by Kaplan, R. & Norton D. (2000).

3.1 Defining performance

Performance is a term that can be understood in different ways depending on the field and the environment in which the performance is examined. The Oxford English Dictionary (2021) defines the noun performance as following: "The action of performing, or something performed. The carrying out of a command, duty, purpose, promise, execution, discharge, fulfillment. The accomplishment, execution, carrying out, working out of anything ordered or undertaken. The doing of any action or work. Working, action (personal or mechanical). The capabilities of a machine or device. The observable or measurable behavior of a person or

animal. The action of performing a ceremony, play, part in a play, piece of music, etc." (Oxford English Dictionary. 2021)

In addition to the dictionary definition described above, the term "performance" has also gained additional meanings, the following are listed as synonyms: Efficiency, capability, accomplishment, and satisfaction. (Samsonova T. 2011, p. 23) The definitions approach performance from many different aspects. According to Samsonowa T. (2011, p. 22), after reviewing relevant literature in defining performance, it is clear that there is no uniform definition for the term "performance". When assessing management literature specifically, management literature offers many proposals regarding how performance can be measured, without defining "performance" first. (Samsonowa T. 2011. p. 22)

In the performance paradox theory set forth by Meyer and Gupta (1994), the ambiguity regarding performance and organizations' ability to manage it is analyzed in depth. They state that there is a great disagreement in what performance is and the universally growing use of performance measures has resulted as the paradox of performance: Organizational performance control is maintained without fully understanding what performance is. (Meyer M., Gupta V. 1994) The definitions described above can still be summarized to two main terms: First is effectiveness, second is efficiency. Drucker (1974, p. 45) defines these two terms in following manner: Effectiveness is the actual foundation for achieving success and focuses on performing the right actions to achieve success. Efficiency is the actions and environment required for maintaining success after it has been achieved. Efficiency focuses on performing the actions in the right way to achieve success. (Drucker P. 1974, p. 45)

In a practical business setting, these terms are often used incorrectly as synonyms for goal-oriented actions or profitability. The definitions of both, effectiveness and efficiency indirectly presume that there is a pre-defined goal determined, as neither one could not be evaluated without having a goal to evaluate against. This means that all the definitions reviewed related to performance in the chapters above are alike with regards to holding one or many goals, and the level of achieving performance for these goals can be assessed for.

Grüning (2002) defines the term performance as the ability of an organization to achieve its goals. When considering this definition, it means that performance is conditioned by the results, which brings in the phenomenon of over performance and under performance. It also means that the performance conditioned by the goal setting. (Grüning M. 2002) Grüning's approach to defining performance is illustrated in the Figure 2 below.

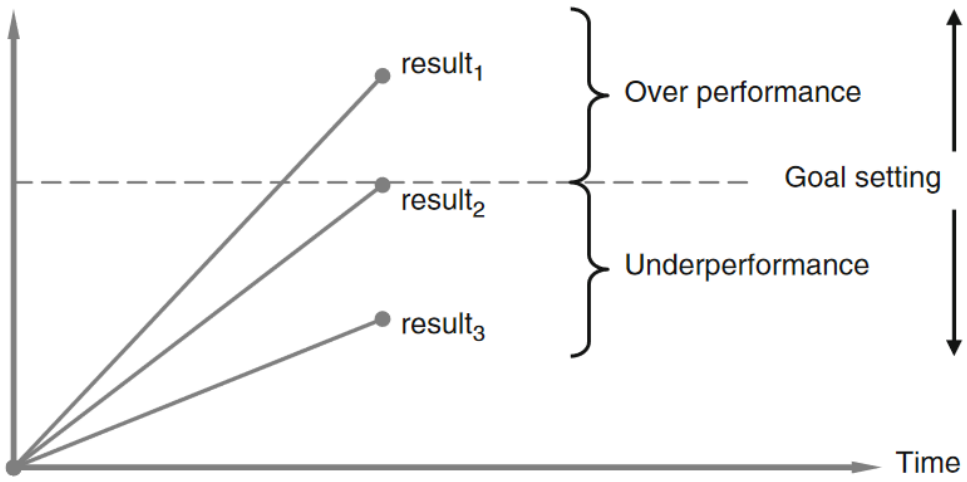


Figure 2. Performance as goal attainment (Grüning M. 2002)

Effectiveness and efficiency can therefore be grasped in an abstract sense as performance measures which need to be carefully developed in order to assess the goal attainment. Effectiveness can be identified as a measure for the degree of goal attainment, and efficiency a measure for the resources utilized in order to reach the level of success. For assessing the overall performance, the value of each aspect related has to be taken into consideration in order to gain the correct and accurate overview of the performance evaluated. (Samsonowa T. 2011. p. 25)

The role of setting right goals in order to achieve desired outcomes is crucial. In an organizational setting, individuals work on different activities to fulfill their responsibilities. According to Nagel (1992), individuals typically have at least slightly different interests between each other. In order to align the efforts and interests of the individuals and lead them strategically to maximize value for the overall organization, leadership in setting the right goals and objectives is required. Methods regarding how these goals and objectives are formulated to achieve the alignment, and how the management by objectives is conducted need to be clear and explicit for all individuals in the organization. In a business-organizational setting, goals

should be used when the objective which is strived for is relevant for action and has a strong connection with the problem and its solution. (Nagel P. 1992, p. 2626) Individuals' goals can be conflicting caused by individuals having different interests. One of the major purposes of setting goals is to discover and handle the conflicts that cause the misalignment of individuals' goals from the organization's objectives. (Dörner et al. 1983, pp. 37-38)

3.2 Managing performance

According to Cadwell (2000), performance management is a proactive partnership in an organization between employees and management which aims at supporting employees to perform at their highest level and align their actions with the organization's objectives, values, and initiatives. Performance management is not something that happens automatically in an organization, and it requires work and commitment from both, the employees and the management. It is not something that is done to the employees, it's something done together, a partnership. (Cadwell C. 2000, p. 2) Performance management's purpose is not to give the management a micromanaging tool to follow and monitor employees' every action, and force employees to get permission from the management before they act. This approach is actually counterintuitive and will not ultimately provide the desired long-term results which the performance management is set to do. The most value that an effective performance management can provide to an organization is the increase in responsibility taken by employees for managing their own performance. It provides freedom for employees to do their work to their best ability and increases trust in decisions made by employees from the managers perspective. When performance management is conducted successfully in an organization, employees are more self-managed and less supervisor-managed. (Cadwell C. 2000, p. 3)

The benefits of performance management in an organization according to Cadwell (2000), are the following: *1. Improved performance.* Managing performance correlates with better performance. Managing performance consists of setting clear goals, as well as increased two-way feedback between employees and management. When management shows interest in their employees and what they are doing, this increases motivation and results. *2. Improved communication.* A working performance management partnership requires communication and

people need to interact with each other. Most common complaints made by employees are typically related to communication. Successful performance management results in better communication. *3. Organization alignment.* When performance management is focused on by the entire organization, there is alignment happening up and down the line. People are more focused on the most important objectives and have a clear picture about how their work brings value to the organization's overall success. *4. Organization capability.* When people in the organization are working towards the same goals and objectives, more results can be achieved. Employees' strong individual performance helps develop organization's capabilities. As organization's capabilities increase, this attracts more highly capable employees to the organization. This leads to an upward spiral where organizations capabilities and performance increase on both, organizational level and individual level. *5. Reduced management time.* Performance management includes investing time into planning and communication that happens between employees and managers. The initial time investment will save time in the long-term by developing employees who actively manage their own performance. *6. Increased employee self-management.* Some systems that organizations typically implement to improve organizational effectiveness often feel that they are directed "at employees", performance management focuses on providing a "with employees" approach. In performance management, managers provide the employees with tools and knowledge to take responsibility on their own performance. Instead of taking all the responsibility regarding performance themselves, managers shift the emphasis to the employees which promotes self-management. *7. Increased employee satisfaction.* When employees have clear objectives, expectations, and feedback regarding performance, this tends to lead to higher employee satisfaction. Also, the more employees are involved in planning and executing their goals, the more satisfying the work being done is for the employees. Providing employees, a voice that is heard in their daily work can highly boost motivation. (Cadwell C. 2000, pp. 4-5)

In order to make performance management work in an organization, the following actions should be done according to Cadwell (2000): *1. Communicate expectations.* One of the biggest reasons for low performance is that employees do not know what is expected from them. If the employees do not understand the goals and objectives, they will not know if they have reached them. On the other hand, if employees do understand what is expected from them, they will work and be more focused on meeting and exceeding those expectations. Expectations should

be understood regarding the goals, budget constraints related to the work, and how the performance will be monitored. *2. Involve employees in the process.* Employees and the management have to work together, and employee involvement in the performance management process is critical for the success. The challenge is being able to create a win-win situation. Even performance management would be based on a partnership, there will always rise a question from both sides: "What's in it for me?". The outcome of the performance management will highly depend on the answer to this question. If the employee only sees the benefits of performance management for the management, this will not create a strong commitment to the cause from the employee. On the other hand, if the management only sees the employee getting all the benefits from the performance management, they will not have interest to proactively participate in the process. Therefore, a positive vision is required from both sides to the question: "What's in it for me?", for performance management to be truly effective. *3. Use a systematic approach.* Performance management is not a one action you perform, it is a system consisting of a series of related activities performed individually to contribute to the whole. Typical with any good systems, the whole is greater than the sum of its parts. The activities to do and the activities to ignore cannot be chosen, as they all are important and contribute to the big picture. Performance management is a process that needs long-term commitment and effort to be successful. Systems like performance management are not designed to provide quick fixes, and in order to provide long-term benefits it has to become a part of organization's culture. *4. Be willing to work hard.* Implementing a performance management system requires a lot of hard work, at least in the beginning. It takes effort to create discussions regarding goals and objectives, and it might be challenging to transform these objectives and ideas to concrete goals that can be measured. It also takes time to discuss and reach the mutual understanding regarding what are the best ways to monitor performance and analyze how the goals have been achieved. Do not be afraid to work hard, once the system is implemented and employees are able to understand the expectations and proceed by their own, it will require less time. A manager's approach to performance management should be acting as a coach and advisor to the employees, instead of acting as the troubleshooter or firefighter. Most manager see this approach as very rewarding as they can focus on supporting employees performing better, instead of focusing on solving problems that could be solved by the employees themselves. *5. Make a commitment to success.* The level of commitment will be the critical factor in the success of performance management. Even if it has been discussed that

performance management is a partnership, it is the management's role to take the lead and demonstrate commitment to the performance management process. The commitment of employees will generally reflect the management's commitment towards performance management. When performance management is introduced and new, many people in the organization will see it as just another program-of-the month, and the initial feeling might be that when time goes on, things will get back to "normal" and this will be forgotten. In order to overcome this challenge, it requires daily commitment and strongly integrating performance management into the everyday work. (Cadwell C. 2000, pp. 9-13)

3.3 Critical success factors (CSFs)

In order to measure performance, goals and objectives have to set, so that the performance can be measured against these goals and objectives. Setting goals and developing plans for accomplishing objectives is one part in performing with high success. To reach a certain objective, an organization must recognize and consider that what are the most important key areas and factors that are critical for reaching this certain objective. (Caralli R. et al. 2004, p. 2) The nature of these key areas and factors is so critical that by failing to successful with these areas and factors might fully compromise reaching the objective, make reaching the objective extremely difficult, or make the reaching the objective highly inefficient. (Caralli R. et al. 2004, p. 2) These key areas and factors are defined as critical success factors (CSFs), a concept that was first introduced by Daniel in 1961 and further developed by Rockart in 1979. Rockart (1979) defined the concept as following: "Critical success factors are the limited number of areas in which satisfactory results will ensure competitive performance for the organization and enable it to achieve its mission". In other words, critical success factors define the key areas and factors where the success is critical for the organization in reaching its objectives. (Caralli R. et al. 2004, p. 2)

When the concept of critical success factors was introduced in the 1960s, it created a new organizational approach for achieving performance objectives and competitiveness. The critical success factor concept offered a systematic way of identifying the key areas and factors, which are crucial for achieving the objectives, and therefore should be constantly followed by the

management. (Ram J., Corkindale D. 2014) Typically, the management has at least an implicit understanding about the key areas and factors regarding the goals and objectives when they are set, and as they lead the operational actions and tasks towards reaching the objectives. Making critical success factors explicit and clear, and actively communicating them throughout the organization can be overlooked, but a lot of value can be created by doing this which can lead to increased performance in long-term. Having clear understanding about the critical success factors can provide a common reference point for the employees and managers in the organization and highlight the most critical aspects of reaching the objectives can help individuals to understand what should be focused on. (Caralli R. et al. 2004, p. 2)

Any actions or initiatives that the organization undertakes, the organization must guarantee consistent high performance with the critical success factors. If this cannot be achieved, the organization might not be able to reach the objectives that have been set. (Caralli R. et al. 2004, p. 2) The critical success factors are areas of activity that require continuous attention from management. The performance related to each area should be actively measured and the information related should be made easily available. Critical success factors support the attainment of organization's objectives. (Rockart J. 1979, p. 85)

It is important to note that critical success factors are not indicators of performance themselves (e.g. Key performance indicators, KPIs). Critical success factors are elements that are crucial for an objective to be successful. Indicator of performance, for example key performance indicators, quantify the performance of objectives and makes measuring them possible. (Samsonowa T. 2011, p. 104) The performance measures and key performance indicators will be defined in the following chapter.

3.4 Performance measures and key performance indicators (KPIs)

By having a rigorous approach to managing performance in an organization, it soon becomes apparent that there is certain number of critical performance measures which are so important that they need to be monitored constantly. (Christopher M. 2016, p. 278)

Strategy Management Group (2021), a company specializing in strategic management systems, provides the following insights regarding KPIs: Key performance indicators establish an analytical foundation for decision-making and help the organizations to focus on details that matter the most. (SMG. 2021)

According to Parmenter (2007), many organizations are using wrong measures, many of which are falsely defined as key performance indicators (KPIs). Only few organizations are able to truly monitor their KPIs. The reason for this is that only few organizations, business managers, accountants and consultants have examined what a KPI truly is. There are three different types of performance measures: *1. Key result indicators (KRIs).* KRIs tell you how you have performed in a perspective. *2. Performance indicators (PIs).* Performance indicators tell you what to focus on and what to do when monitoring performance. *3. Key performance indicators (KPIs).* Key performance indicators tell you what to focus on and what to do to improve performance significantly. Often performance measures used by organizations is an inappropriate mix of these three different performance measure types. (Parmenter D. 2007, pp. 1-2) The three different performance measure types are illustrated with an onion analogy in the Figure 3 below.

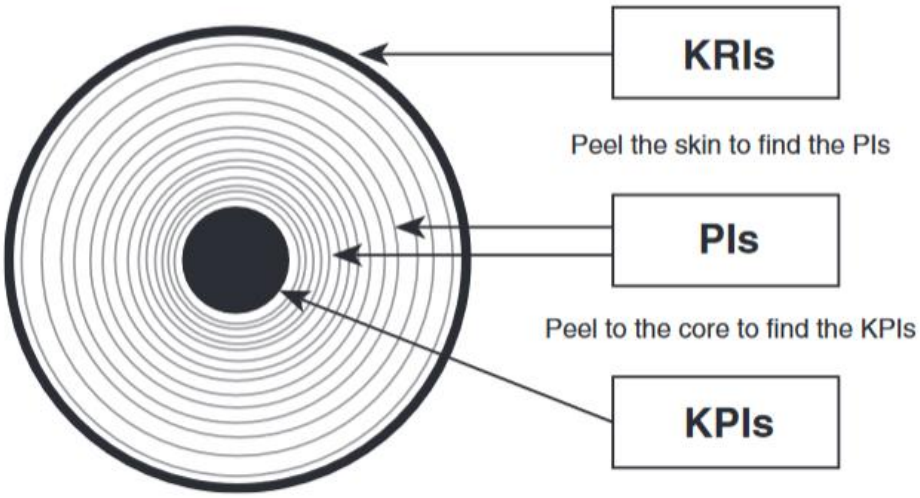


Figure 3. Performance measure types with an onion analogy (Parmenter D. 2007)

The onion analogy used by Parmenter (2007) describes the relationship between these three measures well. The outside skin layer shows the general condition of the onion. It shows how well it has received the required care, conditions, and nutrients. The skin is the KRI. When the skin is peeled, there is more information to be found. It shows what does the onion actually consists of. Maybe the skin was looking great, but after it is peeled you find more facts. Are there signs of negligence in the care of the onion that are not yet visible in the skin surface of the onion, but will be soon? The layers after the skin are the PIs. When you get to the core, the most important information about the onion's condition can be found. The core represents the KPIs. (Parmenter D. 2007, p. 2)

Parmenter (2007) elaborates that key results indicators (KRIs) that are often mistaken for KPIs include: *Customer satisfaction, net profit before tax, profitability of customers, employee satisfaction, return on capital employed.* What is common with these measures is that they are the result of numerous actions. The KRIs give an understanding of whether you are going in the right direction. But they do not give you information regarding what should you do to improve these results. The key results indicators provide information that is perfect for the board's needs, but not necessarily for those who work in day-to-day management. A good analogy for demonstrating this is a car's speedometer. The board will mostly be interested on what speed is the car going forward. The day-to-day management requires more information and understanding to operate, as the current speed of the car is the result of many factors: What

the current gear is, what are the revolutions per minute (RPMs) and so on. These are two completely different perspectives and the day-to-day management's gauges are PIs or KPIs. (Parmenter D. 2007, p. 2)

KRIs generally cover a longer period of time compared to KPIs; they are assessed per month/quarter/year, not on an hour/day/week basis as KPIs are. Separating KRIs from the other performance measures has a significant effect on reporting, which results the separation of performance measures into categories: Those which affect the governance, and those which affect the management. An organization should have a high-level KRI governance report (preferably in a dashboard format), consisting of up to 10 measures for the board. For the managers, there should be a balanced scorecard (BSC) consisting of up to 20 measures, which would be a mix of KPIs and PIs. In the middle of KRIs and the actual KPIs, there are many PIs which complement the KPIs. These are shown with the KPIs on the scorecard for the organization. PIs that are under KRIs could include: *Profitability of the top 10 % of customers, net profit on key products, Percentage increase in sales with top 10 % of customers, Number of employees participating in the suggestion scheme.* (Parmenter D. 2007, p. 3)

Key performance indicators (KPIs) are defined as a set of measures that focus on the aspects of organizational performance which are the most critical for the current and future success of the organization. A key performance indicator is a quantifiable performance measure that is used to assess or compare performance against meeting strategic and operational goals. (Parmenter D. 2007, p. 3) An approach to ensure the alignment between organization's strategic and operational goals would be to define key performance indicators based on critical success factors. (Jahangirian M. et al. 2017) The idea of KPIs is simple. It proposes that even if there are a great number of performance measures that can be deployed in an organization, there is a relatively small number of critical dimensions that contribute more than proportionately to success or failure in the marketplace. (Christopher M. 2016, p. 278)

Parmenter (2007) specifies seven characteristics of key performance indicators, which are based on an extensive analysis and discussions with over 1500 participants in his KPI workshops from different organization types in public and private sectors. The key performance indicator characteristics are: *1. Non-financial measures.* They are measures that are not

expressed in dollars, euros or in other currency. *2. Measured frequently.* They are constantly measured. For example, daily or around the clock 24/7. *3. Acted on by the CEO and senior management team.* The importance of key performance indicators is understood on the higher levels of the organization and they are also ready to make moves according to the situation. *4. Understanding of the measure and the corrective action required by all staff.* The entire organization understand what the key performance indicators mean and what should be done in various scenarios. *5. Ties responsibility to the individual or team.* The key performance indicators have an owner or many owners. *6. Significant impact.* For example, affects most of the core critical success factors and more than one Balanced Scorecard perspective. *7. Positive impact.* For example, affects all other performance measures in a positive way. (Parmenter D. 2007, p. 5)

The features of good KPIs according to Strategy Management Group are following (2021): 1. They show objective evidence regarding the performance against the desired goal. 2. They measure what has been intended to be measured, providing valuable input for decision-making. 3. They offer a structure, where the performance change can be assessed and compared over a longer time period. 4. They can track effectiveness, efficiency, quality, timeliness, governance, compliance, behaviors, economics, project performance, personnel performance or resource utilization. (SMG. 2021)

Practical examples of a results indicator (RI) and a key performance indicator (KPI) in the area of sales can be described as following: *Daily sales in dollars* is a RI, as this describes a result of activities that has already been taken and it is being measured from the financial perspective. *Number of sales meetings with key customers* is a KPI. KPIs go much deeper in recognizing activities that have significant impact on the desired outcome. As KPIs give critical information regarding achieving desired outcomes and objectives, they have to be monitored 24/7, daily, and in some cases weekly, to bring value for the organization. An indicator that is measured monthly or annually cannot therefore be described as a KPI. Something that is considered as a "key" for success should not be monitored when it is already too late to react. KPIs are current- and future-oriented measures as opposed to past measures (e.g. number of key customer meetings scheduled for next month). Typically, organizations are highly focusing on indicators

measuring past events and numbers from the last month or quarter. These indicators cannot be defined as KPIs. (Parmenter D. 2007, p. 6)

An effective performance indicator overview for an organization would consist of an optimal combination of KRIs, PIs, and KPIs. Kaplan and Norton recommended using 20 KPIs at maximum, Hope and Fraser suggest less than 10 KPIs. Parmenter (2007) proposes using a 10/80/10 rule as a good guide, which is: About 10 KRIs, up to 80 PIs, and 10 KPIs for measuring an organization's performance. Rarely would more measures be needed, and most of the organizations require much fewer than proposed. (Parmenter D. 2007, p. 8)

3.5 The process of defining objective-oriented KPIs

Defining detailed performance measures that provide vital information regarding the achievement of higher goals and objectives requires that the process of defining performance measures is started from the higher level. The method for defining performance measures utilized in this study is the top-down CSF/KPI framework used by Jahangirian M. et al. (2017) in their research "Key performance indicators for successful simulation projects". With the top-down CSF/KPI framework, the principal is to start from vaguer high-level strategic goals and objectives, then proceed step by step into more detailed descriptions and finally establish concrete grassroots-level operational performance measures. This approach enables the top-down connection between strategic objectives and operational activities. In other words, these concrete grassroots-level operational measures provide input for measuring goal attainment of higher-level strategic objectives. (Jahangirian M. et al. 2017) The top-down CSF/KPI framework used by Jahangirian M. et al. (2017) is illustrated in the Figure 4 below.

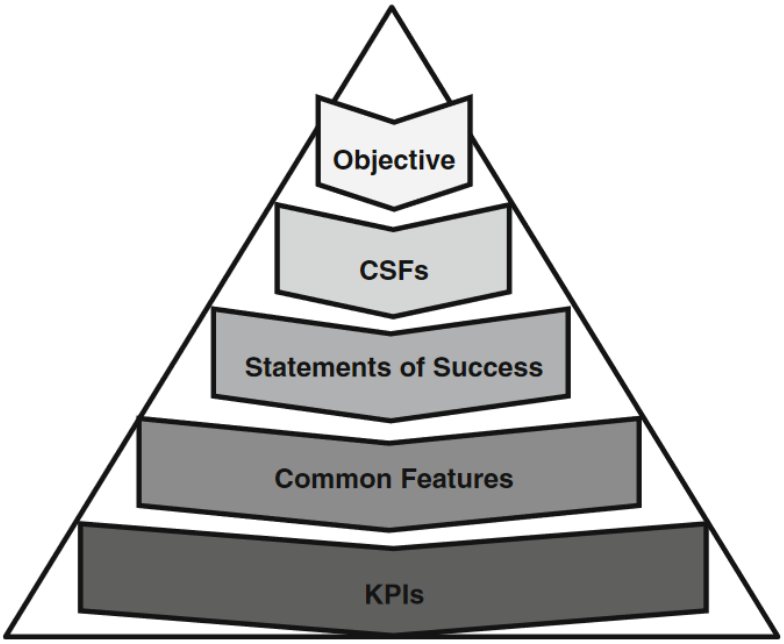


Figure 4. Top-down CSF/KPI framework (Jahangirian M. et al. 2017)

In the process of going through the CSF/KPI framework, examples of different stages will be created in the context of improving performance in an IT organization. The first step in the performance measure definition process, according to the framework pictured above, is to define the objective. This could be an organization or department level objective that is strategically important. (Jahangirian M. et al. 2017) As an example, in the context of improving performance in an IT organization, the defined objective is: *"To achieve higher productivity within the IT organization"*.

The second step is to define the critical success factors (CSFs), which represent the strategic focus areas related to the objective defined in the previous step. In the CSF stage of the framework, the objective is divided to a number of dimensions and success factors: "What are the factors that have to go right in order for the objective to be achieved?". (Jahangirian M. et al. 2017) In the context of improving performance in an IT organization, the CSFs are: *"Communication within the IT organization"*, and *"Use of time and resources within the IT organization"*.

After the CSFs have been determined, there are two interim steps (statements of success and common features) that are proposed in order to enable an informed path from CSFs to KPIs.

The third step is to define the statements of success related to the CSFs. This means: "What has to happen, in order to be successful from the critical success factor point of view?". This stage defines the statements which determine the success for each CSF defined in the previous stage, and provide us with more detailed information about each CSF. There can be as many statements of success as required. (Jahangirian M. et al. 2017) In the context of improving performance in an IT organization, the statements of success for the first CSF (Communication within the IT organization) are: *"There will be consistent communication between different stakeholders of the IT organization"* and *"The communication is effective within the IT organization"*. For the second CSF (Use of time and resources within the IT organization) the statements of success are: *"Waste of time and resources are minimized in the IT organization", "The members of the IT organization have optimal workload",* and *"The members of the IT organization are independent, and have the required knowledge, responsibility and competence to make decisions in their daily work".*

The fourth step is to define the common features. The common features characterize a limited number of features (maximum three) that are recognized to be common among the set of statements of success determined for each individual CSFs. The purpose of the common features is to transform a set of statements of success into a manageable set of criteria. (Jahangirian M. et al. 2017) As in this context and examples used, there are only a small number of statements of success determined. They can simply be transformed into different criteria in the following way. First, the common features will be determined for the first CSF (Communication within the IT organization). The first statement of success (There will be consistent communication between different stakeholders of the IT organization) can be transformed into a following common feature: *"Frequency of communication".* The second statement of success (The communication is effective within the IT organization) can be transformed into a following common feature: *"Communication effectiveness".* Next, the common features will be determined for the second CSF (Use of time and resources within the IT organization). The first statement of success (Waste of time and resources are minimized in the IT organization) can be transformed into a following common feature: *"Work efficiency"*. The second statement of success (The members of the IT organization have optimal workload) can be transformed into a following common feature: *"Work capacity"*. The third statement of success (The members of the IT organization are independent, and have the required

knowledge, responsibility and competence to make decisions in their daily work) can be transformed into a following common feature: *"Organization competence"*.

The fifth step is to define the KPIs. In their study, Jahangirian M. et al. (2017) strived for proposing up to three KPIs to cover different aspects of each CSF in the best way possible. The KPIs can be quantitative or qualitative. As quantitative KPIs are able to be measured and analyzed more easily, Jahangirian M. et al. (2017) approach in their study was to focus more on identifying optimal quantitative KPIs, but without ignoring the importance of qualitative KPIs and the importance of trying to understand ways to measure and analyze these. In the context provided and examples used, the KPIs that cover the first CSF (Communication within the IT organization) and its common features are the following: *"Average number of communications (any type) per week"*, and *"Level of communication effectiveness in the interaction between stakeholders (qualitative)"*. The KPIs that cover the second CSF (Use of time and resources within the IT organization) and its common features are the following: *"Work hours lost per week (due to problems in resourcing, errors etc.)"*, *"Average capacity in use (%) per week",* and *"Number of decisions requested from a higher organization level per week (supervisor, manager etc.)"*. The example of process of defining IT organization's KPIs with the CSF/KPI framework (Jahangirian M. et al. 2017) demonstrated in the chapters above is illustrated in the Table 2 below.

Table 2. Example of defining IT organization's KPIs using Jahangirian M. et al. (2017) CSF/KPI framework

Objective	CSFs	Statements of success	Common features	KPIs
To achieve higher productivity within the IT organization	Communication within the IT organization	There will be consistent communication between different stakeholders of the IT organization	Frequency of communication	Average number of communications (any type) per week
		The communication is effective within the IT organization	Communication effectiveness	Level of communication effectiveness in the interaction between stakeholders (qualitative)
	Use of time and resources within the IT organization	Waste of time and resources are minimized in the IT organization	Work efficiency	Work hours lost per week (due to problems in resourcing, errors etc.)
		The members of the IT organization have optimal workload	Work capacity	Average capacity in use (%) per week
		The members of the IT organization are independent, and have the required knowledge, responsibility and competence to make decisions in their daily work	Organization competence	Number of decisions requested from a higher organization level per week (supervisor, manager etc.)

As pictured in the table above, the statements of success and common features bring structure in defining the KPIs and ensure that different angles that affect performance are covered for the CSFs. Typically, when using this framework, as if there were more statements of successes defined, many statements of successes could be combined as one common feature (discussed in the chapter above, introducing step four) It should also be understood that the framework does not limit the amount of objectives used, and this would depend on the needs and requirements of the organization. More objectives would generate a larger table with a bigger set of CSFs and KPIs. The example of connection between IT organization's KPIs and the objective is illustrated in the Figure 5 below.

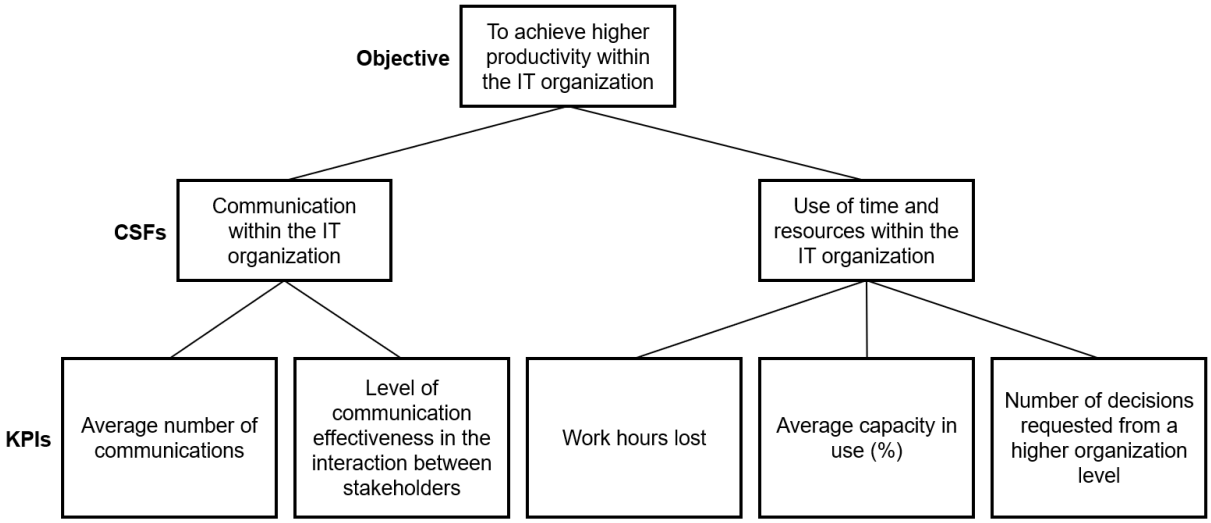


Figure 5. Example of connection between IT organization's KPIs and the objective

As pictured in the figure above, the CSF/KPI framework (Jahangirian M. et al. 2017) ensures that the KPIs that are measured frequently actually connect with the objectives set by the organization. When the CSFs and KPIs are properly defined using this method, focusing on these KPIs, analyzing the data, and making decisions to improve them will have a direct positive effect in reaching the objectives which the organization has set.

This study focuses mainly in defining objectives, CSFs and KPIs, but in order to develop KPIs from CSFs, the statements of success and common features have to be defined inevitably in order to establish KPIs that are strongly and accurately linked to CSFs, and therefore also to the organization's objectives.

3.6 The Balanced Scorecard (BSC)

The balanced scorecard (BSC) was first introduced 1992 in Harvard Business Review management journal. It is an extensive framework targeted to managers, which translates organization's strategic objectives into a coherent set of performance measures. The balanced scorecard is a management system which is able to drive breakthrough improvements in organization's critical areas such as products, customers, processes, and market developments. The scorecard sets four different perspectives which to choose measures from: *1. Traditional financial indicators (How do we look to shareholders?), 2. Customers (How do customers see*

us?), 3. Internal processes (What must we excel at?), and 4. Innovation and improvement activities (Can we continue to improve and create value?). The organizations typically have a comprehensive set of local performance measures being monitored in different areas of the organization, but these local performance measures are typically bottom-up measures derived from the processes. The balanced scorecard has a different approach: The measures are grounded in the organization's strategic objectives and competitive demands. It also requires managers to choose a limited number of critical performance indicators within each of these four perspectives, which increases the focus on the strategic vision of the organization. The challenge with using only traditional financial measures is that they report on what happened last period without demonstrating how managers could improve the performance in the next. The BSC functions as a management system which establishes an overview of organization's current and future success. In addition to the conventional metrics typically used by the organizations, the BSC provides balance between external measures such as operating income and internal measures such as new product development. The balanced set of measures also reveal the trade-offs that the managers have already made among performance measures and encourages the managers to achieve their goals in the future without making trade-offs among key success factors. (Kaplan, R. & Norton, D. 1998)

The BSC is not a template that can be applied as it is to businesses in general or even industry-wide. As there are differences in market situations, product strategies, and competitive environments, these require customized scorecards. Different business units plan their own customized scorecards to fit their mission, strategy, technology, and culture. One of the most critical tests of a BSC's success is its transparency: an observer should be able to see through to the business unit's competitive strategy from the 15 to 20 scorecard measures used. Rockwater's application of the balanced scorecard will be presented as a practical real-world example. Rockwater is a global engineering and construction company, leading in underwater engineering and construction. At the time, Rockwater's management had noticed that the competition in the industry had become keener and the smaller players had left the industry. This meant that the customers of the company were shifting to emphasize importance for developing long-term, valuable, and satisfying relationships with their suppliers over choosing suppliers based on low-price. Based on this, the management developed the following vision: To be the customers preferred partner and be the industry leader providing highest standards of

safety and quality to the clients. They also defined a strategy with five elements to implement the vision: 1. Services that surpass customers' expectations and needs, 2. High levels of customer satisfaction, 3. Continuous improvement of safety, equipment re-liability, responsiveness, and cost effectiveness, 4. High-quality employees, and 5. Realization of share-holder expectations. These elements were further processed into strategic objectives. (Kaplan, R. & Norton, D. 1998) The Rockwater's strategic objectives are pictured in the Figure 6 below.

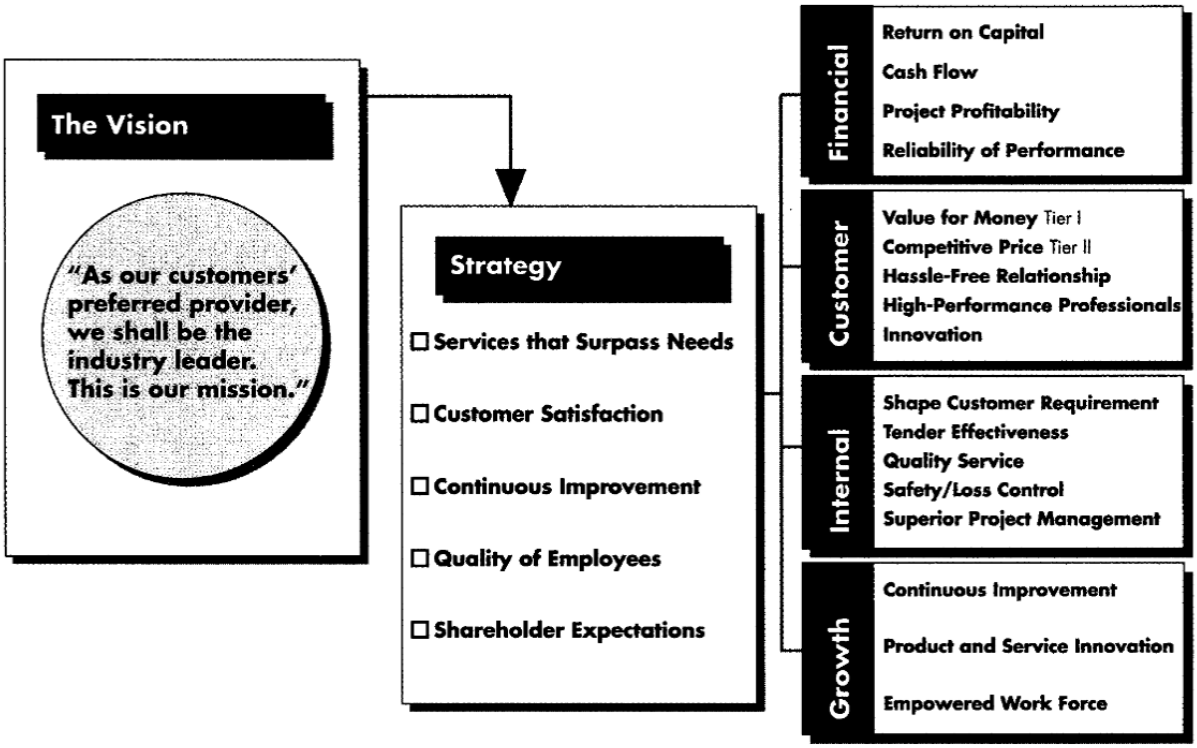


Figure 6. Example organization's (Rockwater) strategic objectives (Kaplan, R. & Norton, D. 1998)

The strategic objectives were then transformed to balanced scorecard's four sets of measures: financial perspective, customer perspective, internal business perspective, innovation and learning perspective. Rockwater's balanced scorecard measures are illustrated in the Figure 7 below.

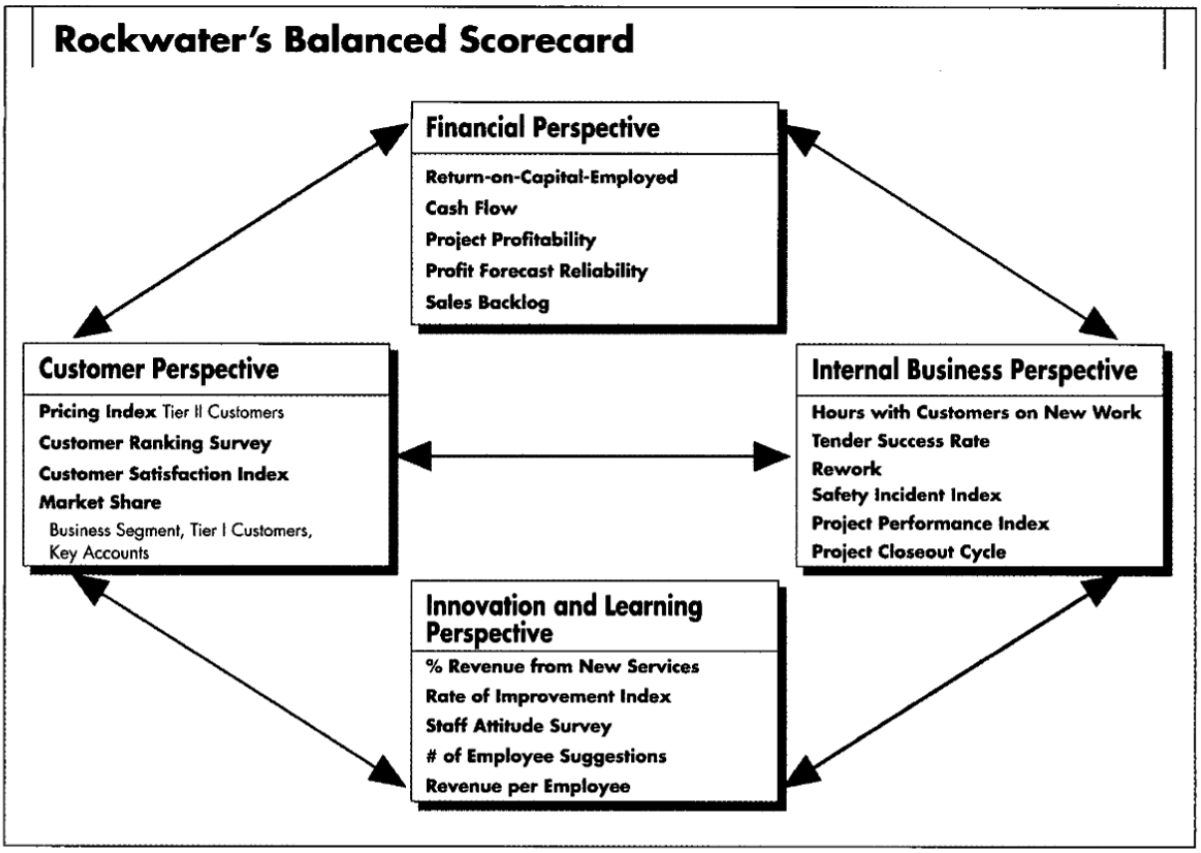


Figure 7. Example organization's (Rockwater) Balanced Scorecard (Kaplan, R. & Norton, D. 1998)

The *financial perspective* consists of three important measures considering the shareholders. Return-on-capital-employed and cashflow focus on short-term results, profit forecast reliability shows the desire to reduce the historical uncertainty caused by unexpected variations in performance. The company's management added two more financial measures. Project profitability focuses on the project as the basic unit for planning and control, with sales backlog helping reduce uncertainty of performance. With the *customer perspective*, the company needed to identify the distinction between its two types of customers: Tier 1 customers, oil companies that desired a high value-adding relationship, and Tier 2 customers, the ones that chose service providers purely based on low-price. The pricing index incorporates the best available intelligence on competitive position and was added to ensure that the company could retain the Tier 2 customers' business when required by competitive conditions. The company focused on increasing value-based business. They used an annual customer ranking survey performed by an individual organization to compare its services against competitors. With Tier 1 customers, they were asked to fill in monthly performance and satisfaction surveys. The management of the company recognized that these ratings would give them a direct tie to their customers and

a high level of market feedback to be used for directing business into the right direction. As the last measure, market share by key customers were chosen to provide objective evidence that improvements in customer satisfaction were being translated into tangible benefits. With *internal business perspective*, in order to develop and improve the measures of internal processes, the company's management defined the lifecycle of a project from start (need is recognized) to finish (need is satisfied). Performance measures were defined for each of the five business process stages in the project cycle which consisted of the following stages: *1. Identify, 2. Win, 3. Prepare, 4. Perform, and 5. Closeout.* The stages of the project cycle are illustrated in the Figure 8 below.

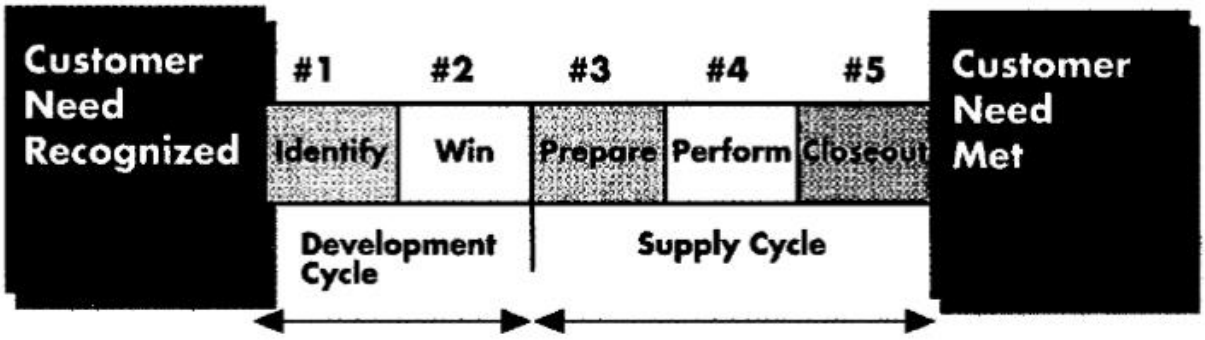


Figure 8. Example organization's (Rockwater) project cycle stages, BSC internal business perspective (Kaplan, R. & Norton, D. 1998)

The measures defined to the balanced scorecard's internal business perspective based on each project cycle stages were the following. *Identify:* number of hours spent with prospects discussing new work. *Win:* tender success rate. *Prepare and Perform:* project performance effectiveness index, safety/loss control, rework. *Closeout:* length of project closeout cycle. Before implementing BSC, Rockwater was focusing on the performance of each functional department. With the new approach, the focus was directed towards measures that integrated key business processes. The development of an extensive and accurate index of project performance effectiveness was seen as a key core competency for the organization. Safety was also recognized as a key competitive factor and this aspect was added to the internal measures. With *innovation and improvement,* the company's management targeted that the innovation and learning objectives would drive the improvement in the financial, customer and internal process performance. In the company, this kind of improvements came from product and service innovation and they would create new sources of revenue and market expansion, and also from

the continuous improvements performed in the internal business processes. The first target was measured by percent revenue from new services and the second target by a continuous improvement index which represented the rate of improvement of several key operational measures (i.e. safety and rework). In order to drive both product/service innovation and operational improvements, having a strong workforce of motivated employees were recognized to be crucial for success. A staff attitude survey and a metric for the number of employee suggestions measured were added to the scorecard to indicate if the targeted workforce was being created. As the final measure, revenue per employee measured the results of employee commitment and training programs. This balanced scorecard supported the company's management have a focused process overview of operations, boost motivation in their employees, and incorporate client feedback into the operations. It also brought the emphasis on the importance of creating long-lasting partnerships with key clients from the strategic level into practice. (Kaplan, R. & Norton, D. 1998)

3.7 Strategy map

In order to implement and execute a strategy, the whole organization and the people involved have to understand it. This includes understanding the important but complex processes which turn intangible assets to tangible outcomes. A strategy map can be used as a tool to overcome this challenge by illustrating the strategy in a visual form and using this picture to communicate it. This provides the people of the organization a clear vision on how their work is being linked to the organization's overall objectives and enables them to focus towards the organization's desired goals. Strategy map is a concept introduced by Kaplan and Norton (2000) and is considered as a supporting component for the balanced scorecard. (Kaplan, R. & Norton, D. 2000)

Traditionally, companies have focused mainly on tangible assets (i.e. raw materials, factories and machines etc.) to create value. As time has passed, the importance of intangible assets (i.e. employee knowledge, information technology, innovation, problem solving, and corporate culture) has been recognized. In the traditional version, the strategy could be described and documented using financial tools such as general ledgers and balanced sheets, but even though intangible assets have started to play a major role in creating a competitive advantage, no tools

have existed to define them and the value they create. One of the biggest challenges is that the value of intangible assets depends on the company's strategy and on the organizational context. As an example: A sales strategy which focuses on growth could require knowledge about their customers, training for their sales-people, information systems and tools, change in company culture, and an incentive-based compensation program. By investing into one or just some of these objectives, but not all, would cause the sales strategy to fail. The value of an intangible asset such as an information system cannot be considered separately from the company's processes, which will transform the information system and other assets into customer and financial outcomes. The value does not come from any single intangible assets. The value comes from a vast collection of different assets and from the strategy which links them together. (Kaplan, R. & Norton, D. 2000)

The balanced scorecard was built by Kaplan and Norton (1998) in an effort to capture how different organizations create value in the information age. The balanced scorecard measures company's performance from four most important perspectives: financial perspective, customer perspective, internal processes perspective, and learning and growth perspective. The balanced scorecard simply presents the knowledge, skills, and systems that the organization's employees need (learning and growth perspective) in order to innovate and build the correct capabilities and efficiencies (internal process perspective), that deliver specific value to the market (customer perspective), which in the end will lead to higher shareholder value (financial perspective). After Kaplan and Norton introduced the balanced scorecard concept and after working with countless of management teams from different organizations, they noticed certain similarities and patters which helped them develop a common visual framework: the strategy map. The strategy map takes different items from the organization's balanced scorecard and sets them into a cause-and-effect chain, connecting the organization's desired outcomes with the drivers of those results. The strategy maps were developed for different organizations in various industries by Kaplan and Norton, and from this experience, a standard template was developed. This standard template built for the executives, so that they could develop their own strategy map. (Kaplan, R. & Norton, D. 2000) An example of the strategy map for company Mobil, which was shown in a Harvard Business Review article from 2000/09 "Having trouble with your strategy? Then map it.", is illustrated in the Figure 9 below.

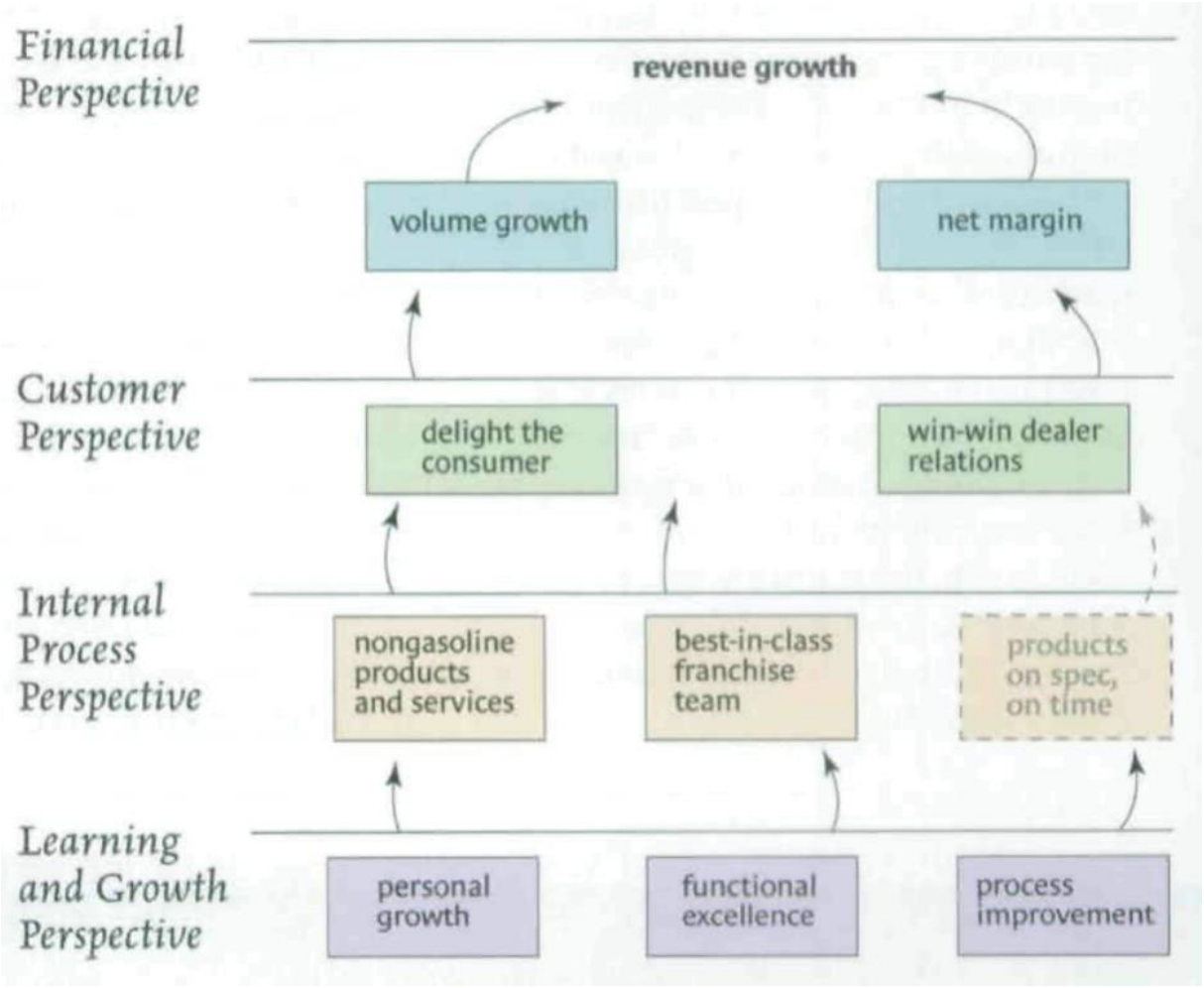


Figure 9. Strategy map example, Mobil (Kaplan, R. & Norton, D. 2000)

As shown in the figure above, the template consists of the same perspectives as the balanced scorecard (financial perspective, customer perspective, internal process perspective, and learning and growth perspective). The strategy map can be used as an effective tool to support the company in finding the major gaps in their strategies when they are implemented in the lower levels in the organization. In the above example, the strategy map which was developed for one of the company Mobil's business units, the senior executives realized that this business units had no objectives or metrics for the dealers. Had the business unit discovered how to bypass the dealers and sell their gasoline directly to their consumers? They did not, but the strategy map defined helped them notice this deficiency and to act on it. (Kaplan, R. & Norton, D. 2000)

4 CASE: PUBLIC CLOUD PERFORMANCE MANAGEMENT FRAMEWORK FOR BUSINESS

This chapter presents the case by the case company to provide an extensive understanding about the current state of their customers and their needs regarding public cloud performance management. The purpose of this chapter is to provide a starting point for solving the challenge which the case company's customers have regarding public cloud performance management. This is done by defining the relevant aspects and important details for solving the challenge, introducing the public cloud utilization areas where the solution for the challenge will be approached from, and by defining the method for building the solution based on the current state and the knowledge and best practice defined in the theoretical section (chapters 3 and 4).

This chapter consists of the following sub-chapters: *1. Case introduction and the challenge*, providing background and details of the challenge which is processed in the study. *2. Public cloud utilization areas*, introducing the public cloud utilization areas defined by the case company (Data on Cloud, Infrastructure Modernization, Application Modernization). The public cloud utilization areas form the three different aspects of public cloud performance and the public cloud performance management framework will be defined for each of these areas. *3. Method for defining the performance management framework*, defining how the solution (public cloud performance management framework) for the case company's challenge will be built and what methods are used in the process.

4.1 Case introduction and the challenge

The case company is an IT management and solution services company offering public cloud services to its customers. This includes offering expert services for planning, developing and operating public cloud, as well as providing a public cloud platform and other technical capabilities. The case company's customers are in different stages in terms of utilizing public cloud. Some of the customers are already fully operating with public cloud, using a platform offered by the case company or procured from another service provider. Maturity of the public cloud operations in the customer organizations vary, from unstructured and ad-hoc low maturity

operations to efficient, highly defined, and systematic high maturity operations. On the other hand, some of the customers are still in the beginning of their public cloud journey. This means either being in the planning stages of public cloud (assessing if the public cloud model is optimal for their business, building business case for public cloud, defining a roadmap), or being in the various stages of the implementation of public cloud (testing and building stages).

Regardless of the stage or challenges the customer is facing with public cloud, the case company strives to add value by providing public cloud expertise to the customer to solve problems and increase efficiency related to the public cloud. The decision of implementing public cloud into the organization is in most cases made based on the benefits the public cloud offers in comparison to the current model the customer is operating. Few of the main questions the customers face when utilizing or planning to utilize public cloud in their business are: *1. "How do we know if the public cloud is bringing the actual benefits planned for our organization?", 2. "What is public cloud performance and how does it divide into different areas within the organization?", 3. "How should we manage public cloud performance?"*. Traditionally, costs have been one of the main and most followed indicators of public cloud performance used in organizations. Implementing a public cloud model typically brings in more capabilities into organization's use compared to the model utilized formerly by the organization. For this reason, managing the public cloud performance only from the cost perspective might not be optimal. As there are more possibilities for value to be created in the organization with public cloud, utilizing these added capabilities might increase the costs of public cloud. However, this also means that more value is created for the organization with these added capabilities. In this scenario, when the organization compares the costs of the former model and the public cloud model, they might see the public cloud model as inefficient if the costs of public cloud model are close to the former models costs, or if the costs are even higher compared to the former model. As there are more possibilities with public cloud to realize value in the organization, the conclusion regarding this is that the costs should not be the only perspective in managing public cloud performance, if more benefits are desired and received compared to the former model. In order to have an accurate overview of the public cloud performance in the organization, it is important to focus on what value is being created (in relation to the costs) in the organization with public cloud and how can this value be measured.

There is a clear need for the case company to provide expertise for their customers regarding public cloud performance management: *1. Customers need ways to manage and measure that the public cloud benefits are realized. 2. Customers need a holistic understanding regarding how public cloud performance management divides into different public cloud utilization areas. 3. Customers need a framework for managing public cloud performance, consisting of objectives, critical success factors (CSFs), and key performance indicators (KPIs) customers should be focusing on in different public cloud utilization areas, to manage public cloud performance.* The current state of public cloud performance management is that there is a vast number of different public cloud performance indicators and measurement systems available, but these focus mainly on the technical and service provider perspectives of public cloud performance. The knowledge available regarding the technical and service provider perspectives include performance metrics and indicators for technical public cloud functionality, such as response times, bandwidth, capacity etc. The knowledge available does not offer answers for the customer organizations on how to manage public cloud performance in the different public cloud utilization areas, in order to realize the business benefits, they are striving to achieve by utilizing public cloud. Public cloud is still relatively new concept being adapted into business organizations, but the demand for maximizing the benefits and performance of the public cloud is rapidly growing, as various types of organizations and needs are making the transition to public cloud. At this moment, the customers are procuring public cloud solutions from service providers and the service providers typically offer practices and tools to monitor the performance of public cloud from the technical perspective. The customers have challenges on understanding how these technical public cloud performance metrics and indicators translate to business benefits in the customer organization. The business perspective of the public cloud performance is often left for the customer organization to define. In most cases this is on the customer organization's agenda, but without former experience of managing public cloud and similar solutions, this can turn out to be a challenging task. As a result, different organizations have different approaches to the public cloud performance from the business perspective, but a commonly proven approaches and frameworks are still missing.

What the case company's customers need is a business-oriented public cloud performance management framework which focuses on the value that the public cloud brings to the business. The customers would use this performance management framework and the information

derived from it to monitor and develop the public cloud performance in order to maximize business benefits which it offers. This performance management framework provides value to the customers in the form of having an overview on public cloud performance in the different public cloud utilization areas, having visibility to how public cloud's performance affects business, and being able to optimize public cloud performance and capabilities in relation to costs.

In this study, a performance management framework will be defined as an answer to this need. The performance management consists of a collection of performance measures, consisting of objectives, critical success factors (CSFs), and key performance indicators (KPIs). Public cloud performance measures are defined for each public cloud utilization area. These performance measures establish a foundation for public cloud performance management from the business perspective for the different public cloud utilization areas.

The defined performance management framework and its performance measures for different utilization areas provide answers for customers to questions: *1. "What are the objectives of public cloud performance in different utilization areas?", 2. "What are the critical success factors in different utilization areas?", and 3. "What are the key performance indicators in different utilization areas?"*. The public cloud performance management framework is illustrated in the Figure 10 below.

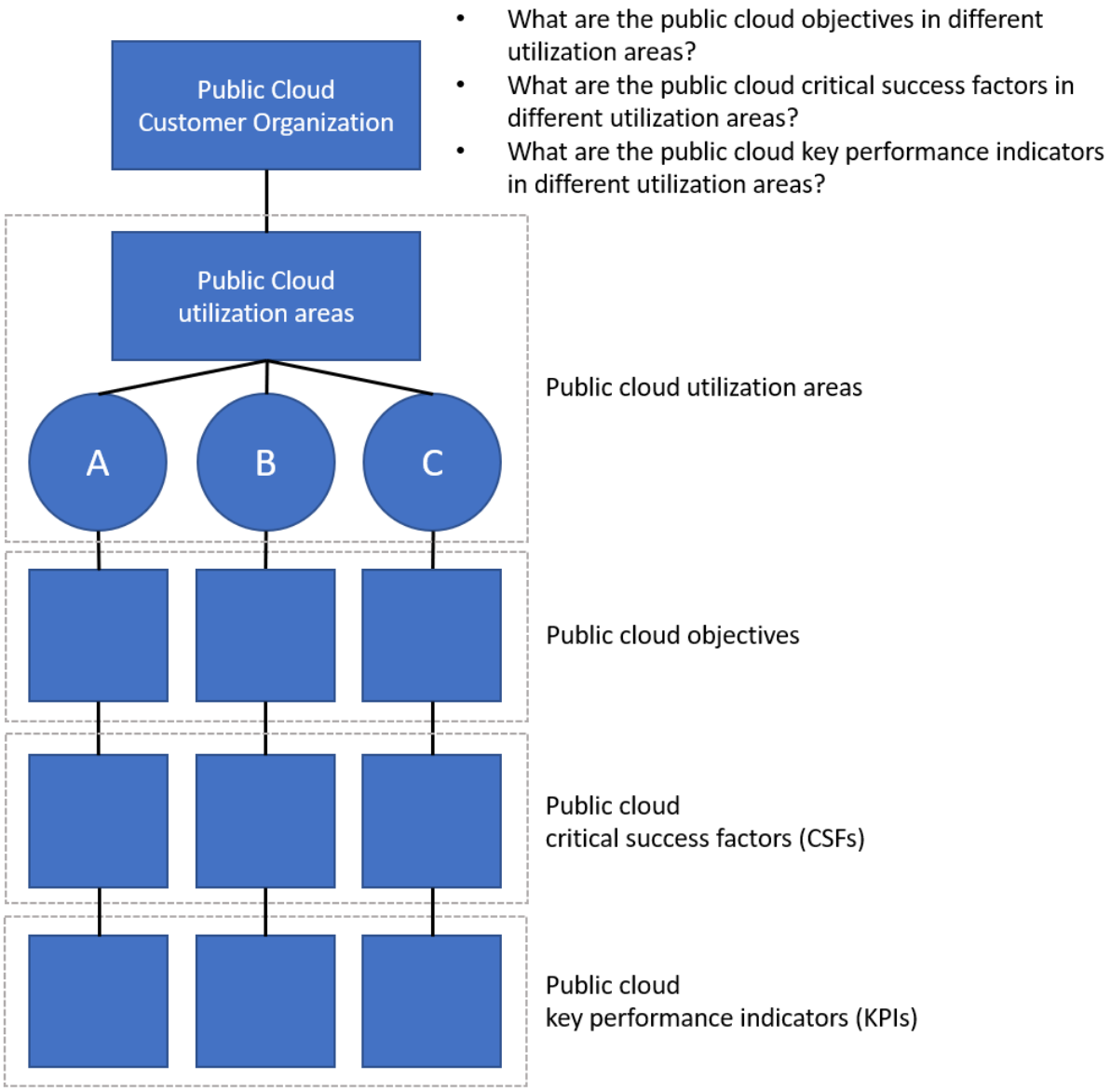


Figure 10. Public Cloud Performance Management Framework for Customer Organizations

By understanding the different public cloud performance utilization areas, the customers are able to understand the most important objectives and critical success factors of public cloud in terms of performance. The customers are also able to manage the performance by monitoring the public cloud key performance indicators and use this information to identify the current challenges and bottlenecks within the public cloud, in order to develop the public cloud performance to a higher level.

4.2 Public cloud utilization areas

In order to manage public cloud performance, it has to be understood how the public cloud provides value in its different utilization areas. Different public cloud utilization areas offer different capabilities for the customers and provide value in different ways. Based on the experience of working with customers, the case company has defined the most important public cloud utilization areas, which are Data on Cloud, Infrastructure Modernization, and Application Modernization. The public cloud utilization areas defined by the case company are pictured in the Figure 11 below.

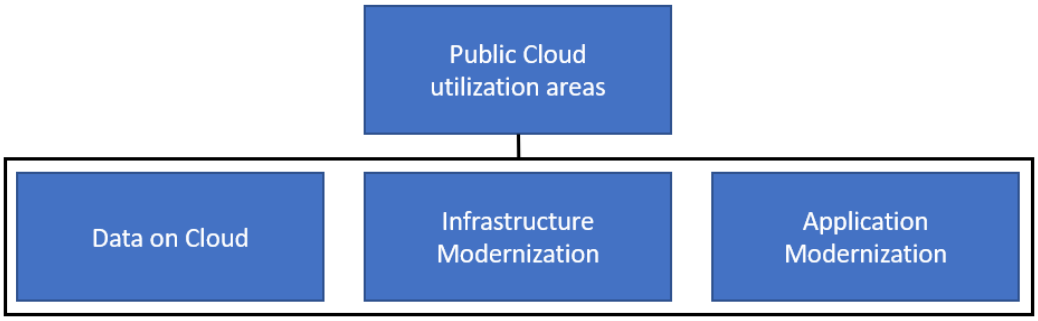


Figure 11. Public cloud utilization areas defined by case company

Data on Cloud utilization area covers data creation and data refinement (target is to create high quality data for business as a source of insight and decision-making), data management (efficient data management and data storage) and data utilization (tools and processes for providing data insights for the business) capabilities required in the customer organization. Before public cloud, customer organizations have typically utilized third-party service providers, or in some cases customer organization's own solutions to manage and process data. The basic principles for performance of data apply also in public cloud. The public cloud offers the possibility to create, manage, and utilize data from the same environment providing a more centralized approach giving customers good visibility on data, and tools to control the data processes as well as performance in public cloud data utilization area.

Infrastructure Modernization area includes hardware and software elements which form the technical business and IT infrastructure required in the customer organization, such as computing capabilities, servers, memory and storage clusters, and enterprise resource planning

(ERP) systems. In most cases, customer organizations making the transition to public cloud have operated using an infrastructure which is partly self-operated and self-managed and has been partly procured from third-party service providers. Making the infrastructure transition to public cloud means starting to provide infrastructure capabilities (fully or partly) for the organization's business to use. The most important benefit which public cloud infrastructure offers is for customers to be able to increase agility and scale the infrastructure capabilities received from the public cloud according to their business needs. If the public cloud infrastructure capabilities are running on a high level continuously, this can significantly increase the costs of the infrastructure. This should be one of main focus areas of performance in the public cloud infrastructure utilization area.

Application Modernization consists of migrating applications (business and other) which are required in the customer organization into public cloud. As customer organizations typically have a vast amount of applications in use, and in some cases even developed in-house for business and support functions, it needs to also be considered which applications should be migrated into the cloud and which should not. When planning and making the transition of applications into the public cloud, this would be an optimal time for the organizations to consider if the applications should be rehosted, rebuilt or entirely replaced. The public cloud offers various capabilities for hosting, building, and replacing applications for the customer. It can also offer great tools to manage and monitor the application processes and means to manage its performance. In the public cloud application utilization area, in order to manage the performance it is important to understand how the different aspects of application management bring value to the business and how do different aspects of application management affect the performance in terms of costs and efficiency.

4.3 Method for defining the performance management framework

The performance management framework defined in this study consist of individual sets of performance measures defined for each public cloud utilization area (three sets of performance measures). The performance measures are defined by using Jahangirian M. et al Top-down CSF/KPI framework (2017) described in the chapter 3.5 *"The process of defining objective-*

oriented KPIs". The performance measures are defined together with case company's public cloud experts using this method. The collaboration is done using interviews. The interviews consist of defining the following for each public cloud utilization area: objectives, CSFs, statements of success, common features, and KPIs. The end-result of this study focuses on establishing the objectives, CSFs, and KPIs for each public cloud utilization area, which form the performance management framework for public cloud for the customers. In the interviews, the statements of success and common features are used as tools in the process of defining the KPIs, ensuring that they are linked to CSFs (defined in chapter 3.5). By ensuring that KPIs are linked to CSFs, this means that there is a strong connection between KPIs and the objectives.

When the case company's public cloud experts are interviewed, and the goal is to build the performance measures based on the experience and knowledge the public cloud experts have on a specific utilization area. The case company's experts have experience on different areas of public cloud. Each set of performance measures for each public cloud utilization area are built with the experts who have significant knowledge and experience on that specific public cloud utilization area. The interviews are conducted using an expert interviews template (Appendix 1) which covers the following contents: *1. Objectives of this interview (goals set for the interview), 3. Public cloud utilization areas (presenting the public cloud utilization areas this study is focusing on), 4. Method used for defining performance management (presenting the method for defining the performance measures), 5. Defining performance management for performance utilization area X (defining the performance measures for the specific utilization area), 6. External knowledge (the external material gathered to support and complement the defining of performance measures for the specific public cloud utilization area).*

In the interviews, experts with different profiles provide inputs from different backgrounds for defining the performance measures for different public cloud utilization areas, as different roles and experience with the subject provide different type of insights and point-of-views. The interviews performed are highly focused on the defining of the performance measures for the certain public cloud utilization area. The performance measures are defined using the experience and knowledge of the public cloud experts, with the support of Top-down CSF/KPI framework (Jahangirian M. et al. 2017). After a draft of the performance measures has been defined for a specific public cloud utilization area, a set of external knowledge gathered are

reviewed together with the experts. The external knowledge consists of information regarding performance measures and other highly relevant content to support the finalization of the performance measures defined with the experts. The external knowledge is gathered from the internet using key words relevant for the study and choosing the knowledge from most reputable and up-to-date sources. After the external knowledge has been reviewed with the experts, the draft of the performance measures are finalized with the support of this external knowledge, identifying, and adding important aspects of performance and measures that were missed when creating the draft. Why this is performed in this order (first forming a draft of the performance measures on a specific public cloud utilization area with the experts, second using external knowledge to complement the finalization of the performance measures), is to enable out-of-the-box thinking and creativity from the experts to freely identify the most important aspects of performance regarding these utilization areas from business perspective. And only after this stage, enabling the experts to look into the external knowledge to see and identify if something crucial has been missed and should be added to the performance measures defined. This way using the external knowledge supports the high quality of the outcome, without restricting the creativity of the experts in the process of defining performance measures. The expert interviews process is described in the Figure 12 below.

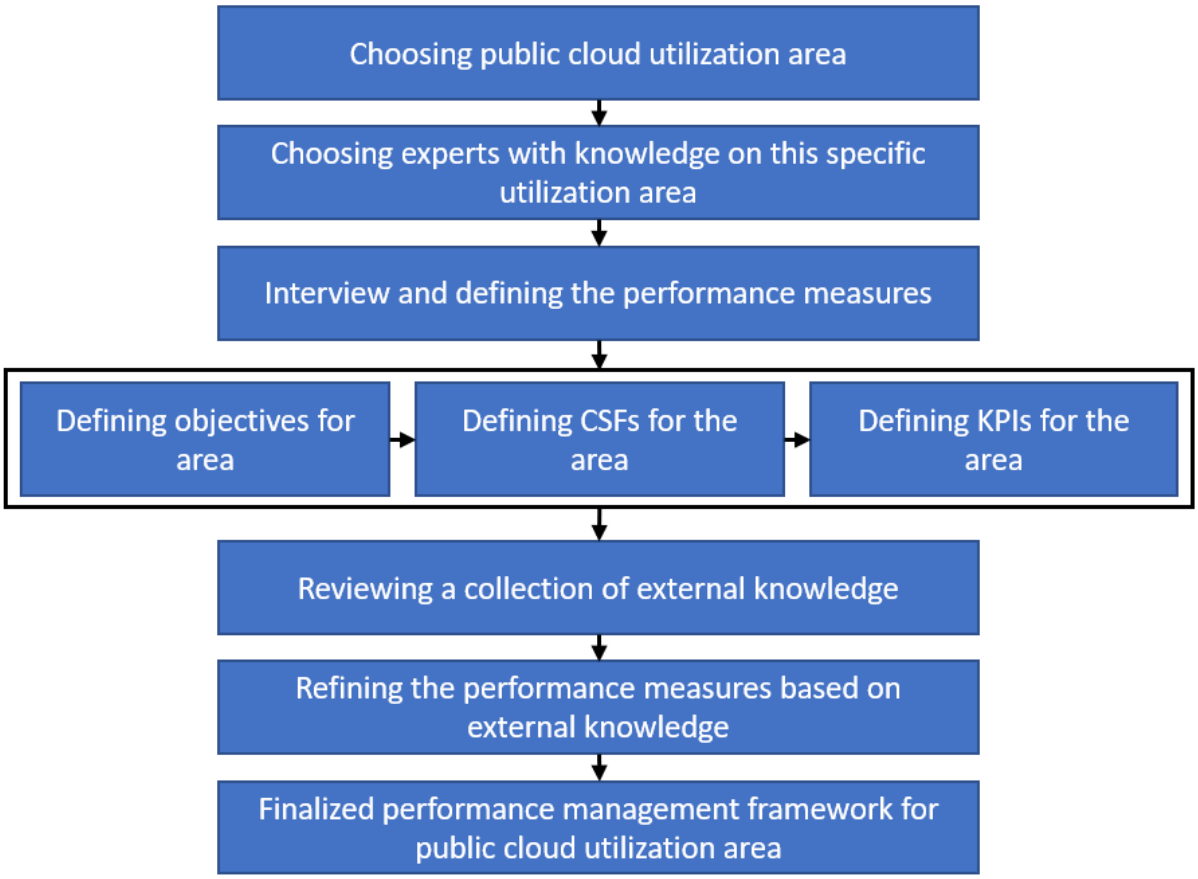


Figure 12. Expert interviews and performance measures defining process for public cloud utilization areas

In the interviews, the objectives, critical success factors (CSFs), statements of success, common features, and key performance indicators (KPIs) are defined for each public cloud utilization area. As the end-result, in order to make the framework more simplified, this study presents the public cloud performance management framework for business, which consists of objectives, critical success factors (CSFs), and key performance indicators (KPIs), leaving out the statements of success and common features used in the Jahangirian M. et al 2017 performance measure definition method. As an there are three sets of performance measures in total which form the public cloud performance management framework to be used by customer organizations. After the performance measures have been finalized for each public cloud utilization area, a strategy map is defined based on the objectives that have been defined from each utilization area. The purpose of the strategy map is to build an illustration of logical, cause-and-effect connection between the objectives. The strategy map is one of the elements of the balanced scorecard (BSC) methodology (described in chapter 3.6 *"The Balanced Scorecard*

(BSC)”.), and it helps to visualize how value is created by the organization. The strategy map is formed based on interviews with the case company experts after the performance measures have been defined and finalized for each public cloud utilization area.

5 DEFINING PUBLIC CLOUD PERFORMANCE MANAGEMENT MEASURES FOR PUBLIC CLOUD UTILIZATION AREAS

This chapter focuses on the work that was performed in order to form the performance measures (objectives, critical success factors, statements of success, common features, and KPIs) for each public cloud utilization area (Data on Cloud, Infrastructure Modernization, and Application Modernization). The work that was performed consisted of case company expert interviews supported by knowledge and best practice researched and gathered for this study (including external knowledge used in the interviews for refining the defined performance measures), and the insights and conclusions regarding each public cloud utilization area and the defined performance measures are described in detail in the chapters below.

This chapter establishes the foundation of knowledge regarding performance measures for each public cloud utilization area, which is required for building the performance management framework for business. In addition, the knowledge formed in this chapter is used for building the public cloud performance management strategy map which is a complementing addition to the results of study (the building process of the strategy map was supplemented with additional case company interviews, and insights focusing on the strategy map are described in detail in chapter 6.2). The finalized versions of the performance management framework for each public cloud utilization areas, among the strategy map, are presented in chapter 6 (Results: Public cloud performance management framework for business and strategy map).

This chapter consists of sub-chapters focusing on each public cloud utilization area separately and presenting the performance measures for these areas. The insights formed with case company experts are presented within each of these chapters, and the different utilization areas are again divided into sub-chapters based on the different objectives defined for each utilization area (e.g. 5.1. Data on Cloud, which is the utilization area, and 5.1.1 Gain value for business by moving data capabilities into public cloud, which is an objective for the Data on Cloud utilization area). The performance measures (objectives, critical success factors, statements of success, common features, and KPIs) are then discussed under the objective, which the performance measures are connected to.

The chapter consists of the following sub-chapters which are based on the public cloud utilization areas defined by the case company: *1. Data on Cloud. 2. Infrastructure Modernization. 3. Application Modernization.* The chapters below summarize the discussions and conclusions established in the case company interviews and provides overview on the insights received and additions made from the external knowledge research gathered for the public cloud utilization areas (the process for defining the performance measures is described in detail in chapter 4.3).

5.1 Data on Cloud

For defining Data on Cloud performance management framework, 5 public cloud experts from the case company were interviewed. Based on the expert interviews, the main organizational goal for managing data in public cloud is to create, manage, refine, and provide valuable data for business. This means that the whole pipeline, from the beginning to the end, is managed effectively and efficiently by public cloud from the moment data is captured or created to the moment of use. This also means that the data which is being created and managed in the organization fits for the use of business and can be used as a source of insight and decision-making to provide value.

5.1.1 Gain value for business by moving data capabilities into public cloud

As the first objective for Data on Cloud utilization area, the case company experts defined *Gain value for business by moving data capabilities into public cloud (PC).* This is defined as the first objective, because this commits the organization to make the transitioning of data capabilities into public cloud based on the value it offers (the transition into public cloud should not be if there is no value to be gained for the organization). The currently used and planned to be acquired data capabilities should be assessed against data capabilities offered by public cloud. If it is evaluated that value can be gained by transitioning data capabilities into public cloud, then those capabilities should be transferred into public cloud, and the actual transition process can start. The first objective with its CSFs, statements of success, common features,

and KPIs are shown in the table 3 below. The details of the defined performance measures are elaborated after the table.

Table 3. Data on Cloud performance measures defined by experts, 1st objective

Objectives	CSFs	Statements of success	Common features	KPIs
Gain value for business by moving data capabilities into PC	PC benefits for data capabilities	Those data capabilities which benefit business by being transferred into PC are transferred into PC	PC data capabilities potential for business	Data capabilities which would benefit business if transferred into PC vs. those data capabilities transferred into PC

As shown in the table above, the case company experts define one CSF for the objective, which is *Public cloud (PC) benefits for data capabilities.* This means that in order to be successful with this objective, public cloud data capabilities have to deliver benefits for the business and the organization. A statement of success for this is: *Those data capabilities which benefit business by being transferred into public cloud (PC) are transferred into public cloud (PC).* This again highlights the objective, if it is recognized that moving data capabilities into public cloud provides value, these data capabilities should be transferred into public cloud. Therefore, a common feature for this is: *Public cloud (PC) data capabilities potential for business.* Based on these performance measures, the case company experts defined the following KPI for the objective: *Data capabilities which would benefit business if transferred into public cloud (PC) vs. those data capabilities transferred into public cloud (PC).* This was chosen as the KPI for the following reason: In order to gain value for business by moving data capabilities into public cloud, the organization must first identify the data capabilities which should be moved into public cloud (those data capabilities that would provide value for business by being moved into public cloud), then start the transition of these identified capabilities in order to gain the desired value. This KPI measures the progress for how much of the identified data capabilities (which benefit from being transferred into public cloud) have actually been moved into public cloud. In order to receive the high value, the number of transferred data capabilities into public cloud should be high. This is because if it has been recognized that value can be gained by transferring data capabilities to the public cloud, but this is not performed, the organization is not realizing the potential available, and therefore is losing value which could be realized.

5.1.2 Create valuable data for business

As the second objective for Data on Cloud utilization area, the case company experts defined *Create valuable data for business.* This includes data processes such as data capture, data creation, and data refinement. This is defined as the second objective, because the purpose of data is to create value for business. Value can be created only for business with data if the data created in the organization is valuable or can be turned valuable by refining it. The second objective with its CSFs, statements of success, common features, and KPIs are shown in the table 4 below. The details of the defined performance measures are elaborated after the table.

Table 4. Data on Cloud performance measures defined by experts, 2nd objective

Objectives	CSFs	Statements of success	Common features	KPIs
Create valuable data for business (data capture, data creation, data refinement)	Data quantity	Data can be combined from different data domains and data assets to create value	Data domains and data assets	# of data domains and data assets
	Data quality	Data provides meaningful information for business and can be used as a source of insight and decision-making (High quality of data)	Data potential for business	% of data that can be refined for business use
		Data is in a form that can be used by the business as-is	Data fit for business use	% of data ready for business use

As shown in the table above, the case company experts define two CSFs for the objective. The CSFs and the following performance measures are be elaborated sequentially. The first CSF is defined as *Data quantity.* This is defined as the first CSF as this establishes the base for *Creating valuable data for business.* This is because without an adequate quantity of data, sources for insights and decision-making cannot be created. The experts define a statement of success as following: *Data can be combined from different data domains and data assets to create value.* The different data domains (i.e. ERP system, CRM system etc.) and data assets (i.e. data "classes" which are located within data domains such as customer information, invoice information etc.) create the width and depth for data. Having a vast amount of data within one data asset (e.g. customer information) can be useful, but the real value which can be created with data is having relevant and combinable data from different data domains and data assets to create sources of insight and decision making. An example would be to link customer contract information (ERP system) with customer information (CRM system) to discover soon

ending customer contracts, this information could be used to acknowledge that these particular customer relationships should be focused on from the sales perspective in order to extend current contracts to produce more business and value. Without having enough data domains and data assets with links to each other, these kinds of opportunities to gain value can be lost. A common feature for this is: *Data domains and data assets.* Based on these performance measures, the case company experts defined the following KPI for the objective: *# of data domains and data assets.* This was chosen as the KPI for the following reason: In order to gain high value from the data quantity perspective, there should be an adequate amount of data domains and data assets with data which can be linked into each other. By monitoring this KPI the organization should target to increase the amount of data domains and data assets, with having the possibility to link data from different data domains and data assets in order to create sources of insights and decision-making to create value.

The second CSF is defined as *Data quality.* This is defined as the second CSF as this as well establishes the base for *Creating valuable data for business.* This is because data with high quality can be easily used to produce value in the organization, as compared to low quality value which is difficult or not even possible to be used for the business' purposes. In this context, the quality is defined as something that fits for the purpose. By data fitting the purpose, it means that the data can be used for business and provides value for business. Based on this, the experts define two statement of successes covering two aspects of value as following: *1. Data provides meaningful information for business and can be used as a source of insight and decision-making (High quality of data), 2. Data is in a form that can be used by the business as-is.* The first statement of success emphasizes that the data that is created is valuable (consists of meaningful information for business), and second statement emphasizes that the data is in a form that can be utilized by the business. By having both of these aspects in order, the business has a created a foundation for gaining value with the data created within the organization. The experts define the following common features for each aspect: *1. Data potential for business, 2. Data fit for business use.* Based on the performance measures defined, the experts define the following KPIs for each aspect: *1. % of data that can be refined for business use, 2. % of data ready for business use.* The first KPI is used for assessing all the data which the organization creates and stores: What percentage of the data can be refined for business use? This includes all the potential data in the organization (including data that is already used by business to create

value). As an example, if the 80% of the organization's current data can be refined for business use, the process should then start for actually refining this data to a useable form (if it already is not). An assessment should also start on why is 20% of the organization's current data not possible to be refined for business use, and what actions should be performed in order to minimize the value lost with creating and storing this type of data. The second KPI is used for evaluating the progress regarding what amount of the potential data is in a form that is ready to be used by the business. By having a high value in this KPI, it indicates that the organization is succeeding in the goal to provide high quality data for business: high percentage of the organization's potential data is ready to be used by the business to gain value.

5.1.3 Develop data capabilities for business

As the third objective for Data on Cloud utilization area, the case company experts defined *Develop data capabilities for business.* This is defined as an important objective for Data on Cloud, because it is important to develop data capabilities within the organization continuously in order to gain the maximum amount of value from the capabilities. As technology evolves and so do the business needs, this aspect cannot be overlooked. The third objective with its CSFs, statements of success, common features, and KPIs are shown in the table 5 below. The details of the defined performance measures are elaborated after the table.

Table 5. Data on Cloud performance measures defined by experts, 3rd objective

Objectives	CSFs	Statements of success	Common features	KPIs
Develop data capabilities for business	Data capabilities development	The data capabilities are developed with high priority to enable business value realization	Data capabilities development status	Remaining work (h) vs. completed work (h) in data capabilities development backlog

As shown in the table above, the case company experts define one CSF for the objective, which is *Data capabilities development.* This means that it is critical that the organization's data capabilities are developed continuously to ensure that the value with data capabilities can be created on the highest possible level. The experts define a statement of success as following: *The data capabilities are developed with high priority to enable business value realization.* As described also earlier above, if the continuous development is not performed the currently used

data capabilities might become outdated and might not properly fit the changing business needs in order to provide value. Therefore, a common feature for this objective is: *Data capabilities development status.* This common feature focuses on the importance regarding how the organization is progressing with the development initiatives. Based on the performance measures defined, the case company experts define the following KPI for this objective: *Remaining work (in hours) vs. completed work (in hours) in data capabilities development backlog.* The purpose of this KPI is to track how the work regarding data capabilities development is progressing. An organization that is ensuring that the business is providing the maximum amount of value for the business by having data capabilities development performing on a high level will have a high number of completed work in the data capabilities development backlog. As new development initiatives always come in the work will never be completely finished, but it is important to recognize the performance levels regarding data capabilities development. This KPI provides a tool for that purpose.

5.1.4 Provide valuable data for business

As the fourth and final objective for Data on Cloud utilization area, the case company experts defined *Provide valuable data for business.* This focuses on the efficiency between the moment from data is being created to the moment the data fulfills the business needs. This is an important aspect to grasp as there can be scenarios where valuable data is being produced and managed within the organization, but the ability to actually utilize the data lacks. One of the challenges can be that there are data needs from the business side which require that the data would be available fast for the use of business for time-sensitive decision-making, but the data capabilities are not able to deliver. The data could be stuck in the data processes and there could be a time delay from days to even a week. In this scenario for some business needs the full value of data could not be realized by the business. Another aspect in *Providing valuable data for business* is that there could be many business needs that would benefit significantly by utilizing the available data in the organization, but at the moment are not able to for various reasons. It could be that the data benefits for these business needs are not recognized by the key decision-makers that would enable to development for utilizing the data for business needs, or the needs have been recognized but the deployment of the required processes and capabilities

are not yet ready. The fourth objective with its CSFs, statements of success, common features, and KPIs are shown in the table 6 below. The details of the defined performance measures are elaborated after the table.

Table 6. Data on Cloud performance measures defined by experts, 4th objective

Objectives	CSFs	Statements of success	Common features	KPIs
Provide valuable data for business (from data creation to data fulfillment)	Data lead time	Data can be utilized fast for the business needs	Fast throughput of data process	Time from data creation to business use
	Data fulfillment	Business needs are fulfilled with data capabilities	Data fulfillment by the business	Business needs that would benefit from using data capabilities vs. business needs fulfilled by data capabilities

As shown in the table above, the case company experts define two CSFs for the objective. The CSFs and the following performance measures will be elaborated sequentially. The first CSF is defined as *Data lead time.* This CSF focuses on the critical importance of making data available with an acceptable lead time. This means that if a specific business need would require a set of data to be ready and visible for the users of the data after 2 days after the data is being created, the organization and its data capabilities should strive to fulfill this requirement in order to enable the full value to be created for the business. Based on this, the statement of success is defined as *Data can be utilized fast for the business needs.* A common feature defined for this is: *Fast throughput of data process.* This indicates that the important feature in achieving this goal is a fast throughput time from the beginning to the end of the data process. Based on the performance measures defined, the case company experts define the following KPI for this CSF: *Time from data creation to business use.* The purpose of this KPI is to concretely monitor the time between data is being created and data is being utilized by the business. The organization should always strive for achieving low throughput times and providing valuable data for the use of business as-soon-as-possible. However, it has to be understood that this is not possible in all cases and all business needs do not require instantly available data to provide high amount of value. Therefore, business needs and required data lead time has to be evaluated case by case, recognizing those which business needs have high priority on having data available fast for realizing maximum value, and striving to make the data lead time on these business needs as fast as possible.

The second CSF is defined as *Data fulfillment.* This emphasizes that in order to succeed in *Provide valuable data for business,* it is critical that the data actually fulfills the business needs that emerge from the organization. If valuable data is created within the organization but the business is not fulfilled by it, it means that the ultimate goal of managing data in the organization has not been reached. This could be caused by business not being able to utilize the data according to their needs for various reasons: data requiring business needs not recognized by the key people in the organization that would enable the data capabilities development for the specific business needs, data capabilities not being fully ready or fit for the specific business needs etc. This CSF is very important to understand so that it can be ensured that the ultimate goal is try to align the data capabilities for the business needs, so that the full value from the data created and managed can be realized. Therefore, a statement of success defined for this is: *Business needs are fulfilled with data capabilities.* A common feature for this is: *Data fulfillment by the business.* Based on the performance measures defined, the case company experts define the following KPI for this CSF: *Business needs that would benefit from using data capabilities vs. business needs fulfilled by data capabilities.* This KPI focuses on the following: The business needs have to be assessed so that it is recognized which business needs would benefit from using data capabilities so that more value could be realized for business. When these business needs that would benefit from using data capabilities are recognized, then the development of data capabilities to align with these business needs should be performed. This KPI focuses on tracking the progress of the recognized business needs versus the business needs where data capabilities have been developed to match these needs to provide more value. When the business needs are met with the correct data capabilities, data fulfillment is achieved. This is the ultimate goal of managing data for business needs and the organization should always strive to produce the highest possible number for this specific KPI in order to realize maximum amount of value created by data.

5.1.5 Added performance measures based on the external knowledge

External knowledge regarding data performance management (Appendix 2) was reviewed with the case company experts. Most of the external knowledge found and researched focused on data quality KPIs and financial data KPIs. The following additions were made to the Data on

Cloud performance management. To the second objective, *Create valuable data for business*, additional missing statements of successes for CSF *Data quantity* were recognized by the experts. The statements of successes that were added (additions made are illustrated with an asterix "*" after the performance measure) were: *1. Data is collected and created frequently to provide up-to-date data, 2. There is an adequate amount of data created for the business in order to gain value.* The performance measures added to the second objective based on the external knowledge are shown in the table 7 below. The details of the defined performance measures are elaborated after the table.

Table 7. Data on Cloud performance measures added based on external knowledge, 2nd objective

Objectives	CSFs	Statements of success	Common features	KPIs
Create valuable data for business (data capture, data creation, data refinement)	Data quantity	Data is collected and created frequently to provide up-to-date data *	Up-to-date data *	Frequency of data collection *
		There is an adequate amount of data created for the business in order to gain value *	Volume of data matches the business needs *	Data volume vs. the data volume required by business *

As shown in the table above, the *Data is collected and created frequently to provide up-to-date data* statement of success was added to the performance measures to include the aspect of how recent the used data is. All business needs do not require data that is created just moments ago, but there is also a limit when the data becomes too old to provide maximum value for the business. Therefore, it is important to focus the efforts on having data up-to-date according to the business needs. A common feature for this is defined simply as *Up-to-date data.* The experts have defined the following KPI for this statement of success: *Frequency of data collection.* The purpose of this KPI is to monitor that the data is collected with a frequency which aligns with the business needs the data capabilities are utilized for. The focus has to be on keeping the frequency of data collection in an acceptable level from the business point of view and striving for meeting the requirements on how recent the data needs to be for each business need.

The second statement of success that was added based on reviewing the external knowledge is *There is an adequate amount of data created for the business in order to gain value.* This states that there has be enough data created for the business needs. If there is too much data, it could mean that value could not be gained at an optimal level as data volume is not adequate for

creating sources for insight or decision-making. However, as important is it is to not have too little data, it is all equally important to not have too much data. Having too much data, especially unvaluable data (data that does not add value to the existing data, for example due to being out of date), can cause inefficiency in refining data for business and it can increase costs significantly due to need for unnecessary additional data storage capacity. Therefore, there should be enough data for the needs of the business so that business can realize the highest amount of value with data, with controlling the volume of data in a way which minimizes the need to storage unnecessary and not valuable data. The common feature defined for this is: *Volume of data matches the business needs.* Based on the performance measures added, the experts define the following KPI for this: *Data volume vs. the data volume required by business.* The purpose of this KPI is to monitor the relationship between the entire volume of data in the organization versus the data which is required by the business needs of the organization. With this KPI, the organization should strive for having the balance of providing the required volume of data for the business to maximize the value being realized, and not having too much data being managed in the organization in order to avoid unnecessary costs that could occur from this. This is an extremely difficult KPI to manage in practice, but the focus should be on not overlooking the aspect of data volume in the organization.

Based on reviewing the external knowledge, the case company experts added one more objective to the Data on Cloud performance measures: *Manage valuable data for business.* This includes the cost aspect of data, with high emphasis on measuring it against the value which is gained from it. This is because the cost of an application should never be evaluated purely based on costs it creates. The costs of an application should always be evaluated against the value the application provides. The fifth objective and related performance measures added based on the external knowledge are shown in the table 8 below. The details of the defined performance measures are elaborated after the table.

Table 8. Data on Cloud performance measures added based on external knowledge, 5th objective

Objectives	CSFs	Statements of success	Common features	KPIs
Manage valuable data for business (data value vs. data cost) *	Data capabilities value *	The data capabilities provided for business creates high amount of concrete business value *	Business value of data capabilities *	Value of data capabilities (€) *
	Data capabilities cost *	The value of data capabilities exceeds the costs of data capabilities *	Data capabilities value vs. data capabilities cost *	Value of data capabilities (€) vs. cost of data capabilities (€) (data processes, data platforms and data management workforce) *

For the added objective, two CSFs were defined by the case company experts: *1. Data capabilities value, 2. Data capabilities cost.* The two added CSFs focus on the value that is created by data capabilities and the costs in relation to the created data capabilities as critical factors in achieving efficient data management in the organization. Based on these CSFs the following statements of success were defined: *1. The data capabilities provided for business creates high amount of concrete business value.* This means that in order to be successful with managing data efficiently for business, the data capabilities have to create high amount of business value in order to exceed the costs the data capabilities create. The higher the business value created with data capabilities, the better. *2. The value of data capabilities exceeds the cost of data capabilities.* This states that the costs should be assessed by evaluating them against the value which the data capabilities provide. In an optimal scenario, the value and benefits of data capabilities significantly exceed the costs that are created. In an opposite and not optimal scenario, the costs of data capabilities significantly exceed the value and the benefits being created by them. Based on these performance measures, the following common features are defined: *1. Business value of data capabilities, 2. Data capabilities value vs. data capabilities cost.* The case company experts defined the following KPIs for these CSFs: *1. Value of data (€).* The purpose of this KPI is to monitor the actual business value (€) which is received from the data capabilities. The target should be to strive for the highest value of data possible, always developing the data capabilities in order to perform better according to this KPI. This KPI is the one that justifies the benefits of data and acts as one of the main reference points for business decisions made regarding data. *2. Value of data capabilities (€) vs. cost of data capabilities (€) (data processes, data platforms and data management workforce).* The purpose of this KPI is to monitor the value created by data capabilities against the costs created by data capabilities.

If only the costs of data would be measured, it would not provide sufficient information to monitor the performance of managing data. With a business-critical function such as data management, striving for the lowest possible costs could cause significant business problems (e.g. loss of data-based business opportunities, low ability to make data-based decisions, low data-based business development etc.) in the long-term. The organization should always strive for having high value of data against the costs of data capabilities. The two KPIs defined above for the fifth objective are extremely challenging to monitor and manage. The organizations with data capabilities should highly focus on maximizing the business value of data and justifying data capabilities development costs with the added business value of data that can be realized with the development.

5.2 Infrastructure Modernization

For defining Infrastructure Modernization performance management framework, 5 public cloud experts from the case company were interviewed. Based on the expert interviews, the main organizational goals for a modern infrastructure is to have an infrastructure which is agile and scalable to meet constantly evolving business needs and changes, stable and secure to provide a reliable base for continuous value creation, and effective and efficient from the cost perspective. Public cloud offers new possibilities for organizations to realize value, especially on the agile and scaling aspect of performance. Organizations need to accurately assess their business needs regarding infrastructure needs. It could be the case that all parts of the infrastructure cannot be transferred into public cloud because of specific requirements for certain business areas where additional capabilities are required, and public cloud does not meet with all these requirements. As with other utilization areas, the focus should always be on striving to achieve the highest business value and selecting the capabilities that enable this to happen.

5.2.1 Gain value for business by moving infrastructure into public cloud

As the first objective for Infrastructure Modernization utilization area, the case company experts defined *Gain value for business by moving infrastructure into public cloud (PC).* This is defined as the first objective (as it was in Data on Cloud), because this commits the organization to make the transitioning of infrastructure into public cloud based on the value it offers (the transition of the infrastructure or parts of it into public cloud should not be if there is no value to be gained for the organization). The currently used and planned to be acquired infrastructure capabilities should be assessed against infrastructure capabilities offered by public cloud. If it is evaluated that value can be gained by transitioning infrastructure capabilities into public cloud, then those capabilities should be transferred into public cloud, and the actual transition process can start. The first objective with its CSFs, statements of success, common features, and KPIs are shown in the table 9 below. The details of the defined performance measures are elaborated after the table.

Table 9. Infrastructure Modernization performance measures defined by experts, 1st objective

Objectives	CSFs	Statements of success	Common features	KPIs
Gain value for business by moving infrastructure into PC	PC benefits for infrastructure	Those parts of infrastructure which benefit business by being transferred into PC are transferred into PC	PC infrastructure potential for business	Parts of infrastructure which would benefit business if transferred into PC vs. those parts of infrastructure transferred into PC

As shown in the table above, the case company experts define one CSF for the objective, which is *Public cloud (PC) benefits for infrastructure.* This means that in order to be successful with this objective, public cloud infrastructure capabilities have to deliver benefits for the business and the organization. A statement of success for this is: *Those parts of infrastructure which benefit business by being transferred into public cloud (PC) are transferred into public cloud (PC).* This again highlights the objective, if it is recognized that moving infrastructure capabilities into public cloud provides value, these parts of infrastructure should be transferred into public cloud. Therefore, a common feature for this is: *Public cloud (PC) infrastructure potential for business.* Based on these performance measures, the case company experts defined the following KPI for the objective: *Parts of infrastructure which would benefit business if transferred into public cloud (PC) vs. those parts of infrastructure transferred into public cloud (PC).* This was chosen as the KPI for the following reason: In order to gain value for business

by moving parts of infrastructure into public cloud, the organization must first identify the parts of infrastructure which should be moved into public cloud (those parts of infrastructure that would provide value for business by being moved into public cloud), then start the transition of these identified parts of infrastructure in order to gain the desired value. This KPI measures the progress for how much of the identified parts of infrastructure (which benefit from being transferred into public cloud) have actually been moved into public cloud. In order to receive the high value, the number of transferred parts of infrastructure into public cloud should be high. This is because if it has been recognized that value can be gained by transferring parts of the infrastructure to the public cloud, but this is not performed, the organization is not realizing the potential available, and therefore is losing value which could be realized.

5.2.2 Provide agile and scalable infrastructure for business

As the second objective for Infrastructure Modernization utilization area, the case company experts defined *Provide agile and scalable infrastructure for business.* This is identified as the second objective, because of the growing need and increasing requirements for the modern infrastructure to meet constantly evolving business needs and changes. The organizations must be able to react fast to changes and ensure that the availability of the infrastructure is always high for the business in order to realize value continuously. The second objective with its CSFs, statements of success, common features, and KPIs are shown in the table 10 below. The details of the defined performance measures are elaborated after the table.

Table 10. Infrastructure Modernization performance measures defined by experts, 2nd objective

Objectives	CSFs	Statements of success	Common features	KPIs
Provide agile and scalable infrastructure for business	Infrastructure speed of change	Infrastructure is able to react quickly to changes	Infrastructure change time	Avg time for change
	Infrastructure capabilities	Infrastructure provides optimal performance for the business	Infrastructure performance	Infrastructure availability

As shown in the table above, the case company experts define two CSFs for the objective. The CSFs and the following performance measures will be elaborated sequentially. The first CSF is defined as *Infrastructure speed of change.* This is defined as the first CSF as speed is one of the most critical factors to enable agility and scalability for the business in the infrastructure.

Without the ability to make changes fast, the organization loses the value that could be gained by adapting to changing business needs. Therefore, the experts define a statement of success for this CSF as following: *Infrastructure is able to react quickly to changes.* A common feature that follows this is *Infrastructure change time.* Based on the performance measures defined, the case company experts define the following KPI for this objective: *Average (avg) time for change.* The purpose of this KPI is to track the time which the infrastructure needs to perform changes in average. This shows how fast the infrastructure is able to adapt to the changing business needs. The organization should strive for lowering this KPI value to a level which enables the highest value for business. It has to be determined that how fast is "fast enough", some business needs might change constantly but only low value can be realized by reacting to these. For this reason, the organization should focus on lowering the average time for change for those business needs which have high impact and a significant amount of value can be achieved by reacting to these business needs fast.

The second CSF is defined as *Infrastructure capabilities.* The performance of infrastructure capabilities is a critical factor in achieving the objective of running an agile and scalable infrastructure for business. It has to be ensured that infrastructure capabilities are able to run at a high performance, in order to enable optimal and consistent value realization for business. A statement of success based on this is: *Infrastructure provides optimal performance for the business.* An optimal performance is defined as high enough to satisfy all the business needs, but not too high to increase the costs of infrastructure significantly. A common feature defined based on this is: *Infrastructure performance.* Based on the performance measures defined, the case company experts define the following KPI for this objective: *Infrastructure availability.* The purpose of this KPI is to monitor and ensure that the infrastructure is available for the business needs always when needed. The organization should strive for highest possible value which is required for satisfying all the business needs. The targeted value can depend on the types of business needs that the infrastructure serves, or for example, if some of the business needs are strongly focused on the office hours. In this case, there could be times when parts of the infrastructure availability would not be required, and suitable adjustments could be done based on this to decrease value lost by unnecessary availability.

5.2.3 Provide stable and secure infrastructure for business

As the third objective for Infrastructure Modernization utilization area, the case company experts defined *Provide stable and secure infrastructure for business.* This is identified as the third objective, in order to focus on providing a strong infrastructure foundation for business to realize value. An agile and scalable infrastructure cannot provide consistent value for business if it is not resistant to problems that will at some point emerge inevitably. The third objective with its CSFs, statements of success, common features, and KPIs are shown in the table 11 below. The details of the defined performance measures are elaborated after the table.

Table 11. Infrastructure Modernization performance measures defined by experts, 3rd objective

Objectives	CSFs	Statements of success	Common features	KPIs
Provide stable and secure infrastructure for business	Infrastructure incidents	Infrastructure is stable and generates minimal amount of incidents	Infrastructure incidents	# of incidents
				# of major incidents
	Infrastructure reliability	Infrastructure is stable and generates minimal amount of downtime	Infrastructure downtime	Infrastructure downtime
	Infrastructure security	Infrastructure security is high, and breaches do not occur frequently	Infrastructure security breaches	# of security breaches

As shown in the table above, the case company experts define three CSFs for the objective. The CSFs and the following performance measures will be elaborated sequentially. The first CSF is defined as *Infrastructure incidents.* This is defined as the first CSF as managing incidents play a key role in running a stable and secure infrastructure. If a significant amount of incidents occur continuously within the infrastructure, the infrastructures efforts have to be heavily directed into resolving them. This could have a significant impact on the stability, and it can also have an effect on the efficiency of the infrastructure. A statement of success based on this CSF is defined as following: *Infrastructure is stable and generates minimal amount of incidents.* A common feature following this is: *Infrastructure incidents.* Based on these performance measures, the case company experts defined the following KPIs for the CSF: *1. # of incidents.* This was chosen as the KPI for the following reason: The number of incidents have to be monitored in order to follow how many incidents do occur within the infrastructure. The organization should strive for managing the incidents and solving the related root causes to their best ability in order to ensure that the incidents disturb the business value created with the infrastructure minimally. The number of incidents on its own does not provide an adequate overview of the status. For example, the type of the incidents (how and on what level do they

affect business) have to also be considered. Also, a certain number of incidents could be low on a certain organization's standards, as for another organization this same number would be considered high. *2. # of major incidents.* The same principles apply as described with the first KPI. Major incident is an event which causes or can cause a significant risk of losing business value and must be handled immediately to minimize its effects. The number of major incidents should always be as low as possible (preferably 0), as these cause a significant business risk. It is relevant to assess and follow the ratio between incidents and major incidents. A medium number of incidents can usually be handled without huge impact on business value realization if the number of major incidents is 0. However, a low number of incidents is not relevant if there are a few major incidents occurring regularly, causing a significant negative impact on business and the value which would be realized.

The second CSF is defined as *Infrastructure reliability.* This is defined as the second CSF as the reliability is another key factor in enabling a stable and secure infrastructure. The infrastructure should be up and running to serve the business needs as planned and the business should be able to trust that this is always performed reliably. High amount of downtime can cause the business to not be able to perform its duties in order to create value, therefore unplanned and unnecessary downtime should be avoided. A statement of success based on this CSF is defined as following: *Infrastructure is stable and generates minimal amount of downtime.* A common feature following this is: *Infrastructure downtime.* Based on these performance measures, the case company experts defined the following KPI for the CSF: *Infrastructure downtime.* The purpose of this KPI is to focus on having the infrastructure up and running, serving the business needs and supporting business in realizing value with infrastructure. The emphasis is on minimizing the time the infrastructure is unavailable for business.

The third CSF is defined as *Infrastructure security.* This is defined as the third CSF as system security has to be high in order to avoid any security risk that could cause or increase the changes of losing business value realized by the infrastructure. A high amount of security breaches could cause confidential business information to leak outside the organization, which would lead to a significant business risk. This should be avoided at all costs. A statement of success based on this CSF is defined as following: *Infrastructure security is high, and breaches*

do not occur frequently. A common feature following this is: *Infrastructure security breaches.* Based on these performance measures, the case company experts defined the following KPI for the CSF: *# of security breaches.* The purpose of this KPI is to monitor the amount of security breaches which are occurring within the infrastructure. As any security breach can cause a significant business risk for the organization, the organization should strictly strive for having as low amount of security breaches as possible (preferably 0).

5.2.4 Manage valuable infrastructure for business

As the fourth and final objective for Infrastructure Modernization utilization area, the case company experts defined *Manage valuable infrastructure for business.* This focuses on the ratio of value created for business by the infrastructure capabilities against the costs created by the infrastructure capabilities. This is identified as the fourth objective because the infrastructure capabilities should never be evaluated purely based on the costs it creates. The costs of the infrastructure capabilities should always be evaluated against the value the infrastructure capabilities provide. The fourth objective with its CSFs, statements of success, common features, and KPIs are shown in the table 12 below. The details of the defined performance measures are elaborated after the table.

Table 12. Infrastructure Modernization performance measures defined by experts, 4th objective

Objectives	CSFs	Statements of success	Common features	KPIs
Manage valuable infrastructure for business (infrastructure value vs. infrastructure cost)	Infrastructure capabilities value	Infrastructure capabilities provided for business creates high amount of concrete business value	Business value of infrastructure capabilities	Value of infrastructure capabilities (€)
	Infrastructure capabilities cost	The value of infrastructure capabilities exceeds the costs of infrastructure capabilities	Infrastructure capabilities value vs. infrastructure capabilities cost	Value of infrastructure capabilities (€) vs. cost of infrastructure capabilities (€)

As shown in the table above, the case company experts define two CSFs for the objective. The CSFs and the following performance measures will be elaborated sequentially. The first CSF is defined as *Infrastructure capabilities value.* It is recognized that in order to manage infrastructure capabilities which provide value for business, the high amount of value (an amount of value which greatly surpasses the amount of costs the infrastructure creates) that is actually created is a critical requirement for reaching this goal. Therefore, a statement of success

for this is defined as following: *Infrastructure capabilities provided for business creates high amount of concrete business value.* A common feature following this is defined as: *Business value of infrastructure capabilities.* Based on these performance measures, the case company experts defined the following KPI for the CSF: *Value of infrastructure capabilities (€).* The purpose of this KPI is to monitor the actual monetary business value which is produced by the infrastructure capabilities. The organization should strive to identifying the value which is produced for the business, so that the impact of the infrastructure and the importance of it for the business can be recognized. The organization should focus on enabling high value creation for the infrastructure capabilities and making decisions that would increase the organization's ability to produce value for the business. The additional costs that would occur from increasing the functionalities and capacity of the infrastructure capabilities have always to be considered in relation to this.

The second CSF for this objective is defined as *Infrastructure capabilities cost.* The costs which the infrastructure capabilities create play a key role in managing valuable infrastructure for business. Traditionally, the costs of infrastructure capabilities have been a key decision-point for organizations for choosing the optimal solution. The decision should never be made purely based on the price which the infrastructure capabilities creates, instead it is important to evaluate the costs against the value which the infrastructure capabilities provide. If extremely high value for business can be gained by selecting a more costly solution, compared to medium value gained by a lower cost solution, a significant advantage of being able to create higher amount of value in total can be lost with a long-term approach. A statement of success for this is defined as following: *The value of infrastructure capabilities exceeds the costs of infrastructure capabilities.* A common feature following this is defined as: *Infrastructure capabilities value vs. infrastructure capabilities cost.* Based on these performance measures, the case company experts defined the following KPI for the CSF: *Value of infrastructure capabilities (€) vs. cost of infrastructure capabilities (€).* The purpose of this KPI is to monitor the value created by infrastructure capabilities against the costs which is created by the infrastructure capabilities. If only the costs of infrastructure would be measured, it would not provide sufficient information regarding the performance of the infrastructure capabilities from the business perspective. Infrastructure capabilities are considered as a business-critical function, striving for the lowest possible costs could cause significant business problems (e.g.

challenges with infrastructure availability for business, low agility and scalability for business needs, and other challenges affecting the organization's ability to realize business value) in the long-term. The organization should always strive for having high value received from infrastructure capabilities against the costs of infrastructure capabilities. The two KPIs defined above for the fourth objective are extremely challenging to monitor and manage. The concrete value which the infrastructure creates for the business can be approached from various perspectives and different stakeholders might have different views regarding the value created. The organizations with infrastructure capabilities should highly focus on maximizing the business value of infrastructure and justifying infrastructure capabilities development and management costs with the added business value which can enabled by continuing infrastructure development. The focus with infrastructure development and management should always be on fulfilling organization's evolving business needs.

5.2.5 Added performance measures based on the external knowledge

External knowledge gathered regarding infrastructure performance management (Appendix 3) was reviewed with the case company experts. Most of the external knowledge found and researched focused on technical IT metrics. The following additions were made to the Infrastructure Modernization performance management. To the second objective, *Provide agile and scalable infrastructure for business*, additional missing KPIs for the CSF *Infrastructure capabilities* were recognized by the experts. The KPIs that were added (additions made are illustrated with an asterix "*" after the performance measure) were: *1. Infrastructure capacity, 2. Infrastructure latency, 3. # of workloads processed.* The performance measures added to the second objective based on the external knowledge are shown in the table 13 below. The details of the defined performance measures are elaborated after the table.

Table 13. Infrastructure Modernization performance measures added based on external knowledge, 2nd objective

Objectives	CSFs	Statements of success	Common features	KPIs
Provide agile and scalable infrastructure for business	Infrastructure capabilities	Infrastructure provides optimal performance for the business	Infrastructure performance	Infrastructure capacity *
				Infrastructure latency *
				# of workloads processed *

As shown in the table above, three additional KPIs were added to represent the *Infrastructure capabilities* CSF to complement the infrastructure performance aspect. *Infrastructure capacity* KPI monitors the overall capacity which is used and available for the business. The purpose of this is to indicate how much of the infrastructure capacity is utilized by the business to realize value. The capacity of the infrastructure should always remain on a sufficient level which enables business to do everything that they need. *Infrastructure latency* KPI monitors the infrastructure's latency and the purpose of this is to follow how responsive the infrastructure is from the business perspective. The latency should remain low and stable so that there are no challenges experienced from the business side regarding this. *# of workloads processed* KPI monitors the amount of the actual workloads that go through the infrastructure and are processed. This is one indicator for the performance and efficiency of the infrastructure which shows on a concrete level that how much work is the infrastructure performing for the business and how much is the infrastructure enabling value realization.

Based on reviewing the external knowledge, the case company experts added two more Statements of successes to the CSF: *Infrastructure reliability*. It was recognized that a couple more aspects should be considered regarding the infrastructure in order to get a more complete overview for the reliability of the infrastructure. The experts also added one more CSF to the *Provide stable and secure infrastructure for business* objective. The performance measures added based on the external knowledge are shown in the table 14 below. The details of the defined performance measures are elaborated after the table.

Table 14. Infrastructure Modernization performance measures added based on external knowledge, 3rd objective

Objectives	CSFs	Statements of success	Common features	KPIs
Provide stable and secure infrastructure for business	Infrastructure reliability	Infrastructure is stable and generates minimal number of outages *	Infrastructure outages *	# of planned and unplanned outages *
		Infrastructure is resilient, and failures do not emerge frequently *	Infrastructure failures *	Mean Time to Failure (MTTF) *
	Infrastructure problem resolving *	Problems related to infrastructure are resolved fast *	Infrastructure problem resolving time *	Mean Time to Resolve (MTTR) *

For the *Infrastructure reliability* CSF, two more statements of successes were defined by the case company experts: *1. Infrastructure is stable and generates minimal number of outages.* The first statements of success acknowledge the importance of having low amount of outages

within the infrastructure in order to provide a reliable infrastructure for the business. The lower the number of outages, the lower amount of disturbance for the business caused by the outages within the infrastructure. *2. Infrastructure is resilient and failures do not emerge frequently.* The second statement of success highlights that in order to have a reliable infrastructure for the business, the infrastructure should be resilient, and failures should not emerge frequently. Frequent failures can cause significant losses for business in regards of gaining value, as these continuous failures disturb the business and the business is not able to rely on the infrastructure on providing the required capabilities which are needed in the value realization. The common features defined based on these are: *1. Infrastructure outages, 2. Infrastructure failures.* Based on these performance measures defined for the *Infrastructure reliability* CSF, the following KPIs were added by the experts: *1. # of planned and unplanned outages.* The purpose of this KPI is to monitor the number of planned and unplanned outages. It is important to follow how many outages there are happening in total within the infrastructure to understand how the business is affected by this. It should also be followed that the ratio between the planned and unplanned outages is in order (having less unplanned outages than planned outages). In the case of the planned outages, in most cases business can be informed appropriately regarding the planned outage and the business impact can be reduced by having time to prepare. If the conditions allow, the outages can also be scheduled in a way which affects the business minimally. The company should strive for keeping the amount of outages low, and with the mandatory (planned) outages the key is making the best effort in performing them with minimal business impact. *2. Mean Time to Failure (MTTF).* This KPI monitors the average time between failures. The purpose of this KPI is to follow how long are the periods (in average) where the business is not disturbed by failures occurring within the infrastructure. In order for the business to have a reliable infrastructure to provide a base for value creation, the average time for failures occurring should be high. This ensures that business can focus on value realization for long periods at a time and do not have to constantly be aware regarding the next failure possibly occurring soon, which would slow the business and value realization with the infrastructure down.

For the objective *Provide stable and secure infrastructure for business,* one more CSF was added: *Infrastructure problem solving.* The case company experts noted that in order to maintain a stable and secure infrastructure for business, one critical aspect for it is to ensure

that problems that arise within the infrastructure are handled promptly and efficiently. Based on this, the following statement of success was defined: *Problems related to infrastructure are resolved fast.* Problems will always arise at some point, but the importance lies in how fast the organization is able to handle the problems which arise. The faster the problem resolution, the sooner the normal service is restored, and the business is able to continue on value realization. Therefore, the common feature defined for this is: *Infrastructure problem resolving time.* Based on the CSF added, and the performance measures identified, the following KPI is added: *Mean Time to Resolve (MTTR).* This KPI monitors the average time which is required to resolve the problems in order to restore to the normal infrastructure state. The purpose of this KPI is to follow how long is the time on average which is needed to resolve the problems that occur within the infrastructure. Fast average resolving time is an indicator regarding the efficiency in problem solving and it signals how long does the business usually have to expect to wait in order for a problem to be resolved. The organization should strive for being able to solve occurring problems quickly, so that normal infrastructure service can be restored, and the business can continue realizing value with the capabilities provided.

5.3 Application Modernization

For defining Application Modernization performance management framework, 4 public cloud experts from the case company were interviewed. Based on the expert interviews, the main organizational goals for modernizing applications is to enable an agile and scalable use and development of applications, which can be achieved with the capabilities offered by public cloud (as in the Infrastructure Modernization). As business needs are continuously evolving and changing, applications have to be able to adapt quickly to the new requirements set by the business. Another important goal for modernizing applications is to ensure stability and security within the applications to provide a solid base for value creation by the business (as in the Infrastructure Modernization). On the application side, public cloud also has new capabilities to offer for the organizations, but the business needs have to be assessed individually and it has to be evaluated that which solution or solutions would provide the best results for the organization’s specific needs. As with other utilization areas, the focus should always be on striving to achieve the highest business value and selecting the capabilities help the organization

to accomplish this. As Applications Modernization and Infrastructure Modernization utilization areas are closely linked together and provide a similar type of service for the business (for example in offering capacity capabilities for realizing business value), and for that reason, these two utilization areas also share similar performance measures together.

5.3.1 Gain value for business by moving applications into public cloud

As the first objective for Application Modernization utilization area, the case company experts defined *Gain value for business by moving applications into public cloud (PC).* This is defined as the first objective (as it was in Data on Cloud and Infrastructure Modernization), because this commits the organization to make the transitioning of applications into public cloud based on the value it offers (the transition of the applications or parts of the applications into public cloud should not be if there is no value to be gained for the organization). The organization should assess the current applications and related capabilities to evaluate if value could be gained with transferring applications to the public cloud, compared to the current setup which the organization is using. If it is evaluated that value can be gained by transitioning applications into public cloud, then those applications should be transferred into public cloud, and the actual transition process can start. The first objective with its CSFs, statements of success, common features, and KPIs are shown in the table 15 below. The details of the defined performance measures are elaborated after the table.

Table 15. Application Modernization performance measures defined by experts, 1st objective

Objectives	CSFs	Statements of success	Common features	KPIs
Gain value for business by moving applications into PC	PC benefits for applications	Those applications which benefit business by being transferred into PC are transferred into PC	PC applications potential for business	Applications which would benefit business if transferred into PC vs. those applications transferred into PC

As shown in the table above, the case company experts define one CSF for the objective, which is *Public cloud (PC) benefits for applications.* This means that in order to be succeed with this objective, public cloud application capabilities have to deliver benefits for the business and the organization. A statement of success for this is: *Those applications which benefit business by being transferred into public cloud (PC) are transferred into public cloud (PC).* This again

highlights the objective, if it is evaluated that moving applications into public cloud provides value, these applications should be transferred into public cloud. Therefore, a common feature for this is: *Public cloud (PC) applications potential for business.* Based on these performance measures, the case company experts defined the following KPI for the objective: *Applications which would benefit business if transferred into public cloud (PC) vs. applications transferred into public cloud (PC).* This was defined as the KPI for the following reason: In order to gain value for business by moving parts of applications into public cloud, the organization must first identify the applications which should be moved into public cloud (those parts of applications that would provide value for business by being moved into public cloud), then start the transition of these identified applications in order to gain the desired value. This KPI measures the progress for how much of the identified applications (which benefit from being transferred into public cloud) have actually been moved into public cloud. In order to receive the high value, the number of transferred parts of applications into public cloud should be high. This is because if it has been recognized that value can be gained by transferring applications to the public cloud, but this is not performed, the organization is not realizing the potential available, and therefore is losing value which could be realized.

5.3.2 Provide capabilities to enable agile and scalable applications for business

As the second objective for Application Modernization utilization area, the case company experts defined *Provide capabilities to enable agile and scalable applications for business.* This is identified as the second objective, in order to support the organization with quickly changing and evolving business requirements and needs. By having agile and scalable application capabilities, the organization is able to respond to these changing needs effectively and efficiently. This ensures the high value for business enabled by the application capabilities. The second objective with its CSFs, statements of success, common features, and KPIs are shown in the table 16 below. The details of the defined performance measures are elaborated after the table.

Table 16. Application Modernization performance measures defined by experts, 2nd objective

Objectives	CSFs	Statements of success	Common features	KPIs
Provide capabilities to enable agile and scalable applications for business	Speed of change for applications	Changes can be introduced to applications fast	Change time for applications	Avg time for change
	Application capabilities	Applications provide optimal performance for the business	Application performance	Application availability
				Application response time

As shown in the table above, the case company experts define two CSFs for the objective. The CSFs and the following performance measures will be elaborated sequentially. The first CSF is defined as *Speed of change for applications.* This is defined as the first CSF as speed of change is one of the most critical factors to enable agility and scalability for the business with the applications. Without the ability to make changes fast when needed, the organization loses the value that could be gained by being able to adapt to the changes quickly. This could be something such as a need for a new feature or functionality in the application to increase value gained or introducing a fix to increase the security and stability of the application in order to prevent losing business value. Therefore, the experts define a statement of success for this CSF as following: *Changes can be introduced to applications fast.* As a common feature, the experts defined: *Change time for applications.* Based on these performance measures, the case company experts defined the following KPI for the CSF: *Average (avg) time for change.* The purpose of this KPI is to follow how long does it take for the application to perform a change in average. This shows how quickly the applications are able to adapt to changing business needs and requirements. The organization should strive for lowering this KPI value to a level which enables the highest value for business. It has to be determined that how fast is "fast enough", some needs for certain applications might change constantly but only low value can be realized by being able to adapt to these. For this reason, the organization should focus on lowering the average time for change for those applications which have high impact on business and a significant amount of value can be achieved.

The second CSF is defined as *Application capabilities.* In running agile and scalable applications for business, the performance of the application capabilities is a critical factor in achieving success. It has to be ensured that application capabilities are able to perform effectively and efficiently, in order to enable optimal and consistent value realization for business. A statement of success based on this is: *Applications provide optimal performance*

for the business. An optimal performance is defined as high enough to satisfy all the business needs, but not too high to increase the costs of applications significantly. A common feature defined based on this is: *Application performance.* Based on the performance measures defined, the case company experts define the following KPIs for this objective: *1. Application availability.* The purpose of this KPI is to monitor and ensure that the applications are available for the business needs always when needed. The organization should strive for highest possible value which is required for satisfying all the business needs. The targeted value can depend on the types of business needs that the applications serve, or for example, if some of the business needs are strongly focused on the office hours. In this case, there could be times when availability for certain applications would not be required, and suitable adjustments could be done based on this to decrease value lost by unnecessary availability. *2. Application response time.* The purpose of this KPI is to monitor the application response times to follow how fast do the applications respond to business. By having fast response times, the business will not be experiencing challenges in realizing business value from this perspective. The organization should strive for having response times as low as required in the applications in order to provide a smooth experience for the business, but also consider how fast is fast enough, as striving for too fast response times could also affect the costs which are created by the extra effort required for this in some cases.

5.3.3 Provide stable and secure applications for business

As the third objective for Application Modernization utilization area, the case company experts defined *Provide stable and secure applications for business.* This is identified as the third objective, because even if the applications in use would offer the highest possible capacity, and the newest features and functions, if the applications cannot remain stable and secure, this does not provide a foundation for business for consistent and reliable value realization. For this reason, it is critical that the stability and security of the applications is considered as one of the main objectives. It has to be ensured that stable and secure value realization capabilities can be provided for business and adequate measures are planned and executed to increase the stability and security for the future needs and demands. The third objective with its CSFs, statements of

success, common features, and KPIs are shown in the table 17 below. The details of the defined performance measures are elaborated after the table.

Table 17. Application Modernization performance measures defined by experts, 3rd objective

Objectives	CSFs	Statements of success	Common features	KPIs
Provide stable and secure applications for business	Application incidents	Applications are stable and generate minimal amount of incidents	Application incidents	# of incidents
				# of major incidents
	Application reliability	Applications are stable and generate minimal amount of downtime	Application downtime	Application downtime
		Applications are stable and generate minimal number of outages	Application outages	# of planned and unplanned outages
		Applications are resilient, and failures do not emerge frequently	Application failures	Mean Time to Failure (MTTF)
	Application problem solving	Problems related to applications are resolved fast	Application problem resolving time	Mean Time to Resolve (MTTR)
	Application security	Application security is high, and breaches do not occur frequently	Application security breaches	# of security breaches

As shown in the table above, the case company experts define four CSFs for the objective. The CSFs and the following performance measures will be elaborated sequentially. The first CSF is defined as *Application incidents.* This is defined as the first CSF because the ability to manage incidents is one of the most critical aspects in maintaining a stable and secure applications for business. Incidents in applications might be experienced by the business as challenges which can make value realization more difficult, and in some cases even block it completely (major incidents). For the applications, there will always be new incidents emerging time to time, but the type of the incidents actually define how serious are the challenges caused by the incidents. The organization should focus on minimizing business impact caused by incidents, handling incidents (especially high business impact incidents) effectively and efficiently, and continuously developing and learning from the past experiences within incident management. A statement of success based on this CSF is defined as following: *Applications are stable and generates minimal amount of incidents.* A common feature following this is: *Application incidents.* Based on these performance measures, the case company experts defined the following KPIs for the CSF: *1. # of incidents.* This was chosen as the KPI for the following reason: The number of incidents have to be monitored in order to follow how many incidents do occur within the applications. The organization should strive for managing the incidents and solving the related root causes to their best ability in order to ensure that the incidents disturb the business value created with the applications minimally. The number of incidents on its own

does not provide an adequate overview of the status. For example, the type of the incidents (how and on what level do they affect business) have to also be considered. Also, having a certain number of incidents could be low on some organization's standards, as for to another organization this same number would be considered as extremely high. *2. # of major incidents.* The same principles apply as described with the first KPI. Major incident is an event which causes or can cause a significant risk of losing business value and must be handled immediately to minimize its effects. The number of major incidents should always be as low as possible (preferably 0), as these cause a significant business risk. It is relevant to assess and follow the ratio between incidents and major incidents. A medium number of incidents can usually be handled without huge impact on business value realization if the number of major incidents is 0. However, a low number of incidents is not relevant if there are a few major incidents occurring regularly, causing a significant negative impact on business and the value which would be realized.

The second CSF is defined as *Application reliability.* This is defined as the second CSF as the reliability is another key factor in achieving a stable and secure applications. The applications should be always operating smoothly to provide the required capabilities for business to fulfill their needs reliably. For example, continuously having a high amount of downtime can make the value realization more challenging and less consistent for the business. For this reason, the organization should strive for avoiding any unplanned or unnecessary downtime. If downtime is necessary, the key is trying to arrange this in a way which has the smallest impact for business. Providing a reliable foundation of applications means also that there would be a minimal number of outages and different types of failures would not be a regular concern. Three statements of success are defined as following based on this CSF: *1. Applications are stable and generate minimal amount of downtime. 2. Application are stable and generate minimal number of outages. 3. Applications are resilient, and failures do not emerge frequently.* The common features following these are: *1. Application downtime. 2. Application outages. 3. Application failures.* Based on these performance measures, the case company experts defined the following KPIs for the CSF: *1. Application downtime.* The purpose of this KPI is to focus on having the applications up and running, serving the business needs and supporting business in realizing value with the applications. The emphasis is on minimizing the time the applications are unavailable for business. *2. # of planned and unplanned outages.* The purpose of this KPI

is to monitor the number of planned and unplanned outages. It is important to follow how many outages there are happening in total within the applications to understand how the business is affected by this. It should also be followed that the ratio between the planned and unplanned outages is in order (having less unplanned outages than planned outages). In the case of the planned outages, in most cases business can be informed appropriately regarding the planned outage and the business impact can be reduced by having time to prepare. If the conditions allow, the outages can also be scheduled in a way which affects the business minimally. The company should strive for keeping the amount of outages low, and with the mandatory (planned) outages the key is making the best effort in performing them with minimal business impact. *3. Mean Time to Failure (MTTF).* This KPI monitors the average time between failures. The purpose of this KPI is to follow how long are the periods (in average) where the business is not disturbed by failures occurring within the applications. In order for the business to have reliable applications to provide a base for value creation, the average time for failures occurring should be high. This ensures that business can focus on value realization for long periods at a time and do not have to constantly be aware regarding the next failure possibly occurring soon, which would slow the business and value realization with the applications down.

The third CSF is defined as *Application problem solving.* In order to maintain stable and secure applications for business, one critical aspect for it is to ensure that problems that arise within the applications are handled promptly and efficiently. Based on this, the following statement of success was defined: *Problems related to applications are resolved fast.* Problems will always arise at some point, but the importance lies in how fast the organization is able to handle the problems which arise. The faster the problem resolution, the sooner the normal service is restored, and the business is able to continue on value realization with the applications. Therefore, the common feature defined for this is: *Application problem resolving time.* Based on this CSF, and the performance measures identified, the following KPI is defined by the experts: *Mean Time to Resolve (MTTR).* This KPI monitors the average time which is required to resolve the problems in order to restore to the normal application state. The purpose of this KPI is to follow how long is the time on average which is needed to resolve the problems that occur within the applications. Fast average resolving time is an indicator regarding the efficiency in problem solving and it signals how long does the business usually have to expect to wait in order for a problem to be resolved. The organization should strive for being able to

solve occurring problems quickly, so that normal functionality of applications can be restored, and the business can continue realizing value with the capabilities provided by the applications.

The fourth CSF is defined as *Application security*. This is defined as the fourth CSF as application security has to be high in order to avoid any security risk that could cause or increase the changes of losing business value realized by the applications. A high amount of security breaches could cause confidential business information to leak outside the organization, which would lead to a significant business risk. This should be avoided at all costs. A statement of success based on this CSF is defined as following: *Application security is high, and breaches do not occur frequently.* A common feature following this is: *Application security breaches.* Based on these performance measures, the case company experts defined the following KPI for the CSF: *# of security breaches.* The purpose of this KPI is to monitor the amount of security breaches which are occurring within the applications. As any security breach can cause a significant business risk for the organization, the organization should strictly strive for having as low amount of security breaches as possible (preferably 0).

5.3.4 Manage valuable applications for business

As the fourth objective for Application Modernization utilization area, the case company experts defined *Manage valuable applications for business.* This focuses on the ratio of value created for business by the application capabilities against the costs created by the application capabilities. This is identified as the fourth objective because the application capabilities should never be evaluated purely based on costs it creates. The costs of the application capabilities should always be evaluated against the value the application capabilities provide. The fourth objective with its CSFs, statements of success, common features, and KPIs are shown in the table 18 below. The details of the defined performance measures are elaborated after the table.

Table 18. Application Modernization performance measures defined by experts, 4th objective

Objectives	CSFs	Statements of success	Common features	KPIs
Manage valuable applications for business (applications value vs. applications cost)	Application capabilities value	Application capabilities provided for business creates high amount of concrete business value	Business value of application capabilities	Value of application capabilities (€)
	Application capabilities cost	The value of application capabilities exceeds the costs of application capabilities	Application capabilities value vs. application capabilities cost	Value of application capabilities (€) vs. cost of application capabilities (€)

As shown in the table above, the case company experts define two CSFs for the objective. The CSFs and the following performance measures will be elaborated sequentially. The first CSF is defined as *Application capabilities value.* It is recognized that in order to manage application capabilities which provide value for business, the high amount of value (an amount of value which greatly surpasses the amount of costs the applications create) that is actually created is a critical requirement for reaching this goal. Therefore, a statement of success for this is defined as following: *Application capabilities provided for business creates high amount of concrete business value.* A common feature following this is defined as: *Business value of application capabilities.* Based on these performance measures, the case company experts defined the following KPI for the CSF: *Value of application capabilities (€).* The purpose of this KPI is to monitor the actual monetary business value which is produced by the application capabilities. The organization should strive to identifying the value which is produced for the business, so that the impact of the applications and their importance for the business can be recognized. The organization should focus on enabling high value creation for the application capabilities and making decisions that would increase the organization's ability to produce value for the business. The additional costs that would occur from increasing the functionalities and capacity of the application capabilities have always to be considered in relation to this.

The second CSF for this objective is defined as *Application capabilities cost.* The costs which the application capabilities create play a key role in managing valuable applications for business. Traditionally, the costs of application capabilities have been a key decision-point for organizations for choosing the optimal solution. The decision should never be made purely based on the price which the application capabilities creates, instead it is important to evaluate the costs against the value which the application capabilities provide. If extremely high value for business can be gained by selecting a more costly solution, compared to medium value gained by a lower cost solution, a significant advantage of being able to create higher amount

of value in total can be lost with a long-term approach. A statement of success for this is defined as following: *The value of application capabilities exceeds the costs of application capabilities.* A common feature following this is defined as: *Application capabilities value vs. Application capabilities cost.* Based on these performance measures, the case company experts defined the following KPI for the CSF: *Value of application capabilities (€) vs. cost of application capabilities (€).* The purpose of this KPI is to monitor the value created by application capabilities against the costs which is created by the application capabilities. If only the costs of applications would be measured, it would not provide sufficient information regarding the performance of the application capabilities from the business perspective. Application capabilities are considered as a business-critical function, striving for the lowest possible costs could cause significant business problems (e.g. challenges with application availability for business, low agility and scalability for business needs, and other challenges affecting the organization's ability to realize business value) in the long-term. The organization should always strive for having high value received from application capabilities against the costs of application capabilities. The two KPIs defined above for the fourth objective are extremely challenging to monitor and manage. The concrete value which the applications create for the business can be approached from various perspectives and different stakeholders might have different views regarding the value created. The organizations with application capabilities should highly focus on maximizing the business value of applications and justifying application capabilities development and management costs with the added business value which can enabled by continuing application capability development. The focus with application capability development and management should always be on fulfilling organization's evolving business needs.

5.3.5 Added performance measures based on the external knowledge

External knowledge gathered regarding application performance management (Appendix 4) was reviewed with the case company experts. Most of the external knowledge found and researched focused on technical IT metrics (same as reviewed for Infrastructure Modernization utilization area), but also important application performance focused metrics were found. The following additions were made to the Application Modernization performance management.

To the second objective, *Provide capabilities to enable agile and scalable applications for business,* additional missing KPIs for the CSF *Application capabilities* were recognized by the experts. The KPIs that were added (additions made are illustrated with an asterix "*" after the performance measure) were: *1. Number and frequency of production deployments, 2. Application load (measuring total number of calls per minute), 3. Application error rate (including both the total number and the error types per minute).* The performance measures added to the second objective based on the external knowledge are shown in the table 19 below. The details of the defined performance measures are elaborated after the table.

Table 19. Application Modernization performance measures added based on external knowledge, 2nd objective

Objectives	CSFs	Statements of success	Common features	KPIs
Provide capabilities to enable agile and scalable applications for business	Application capabilities	Applications provide optimal performance for the business	Application performance	Number and frequency of production deployments *
				Application load (measuring total number of calls per minute) *
				Application error rate (including both the total number and the error types per minute) *

As shown in the table above, three additional KPIs were added to represent the *Application capabilities* CSF to complement the application performance aspect. *1. Number and frequency of production deployments.* This KPI was added to follow how many production deployments are performed for the applications, and how frequently are they performed. In order to have an agile and scalable foundation for business provided by applications, applications have to adapt quickly, and production deployments should be performed continuously. If production deployments would only be made once or twice a year, this would mean that if the needs and requirements for the applications change, it could take a long period of time for the applications to be able to answer to these needs. Continuous production deployments are becoming the new norm and some of the leading organizations with leading application capabilities are performing releases in some cases even daily to ensure that the applications are up to date, and that small fixes and changes are able to be implemented fast to maximize value realization for business. *2. Application load.* This KPI is measuring the total number of calls which are directed to the applications per minute. Monitoring the application load provides information of how much demand is coming into the applications, and this can be used to assess if the application is able

to provide the level of service for the business adequately. For example, if a certain application has an extremely high demand and activity from the business side, it has to be taken into account at the application management perspective. Necessary optimization work and capacity planning has to be performed regarding the application, in order to ensure that there is no risk for losing business value due to too high demand for the application. *3. Application error rate.* This KPI was added to measure the error rate of the applications, including both the total number of errors and the different error types that are occurring per minute. The purpose of this KPI is to gain insight about how these errors might be affecting the business' ability to realize value, and what could be the possible root causes and fixes for the errors occurring in the applications at the moment.

6 RESULTS: PUBLIC CLOUD PERFORMANCE MANAGEMENT FRAMEWORK FOR BUSINESS AND STRATEGY MAP

This chapter presents the results of this study, including the public cloud performance management framework for each public cloud utilization area, and the strategy map which takes the different objectives from the performance management framework and sets them into a cause-and-effect chain, connecting the organization's desired outcomes with the drivers of those results.

This chapter is divided to the following sub-chapters: *6.1 Public cloud performance management framework for each public cloud utilization area*, presenting the performance framework, which was defined by inputs received from the case company experts with the support of gathered knowledge (chapter 5). The presenting of the performance management framework is divided into sub-chapters by the different public cloud utilization areas (Data on Cloud, Infrastructure Modernization, and Application Modernization). These three areas together form the complete public cloud performance management framework. *6.2 Strategy map for public cloud performance management*, presenting the additional and complementing part of the study, the strategy map, which was also defined by inputs received from the case company experts with the support of gathered knowledge. The picture of the defined strategy map is shown in the beginning of the chapter, followed by the detailed description of the strategy map divided into sub-chapters based on the different balanced scorecard perspectives (Learning and growth perspective, internal processes perspective, customer perspective, and financial perspective), which form the strategy map.

Regarding the public cloud performance management framework, the focus is not on justifying each of the performance measures defined by case company experts, because this was performed in chapter 5 (Defining public cloud performance measures for public cloud utilization areas). Instead, this chapter focuses on presenting the finalized version of the public cloud performance management framework, along with the final insights and highlights regarding the result by the case company experts.

The strategy map was built based on knowledge established in chapter 5, and this knowledge was supplemented with additional interviews with the case company experts in order to form the final version of the strategy map. The insights gathered from the knowledge and the additional interviews are summarized in the strategy map chapter (6.2).

6.1 Public cloud performance management framework for each public cloud utilization area

In the chapters below, the performance management framework is presented covering each public cloud utilization area, which were defined in chapter 5. The performance management framework defined and their significance from business perspective are evaluated. More detailed descriptions and purpose for each performance measure can be found in chapter 5.

The performance management framework consist of objectives, critical success factors (CSFs), and key performance indicators (KPIs) defined for each public cloud utilization area. As the case company's public cloud performance capabilities divides into these three areas, these three sets of performance measures together form the public cloud performance management framework, which is the foundation for customers to manage the public cloud performance in their organization.

This chapter focuses on presenting the performance management framework, with final insights from the case company experts for the organizations, in order to conclude the results of this study.

6.1.1 Data on Cloud

The public cloud performance management framework for Data on Cloud utilization area was defined by case company's public cloud experts (5). The performance management framework was built during a series of interviews and workshops conducted with the case company experts. Researched and gathered external knowledge was reviewed in the process, and insights from

the external knowledge were used in finalizing the performance management framework. In the finalizing stage the performance measures defined with case company experts were compared against performance measures researched and gathered externally. Complementing performance measures were found in the external knowledge for Data on Cloud, and these performance measures were added to the performance management framework. With Data on Cloud utilization area, the biggest challenge currently is how the tools and practices can be implemented in order to make effective and accurate performance management possible. As the organizations are progressing at their own pace in achieving effective data management, the ability to manage data performance for business depends on the expertise and competence levels within the workforce, process maturity levels for managing data for business, and the tools chosen from the suppliers to support value realization with data. In order to start the journey of increasing competence and capabilities in data management, the decision has to come from the strategic level of the organization.

The Data on Cloud performance management framework consists of objectives, critical success factors (CSFs), and key performance indicators (KPIs) which are optimal for the utilization area. The performance management framework is illustrated in the figure 13 below. The asterix symbol (*) indicates performance measures that were added from the external knowledge researched for Data on Cloud.

Objectives	CSFs	KPIs
Gain value for business by moving data capabilities into PC	PC benefits for data capabilities	Data capabilities which would benefit business if transferred into PC vs. those data capabilities transferred into PC
Create valuable data for business (data capture, data creation, data refinement)	Data quantity	# of data domains and data assets
		Data volume vs. the data volume required by business *
		Data volume vs. the data volume required by business *
	Data quality	% of data that can be refined for business use
		% of data ready for business use
Develop data capabilities for business	Data capabilities development	Remaining work (h) vs. completed work (h) in data capabilities development backlog
Provide valuable data for business (from data creation to data fulfillment)	Data lead time	Time from data creation to business use
	Data fulfillment	Business needs that would benefit from using data capabilities vs. business needs fulfilled by data capabilities
Manage valuable data for business (data value vs. data cost) *	Data capabilities value *	Value of data capabilities (€) *
	Data capabilities cost *	Value of data capabilities (€) vs. cost of data capabilities (€) (data processes, data platforms and data management workforce) *

Figure 13. Data on Cloud, public cloud performance management framework

As shown at above, the performance management framework provides the key focus areas (objectives, CSFs, and KPIs) for customers on Data on Cloud. A detailed description for the purpose and meaning of each selected performance measure can be found in chapter 5.1. When assessing if the organization should move into public cloud, the first thing would be to evaluate the current data capabilities in the organization to establish a comprehensive overview of the current state. “Is there value to be gained in the public cloud for the data capabilities side?”. If the answer is yes, it should be evaluated what it takes to make the transition. As data management is becoming a stronger asset for organizations and unquestionably will provide significant competitive advantage in the long-term for those organizations with high capabilities in this area, the organizations have to recognize the risk for losing this advantage if they do not

take the right steps. That is why *Gain value for business by moving data capabilities into public cloud (PC)* is defined as the first objective.

Data itself is a vast subject and managing data in an organization covers many aspects and areas. The different aspects of data, *data quantity, data quality, data capabilities development, data lead time, data fulfillment, data capabilities value, and data capabilities cost,* where logically grouped into the different objectives by the case company experts. The objectives defined for Data on Cloud strongly correlate with the modern-day business and data objectives in the organizations. These are, being able to use information to the business' advantage, being able to refine data to produce high value for business and receiving high value for business with data. But at the same time, running the costs of data management efficiently and justifying the costs with the value received for the business. By structuring information and data in the organization in modern way, this should enable the information to be used organization-wide and increase the possibility to find new insights and value for business by combining data from different parts of the organization. These are the objectives that the organizations should strive for in data performance management. Some of the KPIs defined in the performance management framework can be challenging to measure from the start, but the key is to not overlook on these aspects of performance in order to achieve the objectives that have been set.

The Data on Cloud performance management framework provides a foundation for data performance management for customers who are in different stages and levels in terms of competence and capabilities. The different objectives, CSFs, and KPIs provide a structure for performance management, and these can be complemented or modified according to organization's needs and strategy.

6.1.2 Infrastructure Modernization

The public cloud performance management framework for Infrastructure Modernization utilization area was defined by case company's public cloud experts (5). The performance management framework was built during a series of interviews and workshops conducted with the case company experts. Researched and gathered external knowledge was reviewed in the

process, and insights from the external knowledge were used in finalizing the performance management framework. In the finalizing stage the performance measures defined with case company experts were compared against performance measures researched and gathered externally. For Infrastructure Modernization, the external knowledge provided great insights on which critical performance measures should be added to make the framework complete. The nature of public cloud infrastructure performance management is similar to traditional infrastructure performance management. Both provide the business similar capabilities to realize value using different sources of technology (comparing on-premise servers to virtualized cloud computing capabilities). With public cloud, service providers often are able to provide excellent tools for monitoring and managing performance, but the organization still has to always set the strategic direction, and define the needs and requirements for business. The greatest challenge in infrastructure performance management for organization lies in being able to select the most effective and efficient solution which best fits for their organization's needs. This could be partly sourcing value adding public cloud infrastructure capabilities to complement current on-premise solutions designed for specific business requirements, or even making the decision on going fully virtual with public cloud to maximize agility and scalability of the infrastructure.

The Infrastructure Modernization performance management framework consists of objectives, critical success factors (CSFs), and key performance indicators (KPIs) which are optimal for the utilization area. The performance management framework is illustrated in the figure 14 below. The asterix symbol (*) indicates performance measures that were added from the external knowledge researched for Infrastructure Modernization.

Objectives	CSFs	KPIs
Gain value for business by moving infrastructure into PC	PC benefits for infrastructure	Parts of infrastructure which would benefit business if transferred into PC vs. those parts of infrastructure transferred into PC
Provide agile and scalable infrastructure for business	Infrastructure speed of change	Avg time for change
	Infrastructure capabilities	Infrastructure availability
		Infrastructure capacity *
		Infrastructure latency *
		# of workloads processed *
Provide stable and secure infrastructure for business	Infrastructure incidents	# of incidents
		# of major incidents
	Infrastructure reliability	Infrastructure downtime
		# of planned and unplanned outages *
		Mean Time to Failure (MTTF) *
	Infrastructure problem resolving *	Mean Time to Resolve (MTTR) *
	Infrastructure security	# of security breaches
Manage valuable infrastructure for business (infrastructure value vs. infrastructure cost)	Infrastructure capabilities value	Value of infrastructure capabilities (€)
	Infrastructure capabilities cost	Value of infrastructure capabilities (€) vs. cost of infrastructure capabilities (€)

Figure 14. Infrastructure Modernization, public cloud performance management framework

As shown at above, the performance management framework provides the key focus areas (objectives, CSFs, and KPIs) for customers on Infrastructure Modernization. A detailed description for the purpose and meaning of each selected performance measure can be found in chapter 5.2. The same point discussed in Data on Cloud regarding gaining value from public cloud for the utilization areas also applies with Infrastructure Modernization. As a first step, the organizations should take action in assessing if value can be gained for business by moving infrastructure capabilities into public cloud. If it is evaluated that significant value can be gained, the organization should start planning the next steps for making this a reality. On the infrastructure side, public cloud offers agile and easily scalable alternative for traditional on-

premise solutions. These can provide significant value for companies with rapidly changing business needs, who have a demand for easily optimizable infrastructure. Agile and scalable infrastructure capabilities support the business by giving an option to adjust the capacity to changing needs, whether it is a decision for higher cost efficiency focus from the top management, or an operational team is establishing a new service with additional capacity requirements. This is the reason why *Gain value for business by moving infrastructure capabilities into public cloud (PC)* is defined as the first objective in Infrastructure Modernization as well. Assessing which parts of the infrastructure should or should not be moved into the public cloud clarifies the rest of the performance objectives that will be set for the organization.

In the Infrastructure Modernization performance management framework, the case company experts have defined the most important objectives for organizations, in order to succeed with the greatest business challenges of the modern-day. The organizations should focus on enabling seamless collaboration of business and technology for realizing high value. In practice this translates into enabling agile and scalable business initiatives supported by advanced technology solutions and infrastructure, being able to provide stable and secure infrastructure foundation for business to consistently and reliably realize value, and effectively manage the value received from the infrastructure capabilities against the costs which are created. By ensuring that organization's infrastructure capabilities are up-to-date and match the current and future business needs and strategy, the organizations can keep gaining competitive advantage against their competitors. Public cloud offers significant possibilities for companies to gain value against costs created, and the case company experts advise the organizations to strive to use this for their advantage. These are the objectives that the organizations should focus on in infrastructure performance management. Some of the KPIs defined in the performance management framework can be challenging to measure from the start, but the key is to not overlook on these aspects of performance in order to achieve the objectives that have been set.

The Infrastructure Modernization performance management framework provides a foundation for infrastructure performance management for customers who are in different stages and levels in terms of competence and capabilities. The different objectives, CSFs, and KPIs provide a

structure for performance management, and these can be complemented or modified according to organization's needs and strategy.

6.1.3 Application Modernization

The public cloud performance management framework for Data on Cloud utilization area was defined by case company's public cloud experts (4). The performance management framework was built during a series of interviews and workshops conducted with the case company experts. Researched and gathered external knowledge was reviewed in the process, and insights from the external knowledge were used in finalizing the performance management framework. In the finalizing stage the performance measures defined with case company experts were compared against performance measures researched and gathered externally. For Application Modernization, the external knowledge consisted of similar performance measures as Infrastructure Modernization with additional performance measures focusing directly on application performance. These provided great input for further development of performance measures and provided help for completing the finalized version. With defining Application Modernization performance framework, similarities in the nature of performance management with Infrastructure Modernization were noticed. Both provide a similar type of service for the business (for example in offering capacity capabilities for realizing business value), and for that reason, these two utilization areas also share similar performance measures together. Public cloud offers a possibility for organizations to transfer their applications into public cloud. The platforms available provide scalable capacity and typically offer advanced performance management capabilities for the organizations. The performance measures that are followed for application performance management does not drastically differ whether it is performed within public cloud or within another solution. Similar metrics are followed, focusing on business value enabled by application capabilities. These are performance measures such as application availability, response times, number of errors etc. The key point for considering public cloud option for organizations is on getting access to easily scalable and optimizable foundation for applications. Public cloud might be able to offer more advanced capabilities for applications that organizations are currently using, among with additional expertise which can be derived from the supplier side to boost performance, application optimization, and cost effectiveness.

As with Infrastructure Modernization, one of the key objectives the organizations currently have is to increase the ability to react to changes quickly and increase the amount and frequency of production deployments to increase value realization potential for the business. The greatest challenge within applications for businesses lies on choosing the right applications for their business and building the correct competence for managing these applications within the organization. Or as an alternative, having external capabilities to complement the internal competence. The most value out of applications can be done by making the correct decisions in these two areas and optimizing the application performance management to ensure high value vs. cost ratio. Organizations typically have a variety of applications in use. Some applications are considered business critical and might have special requirements for example from security aspects. The organization needs to consider which solutions fits into their needs, and act on that knowledge.

The Application Modernization performance management framework consists of objectives, critical success factors (CSFs), and key performance indicators (KPIs) which are optimal for the utilization area. The performance management framework is illustrated in the figure 15 below. The asterix symbol (*) indicates performance measures that were added from the external knowledge researched for Application Modernization.

Objectives	CSFs	KPIs
Gain value for business by moving applications into PC	PC benefits for applications	Applications which would benefit business if transferred into PC vs. those applications transferred into PC
Provide capabilities to enable agile and scalable applications for business	Speed of change for applications	Avg time for change
	Application capabilities	Application availability
		Number and frequency of production deployments *
		Application load (measuring total number of calls per minute) *
		Application response time
		Application error rate (including both the total number and the error types per minute) *
Provide stable and secure applications for business	Application incidents	# of incidents
		# of major incidents
	Application reliability	Application downtime
		# of planned and unplanned outages
		Mean Time to Failure (MTTF)
	Application problem solving	Mean Time to Resolve (MTTR)
	Application security	# of security breaches
Manage valuable applications for business (applications value vs. applications cost)	Application capabilities value	Value of application capabilities (€)
	Application capabilities cost	Value of application capabilities (€) vs. cost of application capabilities (€)

Figure 15. Application Modernization, public cloud performance management framework

As shown at above, the performance management framework provides the key focus areas (objectives, CSFs, and KPIs) for customers on Application Modernization. A detailed description for the purpose and meaning of each selected performance measure can be found in chapter 5.3. The same point discussed in Data on Cloud and Infrastructure Modernization regarding gaining value from public cloud for the utilization areas also applies with Application Modernization. As the first action, the organizations should take action in assessing if value can

be gained for business by moving application capabilities into public cloud. The organizations should strongly focus on their business needs and how they are evolving. As technology utilization advances within the players of the market, it is expected that more and more organizations will be able to challenge other companies with their technological capabilities in order to gain more value. Applications are one critical area where such advantages can be gained. Applications should fit the business' needs perfectly and one of the most important aspects that gets overlooked, is the ability to manage applications effectively and efficiently. With new tools and methods available, the organizations must explore and try to develop their capabilities to achieve higher returns on investment, which are directed to the applications used by the business. The main objectives for application capabilities in the modern-day are: increase value provided by the applications overall, increase the agility and scalability of applications to meet quickly changing and evolving business needs, increase stability and security within applications, and increase business value vs. cost ratio for applications. Public cloud is able to offer tools for organizations to succeed in these objectives, but it also depends on the organization's strategy and specific requirements for applications. If the conclusion is that significant value for business can be gained by transferring applications into public cloud, the organization should proceed with planning on how this transfer can be made possible. As competition between companies are constantly increasing, available business value has to be claimed by the organizations to stay on top. For this reason, *Gain value for business by moving application capabilities into public cloud (PC)* is also defined for Application Modernization as the first objective. Having a clear vision on which applications can be transferred into public cloud provides the organizations the first step for starting the transformation for gaining more value for the business with applications.

In the Application Modernization performance management framework, the case company experts have defined the most important objectives for organizations, in order to succeed with the greatest business challenges of the modern-day. The organizations should focus on enabling seamless collaboration of business and technology for realizing high value. In practice this translates into enabling agile and scalable business initiatives supported by advanced technology solutions and applications, being able to provide stable and secure applications for business to consistently and reliably realize value, and effectively manage the value received from the application capabilities against the costs which are created. Some of the KPIs defined

(as in Data on Cloud and Infrastructure Modernization) in the performance management framework can be challenging to measure from the start, but the key is to not overlook on these aspects of performance in order to achieve the objectives that have been set.

The Application Modernization performance management framework provides a foundation for application performance management for customers who are in different stages and levels in terms of competence and capabilities. The different objectives, CSFs, and KPIs provide a structure for performance management, and these can be complemented or modified according to organization's needs and strategy.

6.2 Strategy map for public cloud performance management

The purpose of the strategy map is to show the connections between the strategic objectives in a simple visual graphic. After performance management framework was defined for each utilization area, it was recognized that in order to create a good overview regarding the public cloud performance management benefits for the organization's strategic level, a strategy map would be the best way to illustrate this. A strategy map was built based on case company expert interviews in order to complement the performance management framework, and to provide a more holistic and visual overview of how significant the public cloud performance management is for the business. Most of the knowledge used for building the strategy map was gathered in the chapter 5 when defining the performance management framework for the public cloud utilization areas. This knowledge was supplemented with additional interviews with the case company experts to build the final result. The strategy map focused on grouping strategic objectives discussed in the chapter 5 into *financial, customer, internal, and learning and growth perspectives* as defined by Kaplan & Norton (2000), who introduced the concept of strategy map (a more detailed description of the strategy map can be found in chapter 3.7). The strategy map divides into different levels vertically based on the different perspectives *(financial, customer, internal, learning and growth)*. The strategic objectives are shown as ovals in the strategy map, and triangles and arrows between levels and individual objectives show the cause-and-effect of different strategic objectives. The strategy map built together with the case company experts is illustrated in the figure 16 below.

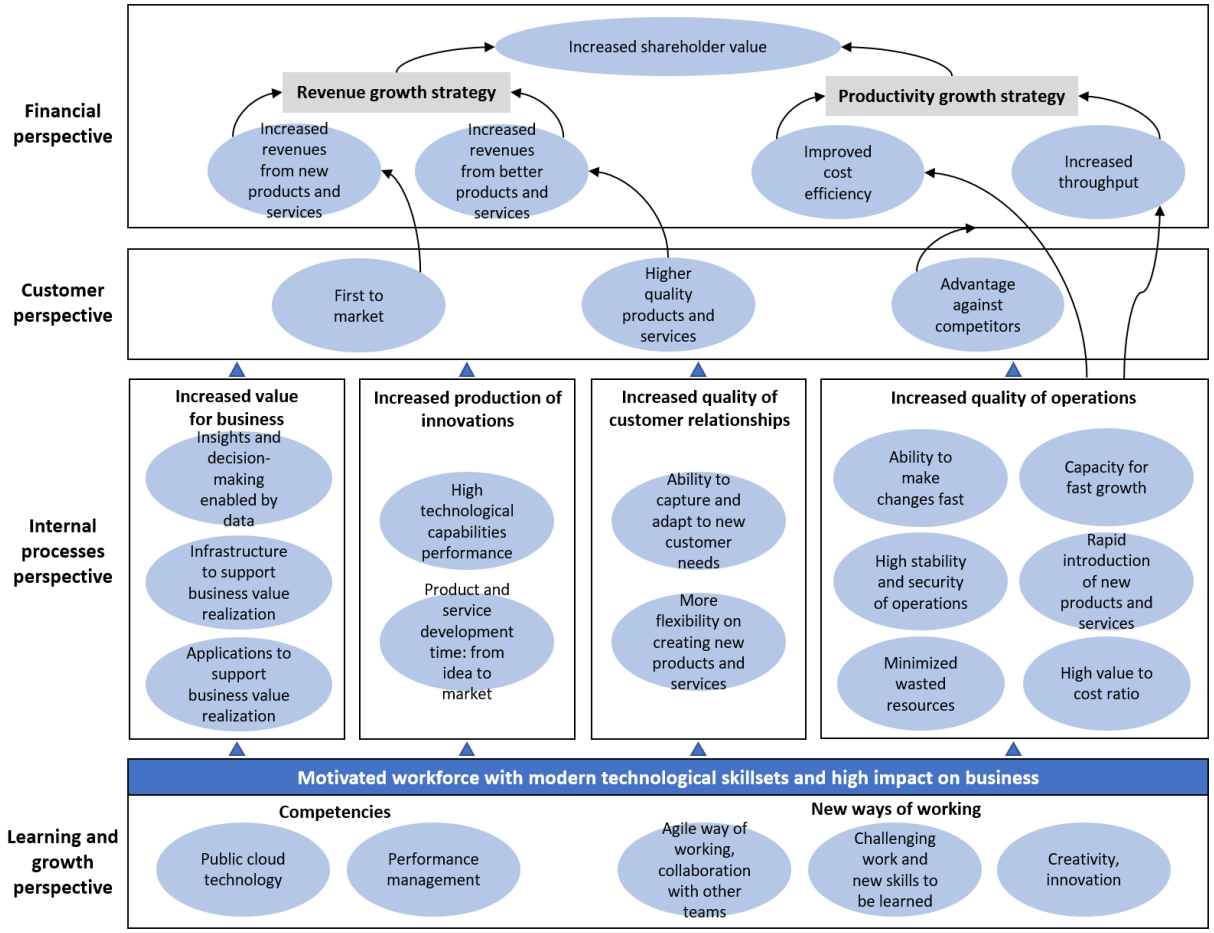


Figure 16. Public cloud performance management strategy map

As it can be seen in the figure above, the creation of value illustrated in the strategy map starts from the bottom level *(learning and growth perspective)* and ends to the top level *(financial perspective)*, and the elaboration of the table also starts from the bottom level. The elaborations of the different perspectives illustrated above are presented in the chapters below. The contents of the chapters below are a summary of the insights case company experts provided for building the strategy map above.

6.2.1 Learning and growth perspective

The strategic objectives on the *Learning and growth perspective* consist of two main groups: building new competencies introduced by the public cloud performance management and

implementing new ways of working introduced by the public cloud performance management. For the *Learning and growth perspective* regarding competencies, the strategic objectives are to build public cloud technology and performance management competence and learning in the organization. These might be completely new subjects for most employees in the organization, and it offers them a possibility to start learning valuable skills in these two areas, which are both extremely important for the organization's success now and in the future.

Regarding new ways of working, the strategic objectives are to establish an agile way of working and collaboration with other teams, provide challenging work and new skills to be learned for the employees, and increase creativity and innovation within the organization. The purpose of the new way of working is to break the routines which the employees have gotten used to. By doing this and by providing new challenges and opportunities for the employees to learn and grow, this can significantly increase the feeling of purpose by the employees as they feel that they are spending their time on something useful and they are able to make an impact for the business. One of the objectives is to increase innovation and creativity, and this is enabled by employees having an opportunity to learn new valuable skills and by enhancing collaboration between teams.

As an end-result, the strategic objectives in the *Learning and growth perspective* form a strong foundation for value realization with public cloud performance management. They all together form a motivated workforce with modern technological skillsets and high impact on business. Without having a skilled and reliable workforce, effective and efficient technology utilization for the business cannot be performed, and this is the reason why the strategic objectives and the outcomes of it are critical for the success.

6.2.2 Internal processes perspective

The *Internal processes perspective* consists of strategic objectives grouped into four sections: Increased value for business, Increased production of innovations, Increased quality of customer relationships, and Increased quality of operations. The value from the *Learning and growth perspective* is equally provided into all sections of the *Internal processes perspective*,

meaning that they have a direct cause-and-effect relationship (illustrated by triangles in between *Internal processes perspective* and *Learning and growth perspective)*.

The increased value for business is supported by the public cloud utilization areas: Data on Cloud, Infrastructure Modernization, and Application Modernization. The data provides better sources of insights and decision making for the business, the infrastructure supports business value realization by offering agile and scalable infrastructure capabilities, followed by the applications in a similar manner. These all feed inputs for increasing value for the business enabled by high public cloud performance.

The increased production of innovations in the organization is supported by building high performance on technological capabilities and by decreasing the performance of product and service development time, which decreases the time it takes for the organization to develop new products and services, from forming the idea to introducing them to the market. By having high performance in technological capabilities and short time from idea to market, the organization is able to produce more innovations to create value.

The increased quality of customer relationships are supported by the public cloud performance by being able to serve the customers better by the ability to capture and adapt to new customer needs, and by having more flexibility on creating new products and services which is enabled by public cloud performance (e.g. agile way of working and faster production deployment cycles). These objectives boost the quality of customer relationships and build trust on the organization from the customer perspective, as the organization is able to truly act as an business enabling partner for the customer, where complex demands and fast changes can be handled by the organization effectively.

The increased quality of operations is supported by the following objectives: the organization's ability to make changes fast (public cloud capabilities supported by agile methods), having technological capacity for fast growth (public cloud capabilities supported by scalable components), having high stability and security within the operations, being able to rapidly introduce new products and services, being able to minimize wasted resources (more efficient

practices and processes established around public cloud performance), and having high value to cost ratio (enabled by high public cloud performance).

These strategic objectives together form solid and effective operations which are able to serve the business in the most optimal way, and act as a solid foundation for the value realization performed by the business. The public cloud performance focus in the operations is to eliminate waste and increase the effectiveness in all areas in order to increase the overall value and quality of the operations. All of the strategic objectives highlighted above feed value inputs into the *Customer perspective* level (indicated by triangles between *Internal processes perspective* and *Customer perspective)*, but in addition, the strategic objectives of the increased quality of operations section in the *Internal processes perspective* level specifically provides direct inputs to the strategic objectives in the *Financial perspective* level, which are visible in the strategy map (indicated by arrows) and will be highlighted later in elaborating the *Financial perspective*.

6.2.3 Customer perspective

The *Customer perspective* receives value inputs from all sections defined for the *Internal processes perspective*. The *Customer perspective* consists of the following strategic objectives: Organization's ability to be the first to the market for the customers, being able to provide higher quality products and services for customers, and having an competitive advantage against other players in the market in the eyes of the customers.

Being able to be the first player in the market for customers is extremely important from the customer point of view, when the company is striving for a forerunner status in the market. This objective also focuses on targeting new segments in the market, the needs that has not been satisfied yet, in order to create new business and build new customer relationships for realizing value. Being able to be the first player in the market provides extensive business opportunities, and this is strongly supported by high public cloud and technological performance. The first to market objective has a direct link on the objective defined in *Financial perspective* (Revenues from new products and services, indicated by an arrow), which is visible on the strategy map, and this will be elaborated later when discussing the *Financial perspective* of the strategy map.

By being able to provide high quality products and services for customers creates a strong image of the organization which leads to new business opportunities and strengthens the organization's business overall. Being known for high quality products and services is an advantage as itself, and by customers being able to trust the quality of products and services brings consistent business for the organization. Higher quality products and services objective has a direct link on the objective defined in *Financial perspective* (Revenues from better products and services, indicated by an arrow), which is visible on the strategy map, and this will be elaborated later when discussing the *Financial perspective* of the strategy map.

Having the competitive advantage against competitors, which is supported by the public cloud performance and technological capabilities, is always important to stay on top of the competition. Being able to have the competitive advantage ensures that the organization has a great chance to produce more business and securing the continuation of current business by winning the competition against other players. The competitive advantage is something organizations do not afford to lose on the long-run. The organization will always be compared to the other players of the market and their offerings, and the organization wants to always stand strong with its capabilities to satisfy customer needs when they emerge. The Advantage against competitors objective has a direct link to whole the *Financial perspective* of the strategy map, (which is also visible on the strategy map, indicated by an arrow). All the components that feed value into achieving the competitive advantage (technological, human, and organizational capabilities defined in *Internal processes perspective* and *Learning and growth perspective*) support all the strategic objectives defined for the *Financial perspective*.

6.2.4 Financial perspective

The *Financial perspective* receives direct value inputs from the Advantage against competitors objective as described in the *Customer perspective* chapter above. The *Financial perspective* consists of the following strategic objectives: increased revenues received from new products and services, increased revenues received from better products and services, improved cost efficiency, and increased throughput. All of these objectives are enabled by the public cloud

performance and from all of the practices and processes which are required for high public cloud performance.

By focusing on increased revenues from new products and services, this feeds inputs to organization's revenue growth strategy (indicated by an arrow), which targets to increase organization's revenues by growing current business and by creating new business opportunities. From the business and financial perspective, it is always critical for organization to focus on and to be able to create and capitalize on opportunities for growth, and having high capabilities to create new products and services strongly supports the company in achieving this goal. Value is also produced directly to this objective by the First to market objective (indicated by an arrow) defined in the *Customer perspective* of the strategy map. By focusing on being the first to market, the organization strives to be the first player to interact with the new and changing customer needs, which will increase the potential for creating new products and services that satisfy the customer needs, and feed into the organization's revenue growth strategy. This supports the organization on the success of one of the main and most important objectives, securing more revenues for the organization's growth.

By focusing on increased revenues from better products and services, this also feeds inputs to organization's revenue growth strategy (indicated by an arrow), which targets to increase organization's revenues by growing current and by creating new business with these higher quality products and services. Increasing the organization's revenue growth is an extremely important objective at the strategic level, and its main goal is to ensure that the organization's business is growing. Organization's main purpose is to provide high value to the most important stakeholders of the company. By growing the organization's revenues and business, the organization is able to grow into a bigger, better and more competitive player in the market in order to increase the amount of value the organization creates to its stakeholders today. Value is also produced directly to this objective by the Higher quality products and services objective (indicated by an arrow) defined in the *Customer perspective* of the strategy map. Being able to produce high quality products and services is a foundation for organization's success, and it provides a strong position to secure business continuity with bringing new opportunities to the table at the same time. Customers that are able to rely on the high quality of organization's products and services is something that the customers will always focus on, and this will keep

providing value for the organization in the long-run if executed correctly. This also supports the organization on the success of one of the main and most important objectives, securing more revenues for the organization's growth.

By focusing on improved cost efficiency, this feeds inputs to organization's productivity growth strategy (indicated by an arrow), which targets to increase organization's productivity by making the organization's operations more efficient from the cost perspective. Increasing the organization's productivity growth is an extremely important objective on the strategic level, and its main goal is to secure that all of the organization's resources are utilized to the maximum potential and minimal amount of available potential is wasted. The more productive the organization is (this is always evaluated with value created vs. costs created in mind), the more effectively it is able to produce value for business and their customers. Value is also produced directly to this objective by the whole Increased quality of operations objectives section (indicated by an arrow) defined in the *Customer perspective* of the strategy map. Effective and high-quality operations provide a foundation for cost efficiency, as they are able to operate with a combination of high productivity and minimal wasted resources within the operations. In other words, value is created to the maximum potential with minimal inefficiencies from the cost perspective (e.g. less unproductive time, less ineffective practices, less ineffective processes etc.). Improved cost efficiency contributes to the organization's total effectiveness to conduct business and it is a critical factor for the organization's success in the long-run. The organization should always strive for conducting business with the highest possible efficiency within realistic limits. That is, organizations should strive to maximize organizational, technological, practical and process efficiency, but not maximize human efficiency across certain limits, as this can actually cause an opposite effect and decrease the productivity growth in the long-term.

By focusing on increased throughput, this also feeds inputs to organization's productivity growth strategy (indicated by an arrow), which targets to increase organization's productivity by increasing the throughput (the amount of value created through the organization). Value is also produced directly to this objective by the whole Increased quality of operations objectives section (indicated by an arrow) defined in the *Customer perspective* of the strategy map. The increased throughput is extremely important from the *Financial perspective*, as the company is

able to produce more value from the organization (efficiency of operations and technological capabilities) for the customers. With the ability to produce value, more is always more, and companies that are able to produce most value with fixed resources will always be highly competitive in the market which links directly to the *Financial perspective*.

Both, revenue growth strategy and productivity growth strategy feed value into organization's ultimate objective (indicated by arrows on the strategy map), which is increased shareholder value. Increased shareholder value is one of the most important objectives for the management of the company. Shareholder value is seen as one of the main indicators of the value of the company, and the management's main objectives is to find ways to increase this with effective methods. As illustrated on the strategy map, public cloud is able to offer capabilities for the organization to effectively develop organization's ability to conduct business and increase the value for business. The different value inputs of the strategic objectives for public cloud and its performance from different perspectives have a significant effect on organization's business which impacts the organization's ability to increase shareholder value. Based on the strategy map defined, it can be concluded that a massive strategic impact can be achieved by the organizations by striving to manage public cloud performance on a high level and by setting the right objectives which support this goal.

7 CONCLUSIONS

This chapter establishes the conclusions of this study. This is performed first by assessing the success of the study against the objectives set, and against the research questions set (chapter 7.1). This is to see, if the objectives of the study were achieved, and if the research questions were answered to within this study. This is followed by the general conclusions (chapter 7.2), which consists of evaluating the significance of the results, and the impact of the results from theory and practical perspectives. For this study, highly value adding follow-up actions were not recognized for continuing this study.

7.1 Reaching goals and answering research questions

The objective for this study was (defined in chapter 1.1) to define a public cloud performance management framework which consists of the most important aspects from the business perspective. The main goal is to provide a sound and logical framework which is easy to understand for business and provides a foundation of knowledge for public cloud performance management. This consists of the most important objectives, critical success indicators (CSFs), and key performance indicators (KPIs) for managing public cloud performance, which can be used as a foundation for starting and developing public cloud performance. As an addition, to provide a strategic and high-level perspective on the value created by effective public cloud performance management, a public cloud performance management strategy map is defined.

In this study, a public cloud performance management framework was defined using knowledge and best practice researched and gathered from relevant areas required for this study, together with the expertise provided by the case company experts (case company interviews). As a result, a public cloud performance management framework was defined, which covered three public cloud utilization areas (Data on Cloud, Infrastructure Modernization, and Application Modernization) defined by the case company. This does provide a sound, logical and complete framework which is easy to understand for business. It also does provide a foundation of knowledge for public cloud performance management, which can be used for starting and developing organization’s public cloud performance. The public cloud performance

management framework consists of objectives, critical success factors (CSFs), and key performance indicators (KPIs) for managing public cloud performance. And as an addition, a strategy map was defined using the knowledge established in defining the public cloud performance management framework, supplemented with additional case company expert interviews for building the final version. The strategy map defined does provide a strategic and high-level perspective on the value created by effective performance management. The objectives presented in the strategy map are based on the public cloud performance measures defined for the public cloud performance management framework for business.

The research questions defined for this study were: *1. What are the objectives for managing public cloud performance in the public cloud utilization areas? 2. What are the critical success factors (CSFs) for managing public cloud performance in the public cloud utilization areas? 3. What are the key performance indicators (KPIs) for managing public cloud performance in the public cloud utilization areas?*

In this study, objectives for managing public cloud performance were successfully defined for three public cloud utilization areas (Data on Cloud, Infrastructure Modernization, and Application Modernization). The total amount of objectives for managing public cloud performance in the public cloud utilization areas defined in this study was 13. Critical success factors (CSFs) for managing public cloud performance were also successfully defined for the three public cloud utilization areas defined above, and the total amount of CSFs defined in this study was 26. Key performance indicators (KPIs) for managing public cloud performance were, as well, successfully defined for the three public cloud utilization areas, and the total amount of KPIs defined in this study for managing public cloud performance in the utilization areas was 42.

Based on the evaluation above, it can be concluded that the goals and objectives set for this study were reached successfully, and the research questions set for this study were answered to comprehensively.

7.2 Conclusions regarding the results of this study

In conclusion, the study was conducted successfully, and the results established in the study were optimal for the case company's needs. In this study, a public cloud performance management framework for business was defined, consisting of most important public cloud performance measures (objectives, critical success factors, and key performance indicators) from the business perspective, which can be offered for the case company's customers as a foundation of knowledge for starting and developing public cloud performance management in their organizations. In this study, also a strategy map was defined which gathered the most important public cloud performance management objectives (defined for the public cloud performance management framework for business) into a visual representation, for showing how public cloud performance management creates value for business. This strategy map brought more concreteness on the benefits which the effective public cloud performance management brings with it, which creates a strong message for the case company's customers on why public cloud performance management should be considered as an important part of organization's strategy.

In researching and gathering relevant knowledge and best practice required for this study, it can be concluded that an extensive set of correct knowledge and tools were successfully gathered and effectively utilized in creating the results. The introduction to cloud computing and public cloud provided adequate context for the study for grasping the key points of the technology, the main benefits which should be strived for, and the main challenges that should be addressed. The material gathered for performance management provided a strong foundation of knowledge which was used to support the process of forming the public cloud performance management framework for business, and the public cloud performance management strategy map.

The case company experts provided excellent inputs in the interviews, and the information was effectively used to build the public cloud performance management framework for business, and the public cloud performance strategy map. As the case company experts had different backgrounds, experience, and knowledge, they provided versatile insights and point-of-views, making sure that the work was not approached from a narrow angle.

As there were no complete public cloud performance management frameworks that would be targeted for the business (most of the available frameworks purely focus on the technical aspects of cloud computing and public cloud performance), this study provides significant impact from the practical perspective by offering a complete framework which is easily understandable and can be taken into use by the companies. From the theoretical perspective, this study introduces public cloud objectives, critical success factors, and key performance indicators which are strongly linked together. Most of the available knowledge researched consisted of individual performance measures linked to a certain utilization capability, but did not express how does measuring these individual performance measures affect the organization on the higher level (e.g. what strategic objective does measuring infrastructure availability link to, and how does this affect business). This study shows a collection of performance measures for public cloud performance management where their cause-and-effect relationships are defined, which elaborates on the effect of each performance indicator for the business. This study also provides a strategy map based on the most important public cloud performance management objectives defined, to illustrate the benefits of the effective public cloud performance management, which is a new and interesting addition to the theoretical realm.

Organizations can use the public cloud performance management framework, and strategy map defined in this study, to establish a foundation for public cloud performance management in their organization. The performance measures (objectives, CSFs, and KPIs) of the public cloud performance management framework can be complemented with additional performance measures or modified according to organization’s own needs and strategy.

8 SUMMARY

The case company's customers utilizing and planning to utilize public cloud capabilities in their business did not have a clear vision for how to manage public cloud performance. There were public cloud performance measures available in various sources, but they were purely focused on the technical aspects of managing the performance of public cloud. For the businesspeople of the customer organizations, there was no indication on why these performance measures were important from the business perspective and how does their performance contribute to the business' strategic goals. There was no business-oriented public cloud performance management framework that would be easily understandable and could be easily taken into use to start managing public cloud performance, or to start developing the current setting used for managing public cloud performance.

Based on this challenge, the case company wanted to gather a collection of the most important business-oriented performance measures for managing public cloud performance, in its different utilization areas (Data on Cloud, Infrastructure Modernization, and Application Modernization). This collection of public cloud performance measures would form the public cloud performance management framework, the foundation of knowledge which enable the case company's customers to start and develop their public cloud performance management. The objective for this study was to define the most important public cloud performance measures (objectives, critical success factors, and key performance indicators) for the business covering all the public cloud utilization areas defined by the company. As an addition, a strategy map would be constructed to illustrate the value created by the effective public cloud performance management, to support the message of public cloud performance management benefits for the business from the strategic perspective.

A collection of relevant knowledge and best practice was researched and gathered to support the defining of public cloud performance management framework for business. An introduction was provided for the cloud computing and public cloud technologies to provide adequate technical context for study. This was followed by a collection of performance management knowledge and best practice, to provide a strong foundation for building the public cloud

performance management framework, and the strategy map, according to the best practice available regarding performance management.

The case company then provided a vast amount of information and insights relevant for the case, introducing the challenge, the public cloud utilization areas which the case company had defined, along with the method that would be used for constructing the results of this study. The results of this study would be built based on the knowledge and best practice researched and gathered, and the main tool used for the definition process was the top-down CSF/KPI framework (Jahangirian M. et al. 2017). The main purpose of the top-down CSF/KPI framework was to help in defining objective-oriented key performance measures, which means that the definition work of key performance indicators was started from the organization's objectives: first defining the important objective for the organization, followed by defining the critical success factor (CSF) for the objective, then defining the statements of success for the critical success factor, defining the common features related to the statements of success, and finally defining the key performance indicators (KPIs) for the common features. As a result, a key performance indicator is defined, which is directly linked to the organization's important objective, which the organization wants to pursue. By monitoring this key performance indicator defined and by improving its performance, the organization can move closer to achieving the objective which is linked to the key performance indicator.

The definition of public cloud performance management framework, and the strategy map, was supported by the case company experts, and the inputs from the case company experts were gathered from interviews conducted with them. In total, six different case company experts from different backgrounds with diverse experience were interviewed for defining the public cloud performance management framework, and the strategy map. The case company experts provided excellent inputs, which lead to constructing clear and logical results.

As a result of the study, a complete public cloud performance management framework for business was built, along with a public cloud performance management strategy map. The public cloud performance management framework for business presented the most important public cloud performance measures (objectives, critical success factors, and key performance indicators) from the business perspective for each public cloud utilization area defined by the

case company (Data on Cloud, Infrastructure Modernization, and Application Modernization). This provides a foundation of knowledge regarding public cloud performance management, which the case company's customers can use to start and develop their organization's public cloud performance management. The strategy map illustrated the value created by the effective public cloud performance management, and this strongly supports the message, that public cloud performance management brings significant concrete benefits for the business which can be recognized on the organization's strategic level.

REFERENCES

Alshamaila, Y., Papagiannidis, S., & Li, F. (2013). Cloud computing adoption by SMEs in the north east of England. *Journal of enterprise information management*.

AppDynamics. (2021). 7 Steps to Maximizing the Value of APM. Available at: https://cloud.kapostcontent.net/pub/5f3a687b-7268-497a-a178-bd8f2704c6db/7-steps-to-maximizing-the-value-of-apm

Bayo-Moriones, A., & Lera-López, F. (2007). A firm-level analysis of determinants of ICT adoption in Spain. *Technovation*, *27*(6-7), 352-366.

Berman, S. J., Kesterson-Townes, L., Marshall, A., & Srivathsa, R. (2012). How cloud computing enables process and business model innovation. *Strategy & Leadership*.

BSC Designer. (2021). KPIs for Big Data initiatives. Available at: https://bscdesigner.com/kpis-for-big-data.htm

Buyya, R., Yeo, C. S., & Venugopal, S. (2008, September). Market-oriented cloud computing: Vision, hype, and reality for delivering it services as computing utilities. In *2008 10th IEEE international conference on high performance computing and communications* (pp. 5-13). Ieee.

Cadwell, C. M. (2000). Performance management. AMACOM Div American Mgmt Assn.

Caralli, R. A., Stevens, J. F., Willke, B. J., & Wilson, W. R. (2004). The critical success factor method: establishing a foundation for enterprise security management. Carnegie-Mellon Univ Pittsburgh Pa Software Engineering Inst.

Carroll, M., Kotzé, P., & Van Der Merwe, A. (2010). Securing virtual and cloud environments. In *International Conference on Cloud Computing and Services Science* (pp. 73-90). Springer, New York, NY.

Christopher, M. (2016). Logistics & supply chain management. Pearson Uk.

Citrix. (2021). What is public cloud? Glossary. Available at: https://www.citrix.com/fi-fi/glossary/what-is-public-cloud.html

Cloud standards. (2020). Cloud computing statistics: 2020 Overview. Article. [Referenced on: 10.3.2021] Available at: https://cloud-standards.org/cloud-computing-statistics/

Daniel, D. R. (1961). Management information crisis. *Harvard business review*, 111-121.

Drucker, P. F. (1974). Tasks, responsibilities, practices. *New Yorks Row*, 121-122.

Dörner, D., Kreuzig, H. W., Reither, F., & Stäudel, T. (1983). Lohhausen: Vom Umgang mit Unbestimmtheit und Komplexität.

Erdogmus, H. (2009). Cloud computing: Does nirvana hide behind the nebula?. *IEEE software*, *26*(2), 4-6.

Gray, A. (2013). Conflict of laws and the cloud. *Computer Law & Security Review*, *29*(1), 58-65.

Grüning, M. (2002). Performance-Measurement-Systeme: Messung und Steuerung von Unternehmensleistung. Springer-Verlag.

Hentsu. (2020). Cloud strategy roadmap: 11 biggest public cloud benefits. Article. [Referenced on: 10.3.2021] Available at: https://hentsu.com/public-cloud-benefits-vital-for-the-best-cloud-adoption-strategy/

Jahangirian, M., Taylor, S. J., Young, T., & Robinson, S. (2017). Key performance indicators for successful simulation projects. *Journal of the Operational Research Society*, *68*(7), 747-765.

Kaplan, R. S., & Norton, D. P. (1998). Putting the balanced scorecard to work. *The economic impact of knowledge*, *27*(4), 315-324.

Kaplan, R. S., & Norton, D. P. (2000). Having trouble with your strategy? Then map it. *Focusing Your Organization on Strategy—with the Balanced Scorecard*, *49*(5), 167-176.

Karakas, F., & Manisaligil, A. (2012). Reorienting self-directed learning for the creative digital era. *European Journal of Training and Development*.

Liu, W., & Cai, H. H. (2013). Embracing the shift to cloud computing: knowledge and skills for systems librarians. *OCLC Systems & Services: International digital library perspectives*.

Meyer, M. W., & Gupta, V. (1994). The performance paradox. *Research in organizational behavior*, *16*, 309-309.

Nag A. 2015. Cloud computing: A paradigm shift in IT infrastructure. Article. [Referenced on: 10.3.2021] Available at: https://www.researchgate.net/publication/270958592_Cloud_Computing_A_Paradigm_Shift_in_IT_Infrastructure

Nagel, P. (1992). Techniken der Zielformulierung. Handwörterbuch der Organisation, *3*, 2626-2634.

NIST. (2011). The NIST Definition of Cloud Computing. Glossary. [Referenced on: 9.3.2021] Available at: https://csrc.nist.gov/publications/detail/sp/800-145/final

Otto, B., & Österle, H. (2015). Corporate Data Quality: Prerequsite for Successful Business Models. Available at: https://www.cc-cdq.ch/Data-management-glossary/data-quality-KPI

Oxford English Dictionary. (2021). Definition of performance noun. Dictionary.

Parmenter, D. (2007). Key performance indicators: developing, implementing, and using winning KPIs. John Wiley & Sons.

Prasad, M. R., Gyani, J., & Murti, P. R. K. (2012). Mobile cloud computing: Implications and challenges. *Journal of Information Engineering and Applications*, *2*(7), 7-15.

Ram, J., & Corkindale, D. (2014). How "critical" are the critical success factors (CSFs)?. *Business Process Management Journal*.

Ratten, V. (2012). Does the sky have to be the limit? Utilizing cloud-based learning in the workplace. *Development and Learning in Organizations: An International Journal*, *26*(5), 21-23.

Ratten, V. (2014). Indian and US consumer purchase intentions of cloud computing services. *Journal of Indian Business Research*.

Raza, M. (2020). Introduction To IT Metrics & KPIs. *BMC*. Available at: https://www.bmc.com/blogs/it-metrics-kpis/

Rockart, J. F. (1979). Chief executives define their own data needs. *Harvard business review*, *57*(2), 81-93.

Rountree, D., & Castrillo, I. (2014). The basics of cloud computing: Understanding the fundamentals of cloud computing in theory and practice. Newnes.

Samsonowa, T. (2011). Industrial research performance management: Key performance indicators in the ICT industry. Springer Science & Business Media.

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for business students*. Pearson education.

Sharma A. (2019). Public Cloud vs. Private Cloud: Pros & Cons. Article.

Srinivasan, S., & Getov, V. (2011). Navigating the cloud computing landscape: technologies, services, and adopters. *Computer*, *44*(3), 22-23.

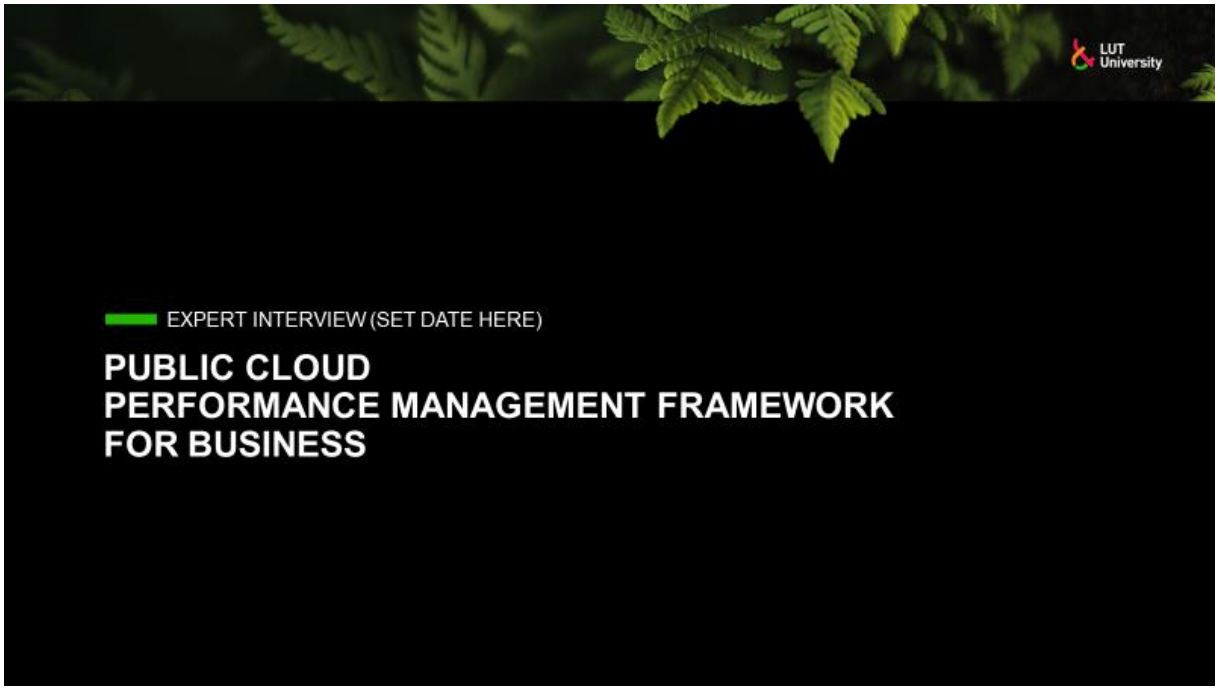
Stein, S., Ware, J., Laboy, J., & Schaffer, H. E. (2013). Improving K-12 pedagogy via a Cloud designed for education. *International Journal of Information Management*, *33*(1), 235-241.

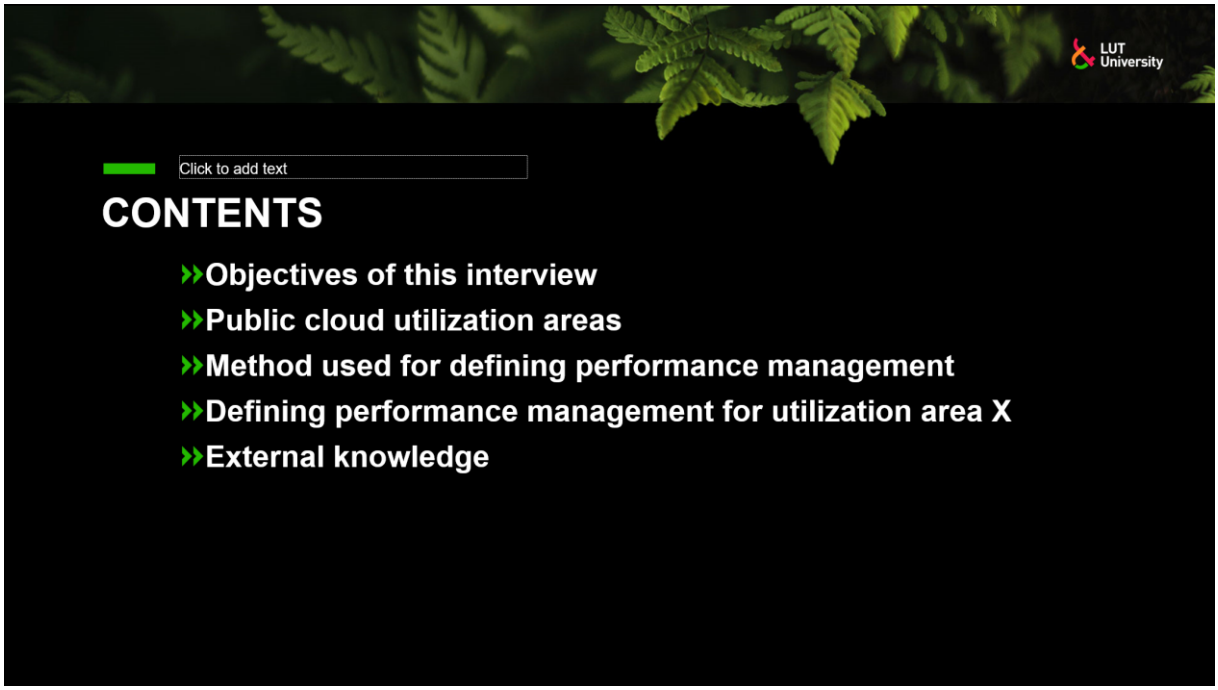
Strategy Management Group (SMG). (2021). What is a Key Performance Indicator (KPI)? [Referenced on: 5.4.2021] Available at: https://kpi.org/KPI-Basics

Sultan, N. (2013). Knowledge management in the age of cloud computing and Web 2.0: Experiencing the power of disruptive innovations. *International journal of information management*, *33*(1), 160-165.

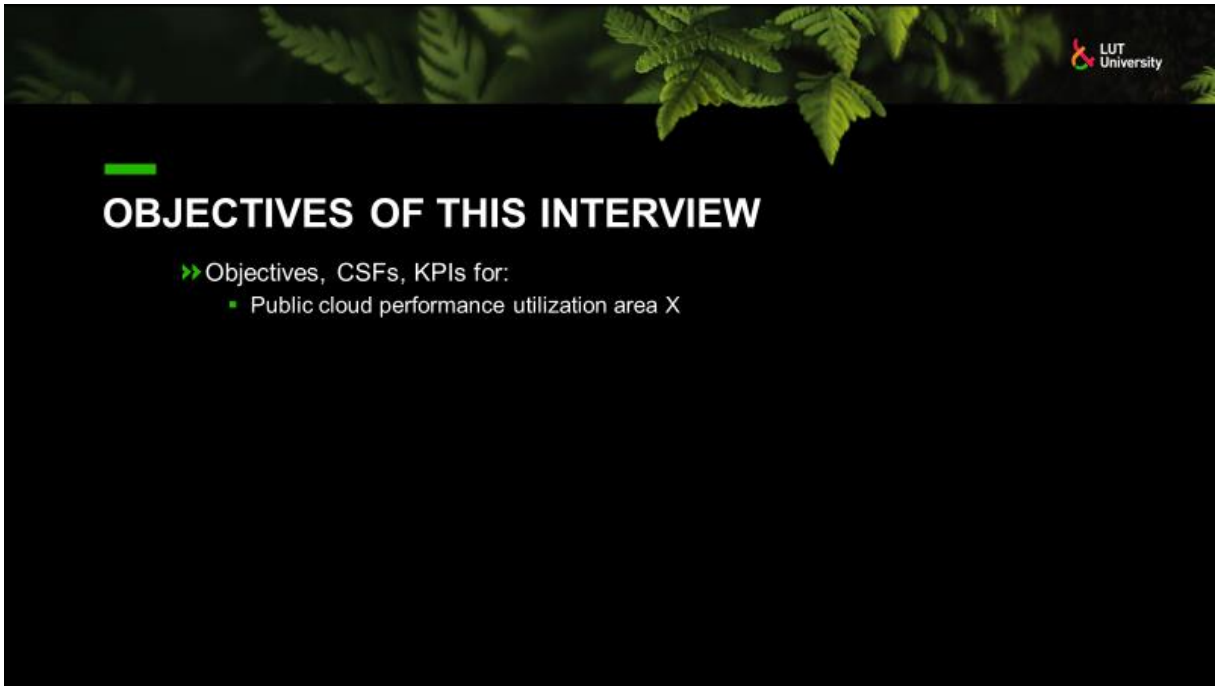
Thinkstrategies. 2002. Solving the IT challenges of small and mid-size organizations via "utility computing". Whitepaper.

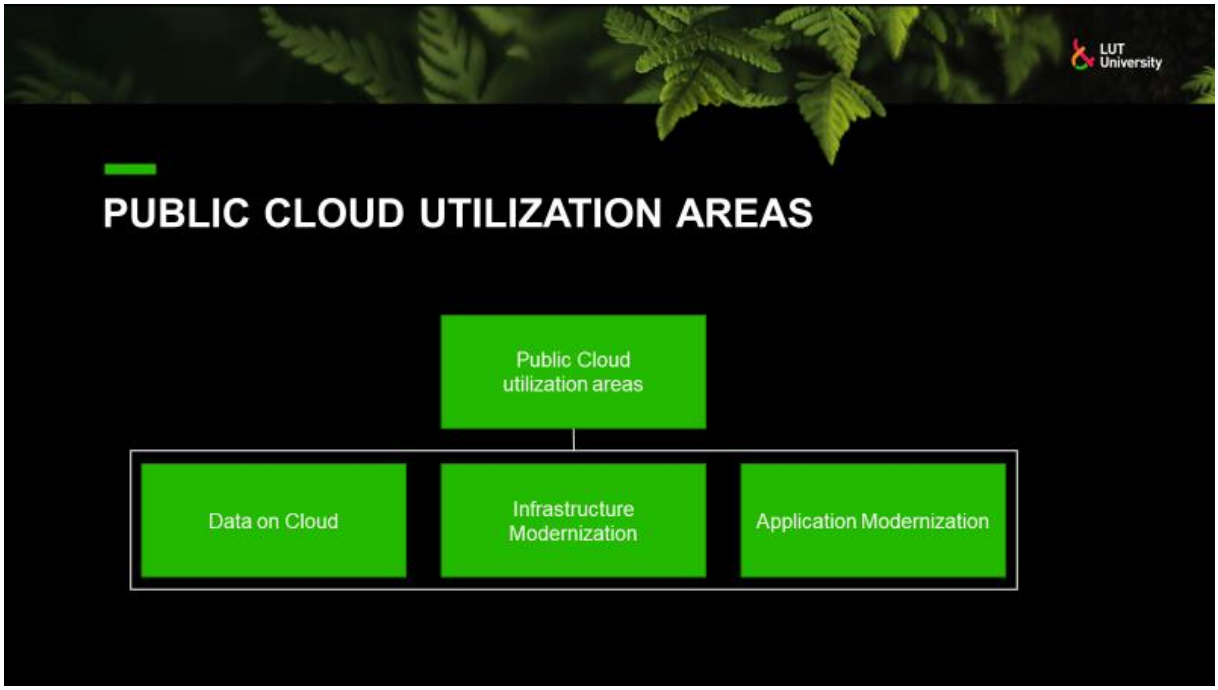
Appendix 1. Expert interviews template





Appendix 1. Expert interviews template

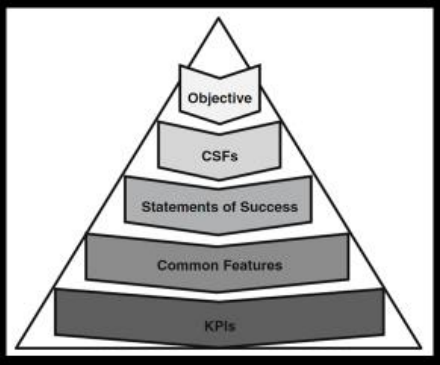




Appendix 1. Expert interviews template

Jahangirian M. et al (2017) Top-down CSF/KPI framework

METHOD USED FOR DEFINING PERFORMANCE MANAGEMENT

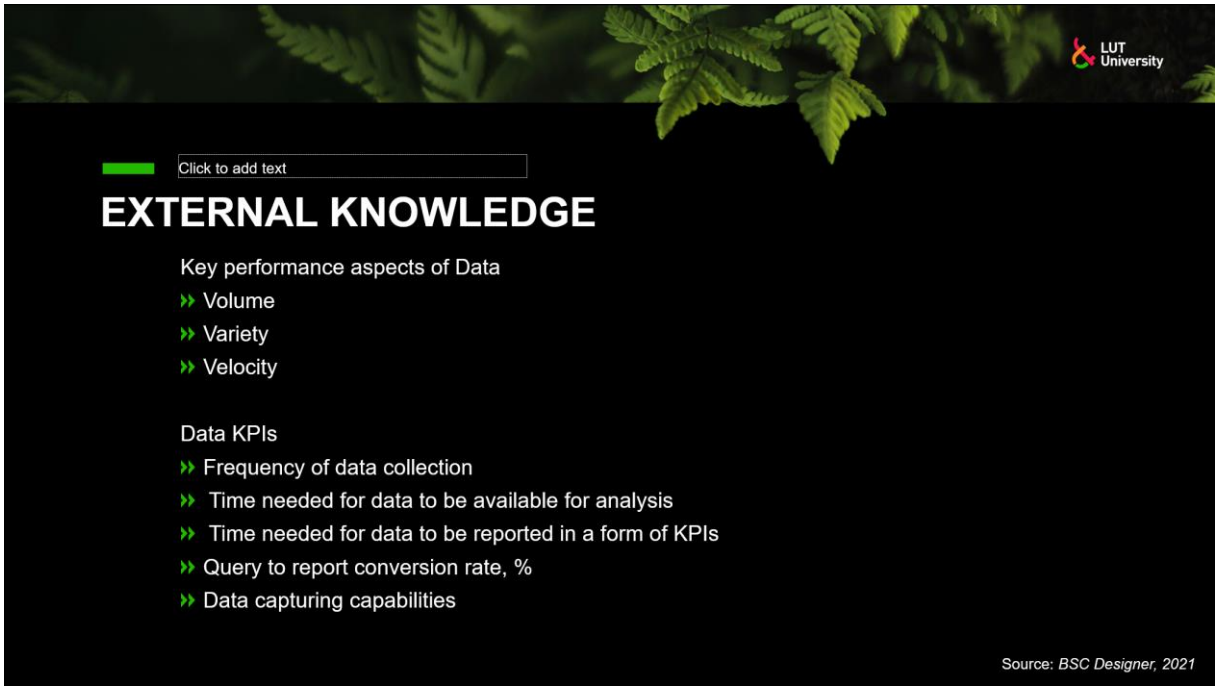


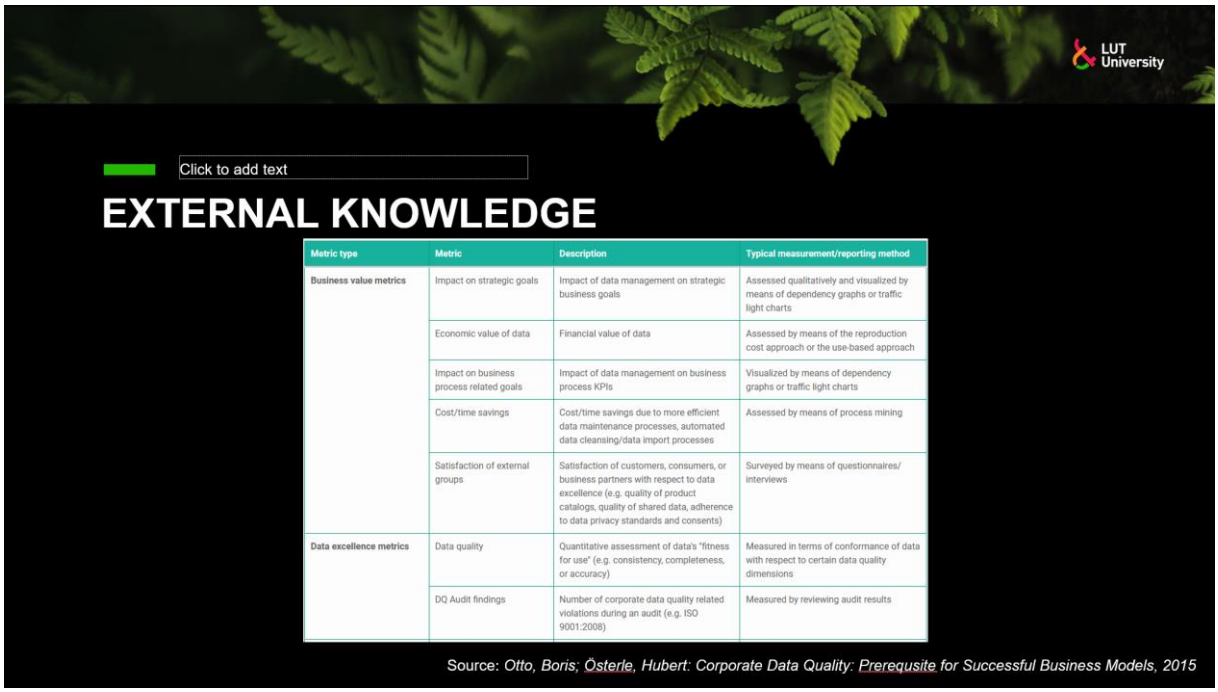
DEFINING PERFORMANCE MANAGEMENT FOR UTILIZATION AREA X

Objectives	CSFs	Statements of success	Common features	KPIs

Appendix 1. Expert interviews template

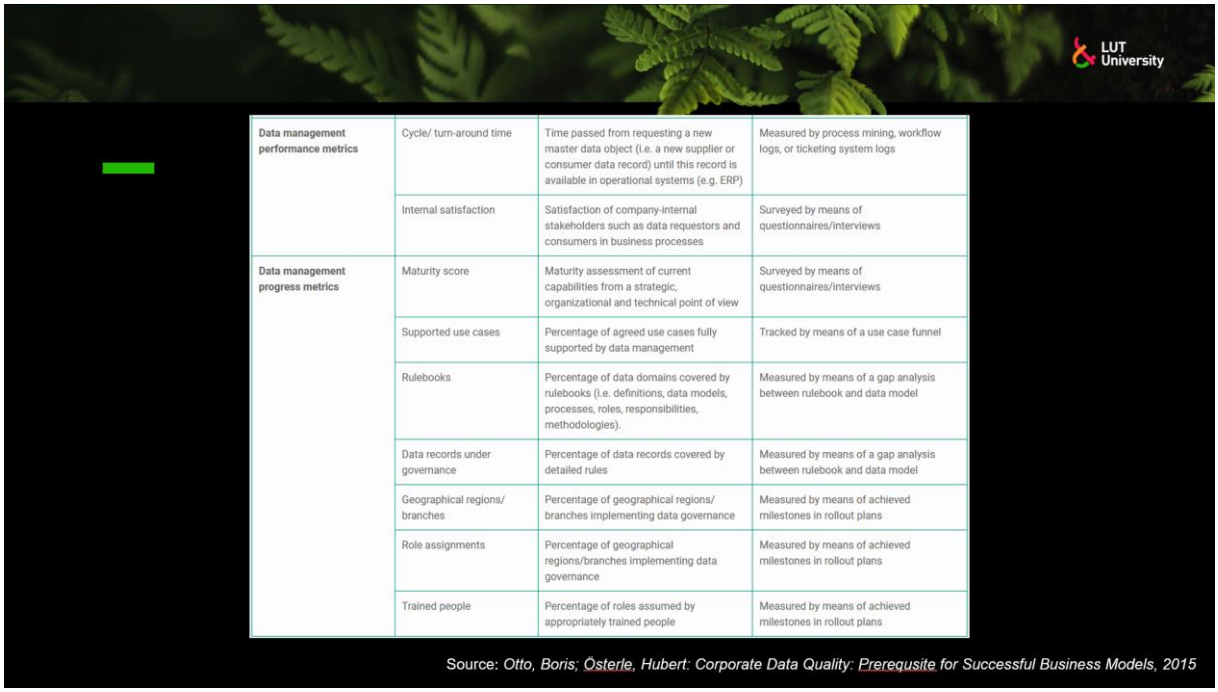
Appendix 2. Data on Cloud, External knowledge



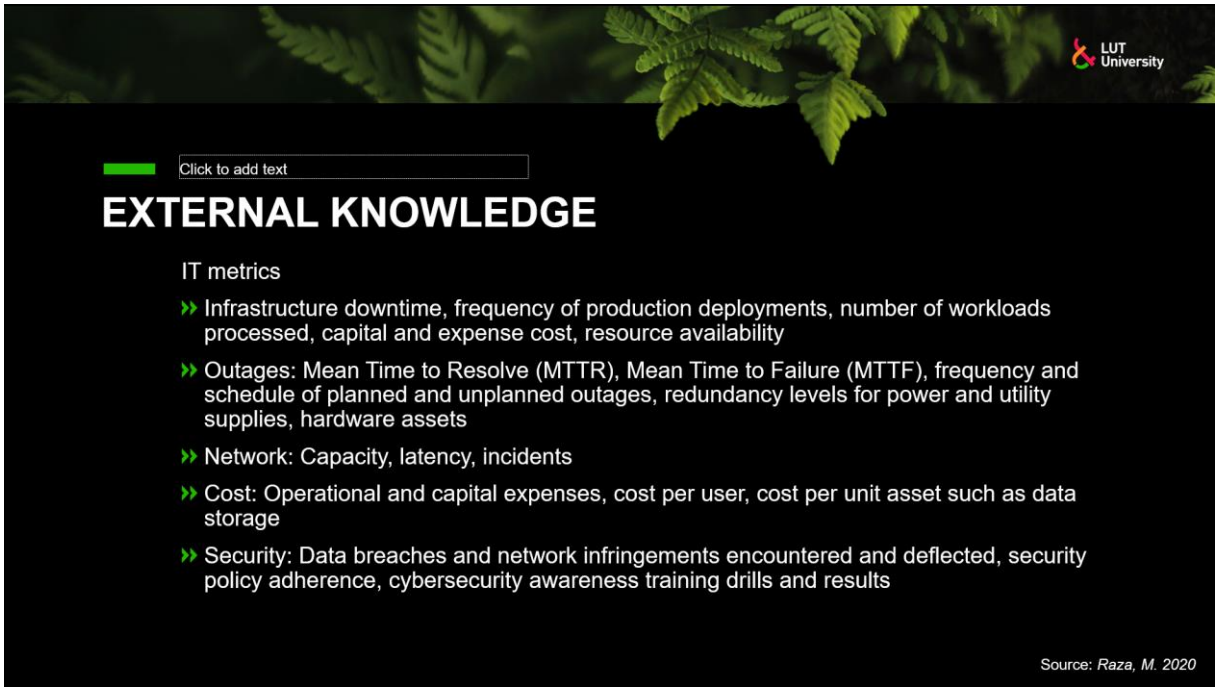


Metric type	Metric	Description	Typical measurement/reporting method
Business value metrics	Impact on strategic goals	Impact of data management on strategic business goals	Assessed qualitatively and visualized by means of dependency graphs or traffic light charts
	Economic value of data	Financial value of data	Assessed by means of the reproduction cost approach or the use-based approach
	Impact on business process related goals	Impact of data management on business process KPIs	Visualized by means of dependency graphs or traffic light charts
	Cost/time savings	Cost/time savings due to more efficient data maintenance processes, automated data cleansing/data import processes	Assessed by means of process mining
	Satisfaction of external groups	Satisfaction of customers, consumers, or business partners with respect to data excellence (e.g. quality of product catalogs, quality of shared data, adherence to data privacy standards and consents)	Surveyed by means of questionnaires/ interviews
Data excellence metrics	Data quality	Quantitative assessment of data's "fitness for use" (e.g. consistency, completeness, or accuracy)	Measured in terms of conformance of data with respect to certain data quality dimensions
	DQ Audit findings	Number of corporate data quality related violations during an audit (e.g. ISO 9001:2008)	Measured by reviewing audit results

Appendix 2. Data on Cloud, External knowledge



Appendix 3. Infrastructure Modernization, External knowledge



Appendix 4. Application Modernization, External knowledge