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Analysis of the Requirements and Methods of Cloud Migration to SaaS Model

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Dissertation submitted as partial requirement for obtaining the master's degree in Information Management

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ANALYSIS OF THE REQUIREMENTS AND METHODS OF CLOUD MIGRATION TO SAAS MODEL

by

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Dissertation submitted as partial requirement for obtaining the master's degree in Information Management with specialization in Knowledge Management and Business Intelligence

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ABSTRACT

In a fast pace changing globe, where quality and security is a must have and the threads are new every day, companies and IT administrations still doubt about the benefits in running a cloud-based technology and stick with local systems which can be expensive in Cybersecurity and vulnerable at their own risk. This thesis aims to provide guidance and understanding of the key factors that serve as a foundation for the process of migrating a system to a cloud-based software.

There are three main types of cloud computing service models and in this thesis is only considered SaaS, also known as Software-as-a-Service. The focus is to demystify some ghosts regarding cloud-based technology, through a comprehensive Model Migration proposal with step-to-step indications, based on a thorough Methodology which is supported by a Literature Review to clarify and justify the decisions made.

KEYWORDS

Information Systems; Cloud Computing; Software Migration; SaaS; BI

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LIST OF ABBREVIATIONS AND ACRONYMS

BIS	Business Intelligence Systems
CRM	Customer Relationship Management
DCS	Distributed Control Systems
DDL	Data Definition Language
DSR	Design Science Research
DSS	Decision Support Systems
DW	Data Warehouse
ECS	Enterprise Collaboration Systems
EIS	Executive Information Systems
ERP	Enterprise Resource Planning
ES	Enterprise Systems
ETL	Extract, Transform and Load
HR	Human Resources
ICT	Information and Communications Technologies
IPC	Inter-Process Communication
IS	Information Systems
ISA	Information System Architecture
IT	Information Technology
MIS	Management Information Systems
MSS	Management Support Systems
OSS	Operations Support Systems
PCS	Process Control Systems
PLC	Programmable Logic Controllers
SaaS	Software as a Service
SCADA	Supervisory Control and Data Acquisition
SCM	Supply Chain Management
SOA	Service Oriented architecture
SWA	Software Architecture
TPS	Transaction Processing Systems
WOA	Web-Oriented architecture

1. INTRODUCTION

The globe is changing and technology even more, every day we see something new emerge, it can be funny, high tech or mere lust, the technology changed so much and so fast in the last 20 years that it can be hard to know how our future days can be, but one thing we know for sure, data will always need a home. Companies are aware of that and therefore they try to keep the pace by making bold and innovate moves, always searching for the most profitable outcome. However, such high demand for top-notch technology can be a very expensive investment for the company. It was only a matter of time until something new, claiming to be better, appeared - the cloud. A new "internet slang" emerged, having people arguing that computers can create anything, even clouds. It would be so simple if someone told them that the cloud it is just really someone else's computer. This statement made people thinking, some people liked it so much they started printing it on t-shirts and stickers, and some people liked it so much that they presented the idea to their company. For the things we know about the future, the cloud seems to be one of those that we will not know how to live without.

Over the last years, the adoption of cloud services such as Software-as-a-Service (SaaS) models had an exponential surge. (Ikram & Hussain, 2019) SaaS delivery model has evolved into one of the three leading categories of cloud services, besides Platform-as-a-Service (PaaS) and Infrastructure-as-a-Service (IaaS). (Tsai, Bai, & Huang, 2014) SaaS is a software distribution model in which the costumers' applications are installed and managed by an external service provider and accessible through the internet. In this way, companies are disposed of setting up and operating programs on their local machines or servers, which revokes the cost of purchasing hardware or installing software and even its maintenance.

The migration of on-premise software to cloud services is being performed by many corporations, yet some obstacles and adversities arise from the intricacy of consolidating their traditional systems to the SaaS delivery model. (Pahl & Xiong, 2013)

1.1. BACKGROUND AND PROBLEM IDENTIFICATION

Software-as-a-Service first appeared in the beginning of the 1990s, but it was overlooked as most of software programs at that time were entirely run on on-premises computers. (Brown & Nyarko, 2013) The subscription proposal for software distribution started to be implemented to supply numerous operating systems, avoiding the need for consumers to acquire and manage programs set-up on the premises of their own corporations. Still, SaaS deployment was improbable as a result of outdated predominant technologies, and its recognition happened only when giant suppliers demonstrated curiosity in the subscription model.

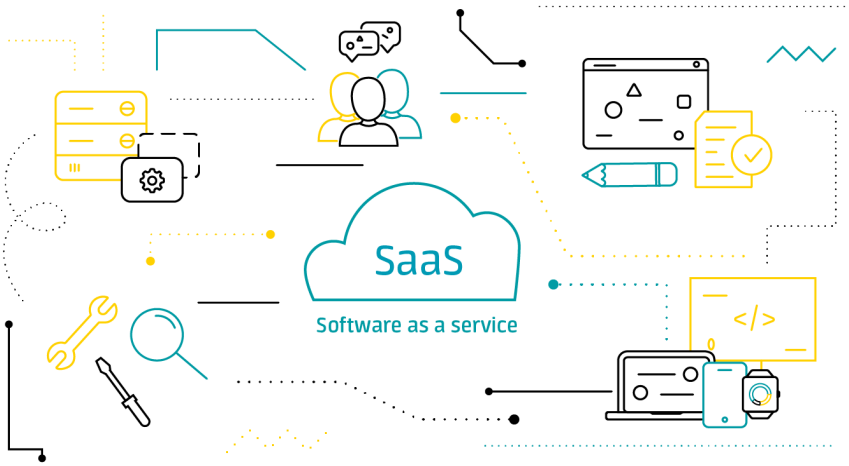


Figure 1 - Software as a Service (AVSystem, 2020)

SaaS is swiftly evolving into the prevailing model for software distribution as an Internet-based service. (AVSystem, 2020) In SaaS, applications are maintained by an external entity which makes them accessible according to the client's requirements, usually over the internet, but users must abdicate of the authority over software upgrades. (Kulkarni, Gambhir, & Palwe, 2012) SaaS allows for a single vendor to maintain and allocate programs to assure the necessities of various consumers. SaaS supports the remote connection to each system and its related functionalities at a lower cost than what companies would normally pay for licensed programs, this business model is typically known as a pay-as-you-go model. (Satyanarayana, 2011) In fact, SaaS is generally deployed due to its smaller cost outlay while sustaining all the benefits of enterprise software capabilities to clients and eliminating the intricacy of setting-up and maintaining on-premise applications.

However, there are many advantages associated with the SaaS delivery model implementation of other than the lower price. SaaS applications are effortlessly adjusted according to the client's requirements, avoiding the obligation to purchase new information technology infrastructure, and are not so susceptible to catastrophes due to the storage of data in the cloud. Additionally, the SaaS model is very straightforward to handle, as it only involves a browser to execute all the programs requested by the customer, and its apt to operate on a broad array of devices. Furthermore, SaaS supports an enhanced cooperation among the various departments of an organization, as data is centrally stored. (Dibie & Hang, 2012)

1.2. MOTIVATION

The impulse to develop this project derives from the exponential evolution of information technology (IT) models based on cloud computing – ad-hoc distribution of storage, computer capacity, among other resources through the internet. Large organizations waste substantial time in processing extensive amounts of data, which tend to suffer increases and in that sense, they are becoming more open to embrace innovative IT solutions, that enable cost reduction and re-think of business procedures, namely cloud services which provide a way for firms to boost agility, efficiency and scalability of their operating systems. Cloud computing services have reshaped conventional information technology tools and business operations for many companies, instituting original ways

to develop software or process data. However, as information technology services and business have such an intricate interplay, organizations should be able to methodically implement and maintain the new IT solutions to benefit from its adoption.

1.3. STUDY OBJECTIVES

The goal of this research is to create a model that can be easily used by an organization to guide their SaaS migration process. The outcome of this project can then be used as a guide for SaaS migration processes, supporting the IT teams in reducing errors, and increasing cost and time savings.

In order to achieve this goal, the following intermediate objectives were defined:

- Identify the most relevant types of IS that could be migrated to SaaS.
- Identify the different types of Cloud Computing platforms that could be used to implement SaaS.
- Study the main existent methods and best practises of SaaS migration.
- Design a general model for SaaS migration.
- Validate the model.

2. LITERATURE REVIEW

The main topics related with this proposal research such as Information Systems, Cloud Computing and Software Migration are explored over the present chapter.

2.1. INFORMATION SYSTEMS

Since its beginning in the late 1960s Information Systems (IS) have evolved tremendously, becoming an essential component for organizations. IS coordinate systems, people and operations concerned with data, or information, and are characterized as the diverse interdependent elements that garner, transform, create, store and distribute relevant information. (Florida Tech, 2019) (Bourgeois & Bourgeois, 2019) (Alshubaily & Altameem, 2017) IS allows raw data to be transformed into valuable information and, furthermore, to elevate this information to become real knowledge for the organization. Organizational knowledge is a crucial asset to assure process efficiency and, with the development of technology, it turned into a sustainable valuable resource for organizations (Kero, 2016)(Bratianu, 2015)

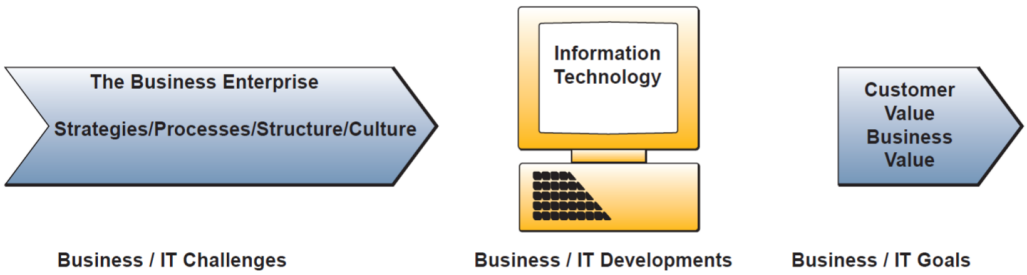


Figure 2 - Balance between Business and IT (O'Brien & Marakas, 2011)

Information Technology (IT) is described by the Merriam-Webster dictionary as a subset of IS which implicate the development, implementation and preservation of software, hardware, databases and networks for the processing and dissemination of data. (Merriam Webster, s.d.)

In fact, the definition above introduces two distinctive approaches to portray an Information System – regarding its role as a key instrument to bolster business processes' efficiency in an organization and in terms of its architecture.

2.1.1. Types and Roles of Information Systems in Business

Organizations must handle various pieces of information regarding the dimensions which impact their business operations (such as staff members, suppliers, consumers, and their products) and coordinate all pieces to propel processes' efficiency and boost the company's performance. The distinct elements and levels concerned in each organization require different types of information systems, as no individual system can arrange all the information within a company. (Laudon & Laudon, 2014)

According to O' Brien & Marakas, information systems can be separately categorized based on their role or applicability mainly between Operations Support Systems (OSS) and Management Support Systems (MSS). During this proposal research we will also go over the main Enterprise Systems (ES), as

it is worth to mention the relevant ways in which they affect business operations. (O'Brien & Marakas, 2011)

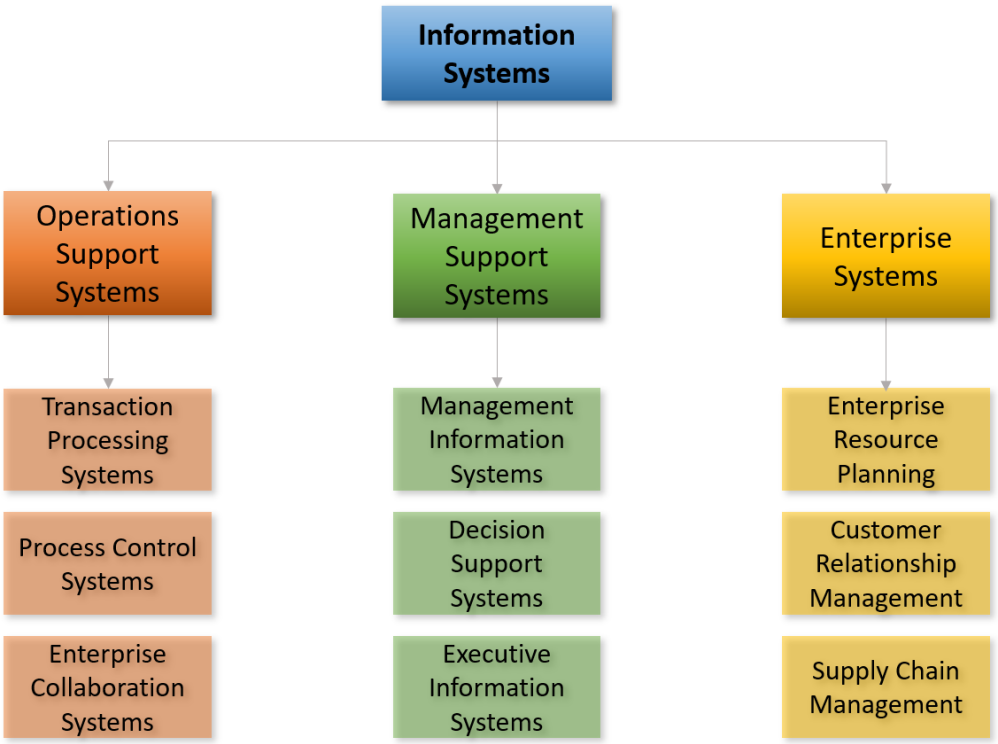


Figure 3 - Operations, Management and Enterprise classifications of Information Systems

Operations Support Systems have the role of processing business transactions, handle industrial procedures and establish communications within the organization. According to O' Brien & Marakas, there are three major sub-types of OSS which are the Transaction Processing Systems (TPS), Process Control Systems (PCS) and Enterprise Collaboration Systems (ECS). (O'Brien & Marakas, 2011)

Transaction Processing Systems are the primary systems dealing with the operational level of an organization, as they manage and store day-to-day transactions inherent to the business, update corporate databases and assemble business reports. TPS perform the storage, transformation and recovery of each transactional record and its main characteristics depend on high performance, stability and reliability. Within this kind of systems, data should be effortlessly reachable in a Data Warehouse (DW), backup operations must be set up and the recovery procedures ought to be ready to handle disasters such as system breakdown, human error or viruses. On the other hand, Process Control Systems involve all the machinery, applications and operational processes within an organization and its role is to govern and track industrial procedures. A PCS operates as groups of electronic devices along the production line that maintain the cohesion and precision in manufacturing processes through the collection, testing and adjusting of data concerning production operations. There are many sub-types of this kind of system such as Supervisory Control and Data Acquisition (SCADA), Programmable Logic Controllers (PLC) or Distributed Control Systems (DCS) which collaborate to provide all relevant data regarding the manufacturing processes. A different type of OSS is the enterprise collaboration system. ECS are used to ease enterprise-wide communication and increase productivity, as they aim to maintain workplace' processes using technology. Common examples of

ECS' tools which are universally adopted by organizations are collaborative document sharing, e-mail and videoconferencing, amongst many others. Enterprise collaboration systems support managers to handle the flow of information throughout the company, as ECS are not limited to one organizational level. (Al-Mamary, Shamsuddin, & Aziati, 2014)

Management Support Systems provide information that enables active and adequate decision making by leaders. Organizations must contemplate numerous factors to make key strategic decisions, so the information they obtain should be specific and rigorous. MSS coordinate data collected by TPS and acquired by external sources to the organization to provide consolidated information to managers. According to O' Brien & Marakas, the major sub-types of MSS are Management Information Systems (MIS), Decision Support Systems (DSS) and Executive Information Systems (EIS) which will be further explored over the present paragraph. (O'Brien & Marakas, 2011) Management information systems compile and transform data from various sources, providing relevant information in a form of specialized reports, whether their aim is to support operations managers or to assist supervisors on making meaningful decisions. In this way, we can allege that MIS are decentralized systems which refer to the company's overall and global framework. This kind of systems must be coherently designed, and the core elements ought to be accurately distributed throughout the framework to provide appropriate information services to all levels of the organization. On the other hand, decision support systems are intended to assist administrators determining what would be the best option when dealing with ambiguous topics or problems. Through the development of abstract models, application of formulas or calculations and by comparing all the results, DSS are able to anticipate what would be most adequate decision to achieve the preferred outcome. This type of systems is more and more being used to examine and interpret extensive amounts of data leading to its recognition as Business Intelligence Systems (BIS). Such as MIS, decision support systems are transversal to all levels of the organization, being used by managers at any hierarchical level. There are two main sub-types of DSS: data-driven and model-driven. As per the data-driven systems, their main goal is to stimulate managers' consumption of files, models and data to early recognize issues within the organization. Data-driven DSS handle both strategic and operational inquiries, can control real-time processes and boost the company's capacity to take decisions. (Power, 2008) Differently, model-driven DSS exploit intricate economic, simulation or optimization models to assist decision making. Model-driven systems deal with small data sets by implementing a predefined model according to the parameters designated by managers. (Gregersen & Zwass, 2011) The last major sub-type of MSS is the executive information system. Executive information systems support executive managers on the decision-making process, as they retrieve data from various different sources to grant the availability of key or critical information. This information is presented normally through dashboards and should be exhibited in a summarized and appropriate manner, leveraged with the capacity to display itemized latent data if necessary. (Al-Mamary, Shamsuddin, & Aziati, 2014) EIS are intended to simplify information regarding the entire organization in a conceptual form so that the senior managers can supervise the performance of the company and define tactical guidelines for the future. (Gregersen & Zwass, Management support, 2011)

Enterprise Systems are complex software packages that govern massive amounts of data and facilitate the integration and synchronization of an organization's business operations. ES support teamwork and communication within the company through the dissemination of useful and convenient information through all operations and hierarchical levels on an enterprise-wide basis. The main types of ES include Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) and

Supply Chain Management (SCM) which combine all features of an organization in order to guarantee the coordination of its business operations, networks of suppliers and distribution channels. (IGI Global) Enterprise Resource Planning systems integrate and associate various computer systems and data regarding the fundamental processes of an organization such as physical operations, finance, suppliers, marketing and human resources (HR), enabling the enterprise to become a more knowledgeable and conscious entity. ERP software supports the connection between all distinct sectors of the corporation making the information about those sectors accessible to other divisions where it can be exploited effectively, which may help to avoid the implementation of conflicting technologies. The presence of an ERP application implies that the access to each sector's particular system is done via one integrated interface, preventing the over-specialization of each system in which regards to the department's individual tasks. (Labarre, 2020) Differently, Customer Relationship Management concerns the specific principles that guide an organization's interaction with their clients from the beginning as well as during all different phases of the customer lifecycle. In this manner, the corporation obtains not only an individual but also a global picture of each client being capable to apply preventive methods to improve the customer's experience and to secure a long-term relationship. CRM includes elements such as the organization's website, mass mailings, phone calls, social media and other software tools to promote sales and customer support. (Hargrave, 2020) Lastly, Supply Chain Management systems concern a centralized approach to govern suppliers, internal stock, manufacturing and distribution within an organization, which allows companies to diminish costs, to grant a brisk shipment of the final product to the customer and, consequently, to increase its competitive advantage in the market. SCM aims to regulate, in a profitable and effective way, all operations regarding the transformation of raw elements into finished products, increase productivity and reduce costs from the beginning of production' operations.

2.1.2. Information System Architecture

System architecture is defined as a set of connected models that characterize the key features and views of an existing system. (Hee, Sidorova, Voorhoeve, & Woude, 2004) Its purpose is to disclose the essence of all components within a system, the link between those components, and the standards applied behind those links. These architectural elements and links comprise hardware, software, notations, equipment, manual processes and the function of each entity/person. The architecture of a system mainly affects the relationship between its elements, and of those with the external environment, particularly the user. (Valverde, 2013) An architecture description provides a formal characterization of a system, facilitating the recognition of the system's structure and the fundamental aspects of its configuration, performance and evolution. (ISO - International Organization for Standardization, 2017)

According to Vasconcelos, Tribolet et Sousa it is possible to discriminate different levels of architecture, such as Software Architecture (SWA), Enterprise Architecture (EA) and Information System Architecture (ISA). SWA concerns the objects and classes required for software implementation, as it describes how systems or applications are internally assembled. Differently, EA regards the delineation of an understandable and consistent portray of the company. This can be achieved by a set of models which designate various perspectives of the company, in each fixating only on a few features of the enterprise to decrease intricacy. Hence, this group of models accommodates various projects, procedures, knowledge and performance of the organization. Lastly, ISA approaches the business processes and its guidelines, the IS elements' architecture and its technical scheme to thoroughly

maintain an information system. The architecture of an IS consists of defining its composition and comprises the hardware and software adopted to properly fulfil the customer' expectations. Commonly, ISA discerns three sub levels: informational architecture, application architecture and technological architecture. Informational architecture displays the predominant data types that promote business progress, combining several classes of data such as original or derived, private or public, and historical or transitional. Application architecture determines the applications required for governance and business endorsement, as it describes the vital elements of the architecture to assure consistent data' accessibility to different data types considering performance time and costs. Finally, technological architecture describes the leading technologies employed in operations and the framework that grants a stable environment for information systems deployment. Technological architecture establishes the fundamental notions necessary to implement applications, inter-process communication (IPC), data archiving, etc. (Vasconcelos, Silva, Fernandes, & Tribolet, 2004)

There have been growing attempts to formalize and promote a consistent practice to maintain architecture frameworks within the system's life cycle. The intent of the ISA framework is to display how all elements are interrelated and portrayed thorough the system. (Sowa & Zachman, 1992)

John Zachman is considered the first person who presented the concept of Information System Architecture. The Zachman framework differentiates ISA as an abstraction of the systems specifics, in contrast to software description and interpretation mechanisms. (Vasconcelos, Sousa, & Tribolet, 2003) Many different entities are implicated in the process of developing an information technology system. Business requirements emerge from the management/executive layer of an organization and, firstly, ought to be converted into Information and Communications Technologies (ICT-requirements), so that posteriorly these requirements can be translated into a solution of hardware and software. The concepts suggested by Zachman and Zachman and Sowa regarding the ISA framework are based on the recognition of various perspectives of the system architecture, as well as the identification of the question we aim to answer. Therefore, the Zachman framework declares that associated with the architecture there are two dimensions: the first regards the distinctive viewpoints of each participant in the process of creating a system, while the second dimension refers to the question which needs to be answered at the moment (*what*, *how*, *where*, *who*, *when* and *why*).

	Data (What)	**Function (How)**	**Network (Where)**	**People (Who)**	**Time (When)**	**Motivation (Why)**
Scope	List of things important to the business	List of processes the business performs	List of locations in which the business operates	List of organizations important to the business	List of events / cycles significant to the business	List of business goals / strategies
Business Model	e.g. semantic model	e.g. business process model	e.g. business logistics system	e.g. workflow model	e.g. master schedule	e.g. business plan
System Model	e.g. logical data model	e.g. application architecture	e.g. distributed system architecture	e.g. human interface architecture	e.g. processing structure	e.g. business rule model

Technology Model	e.g. physical data model	e.g. system design	e.g. technology architecture	e.g. presentation architecture	e.g. control structure	e.g. rule design
Detailed Perspective	e.g. data definition	e.g. program	e.g. network architecture	e.g. security architecture	e.g. timing definition	e.g. rule specification

Table 1 – The Zachman framework (Sowa & Zachman, 1992)

The first dimension concerns the particular view of the different participants. This dimension can also be referred to as a group of architectural representations assembled through the development of an information system. Thus, five perspectives are suggested, being that the business, system and technology models represent a specific view of a certain participant in the process. The **scope** description illustrates the range, structure and scope of the system; it resembles an executive analysis for a shareholder who needs an assessment of the system's scope, cost and performance. The **business model** – *owner's perspective* – regards the organizational model and comprises the picture of the business; it displays all entities and operations involved and how the interplay between them occurs. Basically, the business model characterizes the specific product the owner requires to accomplish the original objective. The **system model** – *designer's perspective* – consists of the translation of the owner's demands into relevant information. In what concerns the designer's view, a system analyst has to establish all data components and operations that portray the real organizational entities and procedures. The **technology model** – *builder's perspective* – considers all existing constraints, such as technology restrictions, and integrates these restrictions on the adjusted system model to guarantee smooth production operations. The **detailed description** regards the sub-areas of the global architecture and its alignment with the implementation tasks, as it describes precise blueprints to the developers with concern over a particular section and not the general framework of the system. Each view submits a distinct group of restrictions, which are gathered through the various models and should not be incoherent. Developers must look for disparities between the diverse perspectives and alter the models when needed to guarantee the coherence of the system. The five views are demonstrated as the rows in table 1. The second dimension regards the elemental queries that represent distinct angles of each architecture. In respect to the angle in focus, the question introduced can be which entities the system has to handle, **how** is the system's performance, the position **where** the system is located, **who** performs a certain task in the system or **when** some procedure is expected to be executed. In line with the various angles presented above, it is possible to elaborate distinct and more specific characterizations of the same object. For each question introduced, Zachman suggests a primary descriptive model that is located at the last row of table 1. To figure out the concept of views or perspectives, the first column – **data** – will be interpreted and simplified. The *scope* incorporates a list of crucial elements to the organization; the *owner's view* presents the elements in a diagram in which the connection between them depicts business standards; the *designer's view* illustrates the logic behind each link between two records; the *builder's view* has the definition of which technology or system will be employed; and the *detailed description* suggests a Data Definition Language (DDL). (Goethals, 2005)

Regarding the major types of ISA, Pearlson et Saunders identify the leading three: Mainframe, Client/Server and Service Oriented architecture (SOA), which will be explored below. (Pearlson & Saunders, 2010)

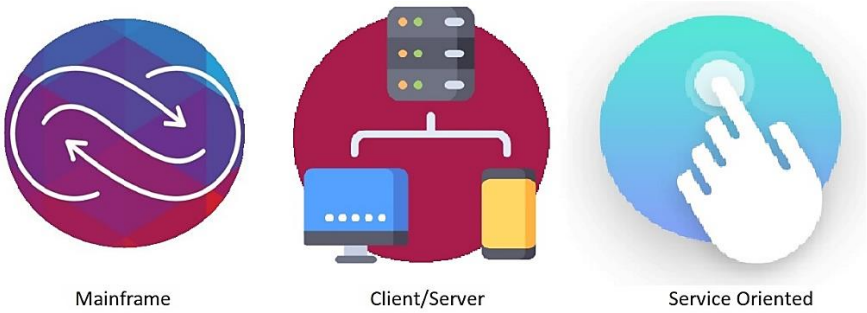


Figure 4 - Types of Information Systems Architecture

Mainframe architecture consists of a powerful and extensive data center that manages all processes within the system and centrally stores data. Agents operating the system only require a simple terminal to connect and all applications are executed on the mainframe. The first commercial mainframe computer was built in 1951 and during the 1960s and 1970s this type of architecture used to be implemented by almost all companies, due to the absence of the technology required to bring all the necessary elements into smaller systems. Accordingly, and although mainframe architecture is currently considered outdated, a considerable number of operational mainframe computers can still be found. More recently, advancements in technology allowed for the linkage of numerous smaller systems to assemble an integrated IT core that performs similarly to the mainframe computers. (Pearlson & Saunders, 2010)

Client/server is recognized as one of the most common architectures. On this type of ISA, there are normally more than one client computer linked through a network to an integrated central server which receives, handles and returns all demands submitted by the client. (Techopedia, s.d.) The dissemination of computing power and capabilities to numerous smaller systems requires a conscious allocation of hardware, software and networks. The three main types of the client/server model are one, two and three-tier (or N-tier). A one-tier architecture combines in a single system the user environment and all the logic behind it, however it is sometimes difficult to maintain because of data discrepancy. This kind of model can comprise several layers in just one operating system. Alternatively, for a two-tier architecture the user environment is located at the client computer and the data warehouse is located on the main server, while the organizational logic can be managed from both sides. In this type of model, an input submitted by the client is directly assimilated by the server to assure prompt outcomes and to prevent complications among distinct clients. Furthermore, the three-tier architecture accommodates an additional middle tier that intermediates not only all queries from the client to the server but also the results being sent from the server to the client. This kind of model is very straightforward to work with as it allows for application execution, querying, ETL (Extract, Transform and Load) processes, etc. to happen on the middle tier, which boosts performance and enhances adaptability. A three-tier architecture is divided into three areas: presentation layer (maintained at the client computer), application layer (handled by the application server) and database layer (administered by the server). (ApacheBooster, 2018)

Service-oriented models are becoming more popular in the last years, as its architecture allows for the building to be nearly exclusively derived from existing elements. It provides an effortless and adaptable way to assemble applications. In SOA, huge systems are split into services which are posteriorly linked to one another to structure the whole business process. This kind of model allocates its numerous

elements on separate computers and even on the Internet, so that each individual block of functionality is accessible and applicable for many distinct operations. An example is a ticketing system that determines the free seats and assigns them.

Moreover, it is worth to mention Web-Oriented architecture (WOA) in which the majority of hardware and software components are located on the internet. WOA provides a considerable adaptability as it is possible to add processing power on demand. This kind of model supports the handling of intensive processing activities when extra skills are needed, as it grants access to web-accessible capacities, instead of acquiring supplementary computers to deal with bigger loads.

2.1.3. Information Systems Security

The wide adoption of data processing machines and the internet by organizations to support their business operations had an impact on the increase of cybersecurity risks. An enterprise or entity should only use a digital device once it is ensured that the computer/network is protected and was not exposed to any kind of cyberattack. According to Bourgeois et Bourgeois, Information System Security (ISS) concerns the guidelines and procedures that help organizations to maintain the accessibility, cohesion and confidentiality of their information. (Bourgeois & Bourgeois, 2019)

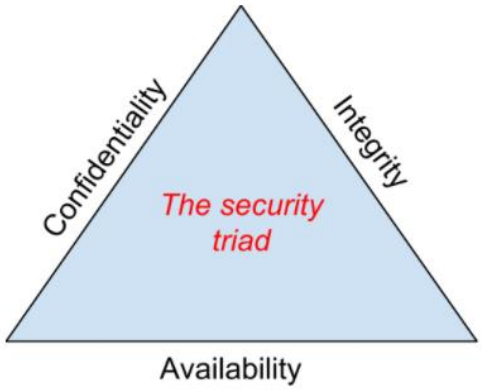


Figure 5 - The security triad (Bourgeois & Bourgeois, 2019)

The main principles of ISS are pointed out as confidentiality, integrity and availability:

- **Confidentiality** is defined as the fact of private information being kept secret (Cambridge Dictionary, s.d.). Within an organization, it means that only people with specific authorization or roles can access certain information, for example data from the Human Resources department is restricted to the remaining employees of the organization.
- **Integrity** is described as the quality of being whole and complete (Dictionary, s.d.), so it regards the cohesion and truth of data, which can be lost through malevolent behaviours – deliberately altering data to distort its proper meaning –, or even by mistake – unintentionally deletion of a file or introduction of imprecise data.
- **Availability** implies that the required data can be obtained by the users when and where they need it. The timeframe in which the information is available depends on the preconditions defined by the users – while a stock trader demands data to be accessible right away, a sales department may require information only on a daily level.

In the pursuance of confidentiality, integrity and availability of data, enterprises have a vast number of mechanisms at hand that should be applied in synchrony to ensure a reliable data security policy. (Bourgeois & Bourgeois, 2019) Some of the available mechanisms will be reviewed below:

- **Authentication** mechanisms have the purpose of assuring the true identity of the individual accessing the data, which is achievable through various methods. One of the most prevailing is the user ID and secret password, as it requires a sequence of characters that is only known by a singular person. Nevertheless, this method can be easily jeopardized and is not enough to ensure the true identity of the individual. Another widely adopted mechanism of authentication is the use of a key or a badge, which is also questionable as the user can lose it or even be robbed. A much safer method concerns the biometric identifiers - identification of a physical feature of an individual through a fingerprint or an eye scanner, for example. Furthermore, the combination of two or more authentication mechanisms makes it a lot harder for an intruder to successfully invade the system and access private information. An example of a reliable procedure that combines two of the methods identified above is the SecurID token. This tool requires a PIN and code automatically created by the token, obliging the individual to know the PIN and to have the token to be able to connect to the system.
- **Access Control** mechanisms regulate access to information by establishing to whom was granted authorization to read, edit, transform and/or erase data. Enterprises have various access control mechanisms available to support them in managing each data resource and one of the most common is the Access Control List (ACL). ACL consists of a list that appoints distinct capacities to individuals who are authorized to perform different operations to a data resource, and only those specified individuals can execute the indicated tasks. ACLs are straightforward and easy to manage, but they are sometimes inefficient. As each data resource is maintained individually, if a security manager needs to edit an extensive array of data resources it can be rather arduous. A more effective access control mechanism is the Role-Based Access Control (RBAC), that alternatively to appoint distinct capabilities to certain individuals regarding a data resource, the individuals are appointed to roles and the roles are appointed to the access. This mechanism permits the management of users and roles individually, which facilitates access control management and enhances overall security.
- **Encryption** mechanisms regard the enciphering of data before its transfer to guarantee that exclusively allowed people can access the data. An application will perform the enciphering of the content to be handed over, and the receiver must decipher it to be able to read it. Both parties, the one who transmits the encrypted data and the one who receives it, ought to determine a mechanism of encryption to allow accurate communication between the two. Symmetric key cryptography is a popular encryption mechanism in which both entities use a single symmetric key to decipher each other's information. A different method is called public key cryptography that employs two different keys – a public key and a secret key. For an individual to transfer a piece of information, he must first acquire the public key, encipher the information and transmit it; and the receiver must have the secret key to decipher what was transmitted.
- **Backups** of all the organizational data and the machines used in the context of the corporation are a fundamental mechanism of ISS. An adequate backup strategy must integrate detailed insights of data resources within the enterprise, like what data is managed by the company

and its specific location. The rate of recurrence of backups depends on both the value of the information to the organization and its proficiency in restoring data that was previously lost. Albeit weekly or monthly backups are appropriate for ordinary data, daily backups ought to be considered for essential information. Moreover, and to prevent that an unexpected incident may destroy both the original and backup data, an efficient backup strategy should incorporate an off-premises site to keep the backup data. The backups must be checked and evaluated periodically to guarantee its performance.

2.2. CLOUD COMPUTING

Cloud computing has arisen as an innovative model and group of technologies for hosting, maintaining, and distributing resources over the Internet in a dynamic way. It is a ground-breaking paradigm with the capability to reduce costs and to improve cooperation, accessibility, and agility. Within this paradigm, it is possible to have a brisk arrangement, supply, and deployment of resources, and to withdraw them when an element or more are no longer required. (Cloud Security Alliance, 2017) Cloud computing comprises the system's virtualization by re-allocating and combining resources on-demand, and also the abstraction of the specific aspects of a system deployment, such as the sites in which the data is warehoused or which third party is in charge of the system's administration. (Sosinsky, 2011)

Cloud computing provides huge benefits in dexterity, flexibility and financially, along with security advantages because cloud suppliers are compromised in protecting their clients. Corporations are more agile, as there is no longer the need to buy and maintain hardware, and they are able to decrease the downtime during upgrades for example, due to cloud properties. (Cloud Security Alliance, 2017) Nonetheless, to take full advantage of these benefits it is necessary for companies to comprehend and implement cloud-native models, while simultaneously accommodating their existing architecture to guarantee its coordination with the cloud platform' characteristics. Actually, if this adjustment is not performed adequately it generally results in a decrease of agility, flexibility and security. (Cloud Security Alliance, 2017)

The National Institute of Standards and Technology (NIST) has a definition of cloud computing which is usually well recognized:

"*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."* (Mell & Grance, 2011)

NIST describes the cloud computing model based on five key characteristics, three cloud service models and four cloud deployment models, all illustrated in the figure below.

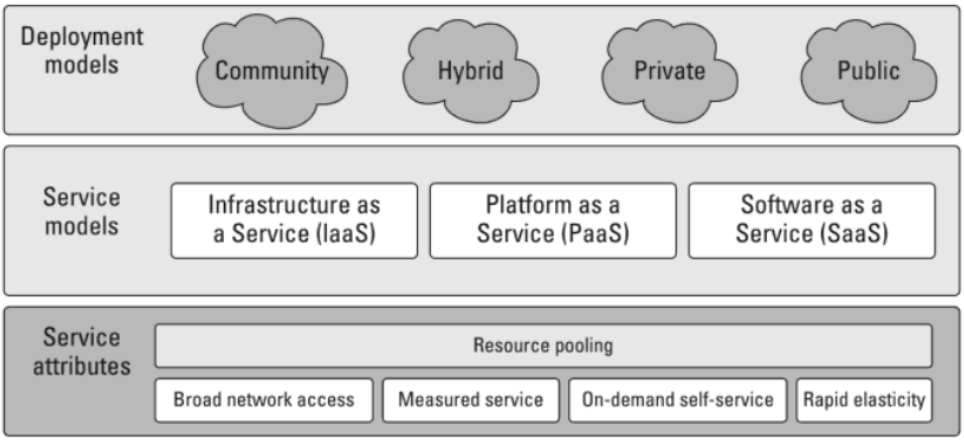


Figure 6 - Cloud Computing model (Sosinsky, 2011)

2.2.1. Cloud Computing Fundamental Characteristics

The five attributes represented on figure 5, namely on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service, are the fundamental characteristics of a cloud. If one of these attributes is absent, it cannot be considered cloud computing. (Cloud Security Alliance, 2017)

- **On-demand self-service:** a client can access the required resources spontaneously and automatically, with no need to interact with the service supplier. (Mell & Grance, 2011)
- **Broad network access:** all components are accessible over the network (through various devices), so there is no obligation for a physical connection. (Mell & Grance, 2011)
- **Resource pooling:** the suppliers' resources are abstracted and pooled, in order to be allocated and re-allocated in line with the client's requirements, in a dynamic approach. (Mell & Grance, 2011)
- **Rapid elasticity:** allows for the resources to be elastically expanded or contracted, typically in an automatized manner, thus enabling the customer to employ resources proportionately to the demand (increasing the number of processing units, for instance, and discard them when demand declines). (Mell & Grance, 2011)
- **Measured service:** resource consumption is routinely regulated, reported and improved by cloud computing systems, adding transparency for both the supplier and client of the system. The client can quantify the amount of resources used and corroborate if the cost matches the consumption. (Mell & Grance, 2011)

2.2.2. Service Models of Cloud Computing

The service models of cloud computing express the kind of services provided by the supplier where the three leading models are Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). (Sosinsky, 2011) Each of these models delivers a certain degree of abstraction and automation that supports the IT department in developing, implementing and maintaining systems. (Kavis, 2014)

Infrastructure-as-a-Service provides connection to essential resources (e.g., storage, memory, processing power) and for that reason the consumer of this service is not responsible for administrating or supervising the core infrastructure. The client has, however, the autonomy and flexibility to set up and maintain applications and operating systems.

On the other hand, Platform-as-a-Service does not allow the client to govern either cloud infrastructure or the operating systems, having only the capability to implement and maintain applications and some settings of the hosting environment. The PaaS model abstracts and provides platforms, tools and components, so that the client has all the necessary conditions to set up and execute applications on the cloud.

Lastly, Software-as-a-Service does not allow the consumer to administrate the core infrastructure, the operating systems or even the applications. The client can only connect via a mobile program or web browser to the applications which are available onto the cloud infrastructure. The SaaS model provides a great degree of abstraction since the client is not responsible for maintaining the various resources, and only has to configure and execute the required applications. (Mell & Grance, 2011)

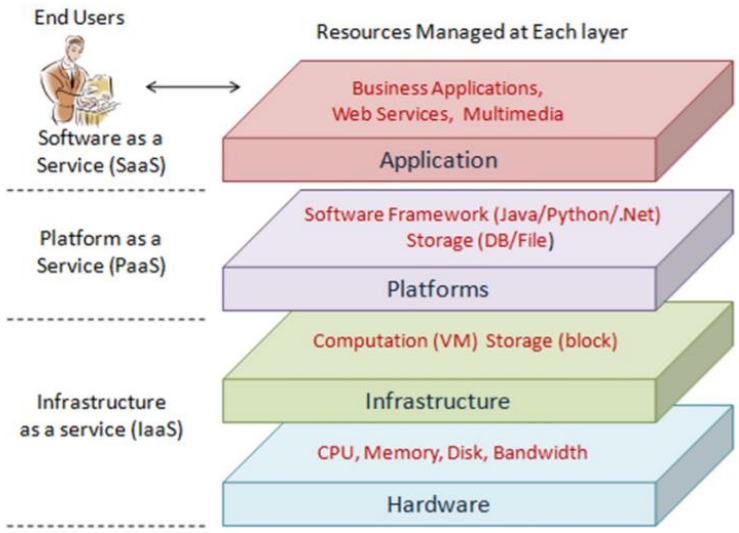


Figure 7 - Cloud Computing architecture (Zhang, Cheng, & Boutaba, 2010)

According to Zhang et al. and as it is represented in figure 6, the three leading cloud service models– IaaS, PaaS and SaaS – can be classified in accordance with the four layers of a cloud computing architecture (Zhang, Cheng, & Boutaba, 2010), each of which we will define below:

- **Hardware layer:** physical IT resources of the cloud, comprising servers, storage, routers and networks, usually deployed in a data center.
- **Infrastructure layer:** abstraction of the physical IT resources by applying virtualization mechanisms.
- **Platform layer:** delivers essential functionalities, as it contains the operating systems and application frameworks. Its intent is to avoid the obligation of the client to deploy applications into VM containers.

- **Application layer:** contains custom cloud applications which provide improved performance by leveraging some cloud characteristics such as automatic scaling.

2.2.3. Deployment Models of Cloud Computing

A cloud deployment model is a detailed set up of the computing environment, and it is not determined by the service model provided by the cloud supplier. The deployment models regard the location and purpose of the cloud and can be classified according to its accessibility. (Sosinsky, 2011)

- **Private cloud:** handled solely by a particular corporation, however it can be owned/supervised by the corporation itself or a third party. This type of cloud is very adaptable, and it may be deployed on or off-premises. (Mell & Grance, 2011)
- **Community cloud:** handled solely by a particular community of users from one or more corporations with common burdens or interests (e.g., mission, security needs). The community cloud can be regulated by one of the corporations or by a third party, and it may be deployed on or off-premises. (Mell & Grance, 2011)
- **Public cloud:** deployed on the premises of the cloud supplier that regulates all the IT resources and it is accessible for public utilization. This type of cloud is easily customizable as the resources are divided though various consumers. (Mell & Grance, 2011)
- **Hybrid cloud:** comprises two or more clouds – private, community and/or public – while prevailing the distinctive characteristics of each model. Within the hybrid deployment model all clouds are linked in a way that supports data and application movement. (Mell & Grance, 2011)

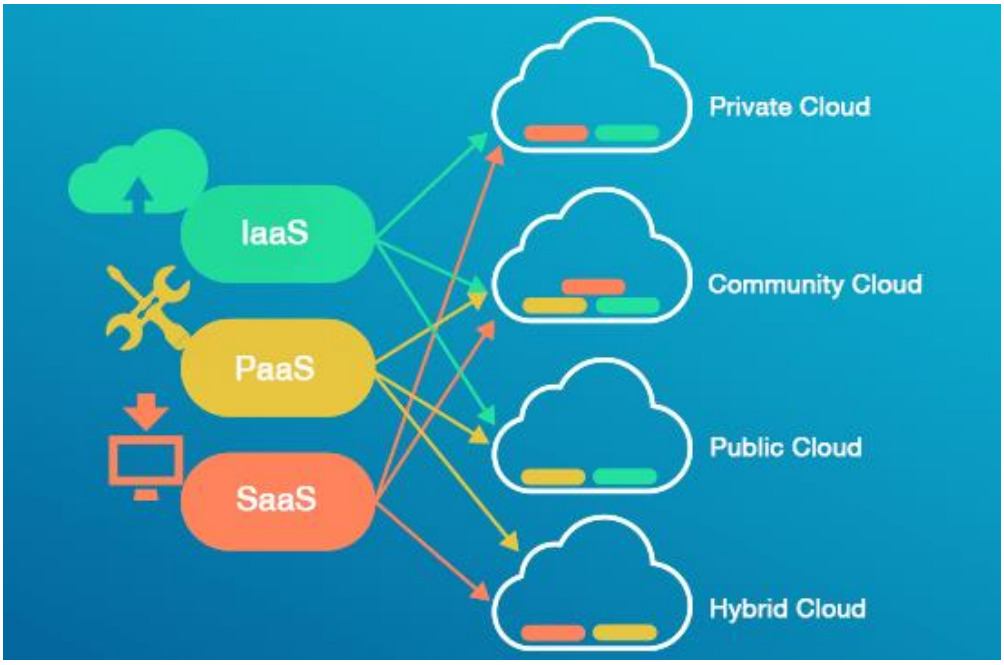


Figure 8 - Service & Deployment Models of Cloud Computing (Shah, 2019)

2.2.4. Cloud Computing Security

Cloud computing institutes various security advantages, such as great accessibility, data segmentation, redundancy and centralization of security, and enables the organization to avoid some conventional risks as well. Nevertheless, some characteristics of the cloud computing model bring in new security threats which we will see in more detail below.

Concerning cloud deployment models, particularly public and community clouds, the supervision is assigned to the owner of the core infrastructure, who must implement an adequate security strategy to assure that the risk is as low as possible. Regardless, for the consumer, security is dependent on the trust placed in the cloud provider. Contrarily, private clouds are regulated by the corporations themselves therefore they are responsible to establish new security threats. (Zissis & Lekkas, 2010)

In what regards the service models, as cloud computing is a shared technology involving distinct corporations maintaining separate sections of the process, security obligations are also disseminated through those corporations – this is appointed by Mogull et al as the shared responsibility model. In the SaaS model, the cloud supplier must ensure practically all security (e.g., logging, monitor, application security) as the client only has capabilities to administer authorizations. Differently, in the PaaS model, the supplier is only accountable for the platform's security and the client is responsible to secure all their implementations on the platform. In the IaaS model, the infrastructure owner is also merely in charge of the foundational security, while the client is accountable for everything that was created on the core infrastructure. (Cloud Security Alliance, 2017)

Figure 9 - Cloud Security & Responsibilities (Cloud Security Alliance, 2017)

The shared responsibility model combines two suggestions (Cloud Security Alliance, 2017):

1. Cloud suppliers must detail thoroughly all internal security controls so that the cloud clients have all the relevant information to decide. Suppliers have to create and employ these controls accurately.
2. Cloud clients must develop a responsibilities matrix to specify who will implement such controls and how, for each cloud project.

2.3. Cloud Migration

Software migration consists of relocating applications, databases or networks, between others, to a new environment, whether it is the migration of a specific software to different hardware elements, or the movement of both software and hardware. (Weller, 2017) Software migration can be completely handled by a third-party solution and it concerns the transferring of software, applications

and programs from an on-site server to a cloud platform, between two on-site servers, or even from one cloud platform to another. (Weller, 2017)

Cloud migration is then identified as the method of transferring data, applications, and other components from on-premise servers to cloud suppliers. (Saleem, 2019) The migration of applications to the cloud will imply a cut in expenses, faster deployment and improved scalability, all while being a potential promoter to better client relations, new collaborations and to boost the organization's competitive advantage. (Cloud Standards Customer Council, 2018)

Nevertheless, the process of migrating applications to the cloud should be structured and meticulous, as current on-site software requires a comprehensive review to verify and define which app will most likely prosper from operating in the cloud. Within the process of selecting the applications to be migrated, the organization must evaluate the costs associated with such tasks, if a new design is required and which will be the security and confidentiality measures to be applied, in order to conclude if the cloud is the right choice. (Cloud Standards Customer Council, 2018)

2.3.1. Cloud Migration Best-Practices

The migration of applications to the cloud can be tricky, as numerous factors can impact the process. (Weller, 2017) Between the most common aspects that usually lead to failure are the misunderstanding of the cloud' capabilities, the hasten into finishing the migration and impractical assumptions related to the due date or scope. The next topics can be considered as best practices that will support any organization into completing the migration process with success. (Worthington, 2018)

Set rational and realistic expectations: A good tip is to split the cloud migration procedure into smaller goals, so that the IT Team can provide recurrent business value and grasp valuable insights during the process. Also, it is important to discern what are the advantages and disadvantages associated with each cloud service model, and to thoroughly plan the monitoring and optimization of the service' utilization. Finally, is it crucial to carefully analyse the costs related to the provision of the cloud service to make sure the expenses are according to previous prospects. (Kavis M. , 2014)

Be aware of cloud security' characteristics: Ensure the IT Team responsible for the migration is knowledgeable about cloud security, regulatory controls and auditing constraints. If this is not the case, consider engaging a third party to carry out an evaluation before and after the deployment. (Kavis M. , 2014)

Understand that interruptions of service are always a possibility: When selecting the cloud service model and supplier make sure to know what the expected risks for interruptions are. Also, the design of the application will be a key factor to deal with these potential disruptions. (Kavis M. , 2014)

Understand the impacts on organizational change: Business practices, accounting standards, HR motivation activities and legal procedures can be impacted by the simple fact of data and services no longer being kept on the premises of the organization. Start the migration process with uncritical programs and have in consideration the possible repercussions on organizational change. (Kavis M. , 2014)

Comprehend customer requirements: The choice for cloud service model and deployment model should be based on the business requirements and consumer needs. (Kavis M. , 2014)

Select the best-suited provider: All options for cloud provisioning should be meticulously examined in order to determine the best-suited cloud supplier to each specific situation. It is essential to

comprehend the distinct characteristics of each cloud service model – IaaS, PaaS and SaaS – to recognize which will be the proper service model for each business case. (Kavis M. , 2014)

2.3.2. Methods for Cloud Migration

Each migration process implies a big commitment into discovering what is the correct approach to transfer applications to the cloud. (Shadow-Soft Team, 2017) Organizations must gather information regarding the content of their environment and the dependencies between each element, to later employ this information in delineating a plan that contains a particular migration tactic for each application and the correct order for the transfer to happen. (Weller, 2017) The five major approaches considered by organizations to achieve their targets will be further detailed below.

Rehosting or "lift-and-shift"

The rehosting approach is usually considered by enterprises that want to stop maintaining their own hardware. This method has relatively low upfront costs and it offers a software solution that is identical to the legacy application, only in the cloud. Rehosting is the quickest migration approach and, as so, the one that results on less interruptions of the business activities. (Shadow-Soft Team, 2017)

This method can be performed manually, but there are many tools available to automatize most of the "lift-and-shift" migration projects, such as CloudEndure Migration and AWS VM Import/Export. (Weller, 2017)

The rehosting approach main disadvantage is related to the fact that the method does not involve any modifications to the applications, as the code is just transferred to a new cloud-based environment. In this way, some cloud characteristics, such as velocity and flexibility, will not be exploited and will not result in improvements at performance level. (Shadow-Soft Team, 2017)

Replatforming

Replatforming is the only approach that supports the utilization of the cloud's complete velocity and adaptability. Organizations which opt for this method want their capabilities to be accessible, flexible, scalable and robust. The replatforming method restructures the code of the program to make it cloud ready, and the process normally involves a thorough reimagination and alteration of the code. (Shadow-Soft Team, 2017) Through this approach, the organization can implement the needed optimizations with the goal of obtaining some substantial benefits. (Orban, 2016)

Although this is considered as one of arduous methods to apply and it is associated with the highest initial expenses, the transformation into cloud native applications results on faster updates and a decrease of development time in the future. Contrarily to recoded programs, restructured platforms can be partitioned through various cloud suppliers, which indicates that replatforming is the best option for organizations that intend to build mobile applications. (Shadow-Soft Team, 2017)

Repurchasing

The repurchasing approach is generally acknowledged as a transfer to SaaS (Orban, 2016), and it is the best option for organizations that don't want to allocate resources to programs that are not directly related with their business. Nevertheless, when transferring a program to SaaS it is essential that the correct service is selected. Repurchasing involves the outsourcing of certain applications to a cloud

provider that will be responsible for maintaining them. Shifting to SaaS also implies that a smaller number of licenses will be required for business tools. (Shadow-Soft Team, 2017)

The major disadvantage of the repurchasing approach is that customization can potentially bring some challenges, as the supplementary code attached to a SaaS tool can exclude it from further support and updates delivered by the SaaS supplier. This said, this method should only be applied to routine tasks, and not highly customized applications. (Shadow-Soft Team, 2017)

Refactoring / Re-architecting

Refactoring is about prioritization and it is the ideal method for enterprises that possess particular apps (or a group of apps) which could take advantage from some cloud-native characteristics, such as scalability and performance. (Orban, 2016)

This approach allows for enterprises to copy the current apps onto a cloud-based environment, which diminishes the risk as the on-premise apps can still be operated while the cloud-native applications are being created. By implementing this method, organizations can swiftly make any modification to need the consumers' requirements. This said, it is essential while implementing a refactoring project, to select the correct platform to deploy the applications. (Shadow-Soft Team, 2017)

Retire

Before choosing any strategy for application migration, it is paramount to understand if all applications are being used. If some programs are no longer needed by the organization, they can simply be shut down which will result in savings that can be employed to other areas of the enterprise. (Orban, 2016)

2.4. SaaS Cloud Migration

The idea that a single cloud service model is able to fulfil all expectations is one of the most common misconceptions about cloud processing, as each model carries some benefits that could handle the requirements of several businesses. (Saratchandran, 2018) In order to pick the cloud model that is most appropriate, the organization has to analyse a few aspects of the model, such as technical, financial, tactical, business and security, and to weight each aspect distinctively according to their requirements. (Kavis M. , 2014)

2.4.1. Software-as-a-Service (SaaS)

SaaS is an entire application provided as a service to the customer that intends to support their respective business activities. (Kavis M. , 2014) The customer just needs to set up and customize some particular parameters, and then is apt to access information, programs and functionalities on-demand, via the internet. (Bielawski, 2017)

Figure 10 - Software-as-a-Service (SaaS) (Priti, 2019)

NIST defines Software-as-a-Service (SaaS) as:

> "*The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure, including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.*" (Kavis M. , 2014)

The adoption of SaaS provides an alternative not only for the acquisition and deployment of hardware on-premises, but also for the maintenance of the whole solution, merely by purchasing the necessary software from cloud vendors. (Fehling, 2019) The cloud service supplier manages the infrastructure, application logic, future versions/upgrades, and basically all topics related with the provisioning of the service. (Kavis M. , 2014) The service is billed on a pay-per-use basis and additional expenses for extra storage or customizations. (Bond, 2015)

SaaS service model should be applied to deploy all programs, features and services that do not consist on a main capability of the organization, as long as it matches their requirements. (Kavis M. , 2014) For enterprises to acquire programs that are not directly related with their line of business, and operating them on-site, is not budget-conscious considering the rise of SaaS solutions. (Kavis M. , 2014)

SaaS contains numerous types of applications, though the most usual apps concern communication and collaboration, organizational business apps such as CRM, ERP and HR, document libraries, BI systems, database-as-a-service, data presentation, accounting and payroll, and there are also numerous alternatives to handle developments, tests, logs, monitoring and security, between others. (Kavis M. , 2014)

Nevertheless, many on-site applications need a substantial re-design – which could take months or even years – in order to be suitable to be transferred to a cloud-based environment. (Bond, 2015)

According to Fehling et al. the key features of cloud computing, established by NIST, are supported by Software-as-a-Service (Fehling, 2019) in this way:

- **Access via network:** the connection to SaaS applications is generally performed via a client interface over the internet or intranet of an organization. Furthermore, the application'

features can also be obtained remotely through an application programming interface (API) which can be combined with additional programs of a client.

- **On-demand self-service:** SaaS apps online client interface delivers maintenance features through which clients can review and assess the app and book it if its according to their requirements. When the client can connect to the corresponding application, it has capabilities that covers adding and removing users, but also the ability to customize the API so that the integration with additional programs is possible.
- **Pay-per-use:** the billing of SaaS applications is usually via a subscription fee. This fee is based not only on the current elements incorporated in the specific application but also according to the usage level of each user.
- **Resource pooling:** different clients share the infrastructure, hardware and software resource. In this situation, clients are referred to as tenants, concerning organizations that contain several users connecting to the application individually. To avoid the interference between distinct tenants, the SaaS app has to take into account the multi-tenancy by isolating users from each other, particularly in what involves the user's data.
- **Rapid elasticity:** within SaaS provisioning, the program can be supplied elastically and released according to the consumer requirements. Consequently, the supplier should adjust the workload of the various tenants using the program.

2.4.2. Roadmap and Process to SaaS Cloud Migration

A methodical plan can be the ticket to a successful application migration, as an inadequate execution could generate higher expenses, loss of data and interruptions of the business operations, withdrawing some of the prospective gains from cloud computing. (Cloud Standards Customer Council, 2018) The migration plan should incorporate the following phases, each of which we will view in detail over the present chapter, to guarantee the success of application movement from on-premise to a cloud-based environment:

Assess your applications

Determining the level of suitability of certain types of applications to cloud migration is sometimes a complicated task, as it consists of multiple principles. (Cloud Standards Customer Council, 2018) However, it is an essential process as it endorses the decision of which apps and data can or can't be shifted. Generally, the first of the migration pipeline should be the elements that have the least dependencies. (Varia, 2010)

Liebmann elaborated a list of the various types of applications according to their suitability for cloud computing. The most suitable categories of apps are the following (Liebmann, 2014):

- **Software development, testing and quality assurance:** Developers and quality controllers require considerable computing power for intermittent periods of time. For on-premise solutions it is not easy to deliver it promptly without a substantial increase in cost, which can interfere with deadlines. Therefore, this type of applications can take in numerous advantages from the migration to the cloud, as it allows for the on-demand consumption of resources which can be subscribed only when needed, removing the costs correlated with the acquisition of additional hardware.

- **Collaboration apps:** Communication apps are vital to the corporations as they boost efficiency and support decision-making processes. The migration to the cloud of this type of application will result on an increase of accessibility, as it permits the connection to the various tools from anywhere, at any time and on a vast range of devices.
- **Personal productivity apps:** The increase of the usage of several devices from various places has also an impact on the cost of owning and handling personal productivity apps, such as desktop word processing, spreadsheet and presentation applications. The migration of this kind of apps to a cloud-based environment can result on lower costs for the owner.
- **Big data, analytics and other computing-intensive apps:** Social media posts and sensor readings, among others, provide valuable perceptions about potential opportunities, issues and threats for the organization. However, to fulfil this potential, corporations need to quickly handle and analyse extensive amounts of data, implying the possession of a significant computing power which can be costly to obtain and manage. By migrating this type of applications to the appropriate cloud service, corporations can access the computing power when they need it, avoiding a high cost of acquisition and maintenance.
- **Disaster recovery, business continuity and records retention:** It is essential to protect the main applications and services from any kind of catastrophe. With cloud computing, copies of key apps and data can be preserved in various places so that they will not be affected by the same tragedy. Organizations can also make sure that cloud suppliers are compliant with the guidelines that regulate records retention.

On the other hand, the least suitable categories of apps for cloud computing are core systems of record. These applications require regular and extensive transactions, and it may incur on performance concerns in a cloud-based environment. Systems of records are often the storage for the corporation's sensitive data, and if there is any regulatory or legal risk implicated, the best practices may discourage the transfer of this information to the cloud. Also, in the case of applications in which even a momentary interference implies considerable consequences, the movement to the cloud is not recommended as it is always vulnerable to a sporadic interruption. (Liebmann, 2014)

After the identification of the most suitable apps to be transferred to the cloud, it is necessary to assess their cloud-readiness by approaching the following aspects (Cloud Standards Customer Council, 2018):

- **Business:** Evaluation of the importance of the application to the organization and measurement of the risk tolerance.
- **Application Lifecycle:** Analysis of the current design of the application to verify if it can be redesigned and if any productivity advantage will arise from the migration to the cloud.
- **Application Architecture:** Understand how the application is assembled, how it interacts with other programs to meet business demands and if the current architecture is compatible with cloud computing.
- **Data:** Determining if the privacy, veracity and quality will be maintained after the migration.
- **Infrastructure:** Appraisal of the network's performance and if it can be at least equated with cloud computing.

- **Security:** Understand that, with a migration to the cloud, security will be a shared responsibility between the application owner and the cloud service supplier.
- **Integration:** Check if there are any dependencies between a migrated application and other on-premise solutions.
- **Operations:** Comprehend how the solution will be executed and maintained after a cloud migration.

Build the Business Case

A business case for the migration of applications to a cloud-based environment consists on a cloud processing plan, which incorporates detailed information that illustrates the existing solution and points to the potential benefits of moving to the cloud. This plan should address particular business challenges over current apps that could be fixed with cloud processing and prove that transferring the application to the cloud is the correct choice. (Cloud Standards Customer Council, 2018) The next topics should be considered when building a business case:

- **Cost and savings analysis:** it is essential to carry out a meticulous assessment of the migration process' expenses, such as the continuous cloud service costs; the security and privacy maintenance; apps remodelling, implementation, testing, integration and government; and human resources. Even though, there are clearly some prospected gains or else it would be illogical to start such a procedure.
- **Service levels:** the cloud ought to deliver a superior level of service (at least equivalent) to the previous levels, and all the prerequisites must be settled with the cloud service supplier. For every app migration to the cloud, it should be scrutinized the application's availability, performance, security, privacy and regulatory compliance.
- **Business impact:** to build up a thorough business assessment, the effect on revenue and client acquisition, the level of client contentment and changes on time to market should be continuously supervised.

Develop the Technical Approach

Overall, SaaS is a whole application delivered as a service to customers, that aims to sustain their particular business processes, so that the customer is just required to adapt or customize specific parameters. (Bielawski, 2017) Considering the migration to SaaS, the application can have to go through with a re-architecture to be suitable for the cloud-based environment, as it could be that there is no SaaS solution available that can fulfil the original requirements. The versions of the on-premise and SaaS-based applications may be different, so that should also be taken in consideration.

There are some technical factors which must be also contemplated in the business case such as the skills of the IT team, privacy, integration, supervising and managing, scalability, accessibility and backup. (Cloud Standards Customer Council, 2018)

Adopt a Flexible Integration Model

Applications can have many connections with other systems or applications as a way to fulfil business requirements. In the case of an application referring to another to operate a particular part of a flow it is called a process integration, while data integration concerns the sharing of master data between

two or more applications, and presentation integration regards the case in which applications have to submit their outcome at the same time. In order to guarantee that the integration between two or more programs is supported in the long term, (Cloud Standards Customer Council, 2018) some points should be validated such as:

- Have flexibility to apply methods that were chosen particularly for each case.
- Utilize standards so that the solution is robust enough to sustain subsequent adjustments and/or modifications to the cloud-based environment.
- Recognize the possibility of further migrations to occur and have that in consideration when redesigning the program's architecture.
- Evaluate the intricacy of each connection to have an idea of how much time and resources will be needed for the migration process.

Address Security and Privacy Requirements

The main topics that distress cloud service consumers are the compliance, security, privacy and data residency, between others, varying according to the sector or line of business of the organization. The main issues related with **compliance** are due to the storage constraints, to particular security elements like authentication procedures and certain controls on specific activities such as logging. On the other hand, troubling **security** topics include the potentially of confidential information being stolen and how to prevent the attack to reoccur. It is also essential for a cloud service client to consider how much their business might be affected by an attach that causes an unexpected service interruption and how the activities of the various admins and users will be controlled in order to identify suspicious behaviours. In terms of **privacy**, the main issue that affects cloud consumers relates to the fact that a breach of privacy can cause extensive damage to the organization, as the loss of clients and even legal repercussions. In what regards **data residency**, the key problems revolve around the policies and rules that restrict the transit and location of specific categories of data. (Cloud Standards Customer Council, 2018)

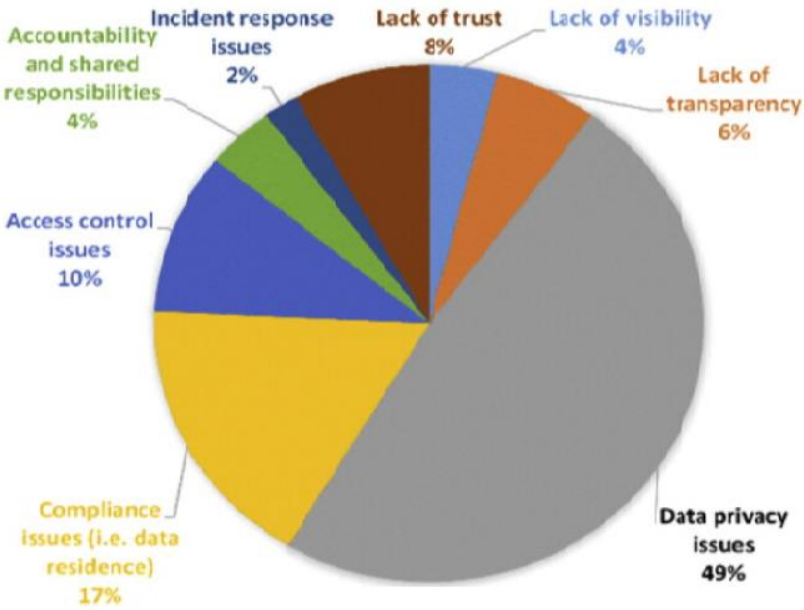


Figure 11 - Top security concerns of SaaS (Tang, 2015)

In spite of these concerns, the transferring of a program to a cloud-based environment may actually enhance its security, as cloud suppliers most likely have superior resources than the majority of their individual clients. (Cloud Standards Customer Council, 2018)

Manage the Migration

Lastly, after all previous points have been analysed and defined, the migration process can be executed. This process can be quite changeling, so it is advised to first perform a trial on a couple of non-vital programs, to test it meticulously and to register all important notes so that this knowledge can be applied in the future and to guarantee a successful migration to the cloud. (Cloud Standards Customer Council, 2018)

Furthermore, to assist the movement of applications to a cloud-base environment, a SaaS migration process was suggested by Pahl & Xiong, sustained on various reports and statements from cloud migration specialists. (Pahl & Xiong, 2013) A cloud migration process consists of a group of precise procedures which can be accomplished step-by-step, intended to assist the complete process of migration to the cloud. The major concerns associated with each procedure are discussed, for instance the type of migration (whether technical or business-focused), recognition of exceptional cases, and potential benefits and risks of the migration.

The migration process suggested for SaaS is presented pictured below, including the four high-level procedures and particular steps that will be described in detail.

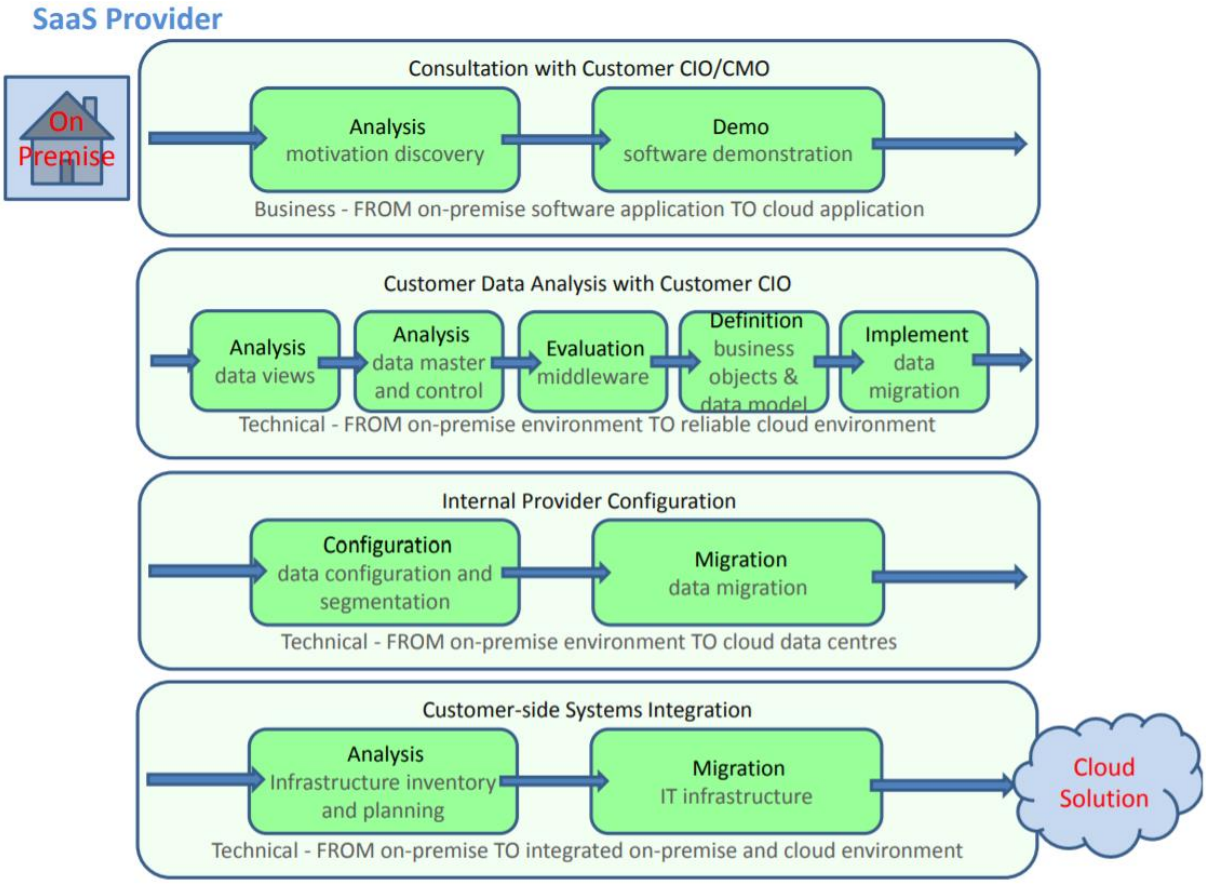


Figure 12 - SaaS Migration Process (Pahl & Xiong, 2013)

The applications contemplated in this process for SaaS migration are traditional ERP packages for accounting, HR, CRM, etc., and also specialized programs for the trading or engineering sectors.

1. **Consultation:** SaaS providers must ensure that the customer is fully aware of the cloud service provisioning method. The first step consists of the identification of the motivation to proceed with such project, like the gains in flexibility, the use of up-to-date software and the advantages of not having to configurate and maintain the software. The second step regards a demonstration of the software behaviour, as usually the loss of control over the system is one of the biggest concerns.

2. **Customer Data Analysis:** It is required to carry out an overview of the data that is planned to be transferred to the cloud and of the views and responsibilities associated with it. The primary step is to define a data perspective, and then to identify who will control the data. The third step encompasses an assessment of the solutions in order to determine if the integration in the cloud will be on a single event or performed sequentially, while the following task is to describe the application data model. The last step consists of the selection of the data to be migrated.

3. **Internal Provider Configuration:** cloud providers are responsible for the configuration of data transmission and storage, and frequently offer data migration tools to support the process. In what regards SMBs (Small-Mid Businesses), the customization requirements point to gains in

productivity and growth, while for the USBs (Ultra-Small Businesses) the requirements concern improvements in commitment, promotions and loyalty.

4. **Customer-side Systems Integration:** It is very unusual that all on-site IT components are migrated to the cloud, which leads to the need to perform the consolidation between distinct on-site programs and cloud solutions (called hybrid scenarios). The larger cloud vendors deliver integration tools to assist in the process.

3. METHODOLOGY

The production of knowledge emerges from the study and consideration of inventive theories supported by a structured process, which is essential in a systematic and hypothetical approach. (Hevner & Chatterjee, 2015)

Design Science Research (DSR) in the area of IS aims to boost and promote the efficacy and performance of the corporation in which the information system is implemented. DSR analysts contribute with innovative solutions to enhance the flexibility of the diverse entities related to the enterprise, allowing it to succeed when facing a dynamic and uncertain situation. These solutions are transmitted as knowledge to the pertinent IS partners and groups. The addition of original knowledge is a required and crucial goal of design science research.

3.1. DESIGN SCIENCE RESEARCH (DSR)

Design science research is a methodology that supports the creation of knowledge through an organized technique, concentrating on how to deal with actual obstacles and establishing the consistency of the outcome. The DSR process model presented in the figure below can be understood as a conventional design science research model with the flows of knowledge, process steps and expected outputs. (Vaishnavi, Kuechler, & Petter, 2019)

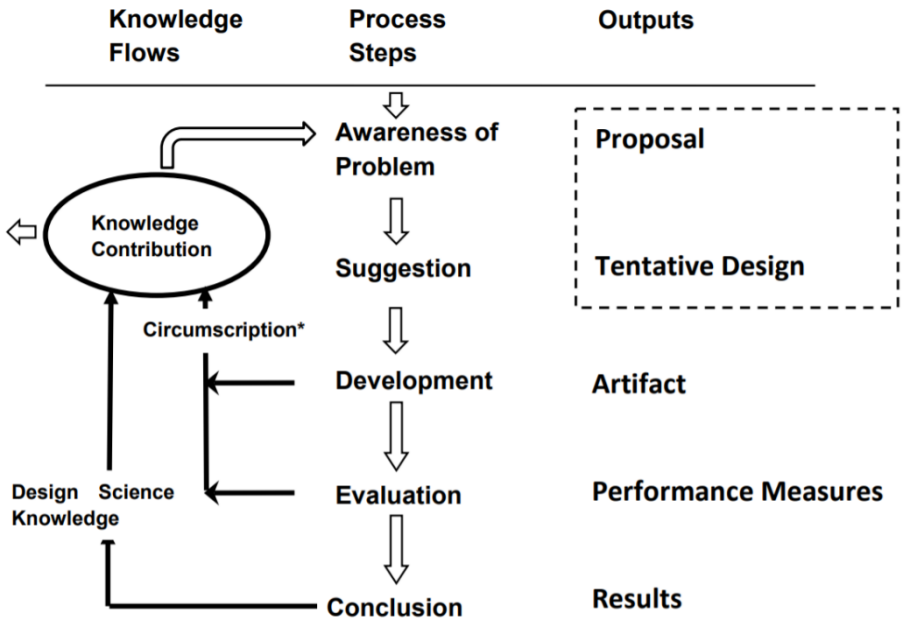


Figure 13 - Design Science Research Process Model

The five process steps of the design science research process model are interpreted bellow.

Awareness of Problem is the first phase of the research process model. The kind of obstacles that DSR addresses are commonly focused on problem-solving techniques, instead of inquiries that can be simply interpreted and clarified. The goal of this phase is to recognize and to understand the problem, along with the scrutinization the principles to assess the feasibility of the ultimate output of the design

science research process. The outcome of the "Awareness of Problem" phase is an idea or proposal for a new research effort.

Suggestion is a visionary phase in which an original application is conceived through the redesign of current and new features. Creativity is an intrinsic factor in the evolution from demonstrating interest in a subject to the actual production of proper formulations that generate a pertinent research model. The outcome of the second phase should be a tentative design that would be incorporated with the proposal. If during the investigation of the subject a plan for solving the problem is not evident to the researcher, the proposal will be discarded.

Development is the phase in which the tentative design is refined and put in action with the purpose of solving the problem. The method used to implement it will differ according to the kind of product in question, and it can be very simple and not include any original techniques – the innovation is present and an integrated part of the design, not the creation of the product.

Evaluation phase concerns the assessment of the artifact in consonance with the principles defined in the proposal. This phase includes a logical process in which assumptions are formed regarding the performance and repercussions of the solution implemented, by applying a plan of action in coherence with the requirements of the assessment. (Venable, Pries-Heje, & Baskerville, 2016) If any discrepancies are found, the knowledge derived from the development and evaluation of the solution generally proposes a different design, which should be supported by further investigation to explain why the performance of the original artifact diverges from what was foreseen.

Conclusion is the final phase of the design science research process model. The results are gathered and consolidated at the conclusion stage, and the knowledge acquired can be adjusted and applied in new situations or used to support additional research. The outcome of the research process model is communicated and discussed with the relevant parties, and its conclusion is the contribution of new knowledge.

3.2. Research Strategy

The design science research process model interpreted on section 3.1 is applied as a directory to this research project and the outcome of each stage is characterized below, on figure 14.

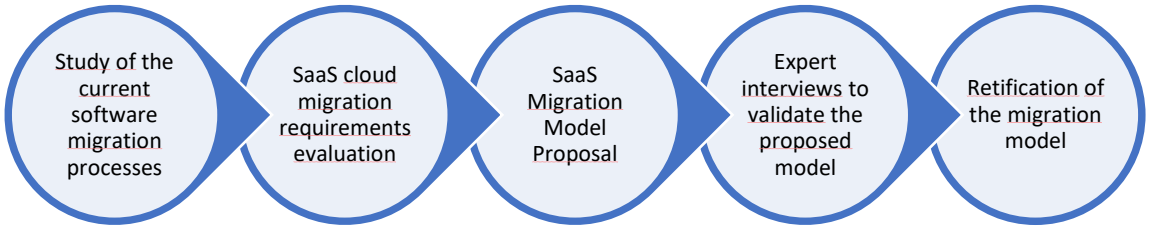


Figure 14 - Outcome of the DSR process model applied in this project

From the first phase, **Awareness of Problem**, emerged the inspiration to this project: to grasp the current difficulties of software migration to SaaS and to seek the necessary information to develop a model that can serve as guide for processes of migration to SaaS.

From the **Suggestion** stage, arises the obligation of reviewing the literature to thoroughly comprehend the SaaS model and the essential migration requirements.

In the **Development** phase, there was the creation and proposal of a SaaS migration model.

In the **Evaluation** stage, the proposed migration model will be corroborated and validated through interviews with experts on the subject.

In the last stage, **Conclusion**, the results from the interpretation of the specialists' interviews will be examined and the derived knowledge will then be disseminated and applied on the migration model.

4. MODEL PROPOSAL

4.1. ASSUMPTIONS

Built on the key notions and fundamentals approached in the literature review, the suggested migration model corroborates these assumptions:

1. There are several SaaS tools which are suitable for a variety of migration projects, designed to fulfil the requirements of various applications to be transferred to the cloud.
2. The migration model targets the most suitable applications to be migrated to a cloud-based environment.
3. Each application that can be migrated to SaaS possesses certain requirements and features that must be assessed.
4. It is essential to have the main cloud processing features in consideration to adjust the application movement to SaaS.
5. Even though the process may be similar for most cloud migration projects, a precise roadmap and process is crucial for a successful transmission of applications to SaaS.

4.2. MIGRATION MODEL

The migration model was elaborated based on the assumptions previously mentioned, and it means to serve as a guide for organizations performing an application migration to the SaaS service model. The proposed model aims to mitigate structural errors or unnecessary changes during the cloud migration process, which may result in lower costs and less effort for the IT team.

The figure below portraits the four main phases of the migration process. Each stage and its steps are described in more detail over the next chapters.

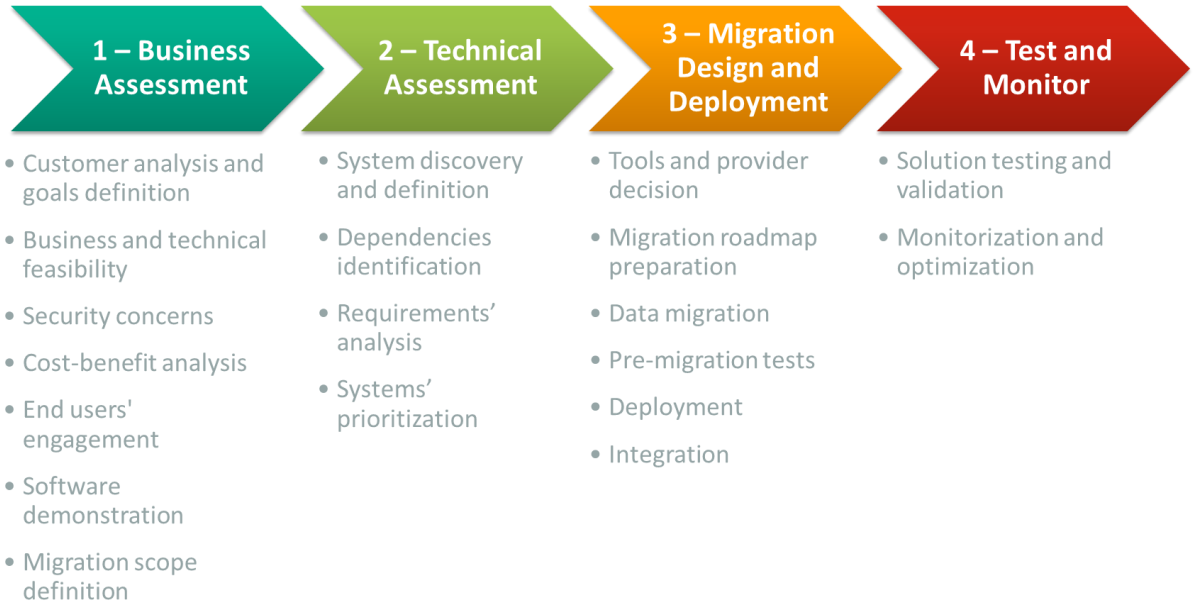


Figure 15 - Framework for SaaS Migration Process

4.2.1. Business Assessment

The first stage of the model is the Business Assessment, and it evolves from a first analysis of the customer's expectations for the migration project, and the clear definition of what is likely to be accomplished.

Figure 16 presents a flowchart that encompasses all steps of the Business Assessment phase in its correct order of execution.

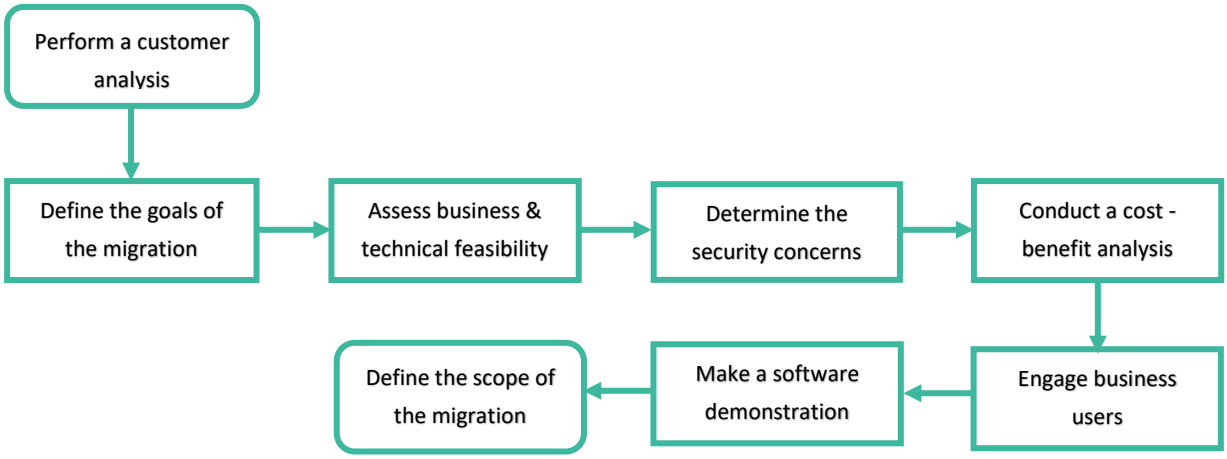


Figure 16 - Business Assessment Flowchart

It is important to arrange a meeting with the business to fully understand his motivation to perform a migration of part, or all of its software, to a SaaS service model. One fundamental step of a migration to the cloud is to gather and document the specific objectives for the project, understand its limitations and delineate what the achievable outcome is.

To proceed with the feasibility assessment, start by estimating the importance of the software to be migrated to the enterprise and determine what is their tolerance in case of failure or postponement of the Go Live date. Also, it is essential at this stage to discern if all the elements and functionalities present on the existing on-premise software can also be assured in the cloud and determine if the preferred technology fulfils the current needs. Ascertain what are the potential implications and if it is viable to transfer from the current solution to a SaaS cloud computing model. The checklist 'Assess Business and Technical Feasibility' is available on annex A.1 – table 3, with activities to gauge the feasibility of the software migration to the cloud.

Security is a considerable aspect of any SaaS program and, assuming that the enterprise has to comply with some particular security standard like PCI (Payment Card Industry) or HIPAA (Health Insurance Portability and Accountability Act), a robust security framework may have to be employed. Assess the overall risk tolerance and gather the requirements of data accessibility, redundancy, consistency and privacy. Further, there should be an arrangement of the datasets into specific categories concerning its sensitivity. Thus it would be easier to grasp what are the potential security risks and threats for each category, and to quantify the probability of those treats happening. This can be a good tool in deciding which datasets or applications to migrate to SaaS, and the ones that should be maintained on-premises. The activities to verify the security concerns related to the software migration to the cloud can be found on the checklist 'Determine the security concerns' on annex A.1 – table 4.

Evaluating the economic factors of maintaining and running an on-premise solution in contrast to engaging a cloud computing service involves a thorough and precise assessment. A cost-benefit analysis can be a very useful tool to establish the viability of a migration to the cloud and also the likelihood of its accomplishment, as it allows the comparison between global costs and benefits of the project. To begin the analysis, proceed to the quantification of the application's actual costs, both direct and indirect costs. For direct costs collaborate with the accounting and logistics department to collect documentation and bills, ensuring the consistency of the analysis. This type of costs comprises functional, maintenance and organizational expenditures; it involves all costs related with the human resources like payroll and training; and also costs associated with the IT infrastructure such as servers, electricity, storage, network connectivity, between others. On the other hand, indirect costs concern immeasurable events like loss of overall productivity, costumer discontent, and many possible others, usually associated with the service interruption. Next, calculate the projected costs post migration and the cost of the migration process itself (time and effort) and compare both to the actual costs. Then, continue to the identification of the expected benefits. To preserve the accuracy of the analysis, a monetary value should be attributed to each benefit, although some in particular may be unquantifiable like more environment-friendly facilities. Benefits can encompass improved overall productivity or higher revenues, and, in the case of cloud computing account also for higher accessibility, consistency, scalability, between many other cloud computing features. After the analysis in concluded, make an informed recommendation regarding the migration project that endorses the business goals. The checklist 'Conduct a cost-benefit analysis' is available on annex A.1 – table 5, with activities to follow during this step.

User engagement is a relevant step to consider since the start of the project lifetime, as their specifications and observations are fundamental in the migration to a new application to guarantee that the new functionalities will consider their core requirements. There should be more than one key user engaged within the migration project team, increasing the chance that the entire end user community will eventually adopt the ongoing change. If the migration project will incur adjustments to the current work processes and activities, provide training to the end users so that they have the necessary knowledge and can be proficient in the new solution. Additionally, prepare a clear communication plan and provide a straightforward status of the project development.

As for some end users can be complicated to envision these new concepts, prepare a software demo presentation to tackle all concerns and doubts the business might have, and to retrieve their feedback early on. Additionally, make clear what is the added value of migrating to the cloud, and define what can be leveraged such as machine learning and industrialization of processes.

A precise definition of the migration scope will support the delineation of the migration timeline, the methodical allocation of resources and will provide guidance for the project team, so that the established timeline and budget are met. To define the migration scope it's fundamental to clearly understand the project requirements, establish and validate the goals of the migration, consider the business users prospects and acceptance of the new solution, determine what can be the possible constraints and recognize the required changes that may be needed.

4.2.2. Technical Assessment

A technical assessment is an essential tool to grasp which programs are a better fit for a migration to the cloud. After the assessment it will be possible to classify the software to be migrated to the cloud first and which programs ought to stay on-premises.

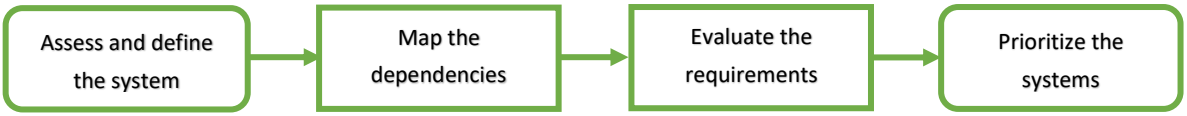


Figure 17 - Technical Assessment Flowchart

To begin, schedule a technical conversation to establish the datasets that will be transferred to cloud computing. The perspectives existing for that data and who will master it should be defined at this stage as well. Conduct an evaluation of the actual architecture of the program to comprehend how it is assembled, how it is integrated with the other applications and if the overall design is well-suited for the cloud. If it is, try to understand how the program will be operated and managed after the migration by performing a thorough assessment of the to-be software, how it is going to integrate with other systems and what is the impact on current processes. The checklist 'Assess and define the system' is available on annex A.2 – table 6, with step-to-step activities.

In order to have a clear perspective of the interdependencies of the enterprise's data, programs and frameworks, it is a prerequisite to assemble a map of dependencies between all assets. Assemble a dependency tree diagram that illustrates meticulously all distinct interconnections between the organization's applications. This will help demonstrate the existence of dependencies between on-premise and migrated programs. The activities to verify the interdependencies can be found on the checklist 'Identify the dependencies' on annex A.2 – table 7.

Furthermore, check all the requirements to be sustained by the migrated program and examine the current design and layer partition of the enterprise's components, in order to determine the distinct elements that have to be developed in the system prior to the migration to the cloud. The checklist 'Evaluate the requirements' is available on annex A.2 – table 8.

The output of the Technical Assessment stage provides a transparent view of the overall system and serves as a guide for the prioritization of programs for cloud migration. Usually, the leading candidates for cloud computing are the programs that have the least number of connections to other applications. Apart from the dependencies, search for programs that are lacking capacity or need to scale immediately or at a global level, and also look for programs with architectural flexibility.

4.2.3. Migration Design and Deployment

The third stage of the model is the Migration Design and Deployment, and it starts from the selection of the cloud provider to the deployment and integration of the SaaS solution.

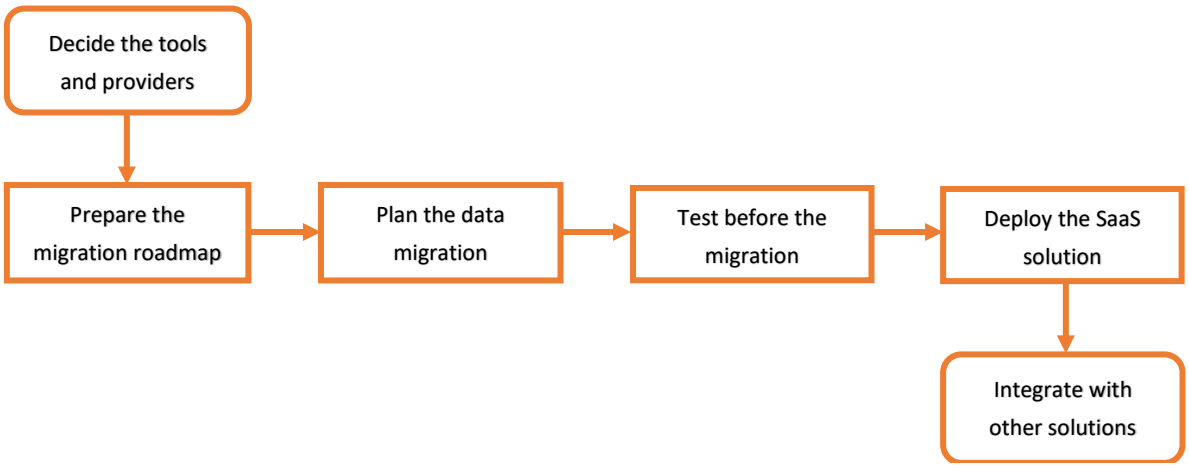


Figure 18 - Migration Design and Deployment Flowchart

Table 2 was built based on the categories of the applications with higher suitability to be migrated to the cloud and the existing SaaS dedicated tools. The categories of the apps proposed in the suggested model were nominated due to the applicability and importance for the business, suitability for cloud migration and the recent technologies being applied. For a particular category of applications, were suggested several SaaS dedicated tools that can be applied alone or in combination with other tools in order to provide a complete solution for SaaS migration projects.

Type of Application	Program	Company	Description
Software development, testing and quality assurance	Jira	Atlassian Corporation	Software Development
	Amazon Web Services	Amazon	Computing, Storage, Networking, Deployment
	Qtest	Tricentis	Test, Visualization
	Test Case Management	Qmetry	Test Cases Creation, Test
	PractiTest	PractiTest	Test, QA, Communication
Collaboration	Jira	Atlassian Corporation	Collaboration
	Confluence	Atlassian Corporation	Collaboration, Project Management
	Trello	Atlassian Corporation	Project Management
	Freshdesk	Freshworks	Customer Service
	Fresh Sales	Freshworks	Sales, CRM
	Fresh Team	Freshworks	HR
	Meet, Gmail	Google	Collaboration
	GoToMeeting	GoToMeeting	Teamwork
	CRM	HubSpot	CRM
	Sales Hub	HubSpot	Collaboration
	Services Hub	HubSpot	Customer Service
	MailChimp	MailChimp	Email Marketing
	Salesforce	Salesforce	Sales

	ServiceNow	ServiceNow	Collaboration
	Shopify	Shopify	Ecommerce
	Slack	Slack	Collaboration
	Workday	Workday	HR
	Zoom	Zoom	Collaboration
	ClickUp	ClickUp	Document Creation, Project Management, Time Tracking, Goal Tracking
Personal productivity	Acrobat	Adobe	Content Management
	Dropbox Paper	Dropbox	Collaboration
	Google Office Suite	Google	Analytics, Document Creation, Collaboration
	CMS Hub	HubSpot	Content Management
	LastPass	LastPass	Password Management
	Microsoft Office Suite	Microsoft	Document Creation, Collaboration
	LibreOffice Productivity Suite	LibreOffice	Analytics, Document Creation
	Hancom Office	Hancom	Document Creation
	Workflow Automation	Zapier	Task Management
Big data, analytics and other computing-intensive	Adobe Analytics	Adobe	Marketing, Analytics
	Hootsuite	Hootsuite	Social Media
	Marketing Hub	HubSpot	Marketing, Analytics
	SurveyMonkey	SurveyMonkey	Analytics, Visualization, Online Survey
	Google Analytics	Google	BI, Analytics
	Amazon Web Services	Amazon	Analytics
	Crazy Egg	Crazy Egg	Marketing, Analytics
	Intercom	Intercom	Marketing, Analytics
	Mixpanel	Mixpanel	Marketing, Analytics
	Einstein Analytics	Salesforce	Analytics, Visualization
	ProfitWell Metrics	ProfitWell	Analytics
	Baremetrics	Baremetrics	Analytics, Forecasting
	Klips	Klipfolio	Visualization
	PowerMetrics	Klipfolio	Analytics
	TapClicks	TapClicks	Analytics, Visualization
	Adaptative Planning	Workday	Analytics, Visualization, Forecasting
	Cyfe	Traject	Visualization
Disaster recovery, business continuity and records retention	Cloud Security	Proofpoint	Cybersecurity
	Sophos Cloud Optix	Sophos	Cybersecurity
	Acronis Cyber Backup	Acronis	Cybersecurity
	Acronis Cyber Disaster Recovery	Acronis	Disaster Recovery
	Acronis Disk Director	Acronis	Records Retention
	x360Recover	Axcient	Business Continuity, Disaster Recovery

	x360Cloud	Axcient	Cybersecurity
	Carbonite Recover	Carbonite	Disaster Recovery
	Carbonite Availability	Carbonite	Business Continuity
	Business Continuity as a Service	Databarracks	Business Continuity
	Disaster Recovery as a Service	Databarracks	Disaster Recovery
	Backup as a Service	Databarracks	Cybersecurity
	Disaster Recovery as a Service	Evolve IP	Disaster Recovery
	Azure Site Recovery	Microsoft	Disaster Recovery
	StorageCraft Cloud Services	StorageCraft	Disaster Recovery
	Quorum onQ	Quorum	Cybersecurity, Disaster Recovery

Table 2 - SaaS Tools by Type

Elaborate a thorough migration plan, encompassing the strategy, project timeline, versions, user communication process, scheduling of recurrent check points with the users, testing and validation, limitations and issue handling. Select the cloud deployment model – private, public, hybrid – considering the domain of the specific program, however several SaaS providers adopt the hybrid model. Adjust and coordinate the application architecture so that all developers are aligned and define the frameworks and specifications (settings and parameters) to be configured. The checklist 'Prepare the migration roadmap' is available on annex A.3 – table 9, with the steps to follow on this phase.

Transferring a program to the cloud generally also requires the movement of all its data. To select the proper storage option consider all dimensions so that the program can scale up and down according to the requirements, with minimum effort. The process and effort of executing a data migration will depend on the size of the datasets and number of users. On annex A.3 – table 10 is present the checklist 'Plan the data migration'.

A crucial step to spare time and diminish risk is to perform thorough testing before the definite cloud migration. This step allows to seize the proper settings for your specific migration process and to measure the applications performance in a cloud-based environment. Finally, you should be able to decide on the pertinent modifications to be done before the deployment. The checklist 'Test before the migration' can be found on annex A.3 – table 11.

Go Live – Deploy the migrated program to production environments.

Commonly, only certain components of the on-premise solution will be moved to the cloud, which arises the need to posteriorly integrate the various on-site programs and the cloud solution. SaaS model must be adaptable and grant sufficient endpoints to allow customization by the business.

4.2.4. Testing and Monitoring

After the go live of your application in a cloud-based environment, further testing is an important task to prevent issues or failure and to guarantee that the system is running smoothly and fully operational. In this stage is also recommended to ascertain how to take advantage of the new cloud benefits, such as scalability and elasticity.

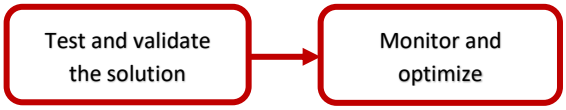


Figure 19 - Testing and Monitoring Flowchart

The movement of applications to the cloud demands various specific tests and validation.

The first step is to proceed with the functional validation, which gauges whether the cloud-based application is ready to be deployed in a Production environment. It is crucial to test the different elements of the application and to validate if it is functioning as per the initial requirements. Integration testing is also a vital step for cloud migration situations, and the dependencies between the various systems, services and third-party tools can make it a complex task. Moreover, it is mandatory to perform a thorough test of the implemented security methods and plans of action after the migration is concluded, to validate that all security, accessibility and privacy policies are working as expected. Ultimately, the evaluation of response times and performance is fundamental to grasp whether the migration to the cloud has a favourable outcome. The application should meet the initial requirements without jeopardizing scalability and stability. On annex A.4 – table 12 is displayed the checklist 'Test and validate the solution' with activities to follow during this step.

Succeeding the assurance that the migrated system is fully operational, the last step is to understand the various alternatives to optimize the migrated applications in order to reduce costs. Considering that SaaS cloud computing generally works as a pay-per-use approach, optimization of your system should a priority after the migration process is completed. In order to handle this scalable environment in an adequate manner, the monitorization and interpretation of the load and traffic patterns is indispensable. The checklist 'Monitor and optimize the system' is available on annex A.4 – table 13.

4.3. MODEL VALIDATION

The validation of the proposed model to support IT Teams undergoing a SaaS migration process was performed based on interviews to specialists in the subjects of Business Intelligence, Application Migration and Cloud Computing.

The proposed work was based on a set of assumptions gathered during the literature review, and these interviews ought to indicate the usefulness of the framework, and also to propose improvements that could be included.

The experts invited for the validation interviews are:

- **Bruno Marques**, Graduated in Computing & Information Systems by Goldsmiths, University of London, with over 13 years of experience in consulting, modelling and solution architecture specialized in design and technical realization with SAP technologies at AXA Group Operations, in several projects related with Risk Management, Insurance and Accounting.

- **Sara Silva**, Master's in Engineering and Management of Information Systems by University of Minho, conducted research in the area of Linked Open Data. With experience in data modelling, software integration and business intelligence, is currently as Business Data Analyst at Microsoft Portugal.

- **Diogo da Costa Alves,** Master's degree in Management with a major in Strategy by Nova School of Business and Economics. Diogo has relevant experience in Data & Business Analytics, Intelligent Financial Modelling & Analytics and Optimization & Efficiency Improvements, having held positions as Analyst, Senior Advisor and Manager in large companies such as Banco Santander and KPMG Portugal and Canada, and responsible for creating several processes to plan the digital transformation for a major Canadian telecom company.

The constitution of the questions and the selection of each specialist was the central part of this step, and intends to validate the proposed work, to grasp its usefulness and to collect suggestions to improve the presented work.

1. **Do you believe that the proposed cloud migration model and table of different SaaS applications by category is useful?**

2. **Do you agree with the approach of the proposed migration process?**

3. **Do you have any recommendation or suggestions for further improvements of the proposed framework?**

4.4. DISCUSSION

After the assessment of the proposed model by experts in BI, application migration and cloud computing (annex C), the feedback obtained was taken into consideration.

With reference to question 1, which concerns the usefulness and practicality of the proposed cloud migration model, the interviewees pointed out the pertinence of a structured approach for the

migration to SaaS and the applicability of the clear sequential guidelines to follow in real-life scenarios, since it homogenizes this process in an effective way, inducing cost and time savings for organizations.

All experts agreed with the approach of the proposed migration model, as per question 2, and it was mentioned that the framework is properly defined in terms of its phases and steps, and that the full scope of the actions that are recommended is distinctly stated. Nonetheless, at this stage it was mentioned that recurrent check point status with the business should be added to the proposal, to assure their ongoing and new requirements.

In what concerns the last question, the interviewees contributed with some suggestions to enhance the proposed migration strategy, such as:

- Emphasize the importance of engaging the business users within the migration plan early on the project lifetime. Having some key users committed to the project can help close the gaps and shorten the time to deployment of the new cloud application.
- Include recurrent check points status with the business users. Business requirements and the objectives outlined initially may evolve during the project lifecycle, and it's important to document and accommodate those.
- Integrate in the software demonstration step the clarification of what can be leveraged with a migration to the cloud, such as machine learning and industrialization of processes.
- Add a stage at the beginning of the migration model, stage zero, to support the choice of the cloud service model.
- Add a 5th phase 'Change Management, Training and User Adoption'. It's important on the roadmap to consider not only the migration and implementation plan, but also the rollout to the users and ensure that they have enough training and time to adopt and adjust to the processes and different technology for their current day-to-day work life.
- Add the assessment of the to-be systems on the Technical Assessment phase.
- Add the key deliverables at each phase.

In regard to the recommendation to emphasize the significance of engaging the business users within the migration plan as soon as possible, the step 'Engage business users' was included in the first stage – Business Assessment – with strategies to implement a successful user engagement plan, please check below:

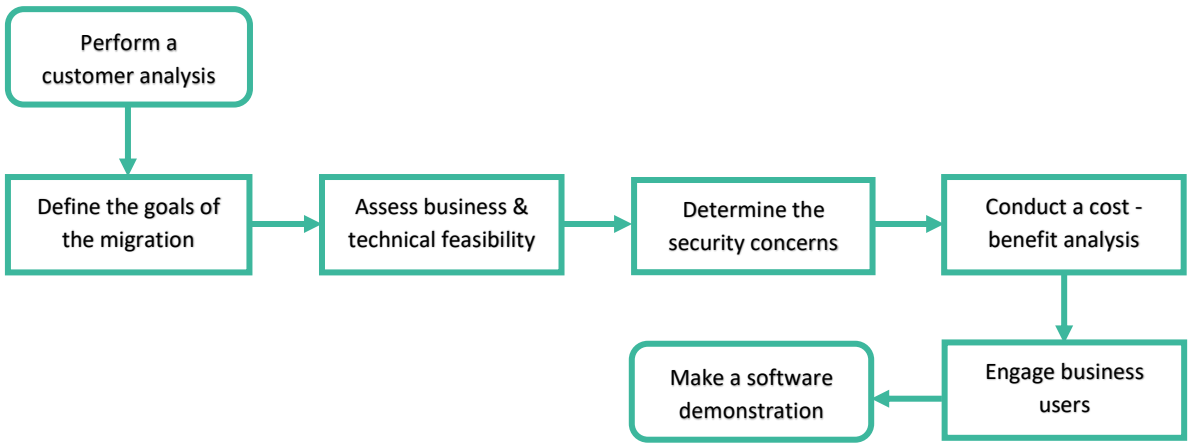


Figure 20 - Business Assessment Flowchart (revised)

Then, section Migration Design and Deployment was revised to incorporate the scheduling of recurrent check point status with the business users. As the initial scope of requirements can change during the project lifecycle, this step was included in the 'Prepare the migration roadmap' checklist (annex A.3 – table 9).

Also, there was a clarification of what can be achieved during the software demonstration at the Business Assessment stage, in terms of explaining to the end user what can be leveraged with a move to cloud and to consider subjects such as the industrialization of processes and data mining.

Considering the recommendation to add a stage zero to the migration model to support the choice of the cloud service model – IaaS, PaaS and SaaS, it was acknowledged that it would be a good option to expand the current model and provide a more complete cloud migration strategy. However, this change would involve the total re-design of the proposed migration model, as it would have to take into account the different options of cloud service model for each of four existing phases. This said, this suggestion is a topic to be analyzed in future works.

In what concerns the suggestion to add a fifth phase related with user adoption, it was recognized that there is an opportunity to carry out a more in-depth study in relation to change management, training and user engagement. It is important to ensure there is enough training provided and appropriate amount of time to embrace and adjust to the new processes and technologies for their day-to-day work-life. As so, it is also a study to be considered for future works.

Next, the Technical Assessment stage was modified to include the assessment of the to-be systems, in order to grasp what will be the new software's layout will be and how the programs are going to integrate. This step was included in the 'Assess and define the system' checklist (annex A.2 – table 6).

Regarding the recommendation to add the key deliverables at each phase of the migration, after its analysis it was concluded that the output of the Migration Design and Deployment and Testing and Monitoring phases are already included within the model with the deployment of the SaaS system and its control and optimization, respectively. Moreover, both the Business and Technical Assessment stages were adapted to incorporate its main deliverables, as per below. The Business Assessment section was revised to include the step 'Define the scope of the migration', as its rigor and accuracy can promote the success of the migration project.

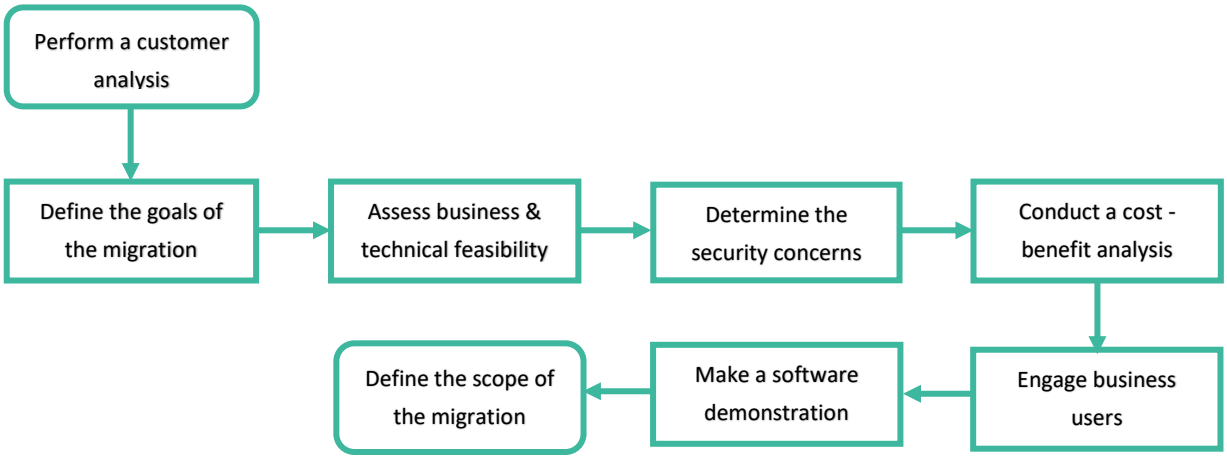


Figure 21 - Business Assessment Flowchart (revised 2)

The step ‘Prioritize the systems’ was added at the end of the Technical Assessment stage, as this phase delivers a clear view of the whole system and serves as a guide for the migration.

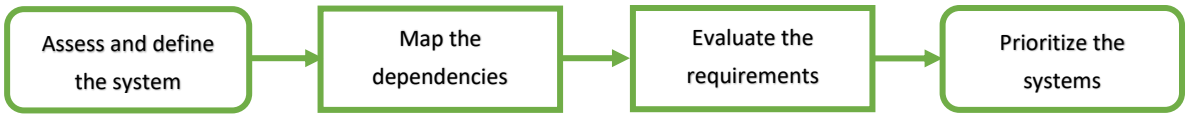


Figure 22 - Technical Assessment Flowchart (revised)

Ultimately, and have taken into examination the answers from the interviews with experts to evaluate and validate the migration framework, it is consistent the opinion that it can bring value to software migration projects to SaaS and, in this manner, facilitate the choice of the most adequate SaaS applications and strategy definition for project managers.

5. CONCLUSIONS

With new technologies emerging each day, organizations need to stay updated and to grow accordingly to stay competitive in the market. Today each second matters in a globalized world demanding strong and secure structures to operate. Cloud computing revolutionized this idea and brought a whole new concept into the market. Although being a somewhat new technology, new cloud solutions appear every day.

This technology is attracting new companies and end-users by its reliability and simplicity, with different and adaptable architectures to fill all kinds of needs. With IaaS, PaaS and SaaS, costumers have a full range of possibilities.

Nevertheless, as the cloud service models evolve at a fast pace and new solutions appear every day, companies may find difficult to choose the right option for them and the migration to the cloud may be an intricate and challenging procedure. Considering the SaaS model, this document tries to enlighten some misconceptions and to deliver a migration model with distinct phases and step-by-step guidance, which aims to support organizations and individuals to better understand this concept.

5.1. SYNTHESIS OF THE DEVELOPED WORK

The major purpose of this research study was to produce a detailed SaaS migration model with distinct stages and sequential steps, based on the analysis of the requirements and methods to migrate applications to SaaS solutions, explored in the literature review.

During the dissertation it was possible to identify the various types of information systems according to its role in business and in terms of its architecture. There was the analysis of the different cloud computing services – IaaS, PaaS and SaaS – and the understanding of its characteristics and deployment models. The best practices for cloud migration were identified, as well as the main existing methods to do so, with a deeper focus on the SaaS model and on the specificities of each application to evaluate its suitability for cloud migration.

The literature review supported the selection of a group of assumptions that preceded the development of a 4-phase migration model to be employed by organizations, which intends to assist the migration of on-premise technologies to SaaS solutions.

The proposed model considers all the needed phases that are involved in a migration to the cloud, in order to reduce errors and unnecessary changes during the migration process, which may lead to lower implementation costs and less effort.

Flowcharts and checklists were developed and incorporated into the model, with step-by-step recommendations in order to elucidate all the actions to be taken and to illustrate the outcome drawn from its adoption.

Later, the proposed model was assessed and corroborated via interviews organized with a group of experts in the fields of BI and cloud migration, seeking to evaluate the model's applicability for organizations.

Moreover, it was possible to gather recommendations for improvement (for example to emphasize the importance of end-users' engagement) that resulted in adjustments in the model and ideas for potential work.

5.2. LIMITATIONS

Even though the adoption of the Software-as-a-Service service model has increased in recent years, there is still some lack of availability of scientific and specialized articles on this subject. In this manner, it was required to carry out an extensive literature review from diverse sources to assemble this dissertation with objectivity.

The selection of specialists in the application migration area and posterior scheduling of the interviews was also not easy, as while various interactions were made, their availability was obviously reduced probably due to the pandemic. Nevertheless, it was feasible to gather feedback from knowledgeable professionals with great paths in multinationals and large companies.

5.3. RECOMMENDATIONS FOR FUTURE WORK

Regarding the work that may be accomplished in the future, the following topics can be a foundation for expanding this research in future projects:

- Inclusion of a stage zero to support the choice of the cloud service model, and respective consideration of this option within all stages of the migration framework.
- Incorporation of a fifth phase to support end user engagement and adoption of the new cloud-based solution, through training and change management methodologies.

BIBLIOGRAPHY

Al-Mamary, Y. H., Shamsuddin, A., & Aziati, N. (2014). The Role of Different Types of Information Systems In Business Organizations : A Review. *International Journal of Research (IJR)*. Obtido de https://www.researchgate.net/publication/264556488_The_Role_of_Different_Types_of_Information_Systems_In_Business_Organizations_A_Review

Alshubaily, N. F., & Altameem, A. A. (2017). The Role of Strategic Information Systems (SIS) in Supporting and Achieving the Competitive Advantages (CA): An Empirical Study on Saudi Banking Sector. *(IJACSA) International Journal of Advanced Computer Science and Applications*. Obtido de https://thesai.org/Downloads/Volume8No7/Paper_18-The_Role_of_Strategic_Information_Systems.pdf

ApacheBooster. (2018). *What is Client-Sserver Architecture and what are its types?* Obtido de ApacheBooster: https://apachebooster.com/blog/what-is-client-server-architecture-and-what-are-its-types/

AVSystem. (2020). *Software as a service – SaaS in device management.* Obtido de AVSystem: https://www.avsystem.com/blog/saas-software-as-a-service/

Bielawski, A. (2017). What is a SaaS Cloud-based Solution? *Knowledge Services*. Obtido de https://www.knowledgeservices.com/technology/what-is-cloud/

Bond, J. (2015). *The Enterprise Cloud - Best Practices for Transforming Legacy IT.* Obtido de https://books.google.pt/books?hl=en&lr=&id=q_1xCQAAQBAJ&oi=fnd&pg=PR2&dq=the+enterprise+cloud+james+bond&ots=pnKHaBx-VK&sig=vPhqL04V8TDjgKgSBxC-oUCShT4&redir_esc=y#v=onepage&q&f=true

Bourgeois, D., & Bourgeois, D. T. (2019). *Information Systems for Business and Beyond.* Saylor Academy. Obtido de https://bus206.pressbooks.com/chapter/chapter-1/

Bratianu, C. (2015). Organizational Knowledge. Em *Organizational Knowledge Dynamics: Managing Knowledge Creation, Acquisition, Sharing, and Transformation.* IGI Global. Obtido de https://www.researchgate.net/publication/322235160_Organizational_Knowledge

Brown, C. W., & Nyarko, K. (2013). Software as a Service (saas) Background.

Cambridge Dictionary. (s.d.). *confidentiality*. Obtido de Cambridge Dictionary: https://dictionary.cambridge.org/dictionary/english/confidentiality

Cloud Security Alliance. (2017). *Security Guidance For Critical Areas of Focus in Cloud Computing v4.0.* Obtido de https://downloads.cloudsecurityalliance.org/assets/research/security-guidance/security-guidance-v4-FINAL.pdf

Cloud Standards Customer Council. (2018). *Migrating Applications to Public Cloud Services: Roadmap for Success Version 2.0 (2018) .* Obtido de Cloud Standards Customer Council: https://www.omg.org/cloud/deliverables/CSCC-Migrating-Applications-to-Public-Cloud-Services-Roadmap-for-Success.pdf

Dibie, O., & Hang, H. (03 de 2012). *Software as a Service.* Obtido de University of Colorado: https://home.cs.colorado.edu/~kena/classes/5828/s12/presentations/software-as-a-service-by.html

Dictionary, C. (s.d.). *integrity*. Obtido de Cambridge Dictionary: https://dictionary.cambridge.org/dictionary/english/integrity

Fehling, C. (2019). Cloud Computing Fundamentals 2. Em *Cloud Computing Patterns.*

Florida Tech. (2019). *Information Systems vs. Information Technology*. Obtido de Florida Tech: https://www.floridatechonline.com/blog/information-technology/information-systems-vs-information-technology/

Goethals, F. (2005). *An Overview of Enterprise Architecture Framework Deliverables.* Obtido de Catholic University of Leuven (KUL): https://papers.ssrn.com/sol3/papers.cfm?abstract_id=870207

Gregersen, E., & Zwass, V. (2011). *Acquiring Information Systems And Services*. Obtido de Britannica: https://www.britannica.com/topic/information-system/Acquiring-information-systems-and-services

Gregersen, E., & Zwass, V. (2011). *Management support*. Obtido de Britannica: https://www.britannica.com/topic/information-system/Management-support

Hargrave, M. (2020). *Customer Relationship Management (CRM).* Obtido de Investopedia: https://www.investopedia.com/terms/c/customer_relation_management.asp

Hee, K. v., Sidorova, N., Voorhoeve, M., & Woude, J. v. (2004). *Architecture of Information Systems using the theory of Petri nets - lecture notes for Systeemmodelleren 1 (2M310)*. Obtido de Department of Computing Science Technische Universiteit Eindhoven: https://www.win.tue.nl/~sidorova/pm/dictaat-sm1.pdf

Hevner, A. R., & Chatterjee, S. (2015). Design Science Research in Information Systems. *Association for Information Systems (AIS)*.

IGI Global. (n.d.). What is Enterprise Systems. *IGI Global*. Retrieved from https://www.igi-global.com/dictionary/building-situational-applications-for-virtual-enterprises/10003

Ikram, M., & Hussain, F. K. (2019, 02). *Software as a Service (SaaS) Service Selection based on Measuring the Shortest Distance to the Consumer's Preferences.* Retrieved from https://www.researchgate.net/publication/331318038_Software_as_a_Service_SaaS_Service_Selection_based_on_Measuring_the_Shortest_Distance_to_the_Consumer's_Preferences

ISO - International Organization for Standardization. (2017). *ISO/IEC/IEEE 42010:2011 - Systems and software engineering — Architecture description.* Obtido de https://www.iso.org/obp/ui/#iso:std:iso-iec-ieee:42010:ed-1:v1:en

Kavis, M. (2014). *Architecting The Cloud - Design Decisions For Cloud Computing Service Models(SaaS, PaaS, AND IaaS).* John Wiley & Sons, Inc. Obtido de http://index-of.co.uk/Cloud-Computing-Books/Architecting%20the%20Cloud%20-%20Design%20Decisions%20for%20Cloud%20Computing%20Service%20Models.pdf

Kavis, M. J. (2014). *Architecting the Cloud - Design Decisions for Cloud Computing Service Models (SaaS, PaaS and IaaS).* Obtido de http://index-of.co.uk/Cloud-Computing-

Books/Architecting%20the%20Cloud%20-%20Design%20Decisions%20for%20Cloud%20Computing%20Service%20Models.pdf

Kero, J. J. (2016). Knowledge Management Practices: Creating Effective and Efficient Processes in Globally Distributed Teams. *University of Oregon*. Obtido de Core: https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/22342/Kero%20Fall%202016%20FINAL.pdf?isAllowed=y&sequence=1

Kulkarni, G., Gambhir, J., & Palwe, R. (2012). *Cloud Computing-Software as Service.* Obtido de https://www.semanticscholar.org/paper/Cloud-Computing-Software-as-Service-Kulkarni-Gambhir/708e0229b299ca71881671203fa1a3c2a22432e5?p2df

Labarre, O. (2020). *Enterprise Resource Planning (ERP).* Obtido de Investopedia: https://www.investopedia.com/terms/e/erp.asp

Laudon, K. C., & Laudon, J. P. (2014). *Management Information Systems - Managing the Digital Firm.* Pearson. Obtido de http://dinus.ac.id/repository/docs/ajar/Kenneth_C.Laudon,Jane_P_.Laudon_-_Management_Information_Sysrem_13th_Edition_.pdf

Liebmann, L. (2014). Which Applications Fit for Cloud Migration — and Which Don't. *BizTech*. Obtido de https://biztechmagazine.com/article/2014/05/which-applications-fit-cloud-migration-and-which-dont

Mell, P., & Grance, T. (2011). *The NIST Definition of Cloud Computing.* Obtido de National Institute of Standards and Technology: http://faculty.winthrop.edu/domanm/csci411/Handouts/NIST.pdf

Merriam Webster. (s.d.). *Information Technology* . Obtido de https://www.merriam-webster.com/dictionary/information%20technology

O'Brien, J. A., & Marakas, G. M. (2011). *Management Information Systems.*

Orban, S. (2016). 6 Strategies for Migrating Applications to the Cloud. *AWS Enterprise Collection*. Obtido de https://medium.com/aws-enterprise-collection/6-strategies-for-migrating-applications-to-the-cloud-eb4e85c412b4

Pahl, C., & Xiong, H. (09 de 2013). *A Comparison of On-Premise to Cloud Migration Approaches.* Obtido de https://www.researchgate.net/publication/286437766_A_Comparison_of_On-Premise_to_Cloud_Migration_Approaches

Pearlson, K. E., & Saunders, C. S. (2010). *Managing and Using Information Systems - A Strategic Approach.*

Power, D. J. (2008). Understanding Data-Driven Decision Support Systems. *University of Northern Iowa*. Obtido de https://www.researchgate.net/publication/220630419_Understanding_Data-Driven_Decision_Support_Systems

Priti. (2019). What is SaaS all about? Software as a service (SaaS). Obtido de http://www.datacenterprofessionals.net/profiles/blogs/what-is-saas-all-about-software-as-a-service-saas

Saleem, S. (2019). Cloud Migration Benefits & Strategies for Online Businesses in 2019. *Cloudways*. Obtido de https://www.cloudways.com/blog/cloud-migration-benefits/

Saratchandran, V. (2018). Cloud Service Models Saas, IaaS, Paas – Choose the Right One for Your Business. *Fingent*. Obtido de https://www.fingent.com/blog/cloud-service-models-saas-iaas-paas-choose-the-right-one-for-your-business/

Satyanarayana, S. (2011). Cloud Computing : SaaS. *GESJ: Computer Science and Telecommunications*. Obtido de https://www.researchgate.net/publication/236901021_CLOUD_COMPUTING_SAAS

Shadow-Soft Team. (2017). Cloud Migration Models: How to Pick the Right Strategy. *Shadow-Soft*. Obtido de https://shadow-soft.com/cloud-migration-models/#:~:text=The%20four%20types%20of%20cloud,%2C%20application%20refactoring%2C%20and%20replatforming.

Shah, K. (2019). *Cloud Computing Deployment And Service Models*. Obtido de Rishabh Software: https://www.rishabhsoft.com/blog/basics-of-cloud-computing-deployment-and-service-models

Sosinsky, B. (2011). *Cloud Computing Bible.* Wiley Publishing, Inc. Obtido de https://books.google.pt/books?hl=en&lr=&id=aY4KiI7kbIcC&oi=fnd&pg=PR13&dq=cloud+computing&ots=JEd180X3SR&sig=LY8s5sG1HVABU5DDt6e3lcB2Eow&redir_esc=y#v=onepage&q&f=false

Sowa, J., & Zachman, J. (1992). Extending and formalizing the framework for information systems architecture. *IBM Systems Journal*. Obtido de https://www.researchgate.net/publication/224102187_Extending_and_formalising_the_framework_for_information_system_architecture

Tang, C. (2015). Selecting a trusted cloud service provider for your SaaS program. Em *Computers & Security.* Obtido de https://www.sciencedirect.com/science/article/pii/S0167404815000139

Techopedia. (s.d.). *Client/Server Architecture*. Obtido de Techopedia: https://www.techopedia.com/definition/438/clientserver-architecture

Tsai, W., Bai, X., & Huang, Y. (2014, 01). *Software-as-a-service (SaaS): perspectives and challenges.* Retrieved from Springer: https://link.springer.com/article/10.1007/s11432-013-5050-z

Vaishnavi, V., Kuechler, W., & Petter, S. (2019). Design Science Research in Information Systems. *Association for Information Systems*.

Valverde, R. (2013). Systems Architecture. Obtido de https://www.academia.edu/26756166/Systems_Architecture

Varia, J. (2010). Migrating your Existing Applications to the AWS Cloud. *Amazon Web Services*. Obtido de https://d1.awsstatic.com/whitepapers/cloud-migration-main.7644e5a95fde37ef9cb53a508096c6b3a83fae4c.pdf

Vasconcelos, A., Silva, M. M., Fernandes, A., & Tribolet, J. (2004). *An Information System Architectural Framework for Enterprise Application Integration.* Obtido de Instituto de Engenharia de Sistemas e Computadores, Investigação e Desenvolvimento: https://www.inesc-id.pt/pt/indicadores/Ficheiros/925.pdf

Vasconcelos, A., Sousa, P., & Tribolet, J. (2003). Information System Architectures. *CEO — Centro de Engenharia Organizacional*.

Venable, J., Pries-Heje, J., & Baskerville, R. (2016). FEDS: a Framework for Evaluation in Design Science Research. *European Journal of Information Systems*.

Weller, J. (2017). Checklists and Tools for Software Migration Planning. *Smartsheet*. Obtido de https://www.smartsheet.com/all-about-software-migration-planning

Worthington, J. (2018). 10 Best Practices for Cloud Migration. *eG Innovations*. Obtido de https://www.eginnovations.com/blog/best-practices-cloud-migration/

Zhang, Q., Cheng, L., & Boutaba, R. (2010). Cloud computing: state-of-the-art and research challenges. *The Brazilian Computer Society*. Obtido de https://link.springer.com/content/pdf/10.1007/s13174-010-0007-6.pdf

Zissis, D., & Lekkas, D. (2010). Addressing Cloud Computing Security Issues. *Elsevier*. Obtido de https://www.sciencedirect.com/science/article/pii/S0167739X10002554

ANNEXES

A. CHECKLISTS

A.1. Business Assessment Stage

Assess business and technical Feasibility	
☐	Estimate the relevance of the application(s) to the business
☐	Gauge the tolerance in case of setbacks or failure
☐	Ascertain if the current key functionalities can be assured in cloud computing
☐	Determine if the preferred technology fulfils the business specifications
☐	Establish the requirements and prioritize the migration
☐	Validate if there are any legal requirements
☐	Determine the potential implications to the system
☐	Assess the viability of migrating the current solution to SaaS

Table 3 - Checklist to assess business and technical feasibility

Determine the security concerns	
☐	Gather the requirements in terms of data accessibility, redundancy, consistency and privacy
☐	Measure the risk tolerance for different categories of business data
☐	Grasp potential security risks and define the probability of it actually occur
☐	Delineate a backup plan to restore the data to the on-site system if needed
☐	Anticipate the rise of bureaucratic problems related to the use of shared computing resources
☐	Make clear that security is a shared responsibility between the customer and the cloud provider

Table 4 - Checklist to determine the security concerns

Conduct a cost-benefit analysis	
☐	Review the existing IT hardware and software elements for the application
☐	Compile all elements specifications, operations data, processes and system connections
☐	Compute the actual direct and indirect costs of running the application on-premises
☐	Assign an economic value to each expense
☐	Assess all potential cloud computing costs – check for online calculators that can aid in this step
☐	Establish the costs correlated with the migration of the application to cloud computing
☐	Evaluate the post migration costs – such as integration, tests and validation
☐	Determine the post migration benefits
☐	Assign an economic value to each benefit
☐	Compare costs before and post migration
☐	Compare the projected costs with the expected benefits
☐	Consider how long it will take for the benefits to repay the costs
☐	Make a recommendation which supports business objectives

Table 5 - Checklist to conduct a cost-benefit analysis

A.2.**Technical Assessment Stage**

Assess and define the system	
☐	Schedule a technical conversation with the costumer/business/enterprise
☐	Define the core data for segmentation
☐	Establish the datasets, views and perspectives to be migrated
☐	Determine who is allowed to master data
☐	Evaluate the actual layout, structure and integration of the application with other programs
☐	Ascertain if the current application design is suited for the cloud
☐	Discern if the data confidentiality and accuracy is sustained after the move to the cloud
☐	Recognize the potential efficiency gains from migrating to cloud computing
☐	Perform an assessment of the to-be systems

Table 6 - Checklist to assess and define the system

Identify the dependencies	
☐	Do a meticulous analysis of the rational concepts of the programs
☐	Inspect the interconnections between the programs and infrastructure
☐	Describe all programs and their dependencies on other software
☐	Characterize all particular segments of the programs
☐	Establish the programs' up and downwards connections to other software
☐	Build a dependency tree diagram to illustrate the distinct interdependencies of the components

Table 7 - Checklist to identify the dependencies

Evaluate the requirements	
☐	Analyse all the requirements to be sustained by the migrated program
☐	Investigate the programs design and layer partition
☐	Classify the possibility of each area to be a performance bottleneck
☐	Establish all elements that require development prior to the migration

Table 8 - Checklist to evaluate the requirements

A.3. Migration Design and Deployment Stage

Prepare the migration roadmap	
☐	Elaborate a thorough migration strategy
☐	Select the cloud deployment model
☐	Designate the required SaaS feature to be built into the solution
☐	Adjust and coordinate the application architecture
☐	Define the frameworks and specifications (settings and parameters)
☐	Establish the limitations of the project
☐	Delineate the migration timeline
☐	Decide on the migration project effort needs
☐	Initiate the communications process with the users
☐	Schedule recurrent check points status with the business users

Table 9 - Checklist to prepare the migration roadmap

Plan the data migration	
☐	Determine the preferred cloud storage option
☐	Establish a strategy for the data segmentation
☐	Decide on the effort needs for the data migration

Table 10 - Checklist to plan the data migration

Test before the migration	
☐	Test data migration
☐	Evaluate the performance in the cloud
☐	Verify security requirements
☐	Determine the cloud costs
☐	Understand the valuable modifications that need to be performed

Table 11 - Checklist to test before the migration

A.4.**Testing and Monitoring Stage**

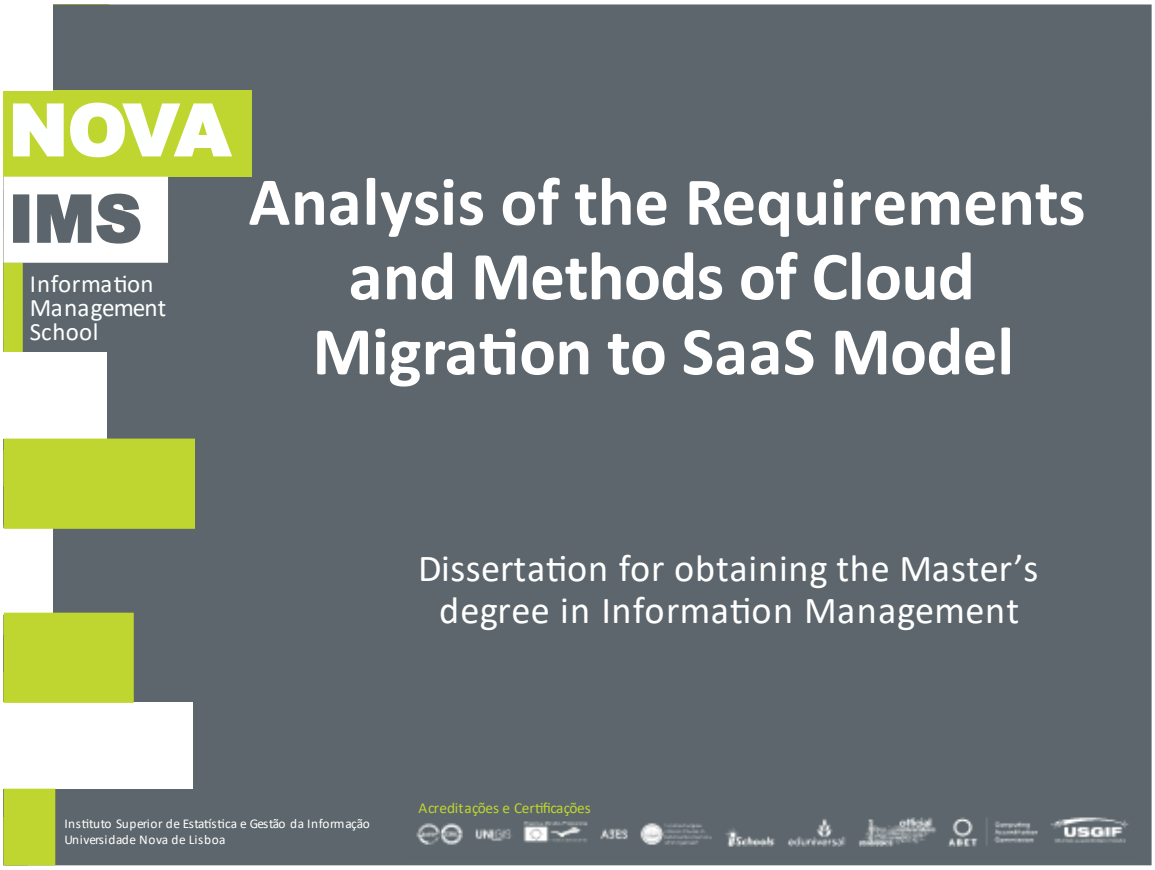
Test and validate the solution	
☐	Validate cloud service functions
☐	Verify applications end-to-end flow
☐	Check if the layout is presented as determined
☐	Test integration with other cloud and legacy applications
☐	Identify coordination issues in the cloud-based environment
☐	Validate user access and privacy
☐	Verify and validate data security
☐	Establish the monitoring requirements and configurations
☐	Execute load tests and analysis
☐	Evaluate the response times

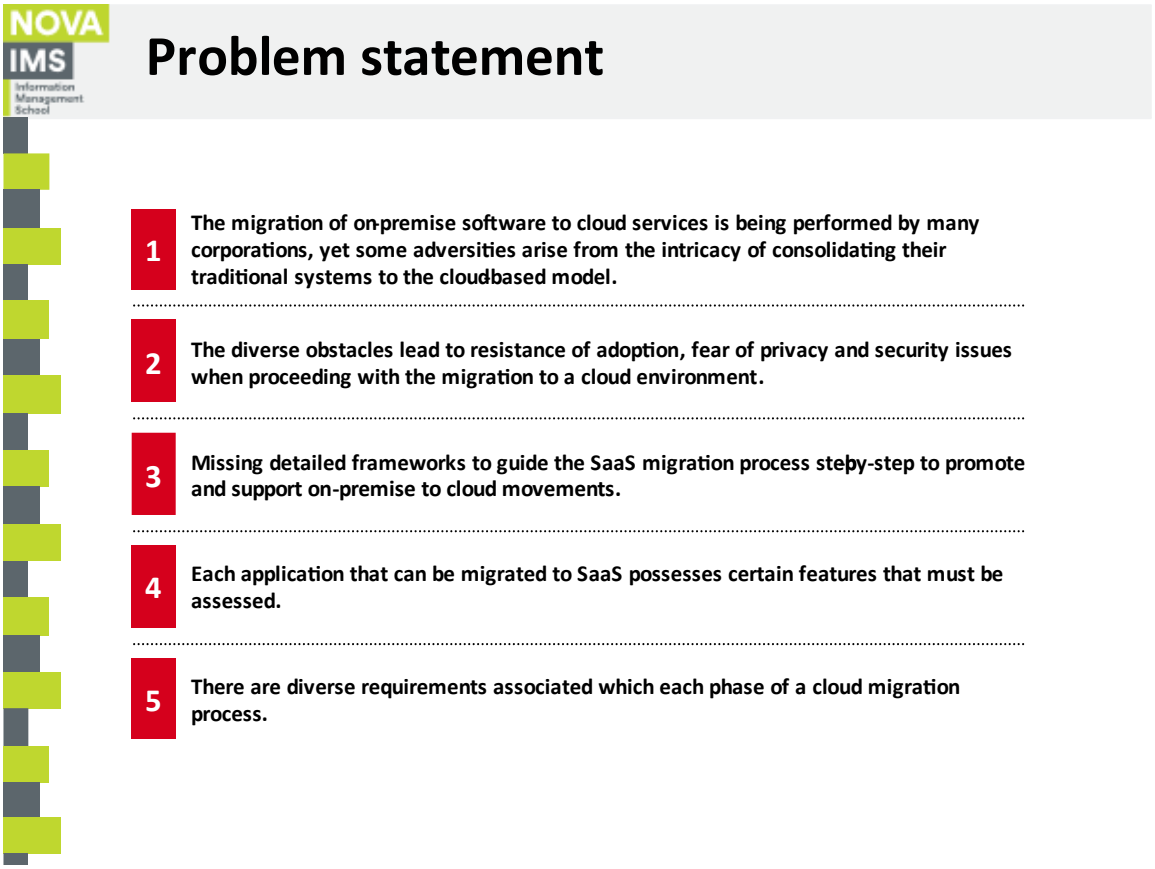
Table 12 - Checklist to test and validate the solution

Monitor and optimize the system	
☐	Monitor load and traffic patterns
☐	Implement scaled usage to improve performance
☐	Evaluate costs and adapt as required

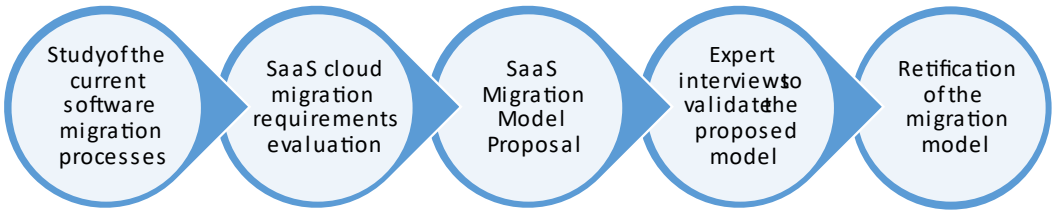
Table 13 - Checklist to monitor and optimize the system

B. PRESENTATION OF THE MIGRATION MODEL





Research Strategy



From the first phase, it emerged the inspiration to this project to grasp the current difficulties of software migration to SaaS and to seek the resolution of the question established as the major goal of this research project "What are the requirements and methods to be deliberated with moving to SaaS?." As so, it arises the obligation of performing a thorough literature review to better comprehend the SaaS model and the main migration requirements.

During the development of the migration model were proposed several recommendations to accomplish the purpose of this project: migrate applications from on-premise to SaaS environment.

In the Evaluation stage, the propositions will be corroborated and validated through interviews with specialists in the topic of cloud migration.

Lastly, the results of the expert interviews will be examined and interpreted, and adjustments will be made to the proposed model according to the experts' recommendations

Framework

01

Identification of scope

- Identify and evaluate each Information System role in business
- Identify the different types of Cloud Computing and its advantages for businesses
- Study the best practices for cloud migration and main existent methods for moving to SaaS
- Evaluate the context of each application to be migrated

02

Definition of requirements

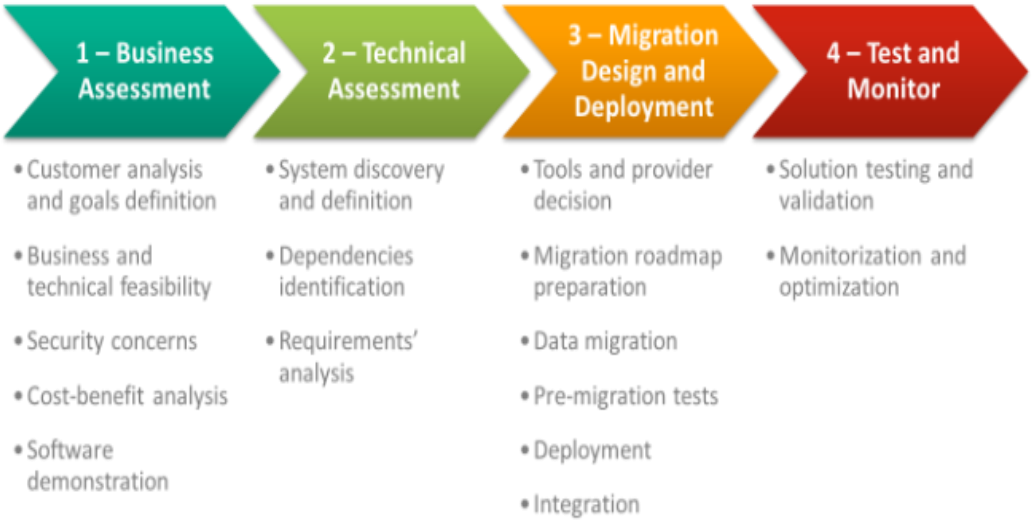
- Identify the main characteristics of SaaS cloud computing
- Describe the different requirements of a migration to SaaS
- Identify the key features of software that is more suitable be migrated

03

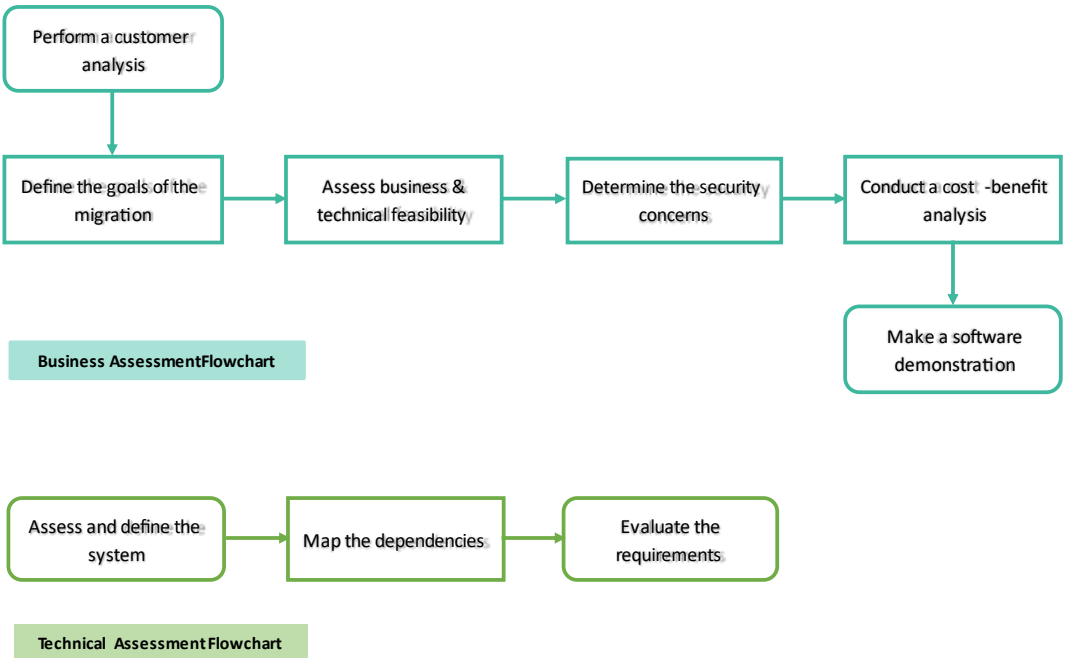
Project design & development

- Study of the current software migration processes to a SaaS based environment
- SaaS cloud migration requirements evaluation
- Proposal of a SaaS migration model

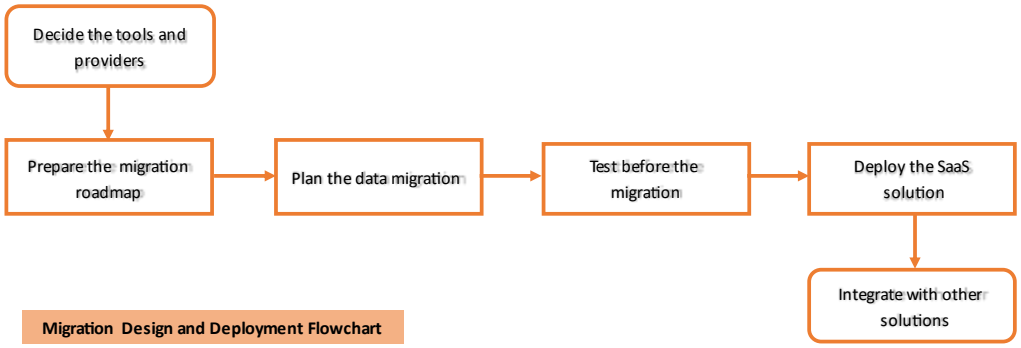
Proposed Migration Model



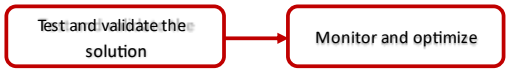
Migration Process - Phase 1 and 2



Migration Process - Phase 3 and 4



Migration Design and Deployment Flowchart



Test and Monitor Flowchart

Migration Process – Checklists

Stage 1 – Business Assessment checklists

Assess business and technical Feasibility
☐ Estimate the relevance of the application(s) to the business
☐ Gauge the tolerance in case of setbacks or failure
☐ Ascertain if the current key functionalities can be assured in cloud computing
☐ Determine if the preferred technology fulfils the business specifications
☐ Establish the requirements and prioritize the migration
☐ Validate if there are any legal requirements
☐ Determine the potential implications to the system
☐ Assess the viability of migrating the current solution to SaaS

Determine the security concerns
☐ Gather the requirements in terms of data accessibility, redundancy, consistency and privacy
☐ Measure the risk tolerance for different categories of business data
☐ Grasp potential security risks and define the probability of it actually occur
☐ Delineate a backup plan to restore the data to the on-site system if needed
☐ Anticipate the rise of bureaucratic problems related to the use of shared computing resources
☐ Make clear that security is a shared responsibility between the customer and the cloud provider

Conduct a cost-benefit analysis
☐ Review the existing IT hardware and software elements for the application
☐ Compile all elements specifications, operations data, processes and system connections
☐ Compute the actual direct and indirect costs of running the application on-premises
☐ Assign an economic value to each expense
☐ Assess all potential cloud computing costs – check for online calculators that can aid in this step
☐ Establish the costs correlated with the migration of the application to cloud computing
☐ Evaluate the post migration costs – such as integration, tests and validation
☐ Determine the post migration benefits
☐ Assign an economic value to each benefit
☐ Compare costs before and post migration
☐ Compare the projected costs with the expected benefits
☐ Consider how long it will take for the benefits to repay the costs
☐ Make a recommendation which supports business objectives

Migration Process – Checklists

Stage 2 – Technical Assessment checklists

Assess and define the system
☐ Schedule a technical conversation with the costumer/business/enterprise
☐ Define the core data for segmentation
☐ Establish the datasets, views and perspectives to be migrated
☐ Determine who is allowed to master data
☐ Evaluate the actual layout, structure and integration of the application with other programs
☐ Ascertain if the current application design is suited for the cloud
☐ Discern if the data confidentiality and accuracy is sustained after the move to the cloud
☐ Recognize the potential efficiency gains from migrating to cloud computing
☐ Understand how the program will be operated and supported after the migration

Identify the dependencies
☐ Do a meticulous analysis of the rational concepts of the programs
☐ Inspect the interconnections between the programs and infrastructure
☐ Describe all programs and their dependencies on other software
☐ Characterize all particular segments of the programs
☐ Establish the programs' up and downwards connections to other software
☐ Build a dependency tree diagram to illustrate the distinct interdependencies of the components

Evaluate the requirements
☐ Analyse all the requirements to be sustained by the migrated program
☐ Investigate the programs design and layer partition
☐ Classify the possibility of each area to be a performance bottleneck
☐ Establish all elements that require development prior to the migration

Migration Process – Checklists

Stage 3 – Migration Design and Deployment

Prepare the migration roadmap
☐ Elaborate a thorough migration strategy
☐ Select the cloud deployment model
☐ Designate the required SaaS feature to be built into the solution
☐ Adjust and coordinate the application architecture
☐ Define the frameworks and specifications (settings and parameters)
☐ Establish the limitations of the project
☐ Delineate the migration timeline
☐ Decide on the migration project effort needs
☐ Initiate the communications process with the users

Plan the data migration
☐ Determine the preferred cloud storage option
☐ Establish a strategy for the data segmentation
☐ Decide on the effort needs for the data migration

Test before the migration
☐ Test data migration
☐ Evaluate the performance in the cloud
☐ Verify security requirements
☐ Determine the cloud costs
☐ Understand the valuable modifications that need to be performed

Migration Process – Checklists

Stage 4 – Testing and Monitoring

Test and validate the solution
☐ Validate cloud service functions
☐ Verify applications end-to-end flow
☐ Check if the layout is presented as determined
☐ Test integration with other cloud and legacy applications
☐ Identify coordination issues in the cloud-based environment
☐ Validate user access and privacy
☐ Verify and validate data security
☐ Establish the monitoring requirements and configurations
☐ Execute load tests and analysis
☐ Evaluate the response times

Monitor and optimize the system
☐ Monitor load and traffic patterns
☐ Implement scaled usage to improve performance
☐ Evaluate costs and adapt as required

Table of SaaS tools by type

Type of Application	Program	Company	Description
Software development, testing and quality assurance	Jira	Atlassian Corporation	Software Development
	Amazon Web Services	Amazon	Computing, Storage, Networking, Deployment
	Qtest	Tricentis	Test, Visualization
	Test Case Management	Qmetry	Test Cases Creation, Test
	PractiTest	PractiTest	Test, QA, Communication
Collaboration	Jira	Atlassian Corporation	Collaboration
	Confluence	Atlassian Corporation	Collaboration, Project Management
	Trello	Atlassian Corporation	Project Management
	Freshdesk	Freshworks	Customer Service
	Fresh Sales	Freshworks	Sales, CRM
	Fresh Team	Freshworks	HR
	Meet, Gmail	Google	Collaboration
	GoToMeeting	GoToMeeting	Teamwork
	CRM	HubSpot	CRM
	Sales Hub	HubSpot	Collaboration
	Services Hub	HubSpot	Customer Service
	MailChimp	MailChimp	Email Marketing
	Salesforce	Salesforce	Sales
	ServiceNow	ServiceNow	Collaboration
	Shopify	Shopify	Ecommerce
	Slack	Slack	Collaboration
	Workday	Workday	HR
	Zoom	Zoom	Collaboration
	ClickUp	ClickUp	Document Creation, Project Management, Time Tracking, Goal Tracking

Table of SaaS tools by type

Type of Application	Program	Company	Description
Personal productivity	Acrobat	Adobe	Content Management
	Dropbox Paper	Dropbox	Collaboration
	Google Office Suite	Google	Analytics, Document Creation, Collaboration
	CMS Hub	HubSpot	Content Management
	LastPass	LastPass	Password Management
	Microsoft Office Suite	Microsoft	Document Creation, Collaboration
	LibreOffice Productivity Suite	LibreOffice	Analytics, Document Creation
	Hancom Office	Hancom	Document Creation
	Workflow Automation	Zapier	Task Management
Big data, analytics and other computing-intensive	Adobe Analytics	Adobe	Marketing, Analytics
	Hootsuite	Hootsuite	Social Media
	Marketing Hub	HubSpot	Marketing, Analytics
	SurveyMonkey	SurveyMonkey	Analytics, Visualization, Online Survey
	Google Analytics	Google	BI, Analytics
	Amazon Web Services	Amazon	Analytics
	Crazy Egg	Crazy Egg	Marketing, Analytics
	Intercom	Intercom	Marketing, Analytics
	Mixpanel	Mixpanel	Marketing, Analytics
	Einstein Analytics	Salesforce	Analytics, Visualization
	ProfitWell Metrics	ProfitWell	Analytics
	Baremetrics	Baremetrics	Analytics, Forecasting
	Klips	Klipfolio	Visualization
	PowerMetrics	Klipfolio	Analytics
	TapClicks	TapClicks	Analytics, Visualization
	Adaptative Planning	Workday	Analytics, Visualization, Forecasting
	Cyfe	Traject	Visualization

Table of SaaS tools by type

Type of Application	Program	Company	Description
Disaster recovery, business continuity and records retention	Cloud Security	Proofpoint	Cybersecurity
	Sophos Cloud Optix	Sophos	Cybersecurity
	Acronis Cyber Backup	Acronis	Cybersecurity
	Acronis Cyber Disaster Recovery	Acronis	Disaster Recovery
	Acronis Disk Director	Acronis	Records Retention
	x360Recover	Axcient	Business Continuity, Disaster Recovery
	x360Cloud	Axcient	Cybersecurity
	Carbonite Recover	Carbonite	Disaster Recovery
	Carbonite Availability	Carbonite	Business Continuity
	Business Continuity as a Service	Databarracks	Business Continuity
	Disaster Recovery as a Service	Databarracks	Disaster Recovery
	Backup as a Service	Databarracks	Cybersecurity
	Disaster Recovery as a Service	Evolve IP	Disaster Recovery
	Azure Site Recovery	Microsoft	Disaster Recovery
	StorageCraft Cloud Services	StorageCraft	Disaster Recovery
	Quorum onQ	Quorum	Cybersecurity, Disaster Recovery

Interview Questions

1) Do you believe that the proposed cloud migration model and table of different SaaS applications by category is useful?

2) Do you agree with the approach of the proposed migration process?

3) Do you have any recommendation or suggestions for further improvements of the proposed framework?

Thank you for your time and expertise!

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C. INTERVIEWS

Interview 1

Name: Bruno Marques

Company: AXA Group Operations

Role: SAP BI Consultant

1. Do you believe that the proposed cloud migration model and table of different SaaS applications by category is useful?

"Yes, for sure. This is the typical workflow and the gate approach that large companies and large enterprises follow. The typical benchmarking when we speak about migration, whether it is to cloud or to any other applications, there is always the need to follow a clear structured migration approach, which I fully agree with your proposal, and it is well explained and well documented. One additional remark and advice that I could provide you, based of course on my experience, is that when we are proposing a migration plan to the business or to the stakeholders, and due to the technologies that we have today and the facility that cloud technologies and apps deliver today, you can also take into account that the short to market we used to know from historical waterfall projects and migrations is somehow obsolete. So, what I want to say in a more objective way is that today, thanks to the way the cloud is built, the way the architecture is currently being provided by the biggest providers, Amazon, Google, SAP, etc., you can do a lot more than in the past, which means the typical scenario where you start with the business assessment and you need to have the validation of the requirements in order to anticipate and to understand if there will be side effects once you do your migration. Thanks to the technology and to the landscape, this is something that in SAP and in the organization where I'm right now we can see already that, where you can somehow close the gaps and shorten the time to deploy your new application because the business can be part of the validation process much earlier than it was happening in the past. This is something I think it's important to add to the overall presentation as the question is very relevant, because the today business stakeholders they have already a very good understanding what are the phases of a typical project of migration. On the field you are setting up your calls to the business stakeholders and you are really engaging the kick-off meetings to start the project, you need to understand that from the other side of the table, the people are always somehow reluctant on the defensive side towards the budget constraints, towards the timelines and towards the added value that the migration is going to represent for them. And that is why I give this example, because I have already a experience on that, which is in a real business scenario, if we present the migration approach by engaging some of the users to quickly make the tests and to validate and to understand that we are not speaking about one year of migration project, or six months, but it rather a work that normally takes weeks to validate, they can do it literally in days, it will be a complete breeze for the business to validate and to participate in the project, because today when you speak about migrating to cloud, you need to think about virtualization, which is you don't need any more to take all that effort to migrate the physical databases, all the database systems and all the software, today you can clone several virtual tables and databases and virtually access the data. The business can simply connect, plug and play, and perform their business validations without the huge pain points that we use to have in the past, because we didn't have the technology that we have today. The bottom

line, to be very upfront and transparent with you, is that no matter how beautiful presentations we do, either in ppts or even in videos, the business will always be in the defensive side if they don't see materialized results. If they don't see a clear plan where they say in a few days I have already data and I have already a front-end to check my values and to compare the new system or my new app against the old system, the old legacy system, and I already immediately see that I have an added value, because before, on my old legacy system I used to take two days to finish, por example, a finance or an accounting closure procedure, and with the new app, thanks to your migration, I can already see that I can shorten these business processes to a couple of hours, so those are the key elements and the key examples that any project team, when is engaging a migration project should identify on the project definition, so that you don't face some feedback from stakeholders that are very sceptic, do not agree with the timelines and most of them, the conversations from the project teams are always very technical and what they really want is the added value straight away. Your bullet point on the software demonstration is also a very good point, that is a really big difference compared to the past I would say. In order to arrive with a software demonstration, it would take months to really move the systems, and have the databases and the software up and running, and this could always cause a lot of frustrations on the business users. And also, another tip that I think you could also add to your presentation is in the real scenarios, when we speak about real enterprises, that are in business, when they signed-off a project to a new migration or to a new upgrade, let's not forget that the changes and the business requirements, that we of course, we follow the best-practices and I see that your presentation sits in a very good framework, but let's not forget one thing: business requirements and the initial goals definition may change during the project lifecycle. So that's why the delivery of the projects today, especially when we speak on cloud, when the users are always thinking of switching in and switching off the services and it's basically to off load all the technical parts and to focus on the business and to really make the business running, rather than taking care of system administration and talk about database patches, etc., so they don't care about that. They go to the cloud and they simply have the infrastructure running, but let's not forget that when we are doing a project like that, we must also accommodate the last minute requests which means that, what we signed-off a few months ago there could be a chance that a business stakeholder comes in and says 'well, we need to also add to the testing phase a new requirement that was not there three months ago, but right-now, due to a new roll-in, we have now these new JAVA applications that run on the tomcat server, and we also need to have these on our Fiori app', just an example. So we need to be very clear that this is not a static document that stays in the shelf and it only opens up when we are saying that the go live is going to be in six months, it needs to be a complete re-work and, I would say, a recurrent check point status with the business users, so that the existing business requirements that they have identified during the GAP analysis, the detailed design, is also true after when they are ready for the go live. Because sometimes, let's say, the business stakeholders they are not 100% clear if their end users or their business entities will arrive with something new and I think the solution must be agile, the project delivery must be agile and must accommodate new requirements in case they arrive. We need to be scalable, and we need to be flexible, we need to be agile, and we need to really fully understand the business needs, not just from a timestamp point of view, but from an ongoing support plan because it's the reality, it's something that the teams and people working in software, in migrations and upgrades, etc., they must understand that the software is a living object and a living object it's always subject to changes."

2. Do you agree with the approach of the proposed migration process?

“Yes I agree, I think it’s a good approach. The migration process is very well outlined in terms of the steps, I would that the full perimeter of the actions that are required are clearly stated. Then, as an additional help or tip that I could provide from my side is to somehow, when those decisions and those presentations are done is also helpful to cascade the message to the stakeholders that the proposed migration is nothing static, is something that evolves, grows and accommodates their ongoing requirements, so that they don’t get the wrong idea that if they agree with something then your migration to the cloud, to SaaS, could then provide an error in case they arrive with something else that the business is demanding. So I think it’s important when we are speaking about cloud to also convey the message that it’s an added value because, not just from a cost efficiency point of view, but also from an app framework. Once they are in the cloud, they can enjoy and leverage the usage of several different apps, which will help them to be more efficient and it’s a huge community that developers provide a lot more apps to the market and to the business where they can enjoy the full efficiency. But in terms of your question, I agree with the migration model, the proposal.”

3. Do you have any recommendation or suggestions for further improvements of the proposed framework?

“Yes, so the recommendations and suggestions for improvement is something that I have already outlined a few of them, on the top of it you could always emphasize that also migration to cloud is something that it’s aligned also with most of the biggest companies are running already on the cloud and they have SAC applications and Software-as-a-Service, so I think it’s something that the business needs to understand that there is a good, very good, added-value to moving to the cloud. But of course, in terms of recommendations I would say it all more related with the engagement and the way that the project team works with the business, so that is clear. I don’t know if in the scope of your migration proposal you also delivered to the customers or to the business some insights with regards to artificial intelligence, also some industrialization of processes and some kind of data mining, because when you go to the cloud you also going to leverage the usage of all this new technologies. So the business can automate lots of manual and human tasks that today are simply under the scope of some key users, where today the technology can also help to automatize and to speed up those checks, let’s say data consistency, data validation, quality assurance checks, those can be all automated thanks to the robotization that are embedded in the software of the application. Today the augmentation and the way the artificial intelligence and machine learning is embedded in the applications is also one of the tips and recommendations to migrate to cloud, because before we used to work in a scenario where there was always these landscape of having a database, on top of the database having your application layer, and on the top of your application layer you have your front-end, and each time the user pushes a button the data needs to flow between all these layers and then to come back, with a static report or a static data set. Today the roadmap and the system landscapes, in the cloud, they are clearly with machine learning and artificial intelligence algorithms, where the user can simply ask a question to the system and the system will outline already a report with the quarter Q1 vs last year report and comparing the figures for a finance department. This is a change, a big game changer in terms of software development, the usage of applications and the architectures towards the end user usage, because today the users, for top companies, are already using those tools and they are taking the advantage of that to save time for themselves to create a new line of business for example, and to

grow the company to other markets, because they are using the technology to do their manual work, so I think that can be also a recommendation to your overall project planning and migration, because I think it's one of the selling points that it's in today's market. It's a huge cost-benefit improvement, and also from the maintenance point of view it's a big change, and also keeping your roadmap up to date using only on-premises applications is very costly, not just from a finance point of view, but also from a human standpoint it requires a lot of resources, resource allocation and project planning. And we all know that today the businesses are rushing and have very tight deadlines and they don't really want to read many mails regarding patching, upgrading, new versions, etc., so it's just another example on how the cloud is an advantage. Thanks to the SaaS approach and to the cloud applications the switch from on-premise to cloud and SaaS it's a consumption based approach, the pay-per-use and the system administrator that is running the cloud infrastructure will outline every month to the manager, how many users are actually using the system and if they can simply switch on and switch off some apps, which the company is actually paying but nobody is using, so this is just an example, how easily and how efficiently the cloud can enable the decision maker to really have a more cost efficient approach towards the end user community. Not just to speak about the multi-platform advantages, because the user can be with his mobile phone submitting some inquiries, can be validating some POs in the mobile, if he's travelling he can use his tablet for any reason, if he is in an outdoor meeting, and it's because everything is in the cloud it allows these 360 degrees view of the business, and systems are always up. If it's on-premise, the VPN and so on, the connection, the limitations are a lot higher than a completely cloud solution."

Interview 2

Name: Sara Silva

Company: Microsoft Portugal

Role: BI Analyst

1. Do you believe that the proposed cloud migration model and table of different SaaS applications by category is useful?

"Yes, I think is useful and practical to have a guide in this type of migrations. Now, more than ever, companies are trying to move to the digital world and trying to adapt to the new reality that we are moving very fast to, and sometimes they may lack the technical expertise to do such moves, which are very complex. So yes, I think is useful to have this kind of framework or model that can present the stages and the steps that they can take in an orderly manner, and also having checklists to know which steps and which actions they need to take into account when considering such moves. Also, the list of providers that you showed there, I think is very useful too, as there are so many options it can be hard to choose one for the right requirements that the company might have."

2. Do you agree with the approach of the proposed migration process?

“Yes, I agree. I think it’s a very complete approach. It touches in, what I believe to be, all the essential points when doing a migration, all the process before, during the migration itself and after the migration. So yes, I agree.”

3. Do you have any recommendation or suggestions for further improvements of the proposed framework?

“Well I think the model is very complete as it is, if the customer knows already that he wants to move to a SaaS solution and that’s the path that he wants to follow. As a suggestion, I would to like to see, as an extra phase, something that could help the customer choose which cloud service model makes more sense to them.”

Interview 3

Name: Diogo da Costa Alves

Company: KPMG Canada

Role: Manager

1. Do you believe that the proposed cloud migration model and table of different SaaS applications by category is useful?

“Yes, I mean overall I’m aligned with the four phases. The only thing that I would suggest you to add here would be the key deliverables in each one of the phases, on the business assessment side it will be probably the scope of the migration. So what exactly is going to be the impact on the systems to actually be migrated. Same thing on the technical assessment that you are going to deep dive on the system and try to understand what the data lineage of each of the systems is and how they integrate currently. So I guess here on the technical assessment, one thing that you can mention is that you will have an as-is system assessment but then you will also have the to-be assessment, what is exactly is going the system to look like in the future, and how do the systems integrate after the migration. And so, I think that’s one thing that might been missing here, at least on the high-level phase assessment. So I would definitely add the to-be systems, how they integrate and what is the impact on current processes. I believe on the migration strategies that is important to have, not only the impact system wise, but also the impact on people and processes, and that way you can have the full view of exactly what is changing in the organization and how the organization is going to be impacted and how you need to adjust for that migration. So taking the lead on that I would add a phase number 5, which would be Change Management, Training and User Adoption. It’s important on the roadmap to consider not only the migration and implementation plan, but also the rollout to the users and ensure that they have enough training and time to adopt and adjust to the processes and different technology for their current day-to-day life. Apart from that, I mean the migration design and the deployment it's pretty much it, there isn't much to mention there, so implementation with possibly some sprints and prioritization on the roadmap that you have define after the definition of technical and business

requirements. And then test, monitor and implement controls to ensure that exceptions are being monitored and everything is working correctly."

2. Do you agree with the approach of the proposed migration process?

"Yes, there only is the 2 or 3 points that I mentioned that I would add."

3. Do you have any recommendation or suggestions for further improvements of the proposed framework?

"So, I would probably just try to add on the Technical Assessment flowchart that activity that you mentioned before, related with the prioritization of systems. Because I would assume this is kind of the deliverable after the Business and Technical Assessment, so probably just add that and apart of that's good. I think the phases make sense and they are structed, so yes apart from the 3 or 4 points I mentioned before I think you are on the good track."