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COMPARISON OF CLOUD MODELS FOR SME BUSINESS



Degree Programme in International Business

2020


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Degree Programme in International Business
April 2020
Number of pages: 35

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The purpose of the study was to provide a comparison for small and medium-sized enterprises (SME) between following models; On-Premises, infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS). Objective was to discover what are advantages and disadvantages each model brings for SME. Approach used in this study was business-driven in comparison to more traditionally used technical approach.

Theoretical part of this study was divided into two parts. First part consisted from main concepts of this study followed by a comparison that was made between different software models.

CONTENTS

# 1 INTRODUCTION

With rapid digitalization importance of hardware and software is becoming more important to maintain and help main functions of company's business. Large enterprise companies are getting competitive advantage with bigger budget and better capabilities to embrace digitalization. Fast rapid adaptation is important in order to keep up with constantly evolving market trends, for SME it is crucial to be able to select most suitable hardware and software solutions to ensure competitiveness of their business.

This study compares four different software models with each other to show what are the main advantages and disadvantages of each software model. Used software models are: On-Premises, IaaS, PaaS, and SaaS. Each software model will be explained individually in theoretical part followed by a SWOT analysis that will cover these four main areas: Strengths, weaknesses, opportunities, and threats.

At the end of this study there will be overview of findings from the SWOT analysis. Purpose of these findings is to serve as a guideline for SME that want to know more about cloud-based service solution and what advantages and disadvantages they bring.

Key concepts

*IaaS* = Infrastructure as a service

*On-Premises* = Software that is installed locally on the premises of a company

*PaaS* = Platform as a service

*SaaS* = Software as a service

*SME* = Small and medium-sized enterprises

*User company* = Company that is using someone's services or products

## 2 PURPOSE OF THE STUDY AND CONCEPTUAL FRAMEWORK

### 2.1 Purpose and objective of the thesis

The purpose of this thesis was to research business benefits for small and medium-sized enterprises (SME) between following software models; on-premises, infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS). Main purpose was to discover which advantages and disadvantages these models bring. In this thesis objective was to take more business-driven approach compared to more traditional technical approach.

The reason for this thesis was to provide comprehensive guide for SME to gain better understanding which software model is most suitable and will suit their business needs the best. Theoretical background of this thesis consists from findings and comparison of different software models.

Objective of this thesis was to provide more knowledge to SME companies about different models to better understand what the benefits and disadvantages of each model are.

### 2.2 Research questions

Which software model is best suitable for SME and what are the advantages and disadvantages that this software model brings compared to other models?

What is the key factor SME should focus on when selecting new cloud services?
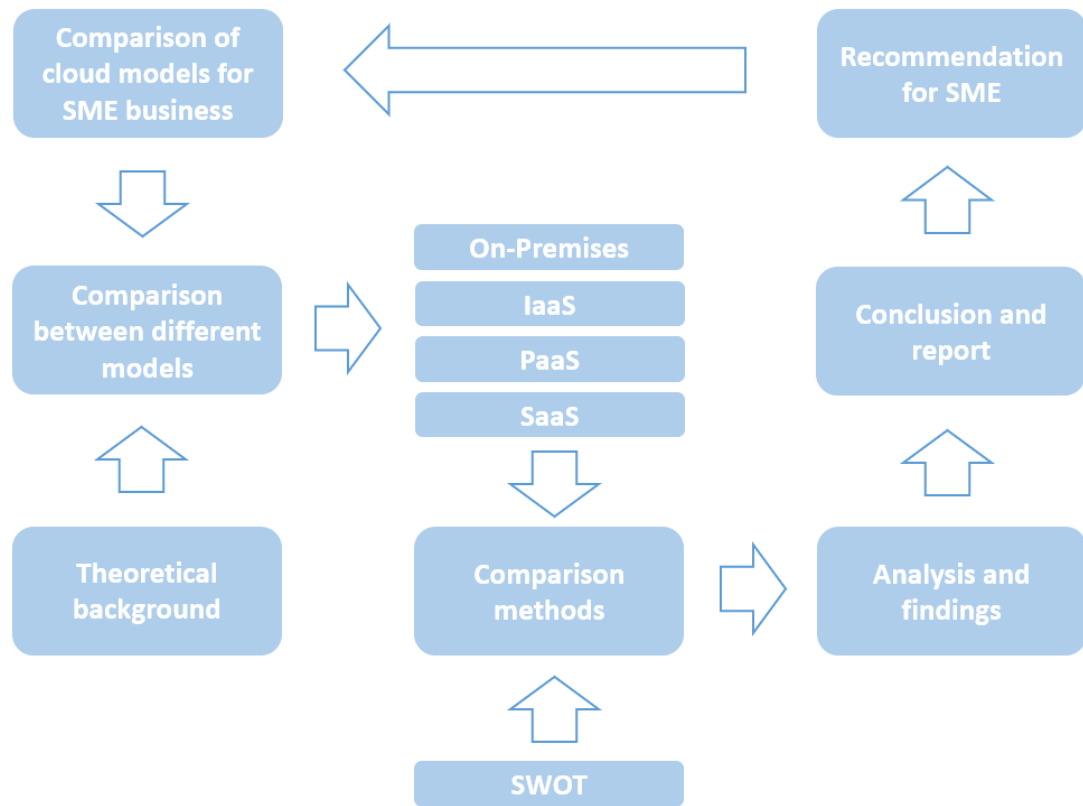
## 2.3 Conceptual framework



Figure 1. Conceptual Framework: Comparison of cloud models for SME business

This conceptual framework (Figure 1) illustrates process that starts from an upper left corner continuing its flow towards the direction that will be pointed out by an arrow. Workflow begins from main objective of this thesis that is to compare different cloud models for SME business. Each box describes next step in the workflow.

Core of this framework is comparison that will be made between four models that are used in this research. Comparison will be made with the help of a SWOT analysis; theoretical knowledge will be also used to provide comprehensive background for this comparison. After completion of this comparison its findings will be followed by a conclusion and report. Final stage of this workflow will be recommendations of selected models for SME focusing on business side upon emerging of a new data this process can be run with new available data.

## 3 MAIN CONCEPTS

### 3.1 Definition of SME

There is no universal definition available to determine which companies fall into small and medium sized enterprises category due to demographic differences around the world, good example is difference between western and developing countries. What may be regarded as a big business in less developing countries can be medium-size or even a small business in western countries. Due to demographic differences in definition, in this research SME will be defined based on European Union definition. (Lind 2012, 25)

European Union defines SME into three different categories:

1. *"Autonomous: if the enterprise is either completely independent or has one or more minority partnerships (each less than 25 %) with other enterprises."*

2. *"Partner: if holdings with other enterprises rise to at least 25 % but no more than 50 %, the relationship is deemed to be between partner enterprises."*

3. *"Linked enterprise: if holdings with other enterprises exceed the 50 % threshold, these are considered linked enterprises."*

Main reason behind categorization is to establish simple and transparent picture of each enterprises economic situation and to distinguish companies that do not fit characteristic of a SMEs. (User guide to the SME definition 2015, 7)

On top of categories there is an additional criteria's company must fit to be qualified as a SME by European Union standards. Company must employ under 250 employees and maximum amount of revenue one company can generate must be under 50 million EUR annual or alternatively balance sheet must be under 43 million EUR annual. (User guide to the SME definition 2015, 10)

## 3.2 Definition of cloud computing

Cloud also known as cloud computing or cloud services can be defined as a service where external vendor provides IT-functionalities on demand wherever and whenever required by a user company. Provided IT-functionalities may wary but do usually consist from these typical services: computing power, infrastructure, applications, and business processes. "The *cloud* itself is a set of hardware, networks, storage, services, and interfaces that enable the delivery of computing as a service." (Hurwitz, Bloor, Kaufman & Halper 2009, 8)

## 3.3 IT outsourcing

There are some similarities between IT outsourcing and cloud services, both are available through external vendor who provides needed services. Company can outsource IT capabilities to external provider who will manage administrative and other IT related tasks for the company such as infrastructure or application development. However, there are differences between more traditional IT outsourcing and cloud services. When company shows interest in acquiring cloud-based services, company approaches available third-party vendors who can offer those type of services, on top of cloud-based services user company will have to use providers hardware or software. Compared to cloud solution IT outsourcing provider is capable to use user company's in-house hardware and software if required. In this option it is possible to gain additional IT resources inhouse, with external workforce compared to cloud solution where user company has to use completely new system that comes externally from provider. (Dubash 2011)

Compared to more traditional IT outsourcing, cloud services have a shorter track record, adoption of cloud services can be time consuming and some companies prefer to run their IT themselves or outsource only a part of IT elsewhere. (Barker 2013)
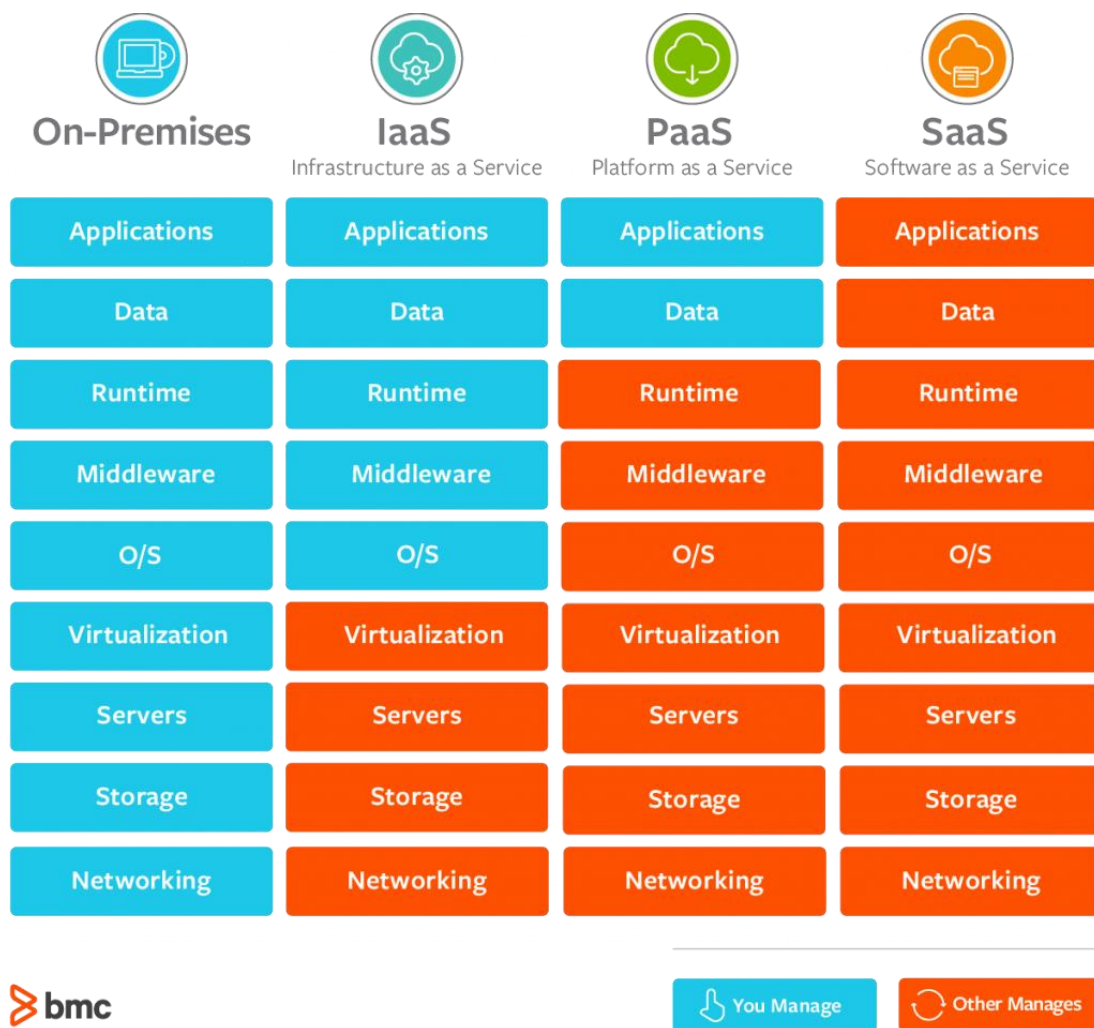
## 3.4 Cloud service models



Figure 2. Summary of key differences (Watts & Raza 2019)

Three of the most popular cloud service models are infrastructure as a service, platform as a service and software as a service. Each model adds new capabilities and functions on top of each other. SaaS model provides widest cloud solution from these three models. (Watts & Raza 2019)

3.5   Cloud deployment models

In a public cloud service is externally provided by a vendor, this cloud model is more commonly known to the public, one of the reasons for popularity of this service model is smaller liability to customers end where responsibility is only for installed software and applications on end-user system. (Rountree & Castrillo 2013, 25)

Private cloud is less known service model for the public, in this model administration and management is on users end and responsibility lies with him. Due to system that is managed internally, access is through VPN or local LAN & WAN. (Rountree & Castrillo 2013, 25)

Hybrid cloud combines public and private cloud together where they are operating separately and linked with each other. (Rountree & Castrillo 2013, 26)

# 4  COMPARISON OF MODELS

Each service model offers unique functionalities and features for its user, this is why it is important that user is able to understand advantages and also disadvantages each service model brings. Whether it is a cloud storage and wide range of different applications and functionalities, or a platform that offers infrastructure and customization, there is a cloud-based solution available to cover these previously mentioned needs. Migration to cloud is getting more popular, due to this it is important for companies to understand difference between these cloud models in order to adapt faster to changing environment. (Watts & Raza 2019)

## 4.1  On-Premises

Compared to other models On-Premises model requires considerably larger upfront investment from companies due to high hardware and software cost. Companies are responsible for their own data security and they have a full control over data in comparison with other models, in which access can be granted to a third-party. In order to maintain high level of security, it is important to have relevant knowledge and resources, this can take a considerable amount from a company's IT budget, if company neglects security with lacking expertise, this can cause a serious risk. Companies own hardware allows better control over upgrades and future new releases. To scale up companies have to invest into new hardware and knowledge that it brings with it; planning, researching, and deploying is often time consuming and relatively slow. In some cases, replacement of old hardware is needed, in order to be able to grow and offer more complex and robust solutions that companies are requiring when scaling up in their businesses. (Leoni 2019)

In this model user company has a full control over customization and updates of their platform. In some cases, customization of software can lead to serious software support issue and reliability becomes unstable. Deployment of software is uniquely tailored to fit company's needs and requirements, allowing more versatile customization in comparison to other models. Uniquely tailored software deployment can sometimes be complex and requires time and dedication. In this model companies have their own

expertise in IT support since they are the ones who oversee most of it. Company needs to have dedicated person or a team whose main purpose is to take care of IT support of their company. (Leoni 2019)
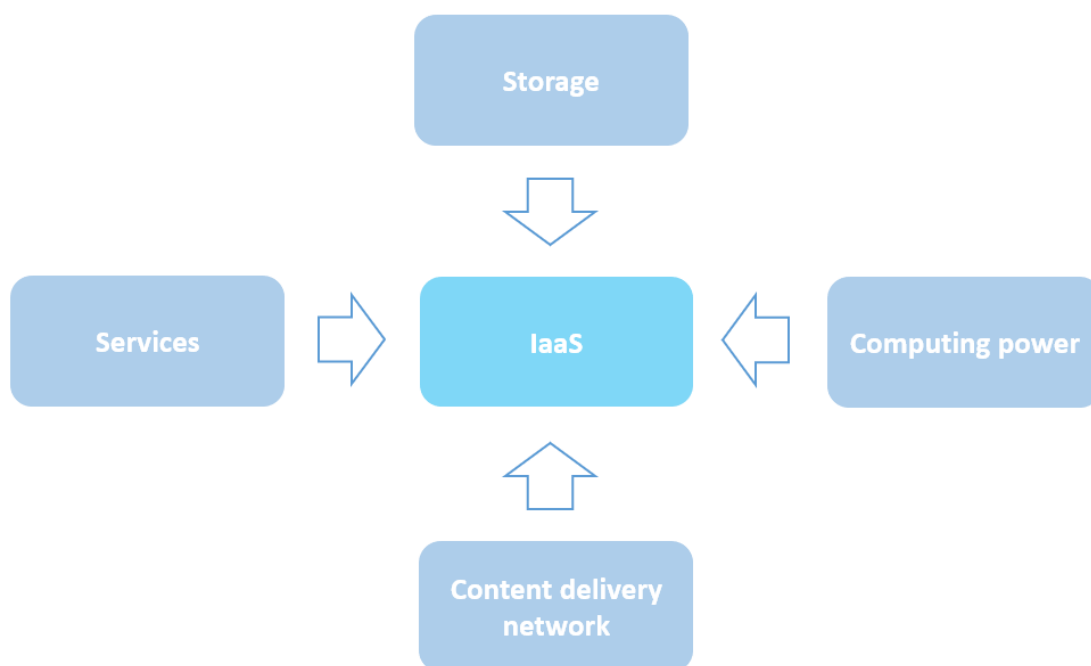
## 4.2 Infrastructure as a service (IaaS)



Figure 3. Infrastructure as a service (IaaS) (Salo 2012, 14)

One of the reasons why companies consider using IaaS model is financial gain and benefit that they get out of it. To maintain existing infrastructure, data center can take up to70% of IT-investments, due to this reason considerable smaller fraction of budget remains to other development purposes. More financially beneficial solution is to use infrastructure as a service from external software provider, doing so allows companies to have more flexible use of capacity on demand. Compared to other model's IaaS provides more autonomous control over service and allows minimal contact to software provider. Billing is based on self-service usage. In IaaS model user has more options and flexibility, this allows scaling up based on needs at any given time. In IaaS model user company is responsible to ensure that applications function properly,

updates and security are working properly, and scalability and efficiency are on a proper level. (Salo 2012, 13)

Main advantage of IaaS solution is capability to deliver infrastructure through cloud services, that includes cloud storage, servers, operating system, and network. These services are provided to user company via dashboard that allows users to have better control over their infrastructure. Cloud services are able to provide data center capabilities without the actual need to have data center, this also removes need of maintaining and managing data center physically. Access to server storage remains direct, only difference is that it is outsourced and managed by IaaS provider. IaaS model also brings responsibility back to user company who have to manage data, applications, and runtime when provider manages servers, hard drive, storage, virtualization, and network. There can also be additional service provided by IaaS vendor that can vary depending on the service and provider. (Watts & Raza 2019)

Benefits present in this model are greater flexibility, highly scalable services and additional resources that can be purchased on demand. Processing power and automated storage deployment is also available in this model. Consumption is based on users' needs and can scale up depending on the situation, this allows cost savings due to maximum utilization of on demand resources. (Watts & Raza 2019)

This model benefits large variety of different companies, starting from companies that are planning to reduce time and cost, to large enterprises that want to maintain full control over their applications and infrastructure. IaaS model also provides advantage for companies that are scaling at rapid speed, IaaS solution allows convenient way to update needed hardware and software on demand as company evolves. (Watts & Raza 2019)

There are some similarities between different cloud models: Security concern of user company's data, customization question and vendor loc-ins that apply to IaaS model as well. More IaaS specific advantages and disadvantages do still exist. Due to the fact that user company is responsible for its own infrastructure in this model, proper education and training is required in order to manage and control required functions of IT. Data security is handled by user company as well as backups of the system and other

crucial data. Proper allocation of resources that meet the standards can be challenging and complex. Security also raises concerns although user company has control over data and apps, security threats can still be found especially in data communication between IaaS provider and user company, such vulnerabilities possess less of a risk when control over applications and data is either in providers or user company's end. (Watts & Raza 2019)

In IaaS model resources for user company's hardware are allocated dynamically according to actual needs, IaaS provider has to ensure that data is secure from its other users. (Watts & Raza 2019)

4.3   Platform as a service (PaaS)
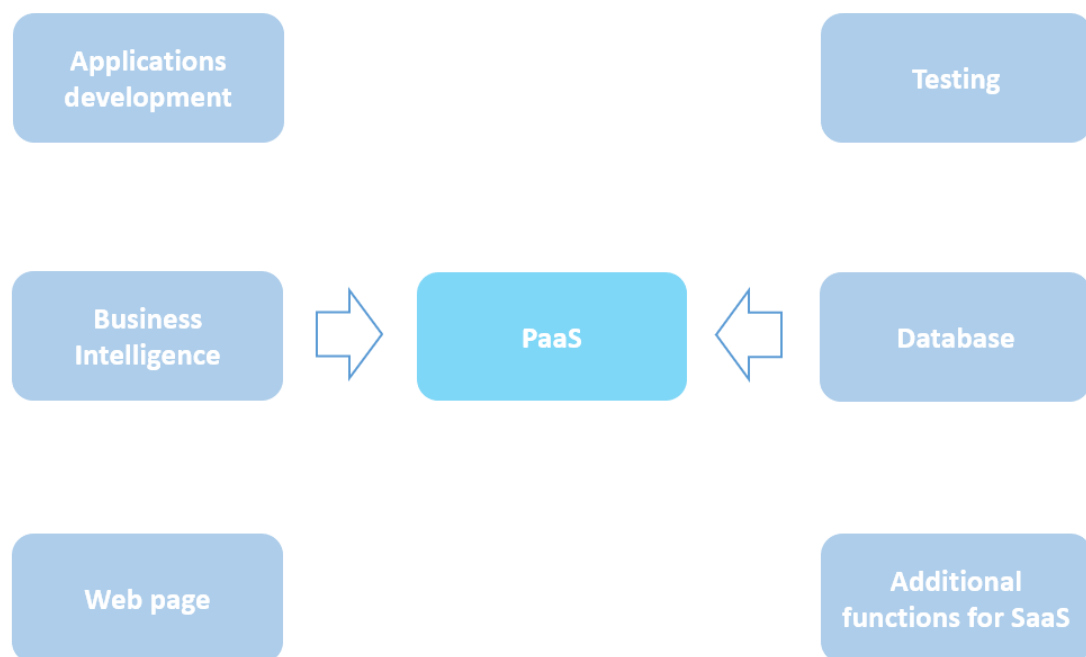


Figure 4. Platform as a service (PaaS) (Salo 2012, 15)

In this model software vendor provides platform for applications. Companies can develop their own applications and test them in this environment which they also have to maintain. In comparison to IaaS model, in this model SME companies do not have to worry about IaaS specific tasks that are liability to the user. Major difference to IaaS model is that you can purchase third-party add-ons, expansions, and other

functionalities. PaaS model also benefits its users with more cost-effective model, this often shows in saved time and resources. As all cloud-based models also PaaS model has vendor lock-in threat, that companies have to take into consideration upon choosing the right model. PaaS provider takes care of scalability and reliability as well as maintenance and upgrades of the platform. (Salo 2012, 15)

In many cases PaaS model shares some similarities with SaaS model, but delivery model in PaaS differentiates in delivering method, PaaS vendor provides platform for software creation instead of ready software solution over the internet like SaaS model. For developers, this solution allows them to work directly on software through internet without need to worry of infrastructure, updates, storage, or operating system. Applications that are created and designed by user company's developers are build with the help of different software components. (Watts & Raza 2019)

Main advantage of PaaS is cost-effective and easily scalable solution that provides simple and efficient way to deploy and develop applications. Applications can be customized by developers without the need to worry regarding the software. This model can reduce amount of required coding and it can also provide business policy automation and easy migration to hybrid model. Way that this is achievable is technology that relies on virtualization allowing scalability to go up or down based on the need of business. PaaS solution can also provide assistance with testing, application deployments and development, provided assistance is not that common in other models. (Watts & Raza 2019)

Ideal utilization of PaaS solution is possible when there is a need for simultaneous access to develop project in a team of more than one developer. When speed and flexibility play a crucial role in development of new project between one or more vendors, PaaS is solution that can achieve this. PaaS also enables more efficient and cost-effective way to achieve this. (Watts & Raza 2019)

One of advantages that PaaS model brings with it is greater control over platform software and applications for IT administrators in comparison to SaaS model. There can also be disadvantages, when user company is only able to control what is built on the

platform, and not on hardware itself nor the operating system that platform is built on, this makes platform vulnerable if something unexpectable will occur such as outage. (Bernazzani 2019)

Although user companies can modify and work on applications and services that are run on PaaS providers solution, data itself is stored in PaaS providers cloud servers. This can raise security issue when data is held by third party vendor, this can also limit user companies since some hosting policies are more specific and tend to have limitations. Cloud servers that are hosted by PaaS provider require connection to user company, this connection of data can be complex which affects adoption of available services and application integration with existing IT system. This brings challenges, especially when IT systems are not built properly for cloud which results in later on integration issues. Other limitations of PaaS solution have to be considered as well, such as language option that might not be fully optimized to fit user company's needs and framework that can be different from the one that user company is used to. (Bernazzani 2019)

Commonly known vendor lock-in is a known problem in cloud-based solutions that raises a question. User company has to plan well in advance what they are going to do and how they will prepare for this challenge if such challenge will occur. SME business and technical requirements can change quickly. When company grows, company's PaaS solution also has to grow with the company, due to limited resources and requirements that SME have, PaaS solution may not be able to grow with them. If there are no convenient migration policies available, switching to alternative PaaS solution can be a challenge and it can affect business negatively. End users' options and capabilities are often limited in PaaS solution, in order to reduce burden on the end user in operational tasks, this option can be suitable for some users, but other might prefer to have a better operational control. (Watts & Raza 2019)
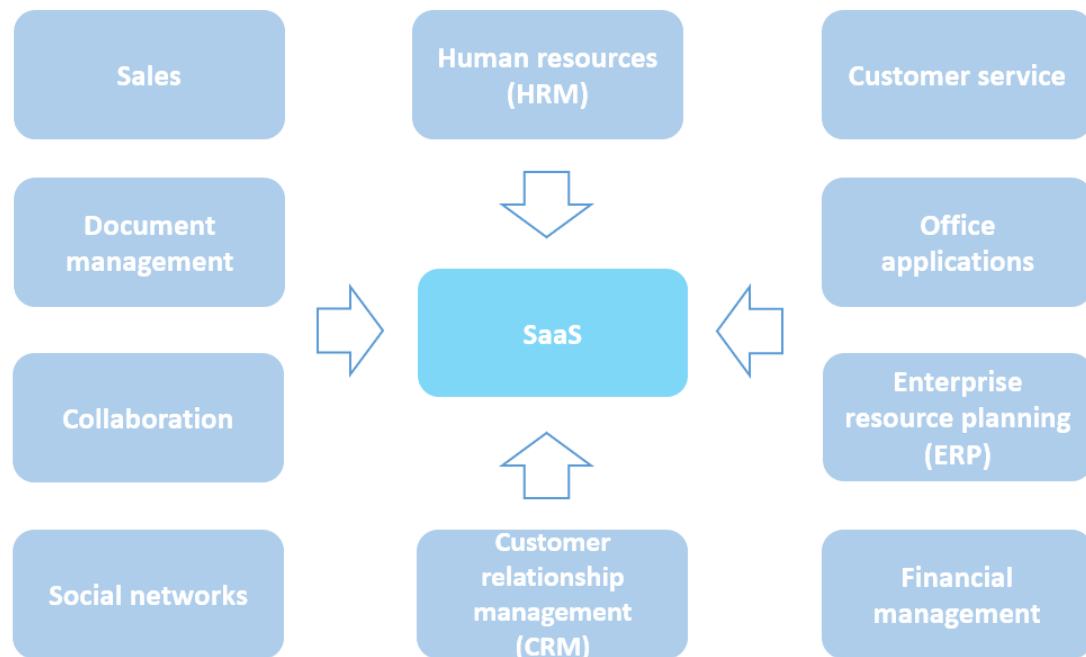
4.4   Software as a service (SaaS)



Figure 5. Software as a service (SaaS) (Salo 2012, 16)

SaaS model provides applications as a service, it covers ownership, installation, and maintenance, it also covers updates and service security. In this model user company has an option to access service through subscription. In subscription-based model user company pays for the service based on used time or quantity of users, that are using the service. Model is subscription / licence based and charges based on the number of computers that have access to software. In this model there are no requirements to have own hardware and software, this removes considerable amount of IT functionalities that companies would normally have. Without hardware and software requirements, user company can focus on its core business allowing more efficient allocation of resources towards more profitable tasks. Although SaaS model has a lot to offer, there are some disadvantages as well. Complex integrations to other software's are often problematic as well as sensitive data of user companies that has to be dealt with accordingly in order to avoid security issues. (Salo 2012, 17)

Typical delivery of SaaS solution is delivered through internet which eliminates need for an IT personnel and manual application installations on computers. (Watts & Raza 2019)

SaaS is typically managed from a central location that is hosted from remote cloud server which is accessible through internet connection. Hardware as well as software are managed by SaaS provider and service is based on subscription / licenses. SaaS is beneficial in situations when companies require a quick access to platform to help them with the launch of ecommerce or other project without the need to worry about servers or software. SaaS is also used when situation requires fast, easily accessible, and cheap short-term solution for a project or task, in this situations SaaS subscription-based licenses are often rented for fixed amount of time until project or task is completed. Applications that are rarely used but serve a specific function are often SaaS based, due to easier accessibility and more affordable price. In some cases, SaaS solution is used for its flexibility to access applications remotely through internet connection. (Watts & Raza 2019)

One of the many benefits that SaaS model brings with it is considerable faster software deployment time compared to other models. Major factor that contributes to faster deployment time is, already installed and configured applications that are managed from cloud by a software provider. Due to the fact that SaaS is generally subscription-based model, it is capable to provide a lower cost of software especially in the beginning when there are no initial license fees involved, this allows lower upfront cost. It is considerably less expensive option to use SaaS solution, compared to other more traditional models. One of the reasons is shared multitenant environment that provides two benefits, it allows lower cost of software and hardware licenses as well as reduced maintenance cost since environment is used by many customers and IT infrastructure is managed by the SaaS provider. Allowing customer base to be increased and decreased on demand this reduces cost of software because of reduced cost companies are now able to use this solution that normally they would not have access to due to relatively high license cost. (Sylos 2013)

Cloud based solution provides good scalability and offers wide selection of applications inside the software offered by SaaS provider. Compared to other more traditional models, users do not have to buy additional servers or software's upon the need to scale their business up. In SaaS model this can be achieved by enabling new offering that allows companies to scale up. This can be used in situations when new employee

requires access to software or business grows and new functions are required. When update of the software is required, SaaS provider will do it directly since everything is hosted from the cloud. Because responsibility is in SaaS providers end, updates are run automatically to newest release. Automatic updates eliminate needed manual work that would be required to update each computer one at a time. SaaS also enables users to have easier and more complete test experience by allowing users to test product beforehand. Testing new functionalities and release features before purchasing the software is also possible for large environments due to good scalability options on cloud. (Sylos 2013)

When user company starts to use new SaaS solution, guarantee is often provided to the user as well. Guarantee covers such things as performance promise, support, scalability options and any other pre-agreed terms between SaaS provider and user company. Idea behind this is to get more trust between two parties and to help user company to engage further into SaaS providers solution. Example of guarantee that can be given is automatic data backups that can be run on a weekly or on a daily basis which ensures integrity of the data. When user company's data is stored for backups in SaaS providers data center, it is controlled by a third party. But in some cases, data can be safer with SaaS provider who has invested heavily on security, training and knowledge as well as on newest hardware and software to keep data safe. Compared to company whose main core business is elsewhere and to whose IT is mandatory to maintain proper IT functions. And due to non-disclosure agreements, that are agreed between SaaS provider and company, there are pre-agreed procedures that will follow if company's private data is not taken care of accordingly to the standards that are agreed upon. Relationship between SaaS provider and user company wary depending on situation. It can be mutually beneficial relationship that has a good synergy, or it can be more complex and demanding. (Cheney 2015)

SaaS solution can be accessed from anywhere in the world if there's an internet connection, in some situation's internet connection is not needed if user company is using offline mode that often comes with limited functions compared to normal online mode. This allows users to access their data and work more efficiently almost from anywhere in the world and anytime they want, which can improve quality of life of users. One of the reasons why SaaS solution is successful, is wide range of different subscription-

based licenses that are available to user companies, user can choose himself which subscription-based licenses he wants to use and change them in the future if needed. (Gomes 2019)

Vendor lock-ins and data security concerns are some of the main threats of SaaS model that is why it is crucial to understand SLA (Service Level Agreement) that is signed between SaaS provider and user company. SLA ensures that both parties follows what is agreed in the agreement and it also improves trust between two parties. SLA can cover things such as performance level and latency promise. (Gomes 2019)

There are also other disadvantages that SaaS model brings, disadvantages such as lack in integrations and integration support. Although SaaS offers wide range of applications and other functionalities it is challenging to integrate these applications and functionalities to other software. Since integration support that is provided by SaaS vendor is often limited, this forces user companies to invest in integrations that will be done without SaaS providers support. Often such integration resources cannot be found inside the organization, which forces companies to rely on external resources that are often expensive. (Watts & Raza 2019)

Advantage of SaaS model is easy and fast deployment due to cloud-based infrastructure. Online applications are accessed through internet connection, this eliminates need to host software servers locally providing more flexibility and options. There is still decision that must be made before user companies start to use SaaS providers software, although SaaS model is attractive with all its perks it does have some risks in it as well such as losing control to SaaS provider. Dependence on the provider can be risky especially if problems will occur, problems such as outage in providers end, in which case user company will have consequences that in worst case scenario can affect company's business processes. (Bernazzani 2019)

# 5 SWOT



Figure 6. SWOT analysis example template.

Purpose of this strategic tool is to provide better overall picture to gain deeper understanding of different software models used in this comparison. SWOT analysis is divided into internal strengths and weaknesses and external opportunities and threats. Internal strengths and weaknesses are present factors compared to external future opportunities and challenges factors. Due to subjectivity of SWOT analysis some information used in this study can be listed as strengths as well as weaknesses. (Vuorinen 2013, 88)

## 5.1 On-Premises

Main strength and advantage of having own hardware and infrastructure is complete control and on demand customization that can be done if necessary. Control over own data enables greater agility and allows companies to do faster decisions if needed, software upgrades and customization can be executed on short notice when company is responsible and also in charge, compared to solutions where software upgrades and

customization requires approval or request from a third party provider. Full control over own data locally can also be safer, when access to data happens internally and third-party is not involved in the process, security is improved and potential risk to have data breaches is reduced. Good level of data security often requires inhouse resources that are competent, this company has to sort out accordingly, which in many cases means that IT department is skillful and highly capable. When IT department is competent accordingly, inside the company it can open many doors, such as inhouse software customization and controlled rapid upgrades, software can be uniquely customized to fill user company's needs and demands. Customization enables more efficient software usage and can be set to provide maximal performance, compared to other non-customizable solutions that do not always provide maximal efficiency and benefit to companies that have to adapt to software that is provided by a third party.

Weaknesses of having on-premises solution are often resource driven, it requires considerable larger upfront investment from company due to high cost of software and hardware. Such a large upfront investment is not always available for new growing companies that often have to rely on third party services. Maintaining own infrastructure and software, as well as security requires skilled workforce that needs a lot of training because of constantly evolving IT industry. Although on-premises solution provides better agility and is in many cases faster in adaptation of new methods and trends compared to third-party solutions, companies still have to plan well in advance, for possible changes that may require time and proper research. Customization of a software can also present a challenge; often complex customizations can lead to reliability and software support issues.

Opportunities that on-premises model brings are software customization that can be developed further according to company's needs and freedom of choice to migrate to newer more advanced solutions in the future, compared to third party alternatives that are often limited and instead tend to lock their users to provided service. Inhouse control over own data allows in many cases easier transition towards new potential software's in the future, reason for this is direct migration that is made between user company and potential provider, there are no third-party members that are involved in the process, compared to scenarios where user company is changing one service provider

to another, in which case data will have to be transferred either between two providers or between a current provider, user company and new provider.

Threats that can affect companies that are maintaining their own infrastructure and software are security driven, lack in expertise can result in serious security risk that can be harmful for entire company. Another threat presents itself when a company is scaling up, to scale up companies often have to invest into new hardware, software and knowledge that comes with it. Deployment is often time consuming and slow; it can also require properly done research and knowledge in order to scale up and be successful.

## 5.2  Infrastructure as a service (IaaS)

One of the main strengths that IaaS solution provides is a financial gain for user companies. Outsourcing infrastructure to external IaaS provider saves resources for user companies in hardware, as well as in maintenance costs. Outsourcing infrastructure to IaaS provider helps companies to gain access to highly scalable and flexible on demand services that help utilize maximum efficiency and prevents companies having excess hardware that they do not necessary need. Greater efficiency and savings in infrastructure allow companies to use gained resources elsewhere.

Security, limited customization, and vendor loc-ins are the main weaknesses of IaaS model. Although user company has a control over its data, security concern occurs in data communication between IaaS provider and user company. Hardware resources are allocated dynamically based on the requirements and needs of user company, security concern occurs when IaaS provider has to ensure that data of user company is secured from other users, in this situation user company has to rely completely on chosen software provider.

Flexible allocation of resources and high capability to scale, provides an opportunity for user companies to react faster to possible changes in demand. Consumption of computing power is often dependent on given tasks and users, because of this, swift

resource allocation can be beneficial especially when need for computing power is temporal and will not be needed afterwards.

Threats can still occur when infrastructure is provided by an IaaS vendor, user company is still responsible in ensuring that applications are functioning properly, security and updates are taken care of accordingly and efficiency is on a proper level. Although infrastructure is outsourced to a professional service provider, it is still important to maintain a proper inhouse IT resources, neglecting this can cause shortage of skillful IT specialists.

5.3  Platform as a service (PaaS)

PaaS model provides additional layer on top of IaaS model and its strengths lay in provided platform solution, user company gains an access to test its own applications in already set environment. User company does not have to worry about infrastructure, maintenance, and upgrades since this is already taken care of by provider. This further improves efficiency and saves resources allowing reliable and stable platform for developers to work on applications that they can scale up without to have to worry about limited scalability resources. Benefit of PaaS solution lays in platform, when environment is already provided with proper resources, user company can focus on software creation freely without vendors interventions, compared to SaaS model where software is already delivered to user over the internet and user does not have an option to modify solution that is given. For developer's platform offers more flexible way to work on the development of their software, when they do not have to worry about infrastructure, updates, storage, and operating system. This option also allows developers to access working environment from various locations through internet. PaaS also provides different software components for software development; this model reduces amount of coding required and allows easier migration to hybrid model. PaaS vendor also provides various assistance services for user companies if needed. Services include testing, applications development, and deployments. Platform solution provides better control for IT administrators for software and applications, which is not always the case in other models.

Similar to other cloud-based solutions one of main weaknesses of PaaS solution is vendor lock-in, in contrast to On-Premises solution in which user company has a full control over all their applications, infrastructure and data. After decision is made to start using PaaS solution, user company is not able to influence which operating system or hardware PaaS provider decides to use in his end, or if provider will decide to change operating system in the future. This makes platform vulnerable if something unexpectable will occur such as outage. Since application development is done on platform solution, data is also stored in the cloud, this can raise a security issue when private data is held by a third party vendor, this automatically limits possibilities regarding what can be done on platform since some hosting policies are more specific and tend to have limitations.

With PaaS model user company has an opportunity to gain an access to third-party add-ons, expansions, and further functionalities. Advantages of PaaS solution can be shown when IT resources are well available, efficient utilization of available recourses eliminates need in hiring new additional specialist when part of the IT related tasks are done by PaaS provider. With new platform capabilities in cloud, bug fixes are instantiated automatically this can allow more focus on core business for user company.

Due to the fact that SME technical requirements may differ in the future, it raises a question how well PaaS solution can evolve to further fit user company's requirements in the future and if such option is not available, how convenient it is for user company to migrate its data away from the platform. Although platform solution provides a working environment for application development without interventions, some end user options can be limited in capabilities and user is stuck with options that are provided in the platform, such as language option that might not be ideal for the user company or a framework that differs from a framework that developers are used to. It is also possible to use framework that developers prefer but there can be a performance issues when framework version is not fully optimal for the platform.

5.4   Software as a service (SaaS)

SaaS solution adds another additional layer on top of IaaS and PaaS solutions, it also covers applications and application ownership, installation, maintenance, updates, and security. Web based software solution eliminates need of application installation on each computer individually which reduces doable work for IT department. In this model software deployment time is fastest, due to the fact that SaaS is generally a subscription-based service. User company gets immediate access to software when subscription is purchased this is especially beneficial when software needs to be used as soon as possible or when software is used for limited time only, for example if user company has an upcoming project that requires additional tools that they do not have available. Although cost of subscription-based licenses varies and can be considerable investment for SME, SaaS solution is still seen as less costly option when it is compared to other models. These cost savings can be seen when infrastructure, as well as software is provided directly to user company as a ready package. SaaS solution also offers scalability and flexibility when user company requires additional functionalities from software, since solution is subscription based, user company can gain access to additional functionalities by upgrading or purchasing new licenses.

Similar to IaaS and PaaS, also this solutions weakness lays in vendor lock-ins. Although SaaS solution is in many cases subscription based and subscription can be terminated on users' terms, data that has been gathered or used in the software can present a challenge upon export of the software for further use. Depending on which software user company is using, exporting existing data can be challenging, what tools to use and in which format should the data be exported are common questions that user companies have to struggle with. Another challenge can be found in software integrations, when user company uses one or two software's, integration between them can be managed but when there is vast amount of different software's that user company uses for different purposes, integration between them can be challenging. Another challenge can be found in lack of customization options in software solution that SaaS provides, because of vast majority of different customers who are all using same software solution. In these types of situations software is implemented to lowest common denominator, limiting available functionalities of the software. Popular reason why SaaS is used among companies is in hardware savings as well as in opportunity to outsource

or reduce IT department resources. As much as it sounds appealing companies should not underestimate true cost of SaaS solution since long-term software licensing can mitigate hardware savings. Security also raises a question since large SaaS providers are aggressively targeted by hackers.

Opportunity in SaaS solution can be seen in saved time, especially when companies require a quick solution that can offer help them in product launch or in any other business activity that requires immediate assist and which would not be able to execute without external help. Subscription based model also allows user companies to use software's that they normally would not have access to due to considerable cost of software's. More accessible and appealing price of software allows companies to explore and experiment new methods which they normally would not do.

Threats can be found if user company's needs will change and company will decide to invest into new software integration between different software's, this integration is often done by company, even though SaaS provider offers some help, help is often limited and do not cover all available software options. User company has to adapt to SaaS providers solution which is often limited in customization options and is a trade-off.

## 5.5 Observations

| | Paradigm shift | Characteristics | Key terms | Advantages | Disadvantages and risks | When not to use |
|---|---|---|---|---|---|---|
| Infrastructure as a Service (IaaS) | Infrastructure as an asset | Usually platform-independent; infrastructure costs are shared and thus reduced; service level agreements (SLAs); pay by usage; self-scaling | Grid computing, utility computing, compute instance, hypervisor, cloudbursting, multi-tenant computing, resource pooling | Avoid capital expenditure on hardware and human resources; reduced ROI risk; low barriers to entry; streamlined and automated scaling | Business efficiency and productivity largely depends on the vendor's capabilities; potentially greater long-term cost; centralization requires new/ different security measures | When capital budget is greater than operating budget |
| Platform as a Service (PaaS) | License purchasing | Consumes cloud infrastructure; caters to agile project management methods | Solution stack | Streamlined version deployment | Centralization requires new/ different security measures | N/A |
| SaaS | Software as an asset (business and consumer) | SLAs; UI powered by "thin client" applications; cloud components; communication via APIs; stateless; loosely coupled; modular; semantic interoperability | Thin client; client-server application | Avoid capital expenditure on software and development resources; reduced ROI risk; streamlined and iterative updates | Centralization of data requires new/ different security measures | N/A |

Figure 7. Cross-Concept Matrix of the Three Classifications of Cloud Computing (Khurana 2013)

There can be found clear similarities between cloud models in all SWOT analysis areas, strengths, weaknesses, opportunities, and threats. Common main strength that is mentioned in all cloud models (IaaS, PaaS & SaaS) is good capacity to scale up, this is beneficial for SME especially when scalability is required on short period notice. Scalability in cloud also eliminates need of new investments into hardware which can be cost effective for SME. Another common strength that was present in all three cloud-based models was cost effective solution, it is known that outsourcing IT can be cost effective, especially for smaller companies. It is known fact that cost of cloud services can vary depending on the model as well as on provider, outsourcing infrastructure to IaaS provider can be more expensive in comparison to SaaS subscription-based model that offers their cheapest license with limited functionalities.

In contrast when observing more traditional On-Premises solution biggest strength lays in having full control over own data which helps to avoid vendor lock-ins. Although this model requires considerable investment in advance from SME, on long

term, hardware costs will hit break-even point since cloud-based software solutions can mitigate hardware savings with time. Another advantage of this model is security if it is taken care of accordingly. Since all the data is inhouse there is lower security risk compared to situation where data is managed by a third party. For companies it is important to do a proper research of cloud providers in advance if company is interested in cloud services.
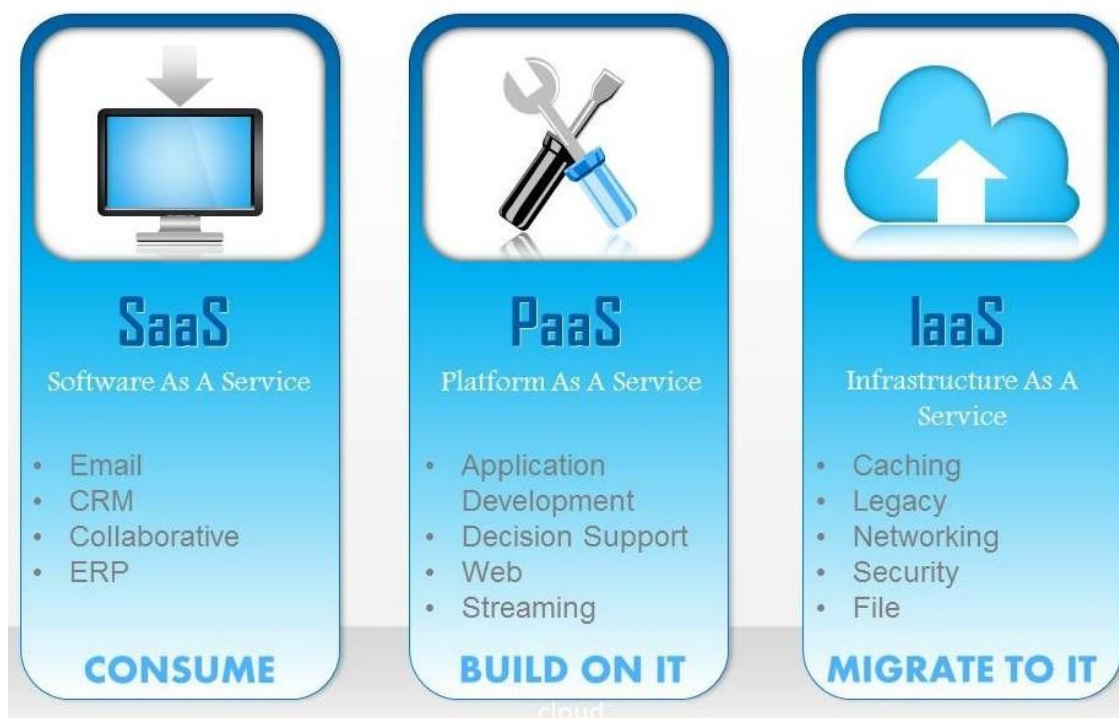


Figure 8. SaaS, PaaS & IaaS (Khurana 2013)

Although cloud-based models share many similarities they also differentiate especially in the way they are used, SaaS is the most versatile solution that can be used by user companies. PaaS solution provides great tools for user companies to build in their ready environment and IaaS solution can offer outsourced infrastructure for the user. Although SaaS solution is most versatile, it is at the same time most limited in customization because it has to serve large group of users. In contrast IaaS and PaaS solutions are more customization friendly when software and application development is in user company's end. This freedom of choice offers user companies to pick right solution that fit their needs. It is user company's responsibility to choose which layer of cloud is most suitable for their business at a time. In some cases, On-Premises model

is the way to go if full control over data and IT is what company is after and only partial inhouse IT outsourcing is available resource vise.

| | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|
| Cloud Business Process Services (BPaaS) | 45.8 | 49.3 | 53.1 | 57.0 | 61.1 |
| Cloud Application Infrastructure Services (PaaS) | 15.6 | 19.0 | 23.0 | 27.5 | 31.8 |
| Cloud Application Services (SaaS) | 80.0 | 94.8 | 110.5 | 126.7 | 143.7 |
| Cloud Management and Security Services | 10.5 | 12.2 | 14.1 | 16.0 | 17.9 |
| Cloud System Infrastructure Services (IaaS) | 30.5 | 38.9 | 49.1 | 61.9 | 76.6 |
| **Total Market** | **182.4** | **214.3** | **249.8** | **289.1** | **331.2** |

Figure 9. Worldwide Public Cloud Service Revenue Forecast (Billions of U.S. Dollars) (Gartner Forecasts Worldwide Public Cloud Revenue to Grow 17.5 Percent in 2019 2019)
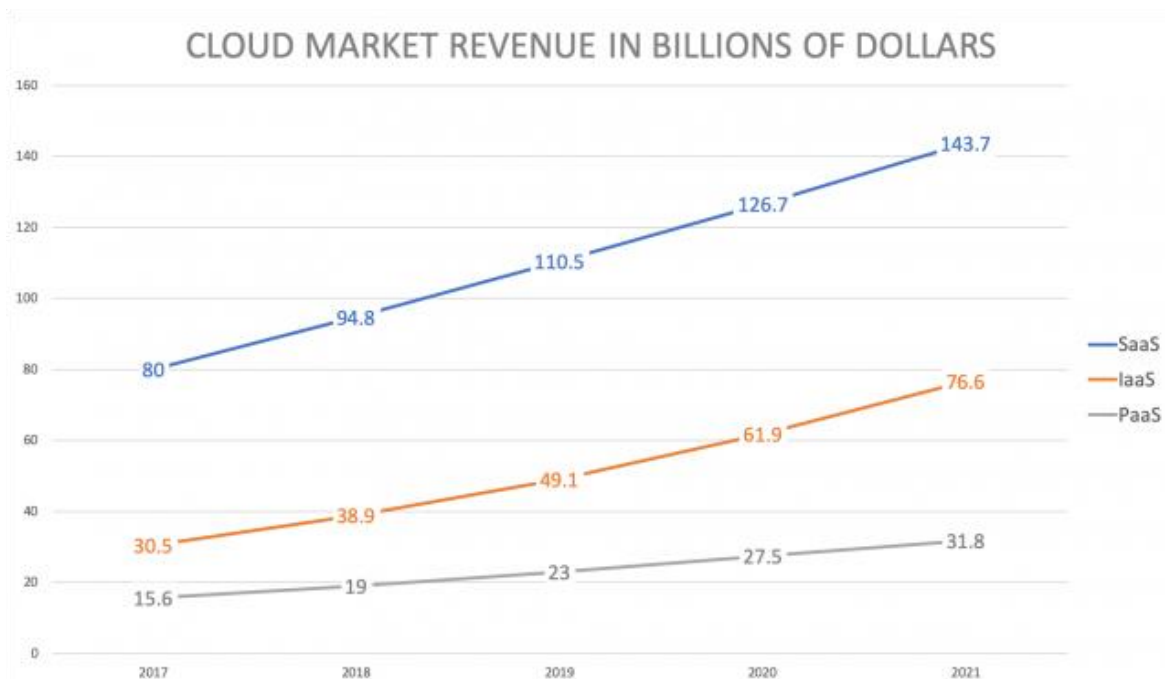


Figure 10. Cloud Market revenue (Vargas 2019)

It was estimated by Gartner that cloud services would grow by 17.5 percent from year 2018 to 2019. Survey that was executed by Gartner also said that companies rank cloud investments in their top three priority. (Gartner Forecasts Worldwide Public Cloud Revenue to Grow 17.5 Percent in 2019 2019)

Based on Gartner survey information it can be seen that demand for cloud services is growing. It is beneficial for companies to be aware of advantages and disadvantages that cloud solution brings. Better understanding allows companies to respond faster to rapidly changing markets and it also provides competitive advantage against competitors.

# 6 SUMMARY AND CONCLUSIONS

Purpose of this study was to help SME to understand better what differences each model brings. From SWOT analysis it can be seen that these models can be divided into two groups, on-premises, and cloud. From this research can also be found that cloud-based solutions share a lot of similarities, but they are also different in their own way. Each solution can offer advantages depending of the situation and company's needs.

Advantages and disadvantages between different models were found and they were explained in business-friendly way. What comes to objective of this thesis, to provide comprehensive guide for SME to gain better understand which software model will suit their business needs. This thesis has explained diversity of advantages and also disadvantages of each model as well as what are the main differences.

Upon working on this study, I learned more in-depth information of each model that will be beneficial for me in the future. Researching right information for this study was interesting and challenging as well. Comparison itself was successful since there were clear differences between models this helped when SWOT analysis was made. SWOT analysis helped to further clarify information that was used in this study.

This work has a potential to provide beneficial new information for SME about previously mentioned models that can save time and resources. It is also possible to do a new research of advantages and disadvantages of each software model upon newer information.

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