Cloud computing and its introduction in small and medium sized enterprises

Bachelor Thesis

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Abstrakt

Simonfy, A. Cloud computing and its introduction in small and medium enterprises. Bakalárska práca. Brno: Mendlova Univerzita v Brne, 2015.

Táto práca sa zameriava na tému Cloud computing a jeho úvod do malých a stredných podnikov a následné zhodnotenie jeho spojitosti s nadchádzajúcimi modernými technológiami a vybranými faktormi operačného menežmentu s dôrazom na náklady. Cloud computing vykazuje značné benefity pre biznis, Skúmaním zvolenej modelovej spoločnosti ukázalo, že je adekvátne pre firmy zvažovať túto technológiu, hoci to nemusí byť prínosom pre všetky typy firiem.

Keywords

práca, cloud, computing, spoločnosť, malý, stredný, podnik, IT, menežment, operačný, big data, sociálny, mobilný

Abstract

Simonfy, A. Cloud computing and its introduction in small and medium enterprises. Bachelor thesis. Brno: Mendel University in Brno, 2015.

This thesis is compiled on the Cloud computing and its introduction in the small and medium enterprises and evaluation of its connection to the up-coming technologies and chosen factors connected to the operations management with the stress on costs. Cloud computing shows strong benefits for the business. The study of selected model company showed that it is justified for a company to consider the technology, however, it might not be applicable for all kinds of small and medium enterprises.

Keywords

thesis, cloud, computing, enterprise, small, medium, enterprise, IT, management, operations, big data, social, mobile

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Introduction

Ever since the Informational technology emerged and penetrated to the business, it became an inseparable and essential part of it. The very proof of it is the quote of one of the greatest men ever to figure in the field, Bill Gates, who said: „*Information technology and business are becoming inextricably interwoven. I don't think anybody can talk meaningfully about one without the talking about the other.*"

Computational power, networking, storage applications and more, those are the main purposes of Informational technology in a company, and most of the time they play crucial role in the whole functioning and providing the service. Should it be neglected, the company may lose its competitiveness and reliability on the market. That is exactly the reason why the Chief Information Officers need to stay sharp about the new technologies, as in today's dynamic world, one rarely survives without them.

And in 21st, one of the very newest and up-coming technologies is Cloud Computing. Switching from local and often inflexible solution to virtual machines, the companies have a chance to open the door to entirely new world of possibilities.

This thesis focuses on the general qualities and models of the Cloud Computing, examination of their value on the market and their usability in Small and Medium Enterprises. The first chapter describes the basic lines of cloud computing and its penetration on the market, followed by the general service and deployment models accessible to the enterprises in the second chapter. Next, the third chapter elaborates the connection with operations management. In the last chapters we discuss the connection to next-to-come technologies and principles, followed by the design of initial Cloud Computing solution for selected small company in order to prove its validity.

Objective and Methodology

The objective of the Bachelor thesis is to depict the basic characteristics of the Cloud Computing and its introduction to the Small and Medium Enterprises.

Based on study of literature and in the sense of directives for elaboration of final theses ad FBE MUAF in Brno, propose detailed structure of the thesis so that it has a project character, and includes the following the chapters: Introduction, Objectives and methodology, Theoretical part, Results, Discussion, Conclusion.

Objective of the thesis will be to recommend the necessary changes connected with a transfer to cloud solutions within a selected type of SMEs, and to identify their impacts on process management. The thesis will be elaborated from a viewpoint of a provider of cloud solutions, and will lead to a proposal of a generic implementation model for the selected type of SMEs. Possible impacts of the solution will be projected to a situation of a real SME.

In the Survey of Literature, basic characteristics of Cloud Computing Service and Deployment Models are depicted and described, laying down their properties, benefits and drawbacks connected to the Operations factors of the company, as well as its connection to the upcoming field related to the informational technologies.

In the Results part, the chosen company is described in order to indicate the type of company that would benefit from such solution, and based on its nature, the Cloud Computing Service and Deployment Models are picked from the ones described in the Survey of Literature. The solution is justified and the cost analysis is done. For the analysis, a specialized software provided publicly by a company actuating in the field is used, along with publicly accessible data of the Cloud Computing services provider. None of the data are made up or obtained by the author or their own sources.

The Internet calculator is fed with basic inputs regarding the country and requested hardware, energy and connectivity parameters and the costs overview is provided by the software. The same hardware parameters are considered when choosing the service from Cloud Computing provider, considering both on-demand and reserved solutions.

The three cost settings are compared in a graph to visualize the costs for five years evaluation period.

The Survey of Literature

1 Cloud Computing – Introduction

1.1 What is Cloud Computing?

Cloud computing is named after the emblem of a cloud used in network diagrams, which represents the Internet [Figure 1], representing everything that is performing outside the local network. I also represents the part of network that does not belong to a company directly, but it is rather rented. [1]
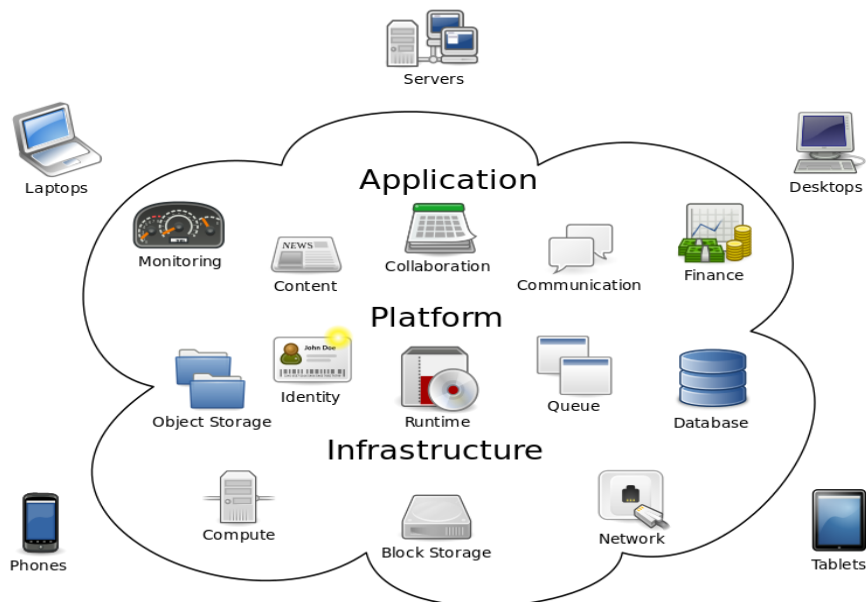
Figure 4 - Cloud Computing – Depiction [2]

The premise of Cloud computing is to cut down the operational and capital costs; as well as significantly free the IT departments of companies of the workload connected to maintenance of data centers, thus allowing the capacities to be focused otherwise. The principle of Cloud Computing, [Figure 1], depicts the hosting how hardware and software being outsourced to another company, relieving the company from a load of managing data center. [1][3]

1.2 Why Now?

The question that we may ask is: 'Why to decide for Cloud right now?' As mentioned, the Information Technology is evolving rapidly and the necessity to consider following points is in place.

1.2.1 Application Opportunities

The rising of Cloud Computing gave the opportunity for creation new types of applications. So called Born-on-Cloud applications and Cloud enabled applications will make the market even more interesting. The recent trend examined by Jim Gray regarding the applications was, with the declining costs of hardware connected to the Wide Area Network, is to put the data to the nearest possible place. Despite the further possible changes in prices of hardware, the break-even point remains valid [3][4]

Mobile Interactive Application Services are one of the branches attracted by new way of computing. The main reason for the switch would be to become much more available to the clients by securing more stable connection to the data center. With the rising complexity of the application and the data consumed on daily basis, the requirements for connectivity rise as well. As Tim O'Reilly expressed: „*The future belongs to services that respond in teal time to information provided either by their users or by nonhuman sensors.*" [5, Page8]

Big Data Analytics is a special case of business analytics, targeting the computation power on better understanding of the habits of customers by analysing the browsing habits, evaluations, buying preferences and more. The large amount of unstructured data is gathered by the companies, requiring processing for its further usability. [3]

Computation-demanding applications, belong which we can include software used in science, architecture and design and any other development that demands mostly irregular complex computing requiring enormous capacities per unit, are definitely an example of prospect for using Cloud Computing, either by feeding the data over the internet to the Cloud for processing or maintaining the data in the Cloud and recall it when needed. [3]

1.2.2   Economies of Scale

Cloud computing, however revolutionizing the Information Technology, it is strongly connected to business impacts as well. Via efficient resource pooling and manipulation with the consumption of information, the significant cost savings can be realized. Resource pooling refers to the multi-tenant character of Cloud Computing, when the same hardware can be utilized by different customers, thus lowering the overall costs. The economics depends on following factors: [6]

- Number of Unique Customer Sets
- Customer Set Duty Cycle
- Relative Duty Cycle Displacement
- Customer Set Load

The variables define the provider's capability to use the minimum of resources in order to satisfy the most customers possible. Of course, the variable also depends on the types of Cloud Deployment Models (see chapter 2.2) chosen by different customers.

1.2.3   Expertise

A small company may embrace the chance to utilize the 'big players' on the market, rather than developing the solution by their own. Global IT companies like IBM, Google, Cisco or Amazon, are often able to provide greater possibilities at lower cost, securing their customer uncompetitive service strengthen by years of continuous

improvement and experience, thus drastically lowering the possibility of failure in case the tenant would try to develop their own Cloud data center. [7]

1.2.4 Virtualization

One of the attributes most characteristic for Cloud Computing is Virtualization, ensuring more efficient usage of hardware resources. It is also the technology which enables Elasticity (see chapter 1.2.4) as such and adding properties like flexibility, speed and better management.

We distinguish Full and Paravirtualization as two basic types: [1]

„Full virtualization is a technique in which a complete installation of one machine is run on another. The result is a system in which all software running on the server is within a virtual machine. In a fully virtualized deployment, the software running on the server is displayed on the clients." [1, Page 9]

„Paravirtualization allows multiple operating systems to run on a single hardware device at the same time by more efficiently using system resources, like processors and memory. In full virtualization, the entire system is emulated (BIOS, drive, and so on), but in paravirtualization, its management module operates with an operating system that has been adjusted to work in a virtual machine. Paravirtualization typically runs better than the full virtualization model, simply because in a fully virtualized deployment, all elements must be emulated." [1, Page 10]

The main difference between the Full and Paravirtualization is, that in terms of paravirtualization, many different operating systems can be launched at the same time.

1.2.5 Commodity Hardware

With the significant progress over past three decades, hardware in overall terms was a subject to remarkable improvements in terms of performance and standardization which allowed significant decrease in production costs of basically all components combined with better compatibility.

1.2.6   Open-source Software

Hand-in-hand with Virtualization (see Chapter 1.2.50 and cheap Commodity Hardware (see Chapter 1.2.6), Open-source Software belong s to one of the main enablers for Cloud Computing. Open-source Linux-based Operating Systems, virtualization software like Xen and Computing Platform Hadoop trigger relatively cheap establishing opportunities for big Cloud Computing data centers, allowing to offer relatively cheap cloud services. [8] [9] [10]

2 Cloud Computing – Models

2.1 Service Models

Cloud Service Models denote the way how the Cloud Computing services are accessible to the users. Three most default Service models are Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) also referred to as Hardware as a Service. These services show a cross connection between each other, as for example Platform as a Service needs Infrastructure on which the model can run, thus prompting the customer to order the hardware as well [See Figure 2].
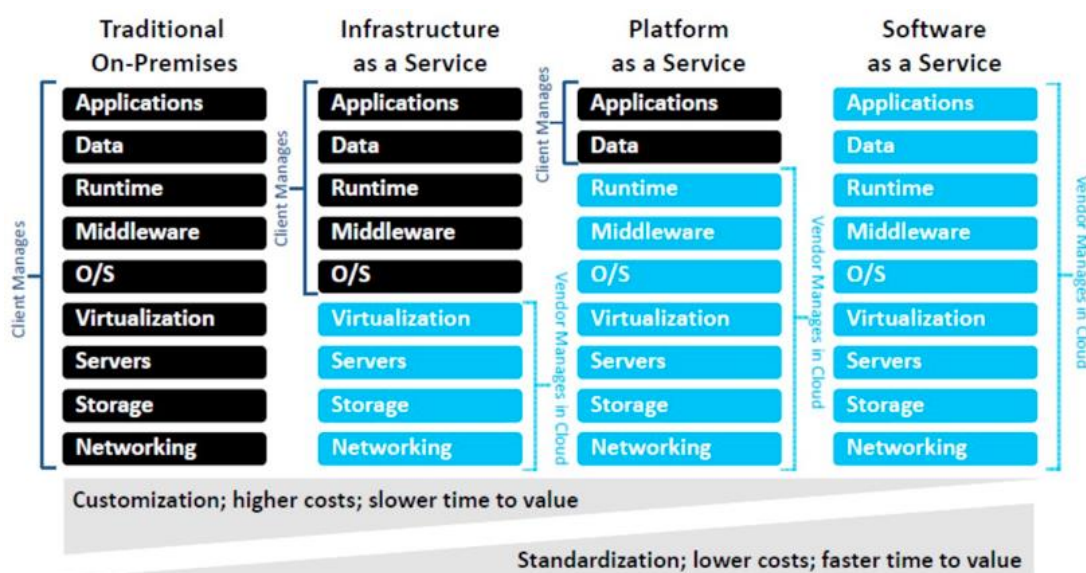
Figure 5 - Cloud computing interdependencies Software as a Service [28]

2.1.1 Software as a Service

As Volte explains in his book: *„Software as a Service (SaaS) is the model in which an application is hosted as a service to customers who access it via the Internet."* ([1] Page 11). The Delivery Model Software as a Service offers an online subscription of applications. With Software as a Service hosted on provider's premises, the customer is not responsible for the maintenance and support of provisioned equipment, even the management of the licenses. The model is considered ideal, when and out of the box 'as is solution' is being deployed and it does not require many modifications for

integration with other systems. The role of patching and upgrading as well as keeping the infrastructure running belongs to provider. [1]

Types of Software within SaaS:
   „Typically, software that performs a simple task without much need to interact with other systems makes them ideal candidates for SaaS." ([1] Page 12)

- Customer Resource Management (CRM)
- Video Conferencing
- IT Service Management
- Accounting
- WEB Analytics
- WEB Content Management

Software as a Service typical advantages: [1] [2] [3] [4] [5]

One of the greatest advantage of SaaS are the **lower costs** connected to the application, when the provider is capable of offering the application or solution cheaper than the company, by either buying or developing it.

Another important added value to be mentioned is the compatibility with the Internet and World Wide Web. The characteristic of our IT era is that the capability of working with the World Wide Web and Internet as such became of the requirements for workers. The application within SaaS, either cloud centric (born on cloud) or cloud enabled, can be accessed and launched via Internet on compatible mobile devices. [1]

Customization on larger yet the aspect that had been brought mainly with Cloud Computing. *„Older applications were difficult to customize and required tinkering with the code. SaaS applications are much easier to customize and can give an organization exactly what they want."* ([1], Page 13)

2.1.2   Platform as a Service

Platform as a Service can be defined as a layer above the hardware of infrastructure, virtualization and operating system, serving the purpose of the environment that leverages the infrastructure and operating system maintenance, giving the companies possibility to focus on their business only. [3]

As Volte specified: „*PaaS supplies all the resources required to build applications and services completely from the Internet, without having to download or install software. PaaS services include application design, development, testing, deployment, and hosting.*" ([1], Page 13-14).

Among other available services belong team collaboration, web services integration, database integration, security, scalability, storage, state management and versioning. Platform as a Service is normally based on HTML or JavaScript. [1]

Types of Platform as a Service [1]

- Add-on development facilities, allowing customization of already existing SaaS applications. The subscription payment is usually a requirement.
- Stand-alone environment that are used on general development, excluding licensing or other financial-related matters.
- Application delivery-only environments, focusing on hosting services, not including development, debugging and testing capabilities.

Platform as a Service main benefits [1]

- Collaboration within virtual teams
- Connecting internet services from various repositories
- Cost savings due to built-in infrastructure services for security, failover and scalability

2.1.3   Infrastructure as a Service

Often called Hardware as a Service, this service available within cloud focuses on hardware layer, rather than software and application layers, as PaaS and SaaS. The providers simply offer infrastructure to their customers, so they can use it in case of need. [1][3]

Storage services are one of the default Infrastructure as a service offerings, belonging to the third party and accessible to the customer online. The storage pools or clusters are usually of complex structure and the data is organized and distributed by employing sophisticated software. Based on the types of Deployment models (See Chapter 2.2) the customers can choose a fitting solution for distribution and saving of their data. [3]

The most common factors affecting storage pricing are:
- The amount of data sored
- The amount of data in traffic – incoming and outgoing

Computing Resources secure the computational power accessible to customer, including CPU, GPU, RAM and communication or terminal equipment offered as virtual machines. [12]

The resources can be either pre-paid in forward, prompting the customer to pay a fixed price for a certain commitment period, or acquired on-demand with Pay-As-You-Go principle applied. The third option is so called auctioned computational resources, obtained via bidding actions launched by providers, enabling the resources to the company with the highest current bid.

Network covers two main aspects, the Load Balancing, which balances the network traffic among single instances using special algorithms in order to guarantee smooth running; and Domain Name System (DNS). [12]

2.2   Deployment Models

Cloud computing comes in three main settings. Depending on the type of data the company works with, it shall consider following options.

2.2.1   Public Cloud

„A public cloud is basically the internet." [13]

Using the internet, providing companies enable every possible service, no matter if it is Software, Platform or Infrastructure as a Service, to the public community of customers, the biggest players of which are Amazon Elastic Compute Cloud (EC2), Goodle AppEngine, IBM Blue Cloud or Windows Azure. [13]

This type of solutions are generally relatively cheap, in comparison with other ones, because everything from hardware to the internet is covered by the providers. Pay-As-You-Go principle (see section 3.2.1) applies, meaning that the only expense is related to the capacity used by the customers. [13]

Mainly because of the lower difficulty of setting-up and relatively short lead time, Public Cloud is a tempting solution to the companies. However, there are several concerns that need to be considered, such as the 'Who owns the Data?' (chapter 3.1.4)

In general, Public Cloud is a perfect solution for an organization that wants to enable their service on the market quickly, with wide accessibility to many customers and low investment regarding their IT resources. [13]

2.2.2   Private Cloud

Private Cloud refers to the enterprise owned data center providing scalability, flexibility, automation and monitoring to its owner.

„The goal of a private cloud is not sell "as-a-service" offerings to external customers but instead to gain the benefits of cloud architecture without giving up the control of maintaining your own data centre." [13]

Typical for large multinational companies, due to its level of investment and economies of scale, Private Cloud requires high level of IT resources engaged in the virtualization of the company's business environment, not showing the economic benefits such in case of the Public Cloud solution. [13]

The main advantage for a Private Cloud solution is the location of data and ownership of the company's sensitive data, control over some critical applications or complex internal or external regulations, however the security such as firewalls and overall compliance are often a concern. [13]

2.2.3   Hybrid Cloud

The Hybrid Cloud, as the name indicates, is the combination of the Public and Private Cloud solutions, allowing the companies to take advantage of both, such as the ability of running an application and allocating sensitive data on the Private Cloud, with enablement of Public Cloud during peak periods when internal infrastructure may not handle the process. [13]

The Hybrid solution supply the best benefits of Cloud Deployment Models, leveraging the peak IT requirements on third parties, taking advantage of the scalability of

resources while keeping everything that is considered private strictly confidential.
[13]

3 Cloud Computing Characteristics – Impact on Operations Management

3.1 Common Cloud Computing Challenges

Despite the fact that the technology is a high priority for some of the biggest and most advanced companies in the world, as an up-and-coming technology, it is suffering multiple challenges to be resolved within next period of time.

3.1.1 Availability of service

"The high-availability computing community has long followed the mantra "no single source of failure, yet the management of a Cloud Computing service by a single company is in fact a single point of failure." [3, Page 14]

Such a situation can happen despite the fact that the Cloud Provider owns multiple data centers and various internet providers, due to the fact that the software infrastructure might be shared, thus having to crush the whole system. [3]

Having their business on the Cloud, the customers are not able to be prepared for such situation and it is very difficult to manage any disaster recovery plan.

Distributed Denial of Service (DDoS) is another connected activity. By overloading the servers with virtual users so called bots, the criminals threaten to cut off the service availability and incomes of the service providers. Such attacks can be prevented by fast scalability of the resources, but only on low to middle level. [3]

3.1.2 Data Lock-In

Having the data stored at the premises of a certain service provider may cause difficulties in cases of the need for a change of providers, or the failure of said provider on the market. Such obstacles are making the customers feel more dependent on

their current providers, causing them to be vulnerable during negotiations regarding the cost and quality of service provided to them. A similar situation occurred in 2008, when The Linkup Company, providing an online storage, ended their activity after losing access to the data of their customers. Caused by the fact that Linkup used third party services in order to secure storage space, the situation raised when the impacted business entities were not able to obtain their lost data back. [3][14]

3.1.3 Data Confidentiality, Auditability and Ownership

It is a serious concern about which data should enter the environment of mostly public Cloud Computing. Once uploaded, the data is stored in premises of the third party provider, making the leaders of businesses nervous about their further processing, even of the fact whether or not the data left the country.

Due to loss of control and visibility about the data movement, the impacted entities cannot be certain where exactly their data is stored or if they are being processes or distributed to third party.

Such manners can be settled in the contract, however, even in this case the customers are not gaining any more control regarding the existence of their sensitive data. It is advised that such data never leave the company's premises and in cases of need for the Cloud Computing, Private Cloud (see section2.2.1) is deployed. [3]

3.1.4 Performance

The performance is one of the biggest concerns when switching from traditional IT to Cloud Computing. The nature of the service, when a physical hardware can be shared by multiple virtual machines, there is a question to be asked about the Input / Output sharing of the devices and nodes employed within the process, such as CPUs, memory, disks and hubs, which threatens the final performance for the customers.

3.1.5   Standardization

With different services provides on the market, the need of general standardization is required. Despite the numerous ISO standardizations for different branches of IT, the compatibility between different providers remains uncertain. Using various systems and proprietary designs, the concern about the possibility of potential switch to a different provider rises questions, taking the negotiating power from the hand of customers.

3.1.6   Different regulations

Securing the service via the employment of multiple large data centers all over the world, it is important to consider a possibly contract what data center will be used, more concretely where the data will be located. Different regulations across the countries play a role in cases of distribution of the data, their possible sharing with the authorities and the manners of back-up and recoveries in cases of a switch among providers.

3.2   General Cloud Computing Benefits

3.2.1   Elasticity and Pay-As-You-Go-Principle

Elasticity is definitely one of the most significant improvements that Cloud Computing brings to IT world. Hardly predictable seasonal computational tasks requiring enormous computational power during peak periods are an ideal case for employing this attribute. With Pay-As-You-Go billing principle, customers dedicated for example to analytical, statistical or graphical rendering activities are able to add more computational power into their pools within hours instead of weeks, freeing themselves of the responsibility for developing, building and maintaining expensive data centers which would lie idle during the off-peak periods, allowing them to pay only for the capacities they actually use.

3.2.2 Reduced Costs

As mentioned in previous chapters, the reduced initial as well as operational costs are enormous advantage of Cloud Computing, mainly for small and medium enterprises that are not dedicated to any activity connected to IT, and also to new phenomenon on the market – Start-up companies. With very low investments the companies are able to utilize everything they need to be functional without having to invest directly. Reduced costs apply to following main areas:

- **Infrastructure investments** connected to building the data centers. The companies save considerable amount of money on design, development and future modernization of data centers.
- **Maintenance costs** defined by the costs of electricity, internet and other operational costs specific for physical maintenance of the facilities.
- **Staff costs** related to the employees hired for purpose of running of the data centers. IT engineers are one of the top-paid segment on the labour market. The companies are also liberated of the employments legal and human resources management.

By leveraging the responsibility, the costs connected to the future reinventions and modernization are applicable to the providers only.

3.2.3 Better strategic position and Differentiation from the market

„Strategies are plans for achieving organizational goals. The importance of strategies cannot be overstated; an organization's strategies have major impact on what the organization does and how it does it. Strategies can be long term, intermediate term, or short term. To be effective, strategies must be designed to support the organization's mission and its organizational goals." [16, Page 38]

It is well known that employing modern technologies and being supported by the biggest players on the market can effect company's performance as well. By employing efficient strategy of assured delivery and performance, low costs and revenues focused on improvements and reinvention, the companies have a chance to form more aggressive strategies within all short, intermediate and long terms, as the resources can be obtained and employed in significantly shorter period. Also, Cloud Computing is connected to other modern technologies (See Chapter 4), which offer significant opportunities on the market, gaining the companies the chance to diversify.

„The strategy of differentiation from competition is to achieve a unique position. The differentiation strategy required that the company succeeds in being unique, or is regarded as being unique by at least one differentiation feature." [17, Page 85]

By employing a unique mix of services (See Chapter 5) with new technologies employed (See Chapter 4) in the right period of time, the companies are both able to succeed at the customer side and obtain an excellent durable position on the market.

3.2.4   Competitiveness and Productiveness efficiency

„Business organizations compete through some combination of their marketing and operations functions. Operations influences competitiveness through product and service design, cost, location, quality, response time, flexibility, inventory and supply chain management, and service. Many of these are interrelated." [16, Page 36]

Embracing the opportunities provided by Cloud Computing and connected technologies, the companies are given the chance to obtain a sane mixture of every important aspect of operations management function in a positive relation to their business. Cloud computing and engaged technologies offer improvement by innovative and modern service design, lower costs possible, improved quality, response time and flexibility by scalable and rapid engagement of resources, improving the overall quality of the whole service as such.

„Productivity is an index that measure output (goods and services) relative to the input (labour, materials, energy, and other resources) used to produce them.“ [16, Page 47] Given the lower input of labour and resources that are necessary to be engaged into the production of goods or services by leveraging them to third parties while offering increased output by flexibility and scalability of engaged resources, companies are very positive to have durable increase in their production, thus gaining the potential for expansion.

4 Connection to Up-coming technologies

The upcoming and future technologies, some of which are currently under intense development, like Cloud Computing, are strongly interconnected among each other, due to the fact that every single one may depend on one or more other ones. As for example Big Data are hardly possible without, or let us say enabled more efficiently with Cloud Computing, but do not have very reliable source of data without Social networks, which are nowadays more than often provided via Mobile applications. Below we express three fields of not only technological, but also environmental and social development that have very strong potential for the future and are intensively connected to the Cloud Computing.

4.1 Big Data

„Big data is a popular term used to describe the exponential growth and availability of data, both structured and unstructured. And big data may be as important to business – and society – as the Internet has become. Why? More data may lead to more accurate analyses." [18]

Defined by popular '4Vs' and their Complexity (noted in sections below), Big Data provide a revolutionary way of processing huge amount of unstructured data via advanced algorithms, thus providing a change for an improved input to the companies that is further on available for analysis.

Volume is one of the key characteristics, as the data are obtained via the Internet, mainly from sources like social media or different applications used by users. Increasing amount of features in the devices which are being used for many purposes on everyday basis are constantly increasing the input. [18]

Velocity in this case refers to the enormous speed of the transitions of the data in the real time, prompting a big challenge for fast storing and processing. [18]

Variety is caused by the different formats of data streamed, from simple texts, through audio and photos, locations and transactions to streamed high-resolution videos. Managing all the possible files of many sized and formats remains a struggle till these days. [18]

Variability expresses rather time irregularities then variety of data as such. Data flow in real-time in medium to hardly predictable amounts caused by social events, causing peak and off-peak fluctuations as well. [18]

Complexity is connected to the source of data, as it can come from many different ways of many different applications installed on many different devices. The behaviour and way of communication by single users cannot be neglected as well. [18]

4.2 Mobile applications and Mobility of data

Today's big trend, not only in IT, is to make everything accessible quickly, reliably and in the real time, providing business critical information in every moment. The trend is to provide the relevant source via two possible ways:

- A mobile browser to access the application on the web
- Native application designed for specific Operating System

Both manners have their advantages and challenges depending mainly on the way of the interaction expected from the users. However, the most important aspect to be considered by the enterprises is safety at all times, via secure company's VPN or Intranet and secure and reliable distributors of devices. [19]

The mobile application are predicted to suffer a big development in the future, focusing on replacements of traditional devices, being available to the bigger amount of employees with application specially developed for this platform. [20]

Taxonomy of Mobile applications [21]

- Mobile advertisement
- Mobile entertainment services
- Mobile personal services
- Mobile distance education
- Mobile product recommendation systems
- Wireless patient monitoring Mobile telemedicine

4.3   Social networks

„It is the easiest to understand and perhaps the hardest to manage and control." [21]

Social media and their networks are probably the biggest influencer to the modern society, affecting the global market functions on much bigger scale that one might expect. Not only they are connected individuals across the planet, providing the revolutionary ways of communication either on personal or professional level in the real-time, they are bringing the products closer to the customer by relevant applications, advertising and advanced marketing options, but also interconnecting the individuals with the businesses and among each other as well.

Some of the world's biggest social media either on personal or professional scale are Facebook, Twitter, LinkedIn, Pinterest, Google Plus+, Tumblr, Instagram, VK, Flickr and more. [23]

Results

5 AppAnalytics.io

5.1 Introduction

AppAnalytics is a small company focusing on the development of solution assisting in the field of mobile application development, allowing the developers to better engage with their customers by measuring and tracking their activity and thus maximize the experience needed for further improvements by real-time mobile application analytics designed for the overall lifecycle of development.

Currently, there are 3 known offices in London United Kingdom, San Jose California USA and Istanbul Turkey.

5.2 Offered Services [15]

Main types of services offered listed.

Touch heat maps

„App Analytics records all touch gestures (taps, swipes, pinches) in each of your app's screens, and aggregates them into a visual 'touch heatmap. You can see where users are tapping, and find out which parts in your app screens users focus the most."

With AppAnalytics' touch heat maps you can understand:

- Which parts of every screen are more interesting?
- Which call to action buttons are being ignored?
- Which features are used and which can be removed?

With the application tracking gestures and monitoring overall activity, the user is able to recognize the obstruction in their user interface by obtaining the review on

what parts of their app are not used, or which gestures are performed on more frequent basis, allowing the developers to modify the graphical user interface.

Gesture recognition

All the gestures up to even four fingers performed by the users can be tracked and recognized by the developers in order to better understand the interaction with the application under development.

Interactions like accelerometer's activity, device's orientation and location can be monitored as well.

In-app analytics

In-app analytics provide overall real-time analysis of total users participating on the current session, application launches, recorded touch events, session time, user locations, retention rate, number of active users, bounce rate, device models and operating systems engaged, session analytics and carriers.

Event-based analytics

Helping to answer questions about what events are triggered the most, their analytics and even what improvements changed the popularity of single event, the application creates a dashboard with overall tracker.

User analytics

Providing the detailed information about the user, form their activity within the application to the types of devices used, allowing the developers better understand and approach their target groups.

6 Cloud Computing Solution

The Cloud Computing Solution for AppAnalytics.io company was derived from the studied nature of the company and its business services in combination with the Cloud Computing characteristics, considering the future technologies and possibilities as well. The Solution is described based on the Cloud Service Model and Cloud Deployment Model suggested, with business justification. The SWOT analysis is performed in order to study the character on the company combined with the Cloud Computing Solution performing on the market. Cost comparison is provided in order to stress the validity of considering Cloud Computing Solution for a small company instead of developing own data center based on the notion of traditional IT.

6.1 Cloud Model Solution

The model Cloud Computing solution chosen for the type of the company was of the Hybrid Cloud (See Chapter 2.2.3) from the Cloud Deployment models and Platform as a Service (PaaS) (See Chapter 2.1.2) from Cloud Service Models.

Figure 6 - PaaS Depiction within Hybrid Cloud [24] [25]

6.2 Business Justification for Hybrid Cloud with PaaS

The Cloud Computing setting was considered and chosen due to the nature of the company, its services provided and the data with which it comes into contact on daily basis.

The Hybrid Cloud solution was considered the relevant one because the company processes both confidential data from its customers, such as emails, phone numbers,

credit card numbers and locations while it processes large amount of obtained data in order to establish their service within customer devices.

With the Hybrid Cloud Computing Deployment model, the confidential data would be stored on local server of the company, while all the interaction and processing would run on Public Cloud secured by Amazon, securing the smooth and continual service for the customer all across the world with no confidential data leaving to the third party.

The Platform as a Service (PaaS) is the best suitable option for the company. As it already covers the infrastructure mentioned, it provides the company with the platform required for development and distribution of their applications, with desired operational system installed.

6.3   Evaluation of Operation factors

The following evaluation was assembled in order to show the initial costs of building a data center in comparison with to the cost of suggested Cloud Computing services offered by top providers.

The evaluation is created for first 5 years, which is the average evaluation period after which the equipment needs to be updated, at current prices for materials and labour and the data center would be located in USA, one of the three official locations and it is assumed that the building used for the built is already possessed by the company.

It is important to mention that due to the nature of the company, the data center was chosen to be one of the smallest which are usually being built for similar purposes, of an intermediate to advanced security standards with 24x7x365 staffing in order to guarantee the stability of services.

Describing the **Costs connected to the build and equipment of data center in Tables 1 – 8,** the specialized internet software provided by a company related to the field. Initial Parameters used for the Calculation of the costs for data center designed were the average price of electricity from the past period of time in the Unites States of America, the speed of the Internet connection that was via software converted into costs, number of cabinets that would contain necessary hardware in order to create a prompt server, redundant power supply and percentage of power consumed.

Table 1- Initial parameters [27]

1	Average price of electricity (US C.kWh^{-1})	12
2	Internet connection speed (Mb.s^{-1})	100
3	Number of cabinets	36
4	Redundant power supply (kWh)	50
5	% of available power consumed	60

It is important to mention that the parameters were chosen based on the evaluation of the functionality of average data center in the USA over the past period of years. Note: (For purpose of better comparison, the paid operating systems were neglected and free open source was considered).

Table 2 - Costs of Engineering and Preparation [27]

Engineering and Preparation			
Description	**Material Costs ($)**	**Labour Costs ($)**	**Total ($)**
Engineering	-	63,887.50	62,887.50
Permits/Approvals	-	11,686.35	11,686.35
Site preparation	-	11,686.35	11,686.35
			86,260.20

Table 2 depicts the costs connected with the initial design of the data center. Engineering – everything from activities as technical aspects consideration up to sole inner preparation of the site. Also, the costs connected to the administrative and legal activities connected to permits and approvals are considered.

As the workload performed is not connected to the materials used for the build, only the labour costs are considered.

Table 3 - Costs of Network [27]

Network			
Description	**Material Costs ($)**	**Labour Costs ($)**	**Total ($)**
Core equipment	-	46,117.50	46,117.50
			46,117.50

Costs connected to Networking in the Table 3 are connected to the assessment of the functionality of the network and the connection of the site to the Internet, rather than the hardware and materials that are depicted in the Table 4.

Table 4 - Costs of Power Supplies [27]

Power			
Description	**Material Costs ($)**	**Labour Costs ($)**	**Total ($)**
Utility improving	23,338.25	10,128.17	33,466.42
Main Switch Gear	125,775.00	57,297.50	183,072.50
Transfer Switches	90,837.50	7,790.90	98,628.40
UPS System	251,550.00	55,900.00	307,450.00
TVSS System	1,558.18	1,558.18	3,116.36
Generators	201,240.00	40,512.67	241,752.67
Conduct + Cabling	6,232.72	6,232.72	12,465.44
Lightning	8,881.62	6,388.54	15,270.16
Room PDU's	69,875.00	55,900.00	125,775.00
			1,020,996.95

The Table 4 focuses on the costs regarding the basic hardware and utilities expenditures, which are connected to the materials as well as the labour required for the assessment.

- Utility Improving is connected to the center's basic tools for power management maintenance.
- Main Switch Gear is directly connected to the energy supply of the whole facility, protecting the electrical devices from the short circuit in case of an accident in the energy network.
- Transfer Switches is a device that distributes the load between the sources.
- UPS System refers to the Uninterruptible Power System which is necessary to ensure the continuous power supply, thus protecting the data center from black-outs.
- TVSS System also known as Surge protector serves as a protecting device dedicated to restrict the voltage delivered to the electric device.

- Generators are devices employed in case of medium to long term electricity loss, ensuring the sustainable power supply during disaster situations.
- Conduct & Cabling refers to all conductors and cables employed in the prompt functioning of the equipment and facility
- PDU refers to Power Distribution Unite, a device used especially for data centers, distributing the power to racks and servers.

Table 5 - Costs of Environmental Controls [27]

Environmental Controls			
Description	**Material Costs ($)**	**Labour Costs ($)**	**Total ($)**
HVAC	86,645.00	62,327.18	148,972.18
Raised Floor	12,153.80	18,698.15	30,851.95
Condensate Drains	1,246.54	1,246.54	2,493.09
Leak Detection	3,739.63	747.93	4,487.56
Fire Suppression	26,412.75	9,349.08	35,761.83
			222,566.61

Table 5 calculates the basic costs connected to the environmental control of the surrounding of the data center. The parameters considered are used to provide safe and stable production of the site, mitigating the risk of disaster situations.

- HVAC refers to Heating, Ventilation and Air Conditioning system used for maintain desired temperature and humidity of the environment

Table 6 - Costs of Security and Monitoring [27]

Security and Monitoring			
Description	**Material Costs ($)**	**Labour Costs ($)**	**Total ($)**
Site Management	9,349.08	1,558.18	10,907.26
CCTV System	4,674.54	779.09	5,453.63
Access System	4,611.75	779.09	5,390.84
			21,751.73

Table 6 depicts the costs connected to the site management and monitoring necessary to ensure the security of the facility.

- CCTV System is a closed-circuit television system that served as an internal monitoring solution, difficult to be breached
- Access System can be on various level, ranging from basic key or badge solution in this case, to biometric verification that are more expensive.

Table 7 - Costs of Computational Power [31]

Intel® Xeon® E5-1410 v2 2.80GHz, 10M Cache, Turbo, 4C, 80W, Max Mem 1333MHz				
CPUs	**RAM (GB)**	**Storage (GB)**	**OS**	**Price ($)**
36 (9x4)	72 (9x8)	4500 (9x500)	Linux/Unix	8,850.00 (9x950)

Table 7 considers costs for computational power of similar setting than the Amazon Cloud Service described in Table 9. In order to match the power, nine servers would be needed, thus the multiplication by nine in the brackets. The discrepancy in RAM configuration is caused by the default settings of the machine by the selling company, as well as including the storage implementation.

Table 8 - Total Costs of 5 years of Operations [27]

Total Cost of Ownership for 5 years	
Construction Costs	$1,397,500.00
Floor Space	$82,500.00
Electricity	$62,208.00 xx` 5
Electrical Maintenance	$14,816.714 x 5
HVAC Maintenance	$2,772.64 x 5
Other Systems Maintenance	$1,441.54x5
24x7x365 Staff	$60,000.00 x 5
Redundant Circuits	$67,200.00 x 5
Computational power	$8,850.00
Grand Total for 5 years	**$2,531,244.47**

Obtaining the final calculation using both the specialized internet calculator combined with other costs consideration, final sum of costs related to the build and equipment for the facility added up to **$2,531,244.47.** The costs also include the maintenance and electric expenditures for the evaluation period of five years.

Table 9 - Amazon EX@ c4.8-xlarge Compute Optimized Current Parameters [26]

| Amazon EC2 c4.8-xlarge Compute Optimized Current Generation					
Configuration	vCPUs	ECU	RAM (GB)	Storage	OS
c4.8-xlarge	36	132	60	EBS only	Linux/Unix

Table 9 describes the hardware setting chosen for the Cloud service solution.

- EBS storage refers to the Elastic Block Store, which is an on-demand storage enabled based on the needs of the customer, with no specific size specified in forward.

Table 10 - Amazon EC2 c4.8-xlarge Compute Optimized Pricing [26]

Amazon EC2 c4.8-xlarge Compute Optimized Current Generation Pricing			
Commitment	**$ per Hour**	**$ per Year**	**$ per 5 years**
On-demand	1.8560	16,258.56	81,292.80
Reserved	1.1653	10,028.00	50,140.00

Table 10 depicts the costs connected to the Cloud Service with regards to per-hour and per-year calculations and respective five years evaluation.
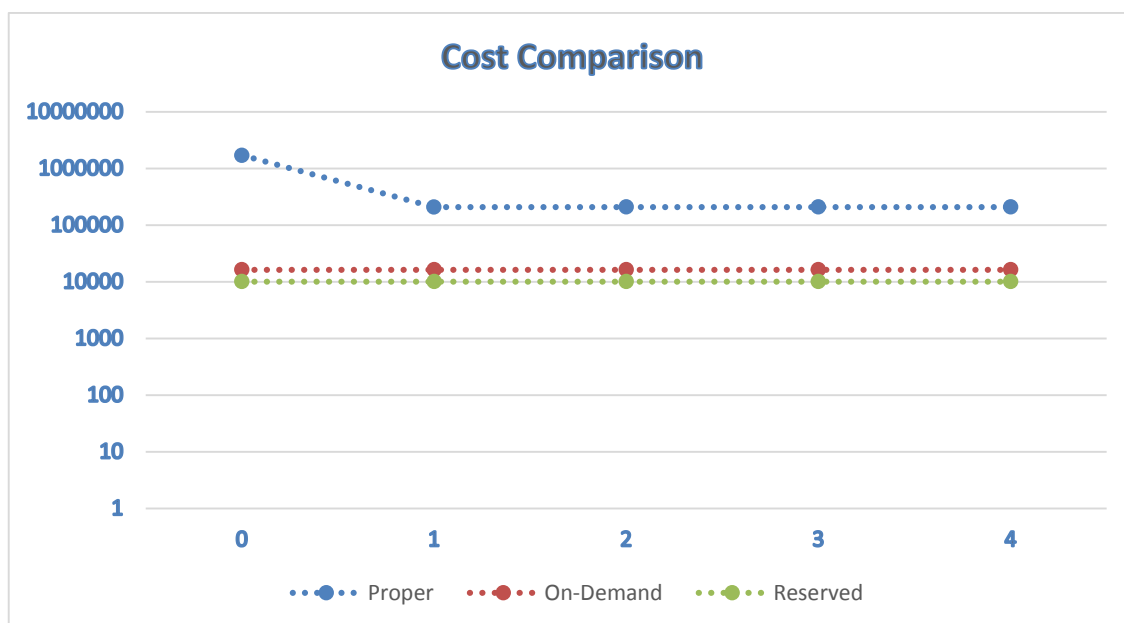
Figure 4- Costs Comparison

The Figure 4 shows the cost comparison, comparing the cost of the proper data center, the on-demand and reserved Cloud Service solution.

It is visible that the biggest costs are related to the initial phase of building and development of the facility, along with the purchase of the equipment. The differences between the proper solution and the Cloud services solutions during the next years are caused by the costs of the maintenance, energies and staffing, as regarding the Cloud Computing solutions, these responsibilities belong to the provider.

The difference between the on-demand and reserved solution is caused by the accessibility options provided to the customer.

Discussion and Limitations

Despite the fact that the Cloud Computing technology shows numerous benefits for business environment, there has been criticism from professionals, aiming mostly on its standardization, data security, issues connected to government and in the end, overall redundancy, thus expressing scepticism about the technology.

Steve Santorelli described his doubt on Data privacy topic:

„The downside is that you are abrogating responsibility for your data. Someone else has access to it and someone else is responsible for keeping it safe." [30]

Followed by Scott Hazdra in the same interview, mentioned lack of standardization concern was expressed:

„The question of how safe the cloud is has many facets, and the answer depends on the cloud services provider, the type of industry a company is in, and the accompanying regulations concerning the data it is considering storing in the cloud." [30]

As Richard Stallman stated in the article for The Guardian, he proposed the idea of Cloud Computing being redundant: „The interesting thing about cloud computing is that we've redefined cloud computing to include everything that we already do. The computer industry is the only industry that is more fashion-driven than women's fashion. Maybe I'm an idiot, but I have no idea what anyone is talking about. What is it? It's complete gibberish. It's insane. When is this idiocy going to stop?" [29]

It is also important to evaluate the significance of the calculations and its usability in the real-world situations. The conditions set in the Results part of the thesis were very specific to the type of company and the country, from which we can observe

that there are multiple factors that affect the applicability of the Cloud Computing solutions being implemented:

- Current situation of the company
- Services offered by the company
- Future plans
- Country of actuating
- Internal regulations of the company
- Costs related to the country of actuating
- Hardware costs offered
- Computational power needed

Observing properties, benefits and drawbacks of the solutions and its connection to the costs, every company shall evaluate its current situation and decide, whether it is relevant to invest in such area. For example, a company focused on data processing and application development, such as the one described in the thesis, has more pronounced reasons to agree to this approach than a company focused mainly on manufacturing processes. The future plans, country of actuating and internal regulations may act as restrictions as well.

The risk connected to Cloud Computing becoming obsolete technology or possible changes of the price ranges in the future shall not be neglected as well.

Conclusion and Recommendations

This thesis was focused on the Cloud Computing technology, its adjacent up-coming technologies and their introduction to the small and medium enterprises. The overall goal was to examine the validity for the small and medium enterprises.

By examination of the chosen small company, the Cloud Computing Service Solution was chosen and the evaluation with regards on the costs was performed and further on compared to the suggested services from Amazon.

It was proven that the most significant costs for the company are the ones connected to the build, development and equipping the facility. The costs for energies, staffing and maintenance are still significant.

It is recommended for each company to evaluate their current situation and future plan, in combination of considering the services offered and the laws and limitations of the market of actuation. The connection of the benefits to the costs and selected operations factors was indicated, yet, the solution may not be always applicable as it is dependent on multiple factors.

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