Czech University of Life Sciences Prague

Faculty of Economics and Management

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Diploma Thesis

Comparison between cloud - based application and on-premises application: case study airline website

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DIPLOMA THESIS ASSIGNMENT

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Thesis title

Comparison between cloud – based application and on-premises application: case study airline website

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Objectives of thesis

1 Benchmarking: Compare the performance of cloud-based and on-premises applications for the organization's current website. Measure performance using factors like response time, availability, and stability.
2 Cost analysis: Calculate and compare the costs of on-premises and cloud-based applications. Consider licensing, updates, maintenance, hosting, and storage expenses.
3 Flexibility evaluation: Assess the scalability and adaptability of each model to meet changing system requirements and technological advancements.
4 Security assessment: Evaluate the level of security and protection provided by on-premises and cloud applications, including data security and access management.
5 Transformation and decision-making recommendations: Provide clear recommendations and insights to help the organization make informed decisions based on the advantages and challenges identified for each model.

Methodology

The performance, cost, adaptability, and security of various airline websites will be compared in this study utilizing either cloud-based or on-premises systems.

We will use interviews and surveys to obtain data as we track the website's performance, gather cost data, understand its flexibility, and evaluate security measures.

Our investigation will thoroughly assess the impact on performance, cost, flexibility, and security using both qualitative and quantitative methodologies.

Tables and visuals will be used to present our data so that the contrasts between the two deployment approaches are clearer.

We will offer practical recommendations based on our study to assist the organization in making better decisions.

Any restrictions or limits that fall inside the purview of our research should be acknowledged.

We place a high priority on data protection and will make sure that throughout the research process, informed consent is obtained.

Our study attempts to give a thorough understanding of how each deployment type satisfies the criteria of the airline website.

We hope to assist the firm in choosing the best strategy for its unique requirements by looking at these variables.

The proposed extent of the thesis

50-60

Keywords

Cloud-based applications, Availability, Stability, Cost analysis, Updates, Hosting

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Recommended information sources

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Declaration

I attest that I independently worked on my master's thesis entitled "**Comparison between cloud - based application and on-premises application: case study airline website**" and solely relied on the sources acknowledged in the thesis bibliography. As the author of the master's thesis, I affirm that the content does not infringe upon any copyrights.

In Prague on 07-03-2024 ____________________________

Yamen Chaban

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Comparison between cloud - based application and on-premises application: case study airline website

Abstract

This study examines the differences between cloud-based and on-premises applications, specifically focusing on an airline website. The investigation uses descriptive statistics from survey responses to analyze performance, cost-effectiveness, scalability, and security aspects.

The study assesses user satisfaction with cloud-based and on-premises applications in terms of response time, availability, stability, peak traffic handling, and overall performance.

Statistical analysis shows that cloud-based applications typically outperform on-premises solutions in these metrics, with mean scores indicating satisfactory performance. An evaluation of licensing fees, pricing structures for updates and upgrades, ongoing maintenance costs, hosting expenses, and overall cost-effectiveness shows that cloud-based applications are generally considered more reasonable, transparent, and cost-efficient than on-premises alternatives.The research examines the scalability and adaptability of both types of applications in response to evolving system requirements and technological advancements. Cloud-based applications are becoming more scalable and adaptable, enabling dynamic adjustments to fluctuating workloads, while on-premises solutions struggle to keep up with new technologies. The study investigates user opinions on data security, access control, encryption methods, regulatory compliance, backup and disaster recovery, and physical security protocols. On-premises applications are considered to provide enhanced data security and improved control over access management, whereas cloud-based applications are known for their strong encryption methods and dependable backup and disaster recovery capabilities.

Dyadic samples T-tests show a statistically significant disparity in user satisfaction regarding performance and costs between cloud-based and on-premises applications. Cloud-based applications show superior performance scores on average, whereas on-premises applications have slightly higher average scores for costs. Regression analysis confirms the correlation between performance and costs, highlighting the beneficial influence of cloud-based performance on cost-efficiency.

The findings provide important insights for the current discussion on application selection, highlighting the importance of performance, cost-effectiveness, scalability, and security factors.

Keywords: Cloud-based applications, Information Technology, Internet of Things, Machine Learning, Cloud Computing

Srovnání mezi cloudovou aplikací a místní aplikací: případová studie webové stránky letecké společnosti

Abstrakt

Tato studie zkoumá rozdíly mezi cloudovými a místními aplikacemi, konkrétně se zaměřuje na webové stránky letecké společnosti. Šetření využívá popisné statistiky z odpovědí průzkumu k analýze výkonu, nákladové efektivity, škálovatelnosti a bezpečnostních aspektů.

Studie hodnotí spokojenost uživatelů s cloudovými a místními aplikacemi z hlediska doby odezvy, dostupnosti, stability, špičkového zpracování provozu a celkového výkonu.

Statistická analýza ukazuje, že cloudové aplikace obvykle v těchto metrikách překonávají místní řešení, přičemž průměrné skóre ukazuje na uspokojivý výkon. Vyhodnocení licenčních poplatků, cenových struktur za aktualizace a upgrady, nákladů na průběžnou údržbu, nákladů na hosting a celkové nákladové efektivity ukazuje, že cloudové aplikace jsou obecně považovány za rozumnější, transparentnější a nákladově efektivnější než místní alternativy. výzkum zkoumá škálovatelnost a adaptabilitu obou typů aplikací v reakci na vyvíjející se systémové požadavky a technologický pokrok. Cloudové aplikace se stávají škálovatelnějšími a přizpůsobivějšími, což umožňuje dynamické přizpůsobení kolísajícímu pracovnímu zatížení, zatímco místní řešení se snaží udržet krok s novými technologiemi. Studie zkoumá názory uživatelů na zabezpečení dat, řízení přístupu, metody šifrování, dodržování předpisů, zálohování a obnovu po havárii a fyzické bezpečnostní protokoly. Předpokládá se, že místní aplikace poskytují vylepšené zabezpečení dat a lepší kontrolu nad správou přístupu, zatímco cloudové aplikace jsou známé svými silnými metodami šifrování a spolehlivými možnostmi zálohování a obnovy po havárii.

Dyadické vzorky T-testů ukazují statisticky významný rozdíl ve spokojenosti uživatelů ohledně výkonu a nákladů mezi cloudovými a místními aplikacemi. Cloudové aplikace vykazují v průměru lepší skóre výkonu, zatímco místní aplikace mají mírně vyšší průměrné skóre nákladů. Regresní analýza potvrzuje korelaci mezi výkonem a náklady a zdůrazňuje příznivý vliv cloudového výkonu na nákladovou efektivitu.

Zjištění poskytují důležité poznatky pro současnou diskusi o výběru aplikací a zdůrazňují důležitost faktorů výkonu, hospodárnosti, škálovatelnosti a zabezpečení.

Klíčová slova: Cloudové aplikace, Informační technologie, Internet věcí, Strojové učení, Cloud Computing

Table of Contents

1. Introduction

In a world where technology is always changing, companies like airlines are always looking for faster ways to do things and meet customer wants. It's important to know the difference between cloud-based and on-premises apps because they affect many things, such as how useful, secure, and cost-effective they are. At an airplane website, this study compares the two models side by side to see how each one affects the site's success and growth.(Ganji Madhuker 2023)

Cloud-based apps are very flexible and can grow as needed, which makes them a good choice for modern companies like planes. Using cloud infrastructure, these apps are stored on faraway computers that are handled by outside companies. This makes it possible to access them easily from anywhere with an internet connection. For a flight website, this means that both customers and employees will be able to get to it more easily. This will allow for real-time changes, bookings, and contacts with customer service from anywhere in the world. Also, cloud-based solutions often have pay-as-you-go price plans, which means that the company doesn't have to make big investments up front and can easily add more digital services without spending a lot of money.(Dialpad. 2022)

Applications that are hosted in the cloud give an unequaled degree of flexibility and scalability, which makes them an enticing alternative for current enterprises such as airlines. Applications that operate in the cloud are physically hosted in the cloud. The bulk of the time, these programs are hosted on faraway servers that are managed by third-party vendors. Utilizing cloud infrastructure enables for the effective accomplishment of this operation. Consequently, this makes it doable for everyone to view them without having any issues from any region in the globe that has an internet connection.(Cleo 2022) The fact that this is the case means that the website of an airline will be simpler to access for both its staff and its valued customers. Customers will be able to make reservations, obtain updates in real time, and connect with customer service professionals from any point on the planet as a consequence of this advancement. Pay-as-you-go pricing mechanisms are typically featured in cloud-based systems. These methods remove the need for major initial expenditures and allow cost-effective scaling as the airline grows its digital presence. This additional perk is provided by cloud-based systems, which is a major plus.(AlSalamah 2017)

Conversely, software and hardware that is hosted inside the physical location of the firm is referred to as on-premises applications. Additionally, the vast majority of applications fall into this category. A substantial outlay of capital is necessary to establish the necessary hardware, software licensing, and IT infrastructure for the implementation of this paradigm. Nevertheless, this expenditure is vital, even while it gives customers a sense of control and security over their data and actions. In order to oversee an airline's website's on-premises servers, competent IT specialists are essential. In order to implement security updates, perform routine maintenance, and install new systems, these experts are needed. Among these duties is the need to make sure data is secure. While this approach may create a sense of safety and conformity while still meeting legal requirements, it may not offer the scalability and agility of cloud-based solutions. This is so even if doing so could provide the impression that regulatory requirements are being met.(V. V. Arutyunov 2014)

Because they can take use of distributed processing power and vast resources, applications hosted in the cloud significantly outperform their on-premises counterparts. Because of these benefits, they outperform competing apps. There are a lot of distinct benefits to using apps that are hosted on the cloud. When it comes to airline websites, the scalability of the cloud ensures that they will remain fully functional even during peak reservation or promotional times. In particular, this is crucial for websites that see variations in the number of unique visitors. The fact that cloud platforms already have failover and redundancy features built in is another perk of adopting them. By incorporating these features, we can lessen the impact of downtime and ensure that our clients will have uninterrupted service. On the other hand, depending on the capacity of the organization's infrastructure, applications stored on-premises may have performance constraints. The reason for this is because the apps are kept on-premises. Because of this, response times may be much slower than usual in cases when the application is highly demanded.(N. Dissanayake 2022)

Airline website security is crucial since customer data is very sensitive and there are serious consequences that might result from security breaches. The information itself is to blame for this. Certain standard advanced security features of cloud-based systems include encryption, multi-factor authentication, and periodical security assessments conducted by the provider. Many cloud-based solutions already have these safeguards built in. Cloud companies that meet the most stringent security requirements and have the most recent compliance certifications are also the most dependable. In this way, customers may rest certain that their data is safe from harm. This notwithstanding, worries regarding data sovereignty and regulatory compliance persist. Regarding airlines based in nations with stringent data privacy laws, this is particularly relevant.(Halpin 2020)

The main benefit of on-premises applications is the increased control they provide organizations over their security measures. Keeping the data utilized by these apps inside the boundaries of the company's network is the reason behind this. For this reason, this remains true. Specifically, this approach stands out as highly beneficial for airlines that face stringent regulatory requirements or are concerned about data privacy and sovereignty. Put simply, airlines greatly benefit from this approach. By implementing robust firewalls, access restrictions, and intrusion detection systems, airlines may lessen the likelihood of external attacks and illegal access to critical data. One way they can achieve this is by integrating these measurements into their operations. To ensure that security measures and upgrades are continuously up-to-date, it is crucial to engage in vigilant monitoring and to invest in cybersecurity personnel and technology. One way to achieve this is to make sure that monitoring is done frequently.(Pinnadhari 2020)

A cost-effectiveness analysis should be conducted before an airline website chooses between cloud-based apps and on-premises applications. Users have easier access to cloud-based applications compared to on-premises applications. There is no need to make upfront expenditures in hardware and infrastructure while using cloud-based solutions. Reason being, these investments are rendered unnecessary by pay-as-you-go pricing techniques, which reduce the need for them. Consequently, solutions hosted on the cloud wind up being a tempting option. In addition, the scalability of cloud resources makes it feasible for airlines to adapt their expenditures with their consumption patterns. This, in turn, helps companies to decrease their operational expenses and optimize their return on investment. Each and every airline enjoys a huge drop in their expenses as a result of this. Despite this, it is of the highest essential to take into consideration the entire cost of ownership over the course of the long period of time that is being evaluated. The expenditures involved with migrating data, the fees associated with membership, and the likelihood of price hikes being imposed by the cloud provider are all included in these costs.(Xperience 2017)

On-premises applications, on the other hand, necessitate large upfront investments in terms of infrastructure, software licensing, and hardware. It is vital to make these investments. This makes them less acceptable from a budgetary viewpoint, especially for small airlines or startups that have limited capital. This is particularly true for smaller airlines. When it comes to beginning firms, this is especially true. In addition, the constant maintenance and operation expenses that are connected with on-premises servers may increase over time, perhaps outweighing the initial cost savings that are available with cloud-based options. The reason for this is the significant financial savings compared to using servers located on-premises. The reason for this constraint is because on-premises servers need continuous maintenance and operations. For bigger airlines with an existing IT infrastructure and extensive security requirements, the on-premises option may provide a more predictable cost structure and better control over spending. The reason for this is because larger airlines have more security measures. Reason being, the airline's own grounds are where the on-premises solution is set up.(Thakur 2022)

In order to choose between cloud-based services and on-premises applications for an airline's website, a thorough evaluation of several variables is required. Considerations such as ease of use, efficiency, safety, and affordability are part of these standards. The utilization of services hosted in the cloud is one tactic that is quickly becoming popular. Despite the greater initial cost, applications that are implemented on-premises provide more control over compliance and security. On the other hand, cloud-based solutions provide unparalleled scalability, flexibility, and affordability. There is no substitute that can match these advantages. Finally, the best solution out of all the ones available will depend on the airline's unique needs, objectives, and available resources. The benefits of both cloud-based innovation and the predictability of on-premises regulated operations are addressed by this strategy. This method finds a happy medium between the two ideas.(Bhanderi 2022)

2. Objectives and Methodology

2.1 Objectives

The key purpose of this Diploma Thesis revolves around the Comparison between cloud - based application and on-premises application: case study airline website. The objectives develoed in the current research includes the analysis for Comparison between cloud - based application and on-premises application: case study airline website.

The main objective of this diploma thesis are :

- Compare the performance of cloud-based and on-premises applications for the organization's current website. Measure performance using factors like response time, availability, and stability.

- Calculate and compare the costs of on-premises and cloud-based applications. Consider licensing, updates, maintenance, hosting, and storage expenses.

- Assess the scalability and adaptability of each model to meet changing system requirements and technological advancements.

- Evaluate the level of security and protection provided by onpremises and cloud applications, including data security and access management.

2.2 Methodology

In the following research, the researcher has implied a mixed-method design, in which a mixture of empirical and non-empirical research approaches has been carried out. We will use surveys to obtain data as we track the website's performance, gather cost data, understand its flexibility, and evaluate security measures. In the empirical study, the quantitative study design has been employed, and in the non-empirical research, the qualitative research design has been employed. The two sections have been briefly explained below.

2.2.1 Empirical Research

The empirical research section includes the quantitative research design in which the data in numerical values have been collected. Data collection in the numerical form has been approached and prospectively collected in relation to better specification using the questionnaire survey, respectively. The questionnaire has been developed and distributed among the sample population within the current research. The sample population include people from various cloud - based application and on-premises application which have provided the respective orientation of perception collection regarding cloud - based application and on-premises application presence and customer involvement. The main information has been getehred from the questionnaire, which is further evaluated using the SPSS software. The implication of impact on performance, cost, flexibility, and security using both qualitative and quantitative methodologies and descriptive statistics have been employed for the analysis of Comparison between cloud - based application and on-premises application: case study airline website.

2.2.2 Non-Empirical Research

The secondary qualitative research design has been followed in the current section under the first phase of research for the completion of non-empirical research. In consideration of primary qualitative, the interviews have been carried out from the participants in Comparison between cloud - based application and on-premises application: case study airline website, respectively.

3. Literature review

3.1 Introduction

The following chapter has been developed with the consideration of reviewing literature with reference to the current issue under discussion for the following research. The key purpose of the research includes Comparison between cloud - based application and on-premises application: case study airline website. Comparison between cloud-based and on-premises applications is studied in the literature. and their respective influences on the contextual case study airline website, respectively. There are multiple orientations that have been followed with the current structure, with which the main follow-up has been carried out with reference to the aligned literature from the respective studies. In that possibility, comprehensive knowledge has been collected with regards to cloud - based application and on-premises application: case study airline website, respectively.(Kanade 2021)

There are multiple orientations that have been developed under the headings of the current literature review in which the understanding has been carried out with airline website. After comprehending of Comparison between clouds - based application and on-premises applicationin the analysis, along with the significance of airline website in it. The general and comprehensive details have been respectively related to the consideration of maintained specifications within which the main approach has been related to the structural review for cloud - based application and on-premises application: case study airline website, respectively. The different factors in literature findings impact clouds - based application and on-premises application respectively.(Srivastava 2023)

Businesses must choose between on-premises and cloud computing for their IT infrastructure in the ever changing digital world of today. In terms of how businesses handle their data, apps, and entire technological stack, this decision marks a crucial turning point..(Lerner 2023)

3.2 Cloud computing

"The cloud" refers to the delivery of various computer services via the internet. These services include storage, databases, networking, software, analytics, and intelligence. By doing so, economies of scale, flexible resource management, and rapid innovation are achieved. By allowing you to pay only for the resources you actually use, most cloud services pave the way for you to scale up or down your infrastructure in response to fluctuating business demands, all while cutting costs and cutting corners.(Steve 2022)

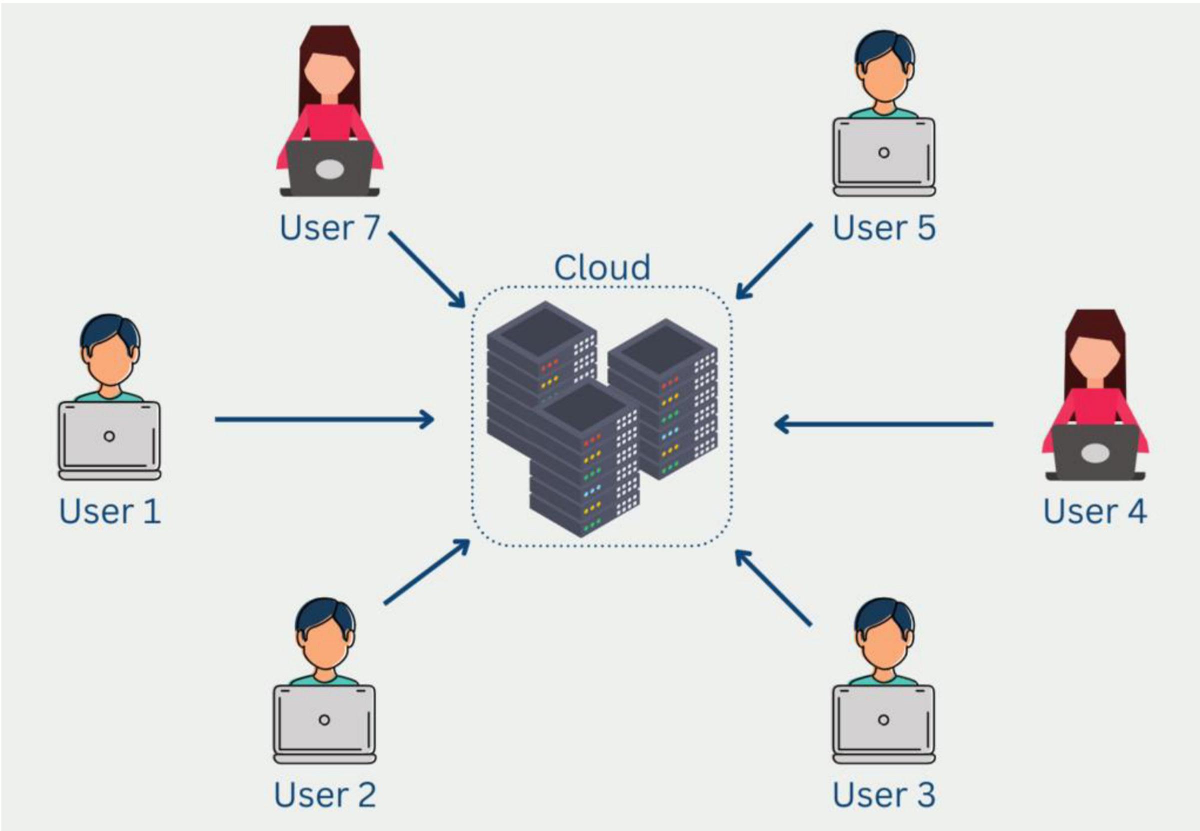


Fig.1:User access to the central infrastructure

Sources: https://rb.gy/r1f0v3

3.3 Cloud Computing Concepts

On-Demand Self-Service - Customers are able to self-serve and control their resources in the cloud without the need for service providers to be physically present. This is an important aspect of cloud computing. By using a web-based interface, customers are able to request and assign resources like storage, computer power, or software programs as required. Users have more control and higher efficiency because to the self-service aspect of cloud computing, which lets them increase or decrease their resource usage based on their needs.(Surianarayanan, C., & Chelliah 2023)

Resource Pooling - The practice of pooling resources to serve several customers or clients is known as resource pooling. These resources, which can include processing power, memory, storage, and networking, are drawn from a shared pool maintained by the cloud provider. The concept of resource pooling ensures that resources are allocated dynamically based on demand, enabling efficient utilization and optimization of the underlying hardware. This approach contrasts with traditional computing models where resources are often statically allocated to specific tasks or applications.(Afrin, M., Jin, J., Rahman, A., Rahman, A., Wan, J., & Hossain 2021)

Scalability - Scalability is a core principle of cloud computing that enables systems to handle changing workloads and demands. Cloud services can be scaled both vertically and horizontally. Increasing a virtual machine or instance's resources, including memory or processing capacity, is referred to as vertical scaling, or scaling up. In order to spread the workload across several computers, horizontal scaling, also known as scaling out, entails creating new instances. Applications can adapt to changing traffic patterns with more effectiveness thanks to this scaling flexibility, which enhances user experience and performance.(Razzaq, M. A., Mahar 2021)

Broad Network Access - By storing data on the cloud, users may have access to it from any number of connected devices, including desktop computers, laptops, smartphones, and tablets. The availability of services through the internet ensures that users can connect and interact with applications and data regardless of their physical location. This concept of broad network access enhances the mobility and flexibility of users, enabling them to work and collaborate seamlessly from different devices and locations.(Noor, T. H., Zeadally 2018)

Rapid Elasticity - The capacity of cloud resources to swiftly scale up or down to suit shifting workloads is referred to as rapid elasticity. Without the need for human involvement, cloud systems may automatically allocate or deallocate resources in response to demand, guaranteeing maximum performance.. This is especially valuable during peak usage times or unexpected spikes in traffic, as resources can be provisioned on-the-fly to prevent performance degradation.(Barnawi, A., Sakr, S. 2020)

Measured Service - Cloud computing uses a pay-as-you-go concept in which consumers get bills according to how much of the resources they really utilize. Efficiency and visibility into spending are both enhanced by the notion of metered service, which allows businesses to pay only for the resources they really use. It also allows for accurate tracking of resource usage, helping users optimize their resource allocation and budgeting.(Vinoth 2022)

3.4 Cloud Service Trends

3.4.1 Serverless Computing

A cloud computing paradigm that has garnered significant interest is serverless computing, commonly known as "Function as a Service" (FaaS). It has the ability to revolutionize the application development, deployment, and maintenance processes. In contrast to traditional server-centric approaches, which require developers to manage infrastructure, scalability, and maintenance, serverless computing allows developers to focus just on coding to execute specified tasks. This approach is not about eliminating servers altogether, but rather about shifting the responsibility of server management to the cloud provider, enabling developers to work in a more agile and efficient manner.(Leitner, P. 2019)

3.4.1.1 Key Concepts

Event-Driven Architecture - An event-driven design is important to serverless computing. Events like HTTP requests, database updates, file uploads, or scheduled tasks are the real triggers for functions to really execute. The relevant function is invoked, executed, and then exited after an event has occurred. This on-demand execution model eliminates the need for maintaining a continuously running server, resulting in cost savings and improved resource utilization.

Statelessness "Stateless" refers to the fact that serverless functions are not designed to keep any data between calls. Data and states must be either supplied directly or saved elsewhere, often in databases or object storage. This statelessness makes scaling easier and makes sure that functions may be readily increased or decreased to meet fluctuating demand.(Laisi 2019)

Micro-Billing - Serverless systems have a pay-as-you-go pricing model, which is a plus. So, you'll only pay for the processing time that your programs really consume. This fine-grained billing aligns with the event-driven nature of serverless, providing cost efficiency as resources are allocated dynamically based on demand.

Automatic Scaling - Scalability is a key advantage of serverless computing. Cloud providers handle the scaling of functions automatically, ensuring that as more events come in, and instances of functions are created to handle the load. Likewise, when the demand decreases, these instances are scaled down to zero to minimize costs.(Acharya 2020)

3.4.1.2 Key Benefits

Reduced Operational Overhead - Simpler operations are achieved with serverless computing since the need to install, configure, and run servers is eliminated. Software engineers no longer have to worry about infrastructure difficulties and can instead focus on writing code.

Faster Time to Market - With the elimination of server setup and management tasks, developers can deploy code faster. This speedier development cycle enables quicker iterations and updates, facilitating rapid innovation.

Cost-Efficiency - You will only ever pay for the computing resources actually required during execution thanks to the pay-as-you-go pricing mechanism and adaptive scalability. If this is done instead of maintaining and operating dedicated servers, a lot of money may be saved.

Scalability - By eliminating the need for manual scaling, serverless platforms make it easy for your application to withstand unexpected surges in traffic.

Focus on Code - Developers can focus solely on writing code to implement specific functionalities, rather than dealing with infrastructure concerns. This promotes cleaner and more modular code development.(Ghorbian, M., & Ghobaei 2023)

3.4.1.3 Key Challenges

Cold Starts - When executed, serverless functions may encounter a "cold start" delay. The time required to establish resources for a seldom called function is the reason for this. While cloud providers continuously work to minimize this delay, it's an aspect to consider, especially for applications with stringent latency requirements.

Vendor Lock-In - Serverless computing has the potential to cause vendor lock-in as the code is designed to operate inside the serverless ecosystem of a particular cloud provider. As a result, switching to a different provider may become more difficult.

Resource Limitations - Serverless functions have limitations on the amount of memory, execution time, and disk space they can use. Certain workloads might not be suitable for this constrained environment.(Jakóbczyk, M. T., & Jakóbczyk 2020)

3.4.1.4 Future Trends

Edge Computing Integration - Extending serverless computing to edge devices allows for processing data closer to the source in real-time. This will be valuable for applications like IoT, where immediate data processing is crucial.

Hybrid Cloud Solutions - The future might see hybrid cloud solutions that seamlessly combine Serverless platforms with traditional infrastructure, allowing applications to leverage the benefits of both environments.

Enhanced Cold Start Mitigation - The continued investment in technology by cloud providers to decrease cold start times will further enhance the allure of serverless for applications that are sensitive to latency.

Standardization Efforts - As serverless computing evolves, there might be increased efforts towards standardization to address challenges such as vendor lock-in and interoperability.(Davis, J. C. 2018)

3.5.1 Edge Computing

In edge computing, data is not sent via a central data center or cloud server but rather processed and analyzed closer to the data source, often known as the "edge" of the network. This results in a decentralized computing paradigm. This approach is driven by the increasing volume of data generated at the edge, the need for real-time or low-latency processing, and the limitations posed by sending all data to distant data centres for analysis.(Cao, K., Liu 2020)

3.5.2 Key Characteristics

Proximity to Data Source - Edge computing handles data processing close to the source, as opposed to further away, as in typical cloud computing. This keeps data transmission across the network to a minimum and decreases latency.

Real-time Processing - Edge computing is built to manage applications that are time-sensitive and need quick processing, such industrial automation, autonomous cars, and Internet of Things sensors. Because edge computing reduces the round-trip time to a central data center, real-time decision-making is made possible.(Chen, J. 2019)

Distributed Architecture - In edge computing, the computational resources are distributed across various edge devices or servers located closer to the data source. This distribution improves fault tolerance, as failures in one part of the network do not necessarily disrupt the entire system.

Data Security and Privacy - By limiting the accessibility of data during transmission and keeping sensitive information confined, edge computing may increase data security and privacy. Applications where data sovereignty laws must be followed will find this to be of utmost importance.

Bandwidth Optimization - Reduced reliance on centralized cloud servers for data transfers is one benefit of edge computing, but also helps with bandwidth optimization and lessens network congestion.(Liu, F. 2023)

3.5.3 Key Benefits

Low Latency - Using processing closer to the data source, edge computing drastically decreases latency. Augmented reality, real-time analytics, and industrial automation rely on this.

Bandwidth Efficiency - It is unnecessary to transmit large quantities of data to the cloud when using edge computing, which saves bandwidth and operational costs by processing data locally.

Scalability - Edge computing allows for seamless scalability, as additional edge nodes can be added to the network to handle increased demand without overburdening a central data centre.

Resilience - Distributed edge architecture enhances system resilience, as failures at one edge node have a limited impact on the overall network.

Privacy and Compliance - Edge computing aids in compliance with data privacy regulations by processing sensitive data locally, reducing the risk of exposure during transit.(Sonmez, C., Ozgovde, A., & Ersoy 2018)

3.5.4 Key Applications

Internet of Things (IoT) - Edge computing is instrumental in managing the massive amounts of data generated by IoT devices, enabling real-time analysis and quick response to sensor inputs.

Autonomous Vehicles - The ability of autonomous cars to interpret data in real- time from their sensors and cameras and make split-second decisions relies heavily on edge computing.

Smart Cities - Edge computing supports various smart city applications, such as intelligent traffic management, waste management, and environmental monitoring.

Healthcare - Applications of edge computing in healthcare include real-time diagnosis, individualized therapy suggestions, and remote patient monitoring.

Industrial Automation - Edge computing is used in manufacturing for predictive maintenance, process optimization, and quality control. (Premsankar, G. 2018)

3.6.1 Multi-Cloud Strategy

The use of several cloud providers' services is known as a multi-cloud approach. Companies now spread their workloads over many cloud platforms, rather of depending on just one. These platforms include AWS, Azure, GCP, and others.(Gundu, S. R. 2020)

Vendor Diversity - By avoiding vendor lock-in, organizations can take advantage of best-of-breed solutions from different providers for specific tasks or services.

Resilience and Redundancy - Using many clouds improves the stability of the system. Transferring workloads to a different provider is a breeze in the event of a provider outage.

Performance Optimization -Organizations can choose cloud services that best match their application requirements in terms of performance, cost, and features.(Achar 2021)

- **Global Reach** - Multi-cloud enables businesses to host services in different geographic regions, improving latency and user experience for a global customer base.

- **Risk Mitigation** - Diversifying across providers reduces the impact of any single provider's security vulnerabilities or compliance issues.

3.7.1 Hybrid Cloud Strategy

A hybrid cloud integrates both public and private cloud services with on-premises infrastructure. This approach facilitates the seamless movement of workloads between environments, granting organizations.(Talaat, M. 2020)

Flexibility - Organizations can choose where to host workloads based on factors like security, compliance, performance, and cost.

Scalability - Bursting into the cloud allows organizations to handle peak workloads without over-provisioning on-premises resources.

Data Sovereignty - Sensitive data can be kept on-premises for compliance reasons, while less sensitive workloads leverage the cloud's agility.

Cost Efficiency - Non-critical workloads can run in the public cloud, while mission-critical applications can remain on-premises to manage costs effectively.

Disaster Recovery - Hybrid cloud setups facilitate robust disaster recovery strategies. Data can be backed up off-site, and applications can be quickly restored in the cloud in case of a data centre failure. (Tao, Y. 2021)

3.8.1 Artificial Intelligence and Machine Learning

Machine learning (ML) and artificial intelligence (AI) have brought about a new age of computing capabilities with the integration of cloud services in recent years. The cloud computing environment has been revolutionized by this convergence, which has opened the door to new solutions that improve efficiency, scalability, and user experiences. The combination of cloud services with AI and ML is going to revolutionize decision-making, optimization, and automation.(Cui, M., & Zhang 2021)

3.8.1.1 Current State

The integration of AI and ML technologies into cloud services has gained momentum due to their combined potential to process vast amounts of data, extract meaningful insights, and enable predictive and prescriptive analytics.

Data-Driven Insights - Cloud-based AI and ML can analyze large datasets in real-time, leading to more accurate and actionable insights for businesses and individuals.

Personalization - Cloud services integrated with AI and ML can offer personalized experiences, ranging from content recommendations to tailored marketing strategies, based on user behavior patterns and preferences.

Automation and Optimization - The convergence of AI, ML, and cloud services facilitates process automation and resource optimization, minimizing manual intervention and maximizing efficiency.

Scalability - AI and ML workloads can benefit from the scalable infrastructure provided by cloud services, ensuring the efficient allocation of resources as computational demands fluctuate.(Angel, N. A. 2021)

3.8.1.2 Future Trends

Edge AI and Federated Learning - As the demand for real-time processing grows, the integration of AI at the edge, closer to the data source, will become more prevalent. Federated learning, which enables model training across decentralized devices, will enhance privacy while maintaining performance.

Explainable AI - Future cloud services will likely focus on enhancing transparency and interpretability in AI and ML models. Explainable AI will be crucial in critical decision-making processes, especially in sectors like healthcare and finance.

AI-optimized Cloud Infrastructure - Cloud providers will develop specialized hardware and software optimized for AI and ML workloads. This will enhance performance while reducing costs, making AI more accessible to a broader range of applications.(Farzaneh, H. 2011)

Hybrid Cloud and Multi-Cloud AI - Organizations will adopt hybrid and multi-cloud strategies for AI and ML workloads to leverage specific services from different providers, optimizing cost, performance, and data residency.

AI-Driven DevOps and Automation - AI will be integrated into the DevOps lifecycle, automating tasks such as code testing, deployment, and monitoring. This will lead to more robust and efficient software development processes.

Predictive Maintenance and Healthcare - Industries like manufacturing will use AI-embedded cloud services for predictive maintenance, minimizing downtime. In healthcare, AI and cloud integration will revolutionize patient care through real-time monitoring and early disease detection.(Telikani, A. 2022)

3.8.1.3 Key Challenges

Data Privacy and Security - Data storage in the cloud requires stringent security protocols to avoid breaches and illegal access.

Ethical AI - The use of AI in decision-making processes should be transparent and unbiased, necessitating careful monitoring and regulation.

Complexity and Skill Gap - The complexity of AI-ML integration demands skilled professionals who understand AI algorithms and cloud infrastructure. (Rahman, A., Hasan 2023)

The integration of AI and ML technologies into cloud services marks a pivotal point in technological evolution. As these technologies advance, their synergy promises to reshape industries, enhance user experiences, and drive innovations that were once considered the realm of science fiction. Addressing challenges and responsibly harnessing this integration will be key to realizing the full potential of AI and ML in cloud services. Embracing these trends will enable businesses and individuals to navigate a future that is increasingly data-driven, intelligent, and efficient.(Rejeb, A., Rejeb, K. 2022)

3.5 Benefits of cloud computing

Cost - Company Going cloud-based allows you more control over IT spending. One good reason for this is because cloud computing eliminates the need to invest in costly infrastructure components like servers, software, datacenter space, power, cooling, and IT staff to oversee all of this. Expenses add up rapidly.(Mell, P., & Grance 2011)

Speed - Organizations have a lot more leeway and capacity planning isn't as stressful since most cloud computing services are self-service and on-demand. This includes the ability to supply massive quantities of computer resources in minutes, usually with only a few clicks of the mouse.

Global scale- Adaptability to fluctuating demand is a benefit of cloud computing services. In the context of the cloud, this means that computing resources like processing power, storage space, and bandwidth are made accessible from the best possible geographical location at the precise time they are needed.

Productivity- Lots of tedious IT administration tasks, such as "racking and stacking" hardware configuration and software patching, are usually required of on-premises datacenters. Because cloud computing takes care of a lot of these things, IT departments can focus on other, more strategic initiatives for the company.(Armbrust, M., Fox, A. 2010)

Performance- Global networks of secure datacenters, often updated with new generations of fast and efficient computer technology, constitute the backbone of the most popular cloud computing services. Multiple advantages, such as lower application network latency and larger economies of scale, are available compared to a single corporate datacenter.

Reliability- The ability to store data in several redundant locations on the provider's network makes cloud computing a cost-effective and easy solution for data backup, disaster recovery, and business continuity.

Security- In order to better safeguard your data, applications, and infrastructure from any dangers, many cloud providers provide a comprehensive suite of rules, technologies, and controls.(Buyya, R., Yeo 2009)

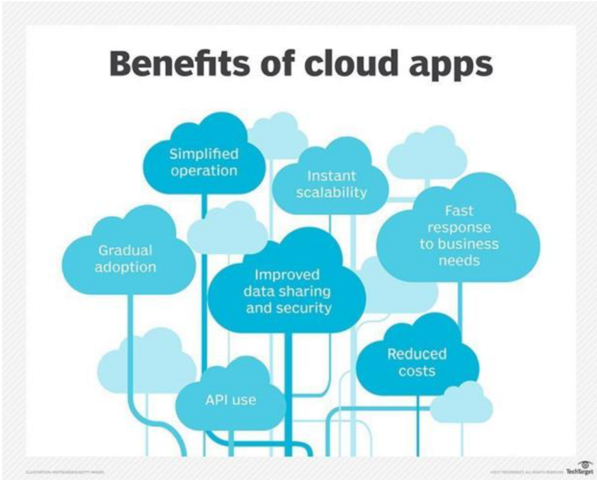


Fig.2:Benifits of cloud apps

Sources: https://rb.gy/j6divq

3.6 Cloud applications

Internet connectivity is the primary means by which users access what are known as "cloud applications," which are programs where at least some of the software is hosted by a server rather than on the users' own computers. Whether it's a physical, virtual, or cloud-based infrastructure, designing applications with consistent experiences (for front-end users and back-end operations teams) across all of them is the goal of cloud-native application development techniques.(Sharma, A., Gupta, R., & Kumar 2020)

3.6.1 Factors Influencing the Decision

Before we delve into the intricate world of decision-making between on-premise and cloud solutions, it's essential to recognize that this choice is far from one-size-fits-all. The decision is influenced by a multitude of factors that can tip the scales one way or the other. In this section, we'll explore four key determinants that hold considerable weight in this decision making process: business size, industry, regulatory compliance, and data sensitivity.(Armbrust, M., Fox, A., Griffith 2010)

3.6.2 Business Size

When it comes to on-premise vs. cloud-based services, the size of your business plays a pivotal role. For small to medium-sized enterprises (SMEs), cloud-based solutions offer the advantage of scalability without the initial heavy investment in hardware and software. The "pay as you go" model enables SMEs to grow effortlessly. On the other hand, larger corporations might find on-premise solutions attractive due to established infrastructure. However, this often involves a more significant initial investment and continuous costs for maintenance, which makes it less flexible when scaling up or down becomes necessary.

3.6.3 Industry

Different industries have varied requirements. For example, the financial sector or healthcare often deals with sensitive information and might initially prefer on-premise solutions for perceived added security. However, cloud providers are now offering robust security measures that often surpass those of an in-house setup. Besides, the cloud provides better opportunities for collaboration and data sharing, which is essential in modern industries like tech, marketing, and e-commerce.(Marston, S., Li, Z. 2011)

3.6.4 Regulatory Compliance

Dealing with cloud vs. on-premise pros and cons also involves understanding how each option meets regulatory compliance standards. Initially, many organizations were hesitant about storing sensitive data in the cloud due to regulations like GDPR in Europe or HIPAA in the US. Nevertheless, most reputable cloud providers are now fully compliant with these regulations, providing auditable records and robust data protection features. On-premise solutions require your team to handle all compliance measures, which can be quite burdensome and prone to error.

3.6.5 Data Sensitivity

Data sensitivity is often a point of concern when considering moving to the cloud. Many organizations feel that on-premise solutions offer more control over their data. While that's true to some extent, the cloud providers today offer end-to-end encryption and multi-factor authentication, significantly minimizing the risk of data breaches. With advanced data encryption, intrusion detection systems, and regular audits, the cloud is increasingly becoming a safer option for storing sensitive data.

In essence, while both on-premise and cloud solutions have their merits and drawbacks, a careful evaluation may reveal that cloud services offer some inherent advantages in the modern era. The ultimate decision, however, should be a strategic one,taking into account the unique needs and long-term objectives of your organization.(Venugopal, S., Broberg 2016)

3.7 Cloud Computing Business

Enabling Scalability and Flexibility - Cloud computing's exceptional scalability and flexibility are driving factors in its increasing importance in contemporary corporate settings. Since traditional IT infrastructures often need large expenditures in software and hardware up front, they sometimes hinder firms' ability to quickly adjust to evolving demands. With cloud computing, companies may increase or decrease their resources on demand, letting them adapt swiftly to changes in the market and expanding client needs. This scalability ensures optimal resource utilization, cost-efficiency, and the ability to handle spikes in demand without disruptions. (Wease, G., Boateng 2018)

Cost-Efficiency and Reduced Capital Expenditure - The advent of cloud computing has caused a sea change in how companies handle their IT spending. No large initial investment in software and hardware is required with the pay-as-you-go strategy. Cloud computing allows companies to pay only for the resources used by their subscribers. This shift from a capital-intensive approach to an operational expense model not only frees up financial resources but also promotes efficient resource allocation and budget optimization.(Allen, A. 2021)

Enhanced Collaboration and Remote Work - In today's interconnected world, collaboration and remote work have become essential components of modern business operations. Computing in the cloud unifies platforms, allowing teams to work together, share, and access information and programs from any device, at any time. Productivity rises, remote work becomes second nature, and teams spread out across the globe are able to collaborate in real time because to this extreme accessibility. Cloud-based communication and collaboration tools have become the backbone of modern businesses, enabling them to maintain operations even during unforeseen disruptions.(Mohammed 2019)

3.8 Cloud Service Models

Infrastructure as a Service (IaaS) - Infrastructure as a service is the backbone of cloud software. The idea behind the cloud is that third-party providers may host virtualized computer resources online. Hardware, storage, and networking resources may be rented by users. With Infrastructure as a service, customers are able to install, configure, and administer applications and operating systems with more control over the underlying infrastructure. Businesses who want to create and run their own apps and need complete control over their environment would love this concept. (Marozzo 2019)

Platform as a Service (PaaS) - PaaS provides a higher level of abstraction compared to IaaS. A platform and environment are provided so that developers may focus on building, deploying, and managing applications rather than the underlying infrastructure. Tools, libraries, and services offered by PaaS make development easier. While the platform takes care of scalability, security, and maintenance, developers can concentrate entirely on writing code and designing apps. PaaS is ideal for developers and teams who want to focus on coding rather than managing infrastructure.(Yasrab 2018)

Software as a Service (SaaS) - In terms of cloud service models, SaaS is the easiest to utilize. With a subscription, customers may access pre-installed software applications online. Customers may access programs using web browsers without the need to install or maintain them locally. Providers of software as a service (SaaS) applications handle program upkeep, upgrades, and security. For end-users who would rather not deal with technical complexities and would want simple software access, this strategy is ideal.(Chak, Y. N. 2021)

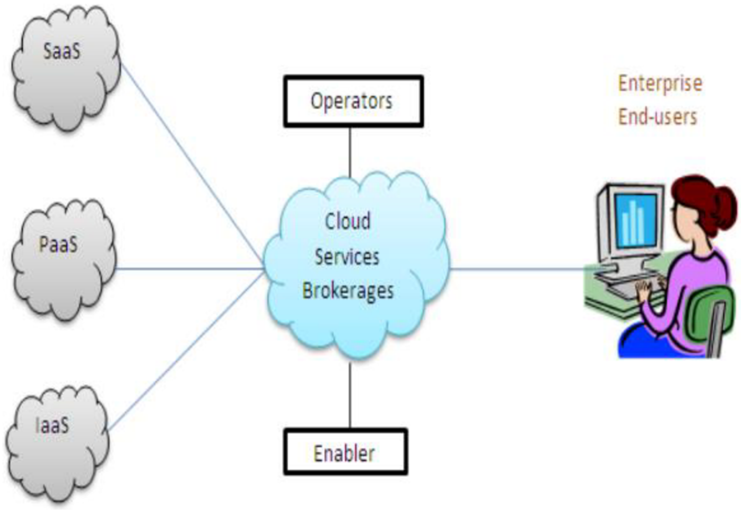


Fig.3: service architecture of cloud computing

Soures: https://rb.gy/yd0166

3.9 Cloud Deployment Models

Public Cloud - A public cloud is one in which any individual or organization may access resources and services over the internet, hosted by an external provider. Saving money is possible since customers pay for exactly what they use. Public clouds are highly scalable and suitable for applications with variable workloads. While they offer convenience, users share resources with others, which might raise security and compliance concerns for some organizations.(Al-Issa, Y. 2019)

Private Cloud - An organization's own resources or an outside firm may run a private cloud, which is exclusive to that company. It provides more privacy, control, and flexibility than public clouds. Companies that deal with sensitive information or have stringent security and compliance standards should use private clouds. While they provide greater control, they might involve higher costs due to infrastructure management.(Katherine, A. V., & Alagarsamy 2020)

Hybrid Cloud - A hybrid cloud allows data and applications to be exchanged across public and private cloud resources. Depending on individual requirements, this provides the freedom to transfer workloads to other environments. Any company looking to reap the advantages of both public and private clouds might consider a hybrid cloud setup. Public cloud resources can manage spikes in workloads, while private cloud resources can protect sensitive information.(Trakadas, P., Nomikos 2019)

Multi-cloud - Multi-cloud involves using services from multiple cloud providers, which can be public, private, or a mix. This approach aims to prevent vendor lock-in, increase reliability, and optimize costs by choosing the best services from different providers. While it offers flexibility, managing multiple providers can be complex and requires careful coordination.(Ramalingam, C., & Mohan 2021)

3.10 Cloud Computing Significance

3.10.1 Economic Significance

Reduced Capital Expenditures - Traditional IT infrastructure often demands significant upfront capital investments for hardware, software, and data centres. Cloud computing eliminates or reduces these costs by shifting the burden to cloud service providers. Virtualization eliminates the need for businesses to invest in and manage physical hardware by providing them with access to a vast variety of computer resources. The pay-as-you-go concept is a way for businesses to turn capital expenditures into operational costs by allowing them to pay for resources as they are used.(Nayar, K. B., & Kumar 2018)

Scalability and Flexibility - With cloud computing, companies can react quickly to fluctuations in demand by increasing or decreasing the amount of resources they use. This elasticity is particularly valuable as it prevents overprovisioning, where companies invest in excess capacity to handle peak loads. By dynamically adjusting resources, businesses can avoid unnecessary expenses, ensuring that they only pay for what they require.

Operational Efficiency - Migrating to the cloud often leads to improved operational efficiency. Cloud services offer automation and centralized management, reducing the need for extensive IT personnel and minimizing the risk of human errors. This, in turn, lowers labor costs and boosts productivity. (Al-Dhuraibi 2018)

Cost-effective Access to Advanced Technologies - Modern tools like AI, ML, and big data analytics are now available to companies via cloud computing.

These technologies were once prohibitively expensive to deploy in-house. By leveraging cloud services, businesses can harness these capabilities without investing heavily in specialized hardware or expertise.

Disaster Recovery and Business Continuity - Protecting mission-critical data and apps has never been more affordable than with cloud-based disaster recovery solutions. Traditional disaster recovery strategies often required duplicate infrastructure investments, significantly driving up costs. Cloud-based solutions provide automated backup, replication, and failover mechanisms, ensuring business continuity without extensive investments.

Reduced Maintenance and Upgrade Costs - Providers of cloud services take care of the regular upkeep, such as installing updates and security patches. By not having to worry about the upkeep and improvement of their hardware and software, businesses are free to concentrate on what they do best.

Global Collaboration and Accessibility - With cloud computing, data and applications can be accessed from anywhere with an internet connection, which greatly facilitates remote work and global collaboration. Travel, infrastructure, and office space costs may all be reduced as a consequence of this accessibility.

Innovation and Time-to-Market - Cloud computing accelerates innovation by reducing the time required to provision resources and deploy applications. This agility enables businesses to bring new products and services to market more rapidly, gaining a competitive edge and potentially increasing revenue streams. (Golightly, L. 2022)

3.10.2Scalability Significance

When it comes to information technology, scalability is how well it can grow or shrink in reaction to fluctuating workloads and needs. Significant initial expenditures in hardware and infrastructure were often necessary to achieve scalability in conventional on-premises systems. Because cloud computing allows companies to grow their resources as needed, it gets rid of these problems. This means that organizations can allocate additional computing power, storage, and network resources as their needs evolve, without the delays and costs associated with physical hardware procurement. (Mansouri, Y. 2020)

Vertical Scalability By using cloud platforms' vertical scalability, organizations may augment the capabilities of a single virtual machine or instance by incorporating more CPU, memory, or other resources. When it comes to situations when a certain part of an application needs additional power, this is perfect.

Horizontal Scalability - Cloud services excel in horizontal scalability, permitting the distribution of workloads across multiple instances or servers. This approach is particularly advantageous for applications designed with a distributed architecture, as it enhances performance and resiliency.

Elasticity - With elasticity, a component of scalability, you can do more than just add more resources. During peak hours, it ensures maximum performance while conserving expenses during off-peak times by automatically scaling resources depending on real-time demand.(Zalila, F. 2018)

3.10.3 Flexibility Significance

Flexibility in cloud computing refers to the freedom and agility that businesses gain to deploy, manage, and customize their IT environments according to their unique requirements. This advantage empowers organizations to innovate more rapidly and experiment with new technologies without being constrained by traditional infrastructure limitations. (Akter, S., Hossain 2023)

Resource Provisioning - Cloud computing allows businesses to provision resources such as virtual machines, databases, and storage instantaneously through self-service interfaces. This means that IT teams can respond to business needs swiftly, accelerating the development and deployment of applications.

DevOps and Continuous Integration - By its very nature, the cloud is very compatible with DevOps methodologies and CI/CD pipelines. product development teams may reduce time-to-market and speed up product releases by simply creating separate environments for testing and deployment.(Giannakis, M. 2019)

Hybrid and Multi-Cloud Deployments - With cloud computing, you're not limited to just one service provider. With the help of hybrid and multi-cloud solutions, companies may match their infrastructure to unique performance, security, and compliance needs by combining on-premises resources with public and private cloud services.

Pay-as-You-Go Models - Cloud services often operate on a pay-as-you-go model, where businesses only pay for the resources they consume. This flexibility in pricing aligns IT costs with actual usage and allows businesses to optimize their spending.(Orzechowski, M. 2023)

3.10.4 Accessibility Significance

Cloud computing has dismantled traditional barriers associated with accessing data, applications, and resources. Accessibility, in this context, pertains to the ability of authorized personnel to retrieve, manipulate, and share information from virtually anywhere, transcending the confines of physical office spaces. This is enabled through cloud-based services and applications that are accessible via the internet.(Barricelli 2019)

Anytime, Anywhere Access - Cloud computing empowers employees to engage with work-related data and applications on a 24/7 basis, regardless of their geographical location. This not only caters to the demands of a globally distributed workforce but also nurtures a culture of flexibility and work-life balance.

Device Agnostic Accessibility - Cloud services ensure compatibility across various devices, including laptops, smartphones, and tablets. This versatility endows businesses with the freedom to choose devices that align with their workflow and employee preferences.

Scalability and Resource Allocation - Cloud computing's scalability lets companies quickly increase or decrease resource allocation in response to fluctuating demand. This implies that companies may expand without being constrained by their gear.(Kibaroglu 2022)

3.10.5 Collaboration Significance

Collaboration lies at the heart of modern business success, and cloud computing acts as a catalyst for fostering collaborative endeavours among teams and stakeholders, regardless of their locations.(Bachnik, K. 2022)

Real-time Collaboration - Cloud-based platforms offer real-time collaboration tools such as document editing, simultaneous access, and commenting. These capabilities break down geographical barriers and enable employees to collectively contribute to projects without the need for physical proximity.

Virtual Meetings and Communication - Cloud-powered communication tools facilitate virtual meetings, video conferencing, and instant messaging. This not only reduces travel expenses but also accelerates decision-making by enabling stakeholders to engage in discussions without the need for face-to-face interactions.(Albahri 2018)

Secure Data Sharing - Cloud services provide secure avenues for sharing sensitive documents and information. Advanced encryption and access controls ensure that only authorized personnel can view and modify data, thereby mitigating security risks.

Global Team Integration - Cloud-enabled collaboration facilitates the integration of diverse teams spread across different time zones. This enables businesses to leverage a broader pool of talent and expertise, resulting in enhanced innovation and problem-solving.(Kotha, S. K. 2022)

3.10.6 Maintenance Significance

Traditional IT infrastructure demands meticulous attention to hardware and software maintenance. This includes tasks such as hardware updates, software patches, security measures, data backups, and disaster recovery preparations. These activities necessitate substantial investments in terms of time, money, and human resources. IT teams must stay updated with the latest technologies, security threats, and industry best practices, further adding to the complexity and cost of maintenance.(Mugarza Inchausti 2019)

Transition to Cloud Computing - A new way of thinking about information technology infrastructure is introduced by cloud computing. Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) are among the many services it provides, all of which are made available online. This shift means that many aspects of infrastructure management are outsourced to cloud service providers, thereby significantly reducing the traditional IT maintenance burden. (Alnumay 2020)

Cost Savings - When you go to cloud computing, you won't have to worry about spending money on hardware up front and much less on infrastructure upkeep in the long run. By moving away from the capital expenditure (CapEx) paradigm and toward the operational expenditure (OpEx) model, businesses may reduce their spending on resources and pay only for what they use.

Expertise Leveraging - Cloud service providers employ teams of experts who manage and maintain the underlying infrastructure. This relieves businesses from the need to hire and retain specialized IT staff for routine maintenance tasks, allowing existing IT personnel to focus on more strategic initiatives.(Pallathadka, H., Sajja 2022)

Automated Updates and Patches - Cloud providers take care of updates, patches, and security fixes for the infrastructure and services they offer. This ensures that businesses remain up-to-date with the latest technology advancements and are better protected against security vulnerabilities.

Scalability and Flexibility- With the advent of cloud computing, a whole new paradigm for IT infrastructure planning has emerged. Many of the services it offers are accessible online and include Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).(Logeshwaran 2022)

Disaster Recovery and Business Continuity - Many cloud providers now provide backup and disaster recovery features as standard. In order to lessen the likelihood of data loss as a result of unanticipated circumstances, this improves company continuity planning and guarantees data redundancy.

Global Accessibility Because cloud services can be used from any location with an internet connection, they make it easier for teams spread out across different locations to work together remotely. (Sawalha 2021)

3.10.7 Recovery Significance

Disaster recovery refers to the process of restoring IT systems, applications, and data to normal functioning after a disruptive event. In traditional IT setups, DR often required expensive infrastructure and complex configurations. Cloud computing changes this paradigm by providing businesses with scalable and flexible resources that can be leveraged for disaster recovery purposes. (Arogundade 2018)

Reduced Downtime - Cloud-based DR solutions minimize downtime during a disaster. Virtualized environments and automated failover mechanisms can ensure rapid recovery and continuity of services.

Cost Efficiency - Cloud-based DR eliminates the need for businesses to invest in and maintain dedicated off-site hardware. They can leverage pay-as-you-go models, which can be more cost-effective. (Al–shammari, M. M., & Alwan 2018)

Geographical Redundancy - Many data centers in different parts of the world are available from cloud service providers. The data and applications are duplicated across multiple sites via this redundancy, which reduces the risk of data loss caused by regional calamities.

Testing and Simulations - Cloud-based DR allows for frequent testing and simulations without impacting production systems. This ensures that recovery procedures are well-practiced and effective.

Remote Work Capabilities - Cloud-based services enable employees to work remotely during disruptions. This minimizes the impact of events that might otherwise halt operations.(Tamimi, A. A., Dawood 2019)

Data Availability - Cloud storage and data synchronization ensure that critical data is accessible from various locations. This reduces the risk of data loss and supports uninterrupted decision-making processes.

Scalability - Online services have the ability to easily increase or decrease the amount of resources available in response to changes in demand. Both normal operations and recuperation stages benefit from this flexibility.

Quick Communication - Cloud-based communication tools facilitate seamless communication among employees, stakeholders, and customers even when physical communication channels are disrupted.

Supplier and Partner Collaboration - Cloud platforms provide collaborative spaces for suppliers and partners, enabling coordinated efforts to recover from disasters together.(Abdul, S. S., Aldujaili 2020)

Accelerating Innovation and Time-to-Market - With the resources made available by the cloud, companies can quickly create, test, and launch new apps and services, which speeds up the innovation process. By using the cloud's vast array of services and on-demand resources, organizations are able to experiment and develop without being limited by conventional IT infrastructure. A few examples of these services include those that deal with machine learning, AI, and IoT. In turn, this nimbleness shortens the time it takes to bring new goods and services to market, giving them a leg up in the competition.(Kakderi, C., Komninos 2019)

Enhanced Data Security and Compliance - Companies in the modern digital era are very concerned about security and compliance. Protecting data stored in the cloud is a top priority for cloud service providers, therefore they implement stringent security measures, use encryption technologies, and conduct frequent security audits. For many businesses, utilizing cloud services can lead to improved data security compared to managing in-house IT systems. Additionally, cloud providers often adhere to rigorous compliance standards, ensuring that businesses can meet industry-specific regulations without investing significant resources in compliance management.(Khan, R. 2019)

3.11 Cloud Computing Challenges

3.11.1 Security Challenges

There are many worries and problems that come along with the many advantages of cloud computing as it continues to change the face of contemporary IT. Protecting personal information is one of the biggest and longest-running problems. As a term, "cloud computing" refers to the practice of storing, processing, and retrieving data over the internet, often via intermediaries. This brings up valid issues about the availability, confidentiality, and integrity of critical information and presents risks intrinsically.(Mehraj, S. 2020)

Data Breaches - Since they handle massive volumes of data for many customers, cloud services are a prime target for hackers. A data breach in the cloud may lead to serious issues, such as losing money, having your brand tarnished, and even facing legal trouble. Defects in the cloud's security architecture, inadequate encryption, or lax access rules may all lead to breaches.

Unauthorized Access - Using the resources and infrastructure that are available in the cloud, several users may share them. In the absence of adequate access restrictions, critical information might fall into the wrong hands. Preventing unwanted access requires effective procedures for managing identities and access. (Altowaijri 2020)

Data Location and Sovereignty - Cloud providers often distribute data across multiple data centres and geographic locations to ensure redundancy and availability. However, this can raise concerns about data jurisdiction and compliance with local laws, especially in cases where data crosses international borders. Organizations might be required to adhere to data protection regulations specific to the regions they operate in.

Data Encryption Protecting information while it is in motion or stored in the cloud is an important function of encryption. Nevertheless, issues emerge when encryption keys are handled by cloud providers. The security of encrypted data is at risk if the keys used to decrypt it are compromised. Many organizations opt for client-side encryption, where they retain control over the encryption keys.(Noman 2018)

Insider Threats - If authorized users in the cloud compromise data security, whether on purpose or by accident, this is known as an insider threat. People working in the cloud, independent freelancers, or even clients themselves might fall into this category. A good way to find and stop insider threats is to set a system for monitoring and auditing.

Compliance and Regulatory Challenges - Different industries and jurisdictions have specific regulations governing data security and privacy (e.g., GDPR, HIPAA). Migrating to the cloud requires ensuring that the cloud provider's security practices align with these regulations. Failure to comply could lead to legal consequences.(Elifoglu, I. H. 2018)

Data Portability and Vendor Lock-In - While cloud services offer convenience, there's a concern of becoming locked into a specific provider's ecosystem. This could make it difficult to migrate data to a different provider or back to an on-premises environment, potentially affecting data availability and control.

Transparency and Accountability - Cloud users often have limited visibility into the security practices and infrastructure of their providers. Establishing transparency and accountability through contractual agreements, third-party audits, and certifications can help alleviate these concerns.

Evolving Threat Landscape - The nature of cyber threats is constantly evolving. As new vulnerabilities and attack vectors emerge, cloud providers must stay vigilant and update their security measures accordingly. Similarly, cloud users need to regularly assess their security strategies to counter emerging threats effectively.(AlTwaijiry 2021)

3.11.2 Compliance Challenges

In the digital age, where the utilization of cloud computing has become ubiquitous across industries, the significance of compliance and regulatory considerations cannot be overstated. The cloud offers unparalleled scalability, flexibility, and cost-effectiveness, but these advantages must be balanced with a comprehensive understanding of the legal and regulatory landscape to ensure the protection of sensitive data, uphold privacy rights, and maintain the trust of customers and stakeholders.(Ali, O., Jaradat 2022)

Complexity of Cloud Compliance - The multifaceted nature of cloud compliance arises from a convergence of international, national, and industry-specific regulations. Different legal frameworks impose different requirements on organizations with global operations. For example, the General Data Protection Regulation (GDPR) of the EU, HIPAA of the US healthcare sector, or PCI DSS of online payment processors are all examples of such frameworks. These regulations impose various requirements on data storage, transmission, access control, and breach reporting, which cloud service providers (CSPs) and their clients must adhere to.(Aceto, G. 2019)

Data Residency and Sovereignty - The concept of data residency and sovereignty introduces another layer of complexity to cloud compliance. Certain regulations mandate that certain types of data, particularly sensitive personal or financial information, must be stored within the borders of specific countries or regions. This requirement aims to safeguard data from potential unauthorized access and adhere to national laws. Cloud providers often need to establish data centres in various locations to meet these legal obligations, leading to challenges in data management, synchronization, and availability across geographies. (Garon 2019)

Cross-Border Data Transfer - Cloud computing facilitates the seamless movement of data across borders, but this convenience must be weighed against data protection regulations. Transferring data across jurisdictions with different privacy and security laws can lead to potential conflicts. To address this, mechanisms such as standard contractual clauses and binding corporate rules have been developed to ensure that data transfers are conducted in compliance with relevant regulations.(Stoyanova, M. 2020)

Vendor Lock-In and Responsibility - Both cloud service providers and their customers share accountability, which is a major issue in cloud compliance.

The responsibility for safeguarding data and applications in the cloud ultimately rests with the customers, even if CSPs do provide a number of security safeguards at the infrastructure level. Problems with clarity and oversight in compliance activities might arise from such a division of labor. Furthermore, businesses should think about the possibility of vendor lock-in, whereby their data portability and the ability to move providers without interruptions are compromised due to their dependence on certain CSP tools and services. (Alouffi, B. 2021)

Continuous Monitoring and Adaptation - Cloud compliance is not a one-time effort; it requires continuous monitoring and adaptation. Regulations evolve over time, and new laws may emerge that impact cloud operations. Organizations need robust mechanisms to stay informed about these changes and to adjust their practices accordingly. This involves maintaining clear documentation, conducting regular audits, and establishing effective communication channels with CSPs to ensure ongoing compliance.(Kunduru 2019)

3.11.3 Performance Challenges

Resource Allocation and Sharing - In a cloud environment, multiple users and applications share the same underlying physical resources, such as servers and storage. This sharing can lead to unpredictable performance variations, where one user's resource-intensive workload might impact the performance of others, causing potential bottlenecks.

Virtualization Overhead - Cloud platforms often use virtualization techniques to create virtual machines (VMs) or containers. While these technologies offer flexibility and resource isolation, they introduce a layer of overhead that can impact performance. The hypervisor or containerization layer adds some processing time, affecting the overall application speed. (Guo, J., Chang 2019)

Network Congestion - Cloud services rely on networks to transmit data between the client and the cloud data centre. Increased network traffic or congestion can result in slower data transmission, leading to degraded application performance. This concern becomes more pronounced in multi-tenant environments.

I/O Performance - Storage I/O performance can be a bottleneck, particularly for applications that require rapid access to data. Disk I/O contention among various virtual machines or containers sharing the same physical storage can lead to delays and affect application responsiveness.(Sfiligoi, I., Würthwein 2020)

3.11.4 Latency Challenges

Geographical Distance - Cloud data centres are often distributed across different regions or even countries. The physical distance between a user and the nearest data centre introduces latency due to the time it takes for data to travel to and from the user. This can impact real-time applications like video conferencing or online gaming.

Network Latency - Network latency is the delay that occurs as data traverses various network components, such as routers, switches, and cables. Higher latency can lead to delayed data transmission and slower application response times.(Wang, P., Chen 2021)

Content Delivery - Latency can be mitigated by using Content Delivery Networks (CDNs), which distribute content to servers that are strategically located closer to users. However, integrating CDNs effectively can be challenging, and if not done correctly, latency issues might persist.

Peak Usage Periods - During peak usage periods, cloud providers can experience increased demand on their resources, leading to higher latency. Users might face slower response times and reduced performance due to the shared nature of cloud infrastructure.(George 2021)

3.11.5 Organizational Challenges

Resistance to Change - One of the most significant challenges is the resistance to change among employees and stakeholders. Moving to the cloud often requires adopting new tools, processes, and ways of working. Employees might be accustomed to traditional IT systems and processes, making them resistant to the changes brought by cloud adoption. Addressing this resistance requires effective change management strategies that emphasize the benefits and train employees on new technologies.

Skill Gaps - The company may lack the necessary expertise to implement cloud computing. The question of how to train current employees better or find qualified candidates with cloud experience becomes more pressing in light of this. In order to fill these knowledge gaps and make the move to the cloud go smoothly, businesses should put money into training programs and certifications.(Alsharari 2022)

Cultural Shift - The cloud adoption journey often requires a cultural shift within the organization. Traditional hierarchies and decision-making processes might not align with the agile and collaborative nature of cloud environments. Cultivating a culture of innovation, collaboration, and continuous learning is crucial to fully leverage the benefits of cloud computing.

Security and Compliance - The shift to cloud computing raises concerns about data security and regulatory compliance. Different cloud models (public, private, hybrid) come with varying levels of control over data. Businesses must verify that the cloud service they choose has strong security measures and abides by industry-specific rules. Data governance rules and risk management procedures may need to be reevaluated in order to accomplish this.(Ahmad, N. 2018)

Vendor Lock-In - Being too reliant on a single cloud provider is a worry, despite the fact that cloud computing gives flexibility. Vendor lock-in occurs when users are unable to easily transfer providers or return to on-premises solutions. A multi-cloud approach may help organizations avoid being locked into one vendor by distributing workloads across several providers.

Organizational Structure - The traditional IT organizational structure might not be suitable for a cloud-centric environment. Cloud computing blurs the lines between traditional IT roles, necessitating cross-functional collaboration between development, operations, and security teams (DevOps). Adjusting the organizational structure to accommodate this collaboration is a significant organizational change that needs careful planning.

Cost Management - Cloud computing offers cost benefits through pay-as-you-go pricing models. However, without proper governance and monitoring, costs can spiral out of control. Managing cloud expenses requires a shift in the organization's financial approach, including budgeting for operational expenses rather than capital expenses.(Harauzek 2022)

3.12 Cloud Factors

3.12.1 Cost Analysis

Cost analysis in cloud involves evaluating various aspects of expenses incurred before, during, and after migration.(Ramchand, K. 2021)

Infrastructure Costs - On-premises infrastructure requires significant investments in terms of hardware, servers, networking equipment, and cooling systems. Cloud eliminates or reduces these upfront capital expenses, as cloud providers offer a pay-as-you-go model.

Operational Costs - Maintaining on-premises infrastructure involves ongoing operational costs such as electricity, maintenance, staffing, and security. Cloud migration can lead to cost savings by transferring these responsibilities to the cloud provider.

Licensing Costs - Traditional software licensing can be expensive. Cloud alter the licensing model, potentially leading to savings or more efficient usage of software resources.(Sen, A., & Madria 2020)

Scalability Costs Although cloud services make scaling easier, it is critical to know how scaling impacts expenses. Growing too large during peak demand may drive up prices, while going small might help you save money when demand is low.

Data Transfer and Bandwidth Costs - You could have to pay for data transmission and bandwidth if you move a lot of data to and from the cloud. These costs should be considered, especially if your application involves frequent data transfers.

Migration Costs - The process of migrating applications, data, and services to the cloud may involve tools, consulting services, and temporary resources during the transition.(Ellison, M. 2018)

3.12.2 ROI Assessment

Return on Investment (ROI) assessment involves calculating the potential benefits and gains from cloud compared to the costs involved. (Rosati, P. 2020)

Cost Savings - Calculate the savings in terms of reduced infrastructure costs, operational costs, and licensing costs. Compare these savings against the expenses associated with migration, including any one-time migration costs.

Increased Efficiency - Cloud environments can offer improved resource utilization, automated scaling, and faster provisioning. Quantify the potential gains in terms of increased efficiency and reduced time-to-market for new services.

Flexibility and Agility - Assess the value of being able to rapidly deploy resources and scale as needed. Consider how this flexibility translates into business agility and responsiveness. (Gangadhar, V. R., & Shaikh 2021)

Downtime Reduction - Cloud computing lead to shorter maintenance windows and reduced downtime. Calculate the potential cost savings from decreased downtime and improved availability.

Innovation - Cloud services can enable the adoption of new technologies and innovation. Evaluate how this potential for innovation impacts your organization's competitive advantage and revenue streams.

Business Impact - Consider how cloud migration can improve customer experiences, enable new features, and lead to increased customer satisfaction and retention.(Nayar, K. B. 2018)

3.13 On-Premises Application

Whatever hardware and software applications make up an organization's information technology infrastructure are considered to be "on-premises" when hosted locally. Hosting IT assets on a public cloud or in a distant data center is different. By handling the placement, performance, and security of their on-premises IT assets, businesses have more control over them.

Many resources used by older and more conventional data centers are located on-premises. A growing number of businesses are embracing cloud computing or creating hybrid environments that blend cloud and on-premises solutions for their IT needs.

Since on-premises platforms are well-suited to satisfy single-tenancy requirements, many firms still employ them for compliance reasons. Robust and providing very secure data encryption, both on-premises and public cloud alternatives are available. An on-premises solution is ideal for organizations that need specialized hardware and processes tailored to their unique needs. While it may be simpler to scale up or down in the public cloud, on-premises solutions provide more control and customization possibilities.(Patel, N., & Shah 2016)

3.14 applications use on-premises

Instead of using a distant or cloud-based environment, the term "on-premise computing" describes when a company uses its own physical location to host data and applications. Many applications are better suited to on-premises computing, including the following:

Security: There is less chance of data breaches and more control over security measures with on-premise computing, making it a good choice for organizations dealing with sensitive data.

Companies that are required by law to maintain sensitive data on-premises may be able to avoid fines and other penalties.

Cost-effectiveness: When looking at long-term costs, on-premises computing may be the better option than cloud-based options.(Smith, J., & Johnson 2020)

Adaptability: Customizable on-premise solutions may be the best option for organizations with unique IT infrastructure requirements.

Existing systems: Many businesses are still using on-premise solutions since migrating to the cloud may be a challenge for companies with existing legacy systems. Until they discover a new replacement, they will continue to utilize the old ones.

Despite these advantages, on-premises computing is not without its flaws. Among them, you may find:

Limited scalability: The inflexibility of these solutions is often due to their inability to scale up or down un response to changes in company demands.(Brown, M., & White 2019)

Maintenance and upgrades: Costly and time-consuming maintenance and updates are a frequent part of on-premise computer systems.

Resource-intensive: Using internal IT resources for such on-premise apps may be costly and time-consuming for employees.

Disaster recovery: Natural catastrophes and other interruptions pose a threat to local computing systems, making them susceptible to data loss and outages.

Lack of innovation: Being slower to embrace new technology, these solutions may fall short of the innovation and new capabilities offered by cloud-based alternatives.

The choice between cloud computing and on-premises computing should be based on the unique requirements of each business. Compared to cloud computing, it provides better control and security, but it might be less flexible and use more resources.(Garcia, R., & Martinez 2018)

3.15 Benefits: On-Premise vs. Cloud

In the ongoing debate of on-premise vs. cloud, enterprises are often torn between these two distinct options. Both have unique advantages that can significantly impact business operations, data management, and cost structures. Here, we delve into the benefits of on-premise solutions to shed light on why they might be the right choice for certain businesses.

3.15.1 On-Premise Benefits

Enhanced Data Control-When discussing on-premise vs. cloud, enhanced data control is one of the most often cited benefits of on-premise solutions. Having data stored within the physical confines of your enterprise grants you direct access and complete control over your data storage and management processes. This kind of control is hard to match in a cloud-based setup, where data could be stored across different geographical locations, often outside your direct purview.(Armbrust, M., Fox 2010)

Compliance and Regulatory Control-In any serious cloud vs. on-premise cost and benefit assessment, compliance and regulatory control can tip the scales in favor of on-premise solutions. Specific industries, such as healthcare, legal services, and finance, have strict compliance and data management requirements. On-premise setups, where data resides within your own infrastructure, often make it easier to implement the specific controls and security measures required to meet these stringent standards.

Latency Control-Another critical aspect of a cloud on-premise comparison is latency control. Industries that require instantaneous or near-instantaneous data access like stock trading, emergency services, or real-time analytics can benefit significantly from on-premise solutions. Because the data is stored within your enterprise's local network, latency is often reduced, allowing for real-time access that is difficult to achieve in a cloud-based environment. Do note that the cloud service providers have significantly upped the ante.

While the cloud vs. on-premise pros and cons extend beyond just control, delving into aspects like cost, scalability, and remote access, these are areas where cloud solutions typically excel. Understanding these strengths and limitations in the on-premise vs. cloud debate can help enterprises make a well-informed decision that aligns with their specific operational needs, compliance requirements, and financial considerations.(Broberg, J., & Brandic 2009)

3.15.2 On-Premise Costs

Initial Capital Expenses-In a cloud vs. on-premise cost analysis, the initial capital investment for on-premise infrastructure often stands out. Businesses usually need to invest heavily in hardware, software, and networking equipment. The impact of this initial financial outlay can be especially significant for small and mid-sized enterprises operating with constrained budgets.

Ongoing Maintenance Costs- Once the on-premise infrastructure is up and running, it's not set-and-forget. Businesses also have to budget for continual expenses such as software updates, hardware repairs or replacements, and IT support. These ongoing costs can accumulate over time and must be accounted for when considering the total cost of ownership.(Chen, D., Dou, W., & Jin 2012)

Scalability Costs-Another notable element in the cloud on-premise comparison is the cost associated with scaling up an on-premise system. Adding additional hardware and software, upgrading networking infrastructure, and potential downtime during these expansions can add up. Additionally, the manual labor required for these tasks adds an extra layer of cost.(Mell, P., & Grance 2014)

3.16 On-Premise Risks

Security Vulnerabilities-When discussing the on-premise vs. cloud difference, it's crucial to focus on the risks each option presents. One significant downside to on-premise systems is their vulnerability to security threats. These systems are generally maintained in-house, meaning the business is solely responsible for any security measures.

While this can be an advantage in terms of control, it also means that if your IT team is not up to par, the system is at greater risk. This risk is especially pronounced when compared to cloud solutions, where providers typically have specialized security staff and robust protocols, illuminating the benefits of cloud vs. on-premise in the area of security.(Gonen, Y., Ayyagari, M., & Yablon 2017)

Limited Scalability- Another considerable drawback of on-premise solutions is limited scalability. When a business grows, it's not always straightforward to scale on-premise solutions to meet increased demand.

Buying, installing, and configuring hardware can be an expensive and time-consuming ordeal. In contrast, the advantages of on-premise vs. cloud often don't extend to scalability. Cloud services usually offer much simpler scalability options, reinforcing the benefits of cloud vs. on-premise for rapidly growing businesses.

Resource Redundancy- The on-premise systems typically require a higher degree of resource redundancy. If a physical server in an on-premise data center fails, for instance, the process for switching to a backup may not be as seamless as it would be in a cloud environment.

To illustrate with an on-premise vs. cloud example, If an on-premise server goes down due to a power outage or hardware failure, there might be significant downtime before a backup server can take over. This contrasts sharply with cloud computing, which often distributes data across multiple locations to ensure continuous availability, highlighting cloud vs. on-premise security and reliability advantages.(Moore, T., Akselsen, S., & Young 2018)

3.17 Comparison between Cloud applications and On-premise applications Cloud Applications

Accessibility: Cloud applications are accessible over the internet from any device with an internet connection. Users can access their data and software from anywhere, making it convenient for remote work and on-the-go access.

Cost and Scalability: The majority of cloud apps use a subscription or pay-as-you-go pricing model. As companies only pay for the resources they really use, it's a great deal for SMEs. Depending on the demands of the company, cloud services may be quickly and simply scaled up or down.

Maintenance and Updates: Updates, fixes, and maintenance are handled by cloud service providers. Users automatically receive the latest features and enhancements, reducing the burden on IT teams.

Data Security: Trustworthy cloud services spend a lot of money on encryption, data redundancy, and security.

However, some businesses may have concerns about data residing on external servers.(Gupta, R., & Sharma 2018)

Quick Deployment: Cloud applications can be quickly deployed since there is no need for on-premise infrastructure setup. Users can start using the software as soon as they subscribe to the service.

Customization: While cloud applications offer some level of customization, they may not be as extensive as on-premise solutions. Providers usually offer configurable options to cater to different user needs.(Lee, S., & Kim 2017)

On-Premise Applications:

Control and Data Security: On-premise applications are installed and operated locally on the organization's own servers. This provides businesses with direct control over their data, making it suitable for companies with strict data privacy and security requirements.

Customization and Integration: On-premise applications offer more extensive customization options to tailor the software to specific business processes. Integration with existing on-premise systems is typically smoother due to direct access to local resources.

Cost and Ownership: On-premise solutions involve higher upfront costs for hardware, licenses, and infrastructure setup. However, over time, the total cost of ownership may be lower compared to ongoing subscription fees for cloud services.(Kumar, A., & Singh 2016)

Compliance and Regulatory Requirements: Some industries have stringent regulatory requirements that necessitate keeping certain data on-premise.

On-premise solutions can address compliance concerns for businesses with specific legal obligations.

Internet Dependency: On-premise applications do not rely on Internet connectivity for day-to-day operations. This can be advantageous in areas with unreliable or limited internet access.

Upgrades and Updates: Upgrading on-premise software requires manual intervention, which may lead to delayed deployments and potential compatibility issues.(Liu, Y., & Wang 2015)

3.18 Similarities between On-Premise vs. Cloud

Drifts in the information technology sector have persisted for decades. The cloud is a convenient, all-in-one option that has spread around the world. The network-based management of essential infrastructure components alleviated IT maintenance worries. Cloud adoption has many benefits, but it is not seen as a panacea since some companies still want on-premise solutions.(Zhang, Q., Cheng, L., & Boutaba 2010)

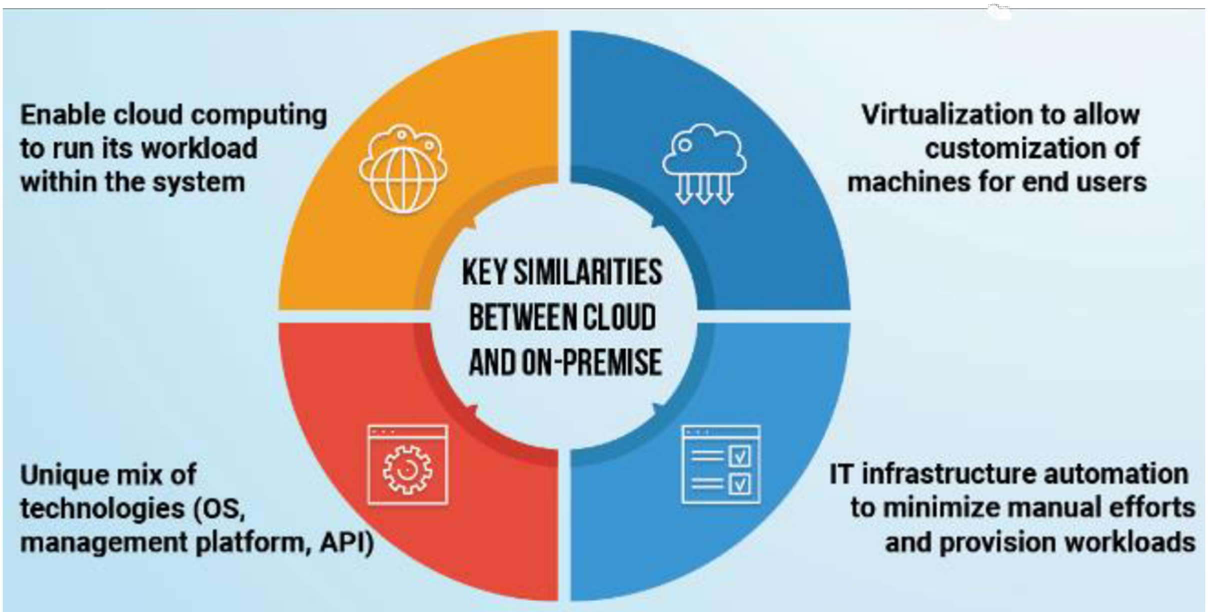


Fig.4: Similarities Between Cloud and On-Premise

Sources: https://rb.gy/o4qj8v

Whereas cloud computing takes care of infrastructure on the cloud, on-premise solutions manage infrastructure at the physical location of the firm. Yet, deploying an agile IT infrastructure is the primary goal of both of these solutions, which is to lessen the financial and administrative demands on organizations. Since cloud computing allows for inexpensive, agile, and adaptable integrations, it has become more attractive to small enterprises due to its ease of use and low cost. Both methods have some commonalities, however.(Benlian, A., & Hess 2011)

3.18.1 Workloads within the system

The capacity to manage workloads, rapid application development and deployment, on-demand service availability, near-instant software updates (in the absence of supplementary hardware required by a data center), and limitless memory space are some of the most well-known features of the cloud.

Such features are not available with an on-premises infrastructure solution. For the time being, however, businesses with on-premise equipment will continue to use cloud services for testing and application execution. A same logic applies to on-premises environments, allowing cloud computing to execute its job locally.

Companies are able to keep running smoothly without any interruptions caused by an overabundance of work. Businesses may use the cloud to test and execute new workloads as needed.(Chou 2012)

3.18.2 A unique mix of technologies

Both on-premise and cloud infrastructures are built using a range of technologies. Included in this are APIs, a management platform, and an operating system. The ability to manage both cloud and on-premises systems is made possible by a management platform's suite of capabilities and modules.

The creation of services and apps for the provisioning of cloud and on-premise platforms, hardware, and software is made easier with an API. Indirect and direct software and infrastructure services to end users are made possible via it, acting as a service gateway.

3.18.3 Additional capabilities or increased efficiencies

Vulnerabilities in operating systems and applications may be more easily accommodated with virtual machines. Accounting, marketing, sales, executive, IT access, and front-line demands may all influence the types of data and application packages offered.

With virtualization's exponential growth, it's permeating every area of the computer network, whether it's in the cloud or on-premises. More progress in terms of user-friendliness and machine customisation is provided by virtualization. Costs are also helped by this.

Nowadays, most computer setups are somewhat complicated. Network operations are better handled on-premise for certain businesses. Like with cloud infrastructures, they construct internal "private clouds" and use virtualization to manage the burden.(Whittaker, Z., & Ellender 2013)

3.18.4 IT infrastructure automation

Automation of IT infrastructure helps organizations reduce the amount of human labor needed for managing and supplying workloads. Through the use of automation, on-premise and cloud resource-related tasks may be made to run more smoothly and with less human interaction.

When IT tasks are automated, IT workers have more time to focus on critical concerns and future planning. When IT departments can automate mundane processes, they free up resources to concentrate on higher-value initiatives.

Given these benefits, IT infrastructure automation is being used in many cloud settings, such as public, private, and hybrid clouds, as well as on-premises. Works well for streamlining the deployment of workloads. By reusing previously squandered technology resources and software licenses, it also aids in decreasing expenses.(Bhadauria 2012)

3.19 Differences Between On-Premise and Cloud

Above, we see that both on-premise and cloud environments have several commonalities. Nonetheless, a number of essential distinctions exist between the two. Each of these settings has unique capabilities, so businesses may choose the one that best suits their requirements.(Sultan 2010)

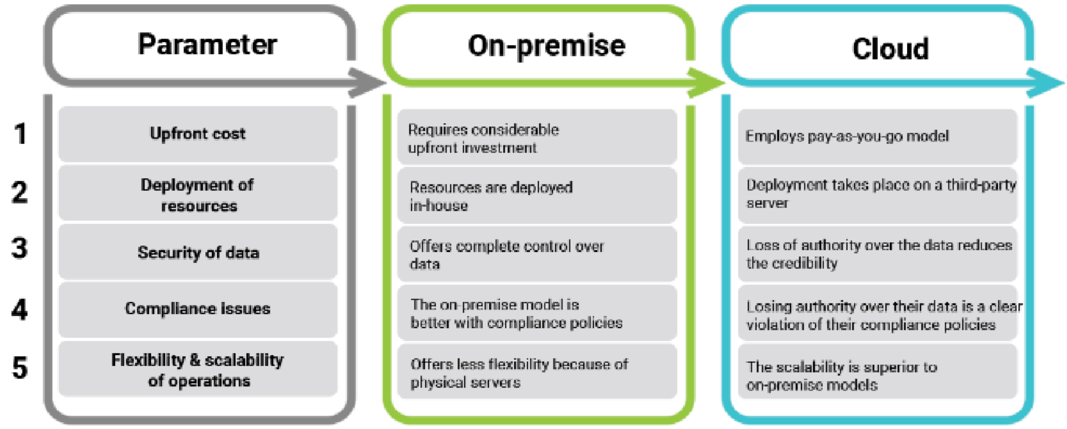


Fig5: Differences Between Cloud and On-premis

Sources: https://rb.gy/o4qj8v

3.20 Fuzzy Logic In Cloud Computing

When making decisions in situations where there is uncertainty or ambiguity, fuzzy logic may be a useful mathematical tool. A membership function serves as its foundation, and it is implemented using Fuzzy rules. Fuzzy Logic is utilized in many domains, such as control systems, artificial intelligence (AI), medical diagnostics, picture processing, natural language processing (NLP), and image processing.

Cloud computing is a paradigm for allocating computer resources that enables consumers to access several services via the internet; Fuzzy Logic might be applicable in this context. There are a number of benefits of using Fuzzy Logic with cloud computing, such as:

- It is capable of handling any uncertainty or imprecision associated with the cloud, including resource availability, user demand, network constraints, and more.

- With its adaptability and flexibility, this system may offer cloud management solutions such as load balancing, job scheduling, and optimization of quality of service, among others.

- Users can be certain that cloud systems will work reliably, and it has the potential to think like a person.

3.20.1 concept of a fuzzy logic

A fuzzy logic diagram in cloud computing is a graphical representation of the fuzzy logic system applied to the cloud computing domain. It shows the input variables, output variables, fuzzy sets, fuzzy rules, and the inference process.

Resource pooling, scalability, wide network access, quick elasticity, measured service, serverless computing, edge computing, multi-cloud strategy, hybrid cloud strategy, AI, and ML are all examples of input variables that impact cloud computing decision-making.

The output variables are the desired outcomes of the cloud computing decision-making, such as cost, speed, global scale, productivity, performance, security, data sensitivity, and regulatory compliance.

The fuzzy sets are the linguistic terms that describe the input and output variables, such as low, medium, high, very high, etc.

The fuzzy rules are the if-then statements that define the relationship between the input and output variables, such as if resource pooling is high and scalability is high, then cost is low and performance is high.

The inference process is the method of applying the fuzzy rules to the input values and obtaining the output values.

The provided Diagram describes the concept of a fuzzy logic diagram in the context of cloud computing.

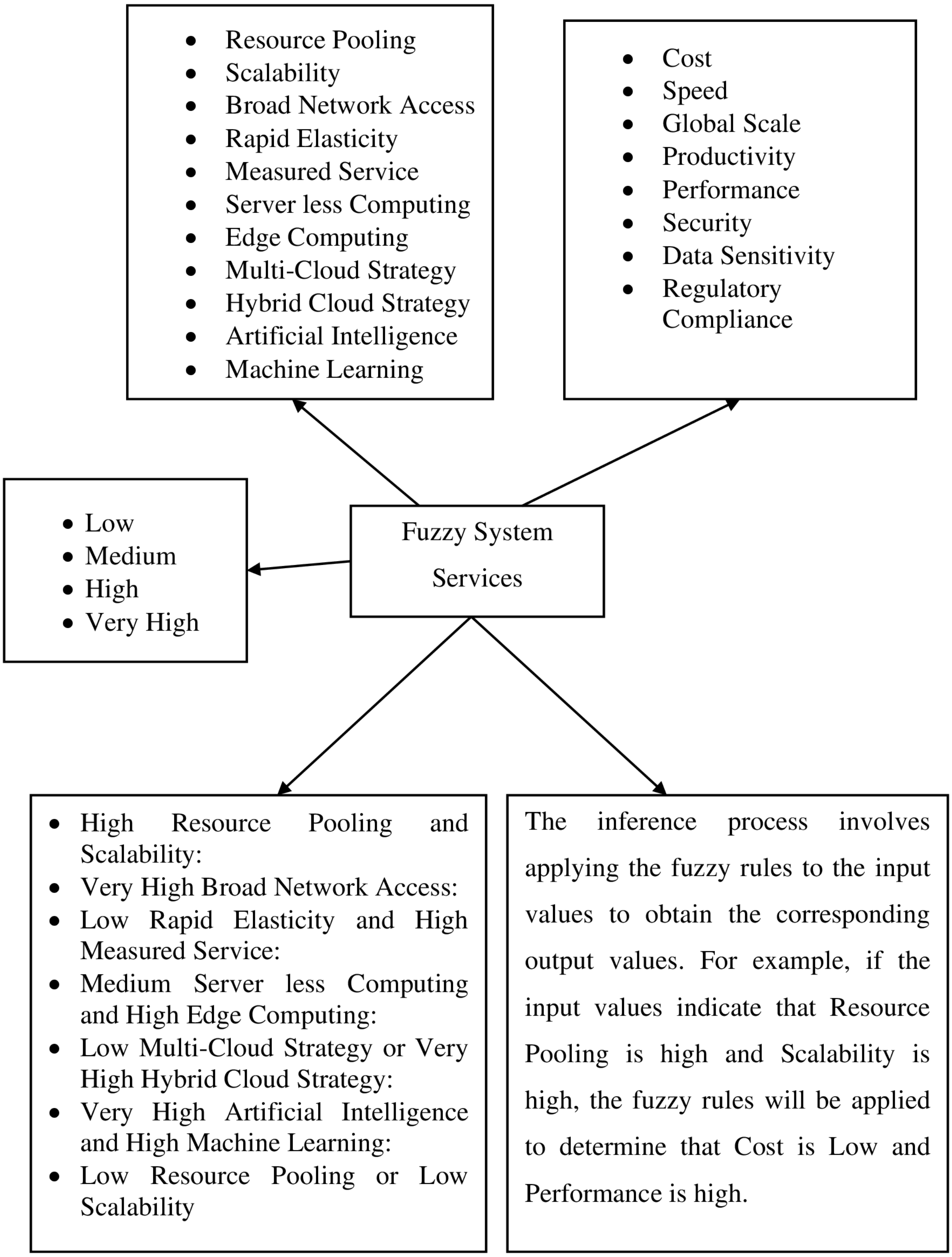


Fig.6:concept of a fuzzy logic diagram

Sources: Author

By utilizing aggregation and defuzzification techniques, like centroid and max membership, one can precisely determine the Overall Cloud Service Quality.

The intricacy and linkages inherent in cloud computing are not adequately addressed by its oversimplification. Building a thorough fuzzy logic diagram requires an in-depth analysis of the provided data, knowledge of relevant fuzzy logic methods and techniques, and any other background information.

Incorporating fuzzy logic into cloud computing requires us to consider its potential applications across various cloud service components. Fuzzy logic could be useful for optimizing performance, managing resources, and making decisions in dynamic and uncertain environments like cloud computing. Some of the numerous applications of fuzzy logic in the cloud are listed below.

Resource Management using Fuzzy Logic:

Dynamic Resource Allocation: In order to adapt to changing demand patterns, fuzzy logic can be used to distribute resources (such as storage space, processing power, and bandwidth) on the fly. Fuzzy logic controllers increase performance and cost-efficiency by assessing previous use data and current workload factors to change resource allocations in real-time.

Load Balancing: By intelligently distributing incoming requests across available cloud resources, fuzzy logic controllers may ensure maximum usage and avoid certain servers or data centers from being overwhelmed. To enhance system performance, fuzzy rules can take into account things like server capacity, network latency, and geographical closeness.

Energy-Efficient Resource Management: Cloud data centers may reduce their energy consumption by optimizing resource use with fuzzy logic. Fuzzy controllers dynamically optimize resource allocations by taking workload intensity, temperature, and power consumption effectiveness (PUE) into account, to strike a compromise between performance and energy economy.

Security and Compliance using Fuzzy Logic:

Anomaly Detection: To improve security, fuzzy logic may examine user actions, network traffic patterns, and system records for irregularities that could indicate a compromise. Anomaly detection systems that use fuzzy logic can change their detection thresholds in real-time to account for changing threats.

Risk Assessment: By putting a numerical value on the degree of ambiguity around security policies and regulatory requirements, fuzzy logic may make risk assessment and compliance management easier. Integrating qualitative and quantitative risk variables, fuzzy inference algorithms may evaluate compliance posture comprehensively and prioritize repair actions.

Access Control: Fuzzy logic has the potential to enhance existing access control methods by evaluating membership grades in light of contextual elements such as user role, location, and time of day. To implement granular access control policies, fuzzy inference engines may adapt membership functions in real time to new circumstances.

Performance Optimization using Fuzzy Logic:

QoS Management: Fuzzy logic can optimize QoS measures like reliability, throughput, and reaction time by dynamically allocating resources and prioritizing tasks. Fuzzy controllers can adapt to different user demands and workloads to maintain acceptable service levels.

Fault Tolerance: In the event of hardware failure or network interruption, fuzzy logic can improve fault tolerance systems by intelligently redirecting traffic, reallocating resources, and starting recovery operations. In order to properly identify failure circumstances and begin mitigation techniques, fuzzy-based fault detection systems can examine sensor data and diagnostic information.

Performance Prediction: Using patterns in past data, current conditions, and the nature of the task, fuzzy logic may foretell how well a system will perform in the future. To help with decisions about capacity planning, resource provisioning, and workload scheduling, fuzzy inference models can produce probabilistic predictions of key performance indicators (KPIs).

Cost Optimization using Fuzzy Logic:

Cost-Benefit Analysis: Fuzzy logic may help with cost-benefit analysis by putting a number on the benefits and drawbacks of various cloud deployment strategies, pricing models, and resource configurations. Fuzzy decision-making frameworks can find the best cost-effective solution by considering aspects including performance needs, financial limits, and service-level agreements (SLAs).

Optimal Workload Placement: By optimizing workload placement decisions across various cloud providers or deployment models, fuzzy logic takes into account issues like data location, network latency, and resource availability. By weighing the weight of many placement criteria, fuzzy inference algorithms may advise on the most cost-effective and performance-enhancing deployment techniques..

Dynamic Pricing Optimization: Cloud service pricing methods may be improved with the use of fuzzy logic, which allows for the continual modification of price parameters (such as use rates, discounts, and contract terms) in reaction to market, demand, and customer preferences. By responding to changing customer tastes and market circumstances, fuzzy pricing algorithms can maximize revenues.

Integrating fuzzy logic into many aspects of cloud computing can help organizations improve their agility, resilience, and efficiency while managing complex and constantly changing cloud infrastructures. Fuzzy logic offers a flexible and easy-to-understand framework for reasoning through uncertainty and making educated decisions in real-time. This may help cloud users and providers optimize resources, save costs, and improve security.

When making decisions, fuzzy logic lets you logically reflect fuzziness and ambiguity. It permits what is known as a partial truth, in which a statement is only partly true or untrue rather than entirely true or wrong. Fuzzy rules, which are if-then statements that describe the fuzzy relationship between the input and output variables, are the building blocks of fuzzy logic. A fuzzy set, which contains membership degrees for each potential output value, is the final result of a fuzzy logic system.

Cloud computing provides access to a wide range of computer resources, including servers, data storage, databases, networking, software, analytics, and intelligence. Cloud computing has several benefits, such as improved speed and security, faster access to state-of-the-art technology, reduced overhead, and more scalability and flexibility.

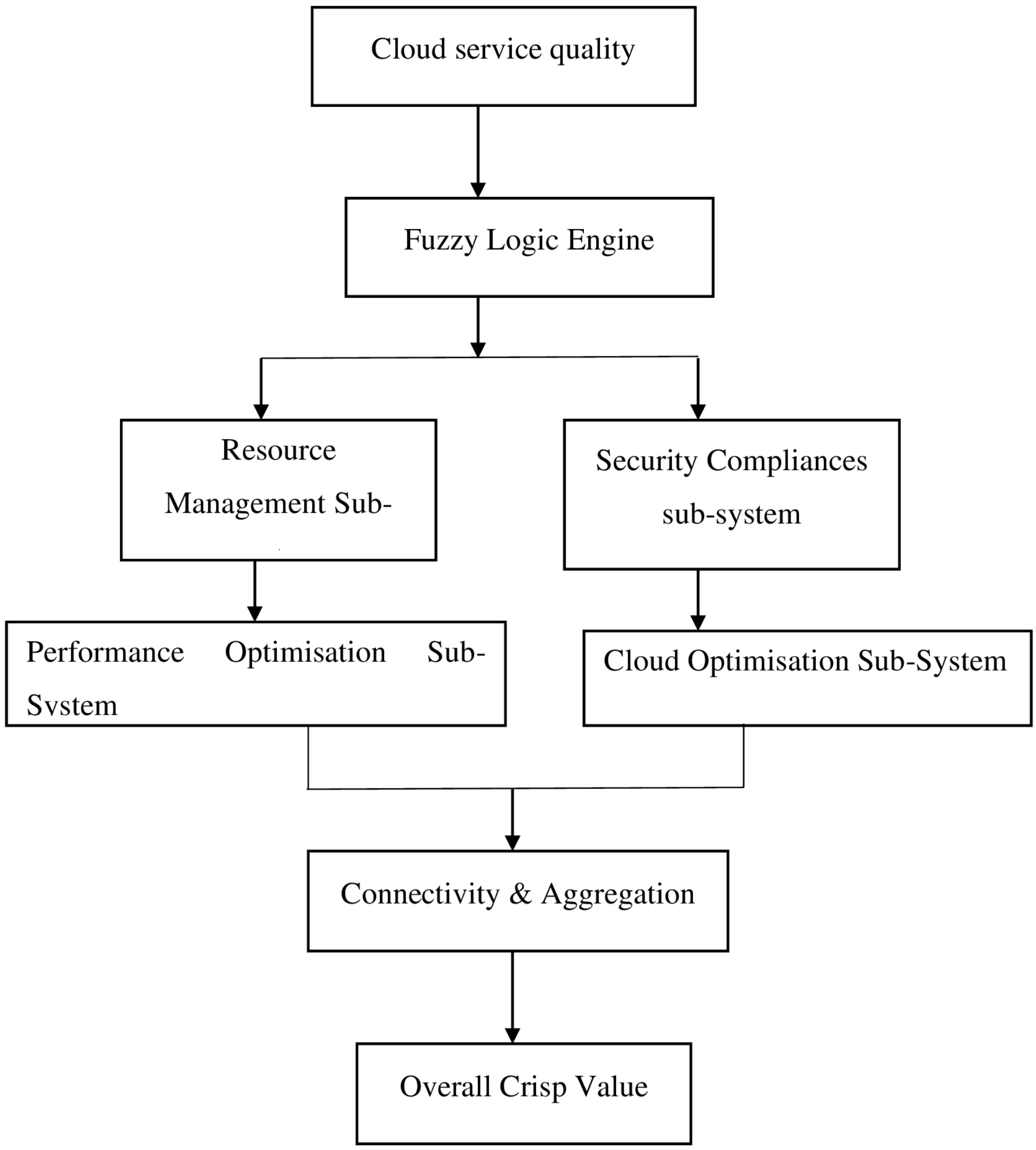


Fig.7: Cloud Service Quality

Source: Author

4. Practical part

4.1 Data Analysis

In this study, the investigator make use of mixed-method design, integrating both qualitative as well as quantitative information and data for Comparison between cloud - based application and on-premises application: case study airline website. The primary qualitative method collects interviews from the participants. The collected interviews were analysed using systematic approach. The interview sessions were recorded and transcribed. The analysis performed in different stages in which the transcripts were read to develop understanding. After the familiarisation stage, the initial codes were searched based on similar concepts. The re-occurring pattern of codes was merged and transformed into themes. The themes were named and then reviewed by an independent reviewer. The resulting themes were reported in the final stage. As per researcher statistical analysis primarily facilitated the summarization the collected data, offering key insights into the investigator or readers concerning to Comparison between cloud - based application and on-premises application: case study airline website.

In contrast, quantitative information was attained through the close-ended questionnaire, and the responses of participants were primarily coded utilising Likert scale that is designed determining the value of (1= strongly agree, 5=strongly disagree). Using SPSS software, several statistical analyses were performed, involving descriptive analysis to reveal the mean of the overall responses of the participant, to determine Comparison between cloud - based application and on-premises application: case study airline website. Thus, these statistical analyses played a key role in drawing conclusions as well as determining the main findings of the research. The adoption of both mixed method designs permitted for an in-depth exploration and Comparison between cloud - based application and on-premises application: case study airline website, enriching the breadth and depth of the study findings.

4.2 Methodology

On the other hand, the closed ended survey questionnaire instrument was utilised in the study for the data collection.(Aktan 2009)We circulate questionnaire through googleform to 400 respondents in which only 223 respondents responed to our questionnaire. A researcher also demands that sample size is critical for the recognition of potential information collection. The participants involved in the study were individuals from several websites and organisations that contributed to providing the key benefits, challenges and reasons for Comparison between cloud - based application and on-premises application: case study airline website. Thus, the adequate sample size adoption assisted in examining the key research questions. The questionnaire survey consists of these core variables: (Nihan Gulsoy 2019)

Thus, 223 respondents were selected for the study which assisted in the relevant collection of data findings and adequate results interpretation. The participants involved in the study were individuals from several websites organisations that contributed to providing the key benefits, challenges and reasons for cloud - based application and on-premises application: case study airline website. Thus, the adequate sample size adoption assisted in examining the key research questions. The questionnaire survey consists of these core variables:

Demographics: It includes the basic information of the survey involves age, gender, employment etc.

Dependent variable: it is the primary response or outcome that is being influenced, measured and predicted by the independent variable. In this context, costs that is being impacted and examined.

Independent variable: The independent variable is controlled or manipulated by the investigator to measure its impact on the dependent variable. In this context, level of security and protection , scalability and adaptability, performance are being examined.

Based on the provided information, it appears that a structured survey method was employed for the research. The structured survey is a scientific method characterized by a predetermined set of questions asked in a standardized mannerThe results may be more easily analyzed and understood when a structured survey is used since it ensures uniformity in data collecting.

4.3 Demographic Information Analysis

Table: 4.1 Age wise distribution of the respondents

Age of respondents		
	Frequency	Percent
Below 30 years	65	29.1
30 to 35 years	76	34.1
36 to 40 years	24	10.8
41 to 45 years	36	16.1
Above 45 years	22	9.9
Total	223	100.0

The above table discusses the age wise distribution of the respondents. In below 30 years group, Frequency is 65 and percentage is 29.1%. In 30 to 35 years group, Frequency is 76 and percentage is 34.1%. In 36 to 40 years group, Frequency is 24 and percentage is 10.8%. In 41 to 45 years group, Frequency is 36 and percentage is 16.1%. In Above 45years group, Frequency is 22 and percentage is 9.9%.

Graph: 4.1 Graphical representation of age wise distribution of the respondents

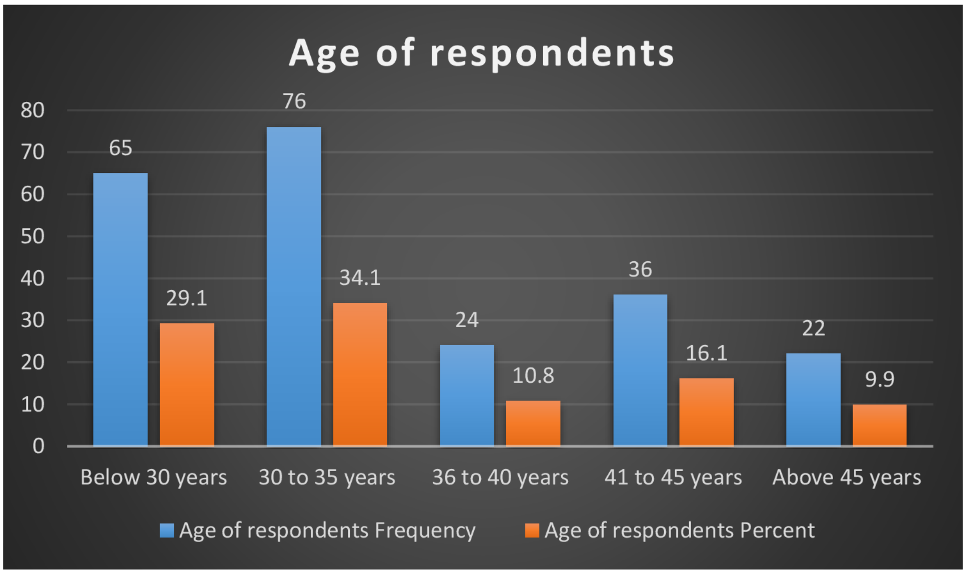


Table: 4.2Genderwise distribution of the respondents

Gender		
	Frequency	Percent
Male	139	62.3
Female	84	37.7
Total	223	100.0

The above table discusses the gender wise distribution of the respondents. There are 139 males and 84 females are participated in this study whose percentages are 62.3% and 37.7%.

Graph: 4.2 Graphical representation of gender wise distribution of the respondents

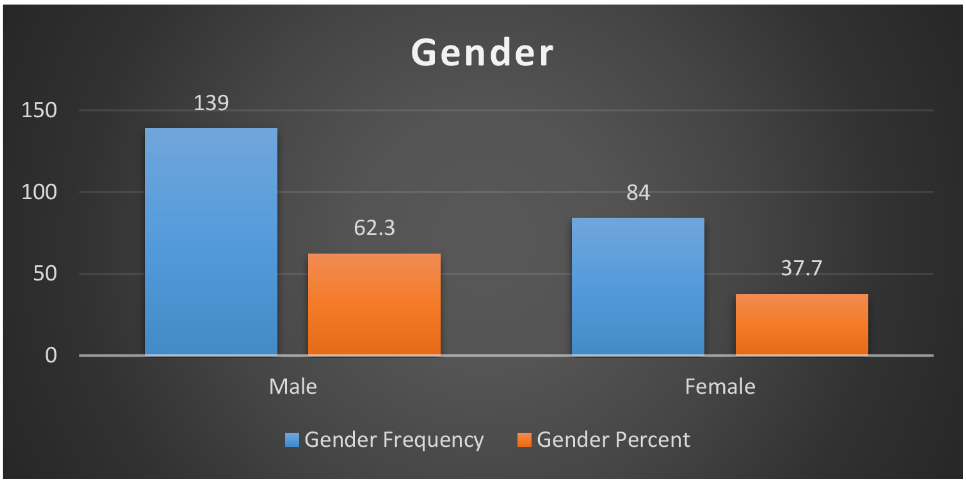


Table: 4.3Educationwise distribution of the respondents

Education		
	Frequency	Percent
Graduate	74	33.2
Post graduate	108	48.4
Doctorate	23	10.3
Others	18	8.1
Total	223	100.0

The above table discusses the education wise distribution of the respondents. In graduate, Frequency is 74 and percentage is 33.2%. In post graduate, Frequency is 108 and percentage is 48.4%. In Doctorate, Frequency is 23 and percentage is 10.3%. In others, Frequency is 18 and percentage is 8.1%.

Graph: 4.3 Graphical representation of education wise distribution of the respondents

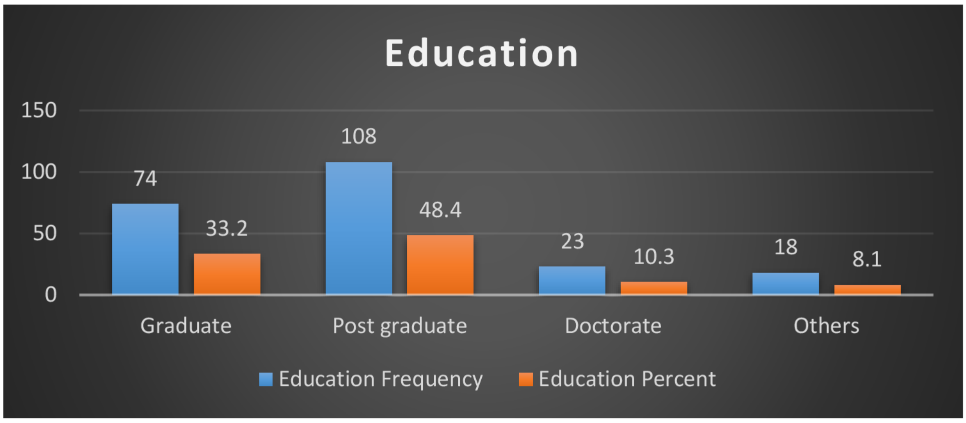
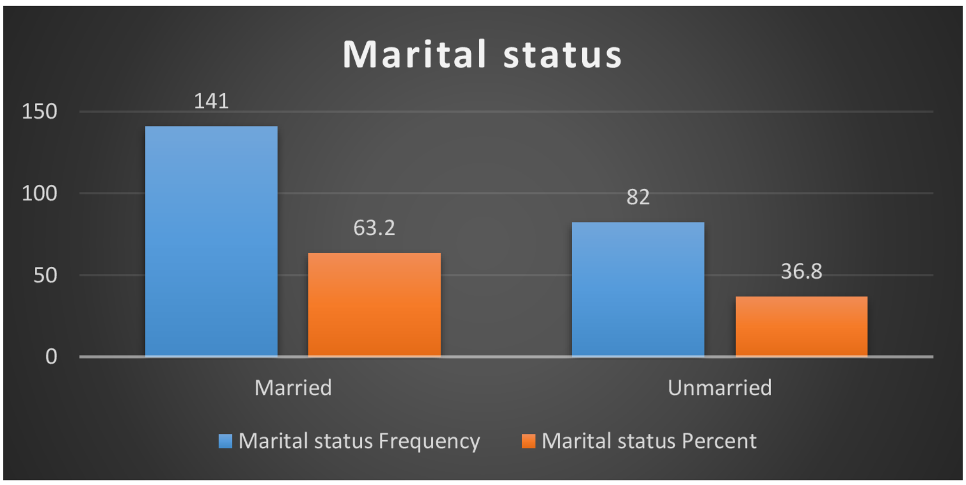


Table: 4.4Marital status of the respondents

Marital status		
	Frequency	Percent
Married	141	63.2
Unmarried	82	36.8
Total	223	100.0

The above table discusses frequency and percentage of marital status of respondents. In married, frequency is 141 and percentage is 63.2%. In unmarried, frequency is 82 and percentage is 36.8%.

Graph: 4.4 Graphical representation of marital status of the respondents



4.4 Descriptive statistics

4.4.1 cloud based performance

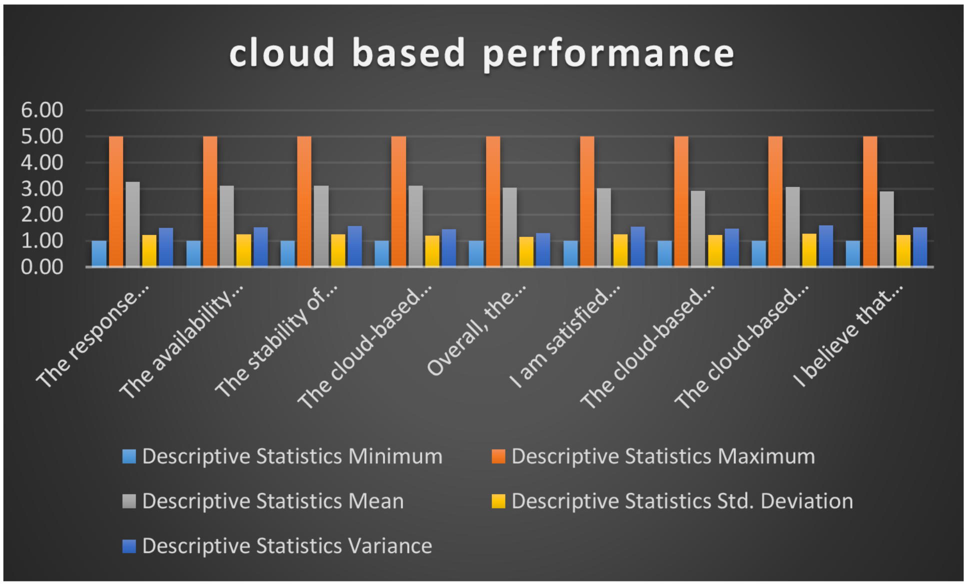
Table: 4.5Descriptive statistics of cloud based performance

Descriptive Statistics						
	N	Minimum	Maximum	Mean	Std. Deviation	Variance
The response time of the cloud-based application is satisfactory.	223	1.00	5.00	3.2511	1.21540	1.477
The availability of the cloud-based application meets our expectations.	223	1.00	5.00	3.0987	1.22994	1.513
The stability of the cloud-based application is reliable.	223	1.00	5.00	3.1166	1.24656	1.554
The cloud-based application effectively handles peak traffic loads without significant performance degradation.	223	1.00	5.00	3.0942	1.20252	1.446
Overall, the performance of the cloud-based application is satisfactory for our organization's website.	223	1.00	5.00	3.0404	1.13232	1.282
I am satisfied with the level of support provided by the cloud service provider regarding application performance issues.	223	1.00	5.00	3.0179	1.23742	1.531
The cloud-based application meets our organization's requirements for uptime and reliability.	223	1.00	5.00	2.9058	1.21370	1.473
The cloud-based application performs consistently across different devices and platforms.	223	1.00	5.00	3.0583	1.26320	1.596

I believe that the cloud-based application has improved our organization's website performance compared to previous solutions.	223	1.00	5.00	2.8789	1.22609	1.503
Valid N (listwise)	223					

The above table discusses descriptive statistics of cloud based performance questionnaire in which mean value of all items are above 2.8 indicates positive response.

Graph: 4.5 Graphical representation of descriptive statistics of cloud based performance



4.4.2 On premises based performance

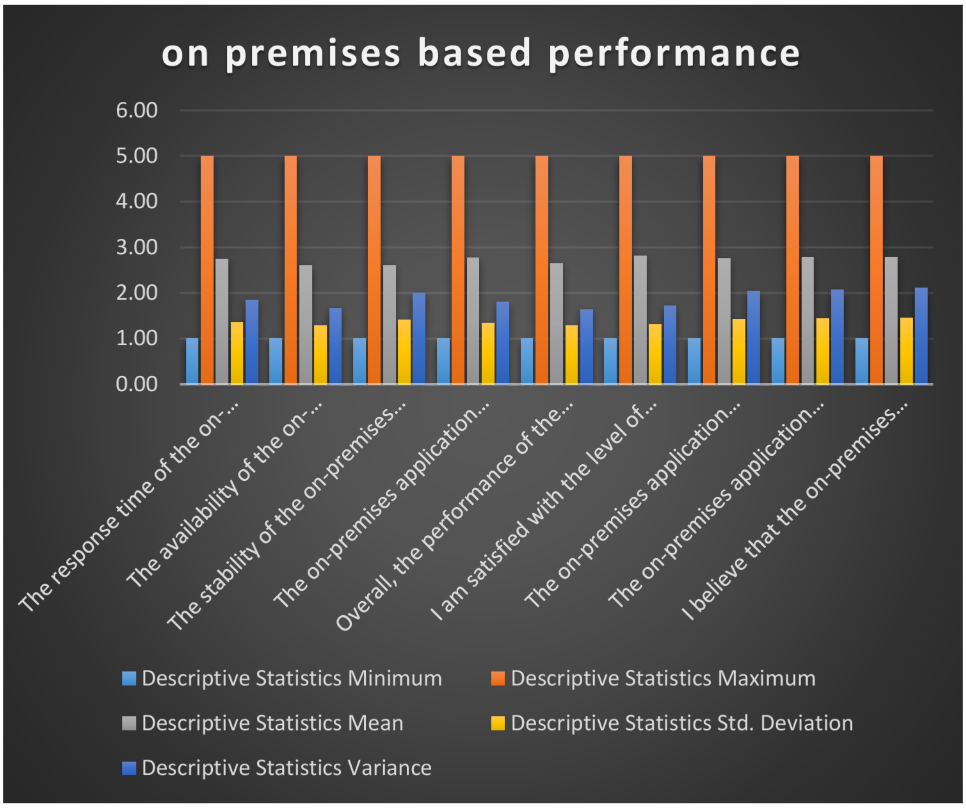
Table: 4.6Descriptive statistics of on premises based performance

Descriptive Statistics						
	N	Minimum	Maximum	Mean	Std. Deviation	Variance
The response time of the on-premises application is satisfactory.	223	1.00	5.00	2.7399	1.36050	1.851

The availability of the on-premises application meets our expectations.	223	1.00	5.00	2.6009	1.29009	1.664
The stability of the on-premises application is reliable.	223	1.00	5.00	2.5964	1.41370	1.999
The on-premises application effectively handles peak traffic loads without significant performance degradation.	223	1.00	5.00	2.7758	1.34028	1.796
Overall, the performance of the on-premises application is satisfactory for our organization's website.	223	1.00	5.00	2.6502	1.27823	1.634
I am satisfied with the level of support provided by our internal IT team regarding application performance issues.	223	1.00	5.00	2.8072	1.30954	1.715
The on-premises application meets our organization's requirements for uptime and reliability.	223	1.00	5.00	2.7623	1.43069	2.047
The on-premises application performs consistently across different devices and platforms.	223	1.00	5.00	2.7803	1.43670	2.064
I believe that the on-premises application has effectively served our organization's website performance needs.	223	1.00	5.00	2.7848	1.45142	2.107
Valid N (listwise)	223					

The above table discusses descriptive statistics of on premises based performance questionnaire in which mean value of all items are between 2.5 to 2.8 indicates average response.

Graph: 4.6 Graphical representation of descriptive statistics of on premises based performance



4.4.3 Costs of cloud-based applications

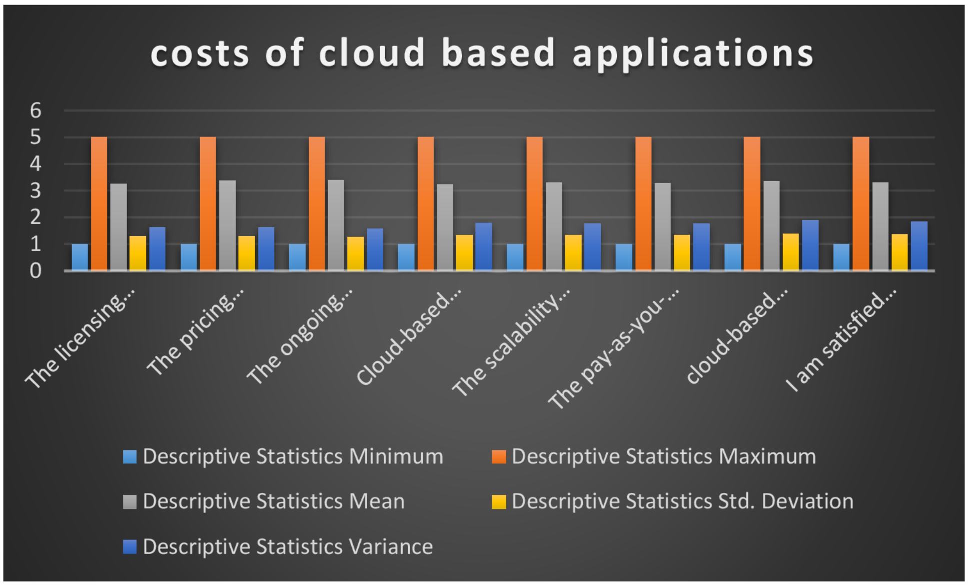
Table: 4.7Descriptive statistics of costs of cloud-based applications

Descriptive Statistics						
	N	Minimum	Maximum	Mean	Std. Deviation	Variance
The licensing fees for cloud-based applications are reasonable compared to traditional software licenses.	223	1.00	5.00	3.2646	1.27589	1.628

The pricing structure for updates and upgrades of cloud-based applications is clear and understandable.	223	1.00	5.00	3.3812	1.27802	1.633
The ongoing maintenance costs of cloud-based applications are lower than those of on-premises solutions.	223	1.00	5.00	3.4036	1.25144	1.566
Cloud-based hosting expenses are justified by the benefits and features provided by the service.	223	1.00	5.00	3.2332	1.33874	1.792
The scalability of cloud-based applications allows for efficient cost management as our organization's needs change.	223	1.00	5.00	3.2960	1.32622	1.759
The pay-as-you-go model of cloud-based services helps in controlling unnecessary expenses.	223	1.00	5.00	3.2780	1.32672	1.760
cloud-based storage costs are reasonable considering the accessibility and reliability they offer.	223	1.00	5.00	3.3408	1.37562	1.892
I am satisfied with the cost-effectiveness of our organization's investment in cloud-based applications.	223	1.00	5.00	3.2915	1.35243	1.829
Valid N (listwise)	223					

The above table discusses descriptive statistics of costs of cloud-based applications questionnaire in which mean value of all items are above 3.2 indicates positive response.

Graph: 4.7 Graphical representation of descriptive statistics of costs of cloud-based applications



4.4.4 Costs of on premises-based applications

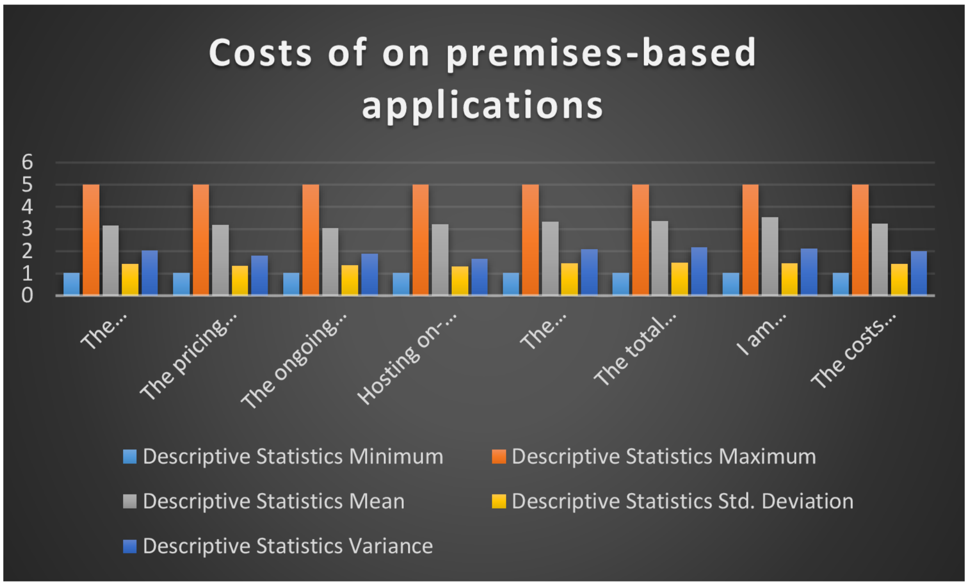
Table: 4.8Descriptive statistics of costs of on premises-based applications

Descriptive Statistics						
	N	Minimum	Maximum	Mean	Std. Deviation	Variance
The licensing fees for on-premises applications are reasonable compared to cloud-based alternatives.	223	1.00	5.00	3.1614	1.42403	2.028
The pricing structure for updates and upgrades of on-premises applications is transparent and understandable.	223	1.00	5.00	3.1704	1.33815	1.791
The ongoing maintenance costs of on-premises applications are justifiable considering the level of support provided.	223	1.00	5.00	3.0224	1.37036	1.878

Hosting on-premises applications is cost-effective compared to cloud-based hosting solutions.	223	1.00	5.00	3.2063	1.28839	1.660
The expenses associated with on-premises storage solutions are reasonable given the level of control and security they provide.	223	1.00	5.00	3.3139	1.44576	2.090
The total cost of ownership (TCO) for on-premises applications is justifiable compared to the benefits they provide.	223	1.00	5.00	3.3543	1.47198	2.167
I am satisfied with the cost-effectiveness of our organization's investment in on-premises applications.	223	1.00	5.00	3.5112	1.44839	2.098
The costs associated with maintaining on-premises applications are manageable and within budget constraints.	223	1.00	5.00	3.2287	1.40997	1.988
Valid N (listwise)	223					

The above table discusses descriptive statistics of costs of on premises-based applications questionnaire in which mean value of all items are above 3.0 indicates positive response.

Graph: 4.8 Graphical representation of descriptive statistics of costs of cloud-based applications



4.4.5 Scalability and adaptability

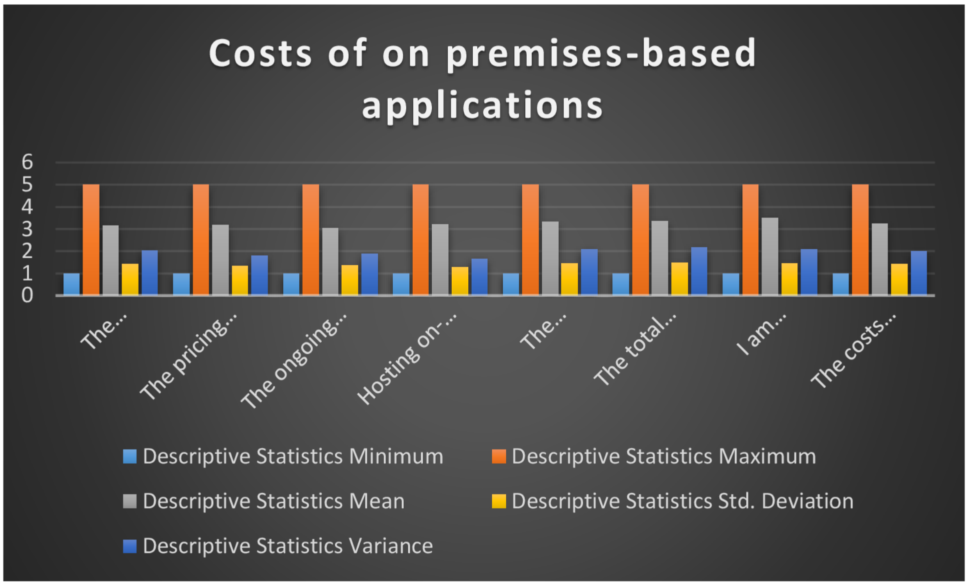
Table: 4.9Descriptive statistics of scalability and adaptability

Descriptive Statistics						
	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Cloud-based applications offer greater scalability to accommodate changes in system requirements compared to on-premises solutions.	223	1.00	5.00	3.2332	1.42670	2.035
Cloud-based applications can easily adapt to technological advancements and new features without significant disruption to operations.	223	1.00	5.00	3.1794	1.42820	2.040

On-premises applications require more effort and resources to scale up or down in response to changing demands compared to cloud-based solutions.	223	1.00	5.00	3.1704	1.42930	2.043
On-premises applications are less adaptable to rapid technological changes and may require extensive updates or replacements to incorporate new features.	223	1.00	5.00	3.1883	1.35249	1.829
Cloud-based applications provide flexibility to adjust resources dynamically based on fluctuating workloads, resulting in better optimization of IT resources.	223	1.00	5.00	3.4305	1.45298	2.111
On-premises applications often face challenges in keeping pace with emerging technologies and industry trends compared to cloud-based counterparts.	223	1.00	5.00	3.3722	1.47365	2.172
Cloud-based applications enable easier integration with third-party services and APIs, enhancing adaptability to evolving business needs.	223	1.00	5.00	3.4395	1.52595	2.329
Valid N (listwise)	223					

The above table discusses descriptive statistics of scalability and adaptability questionnaire in which mean value of all items are above 3.1 indicates positive response.

Graph: 4.9 Graphical representation of descriptive statistics of scalability and adaptability



4.4.6 level of security and protection

Table: 4.10Descriptive statistics of level of security and protection

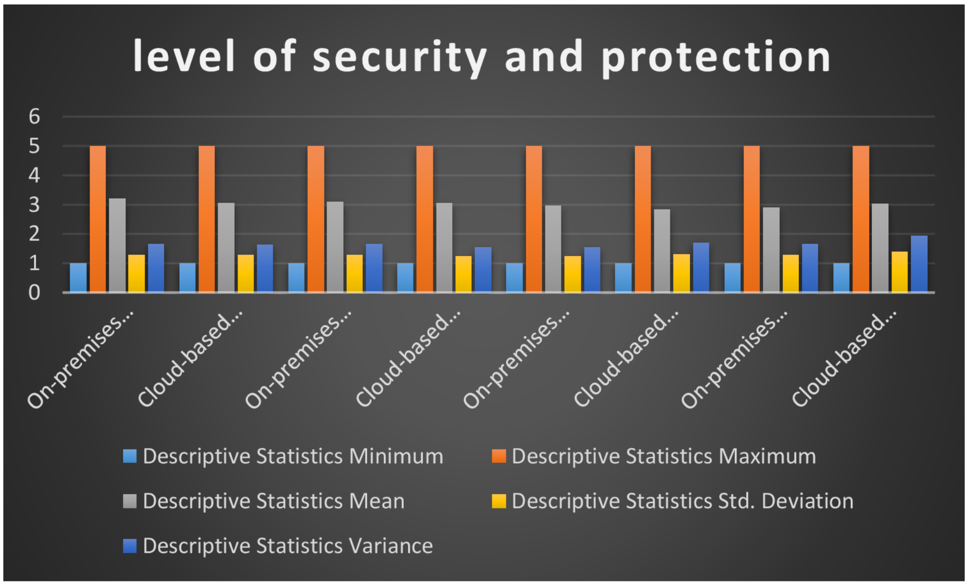
Descriptive Statistics						
	N	Minimum	Maximum	Mean	Std. Deviation	Variance
On-premises applications offer stronger data security compared to cloud-based solutions.	223	1.00	5.00	3.2108	1.28241	1.645
Cloud-based applications provide adequate protection against unauthorized access to sensitive data.	223	1.00	5.00	3.0448	1.27970	1.638

On-premises applications allow for better control over access management and user permissions compared to cloud-based solutions.	223	1.00	5.00	3.0852	1.28291	1.646
Cloud-based applications implement robust encryption mechanisms to safeguard data during transmission and storage.	223	1.00	5.00	3.0404	1.23871	1.534
On-premises applications offer greater assurance of compliance with industry regulations and data privacy laws compared to cloud-based solutions.	223	1.00	5.00	2.9686	1.23897	1.535
Cloud-based applications provide reliable backup and disaster recovery mechanisms to ensure data integrity and availability.	223	1.00	5.00	2.8251	1.30519	1.704

On-premises applications offer more control over physical security measures, such as access to servers and data centers, compared to cloud-based solutions.	223	1.00	5.00	2.9013	1.28370	1.648
Cloud-based applications employ advanced intrusion detection and prevention systems to mitigate security threats and attacks.	223	1.00	5.00	3.0224	1.39317	1.941
Valid N (listwise)	223					

The above table discusses descriptive statistics of level of security and protection questionnaire in which mean value of all items are above 2.8 indicates positive response.

Graph: 4.10 Graphical representation of descriptive statistics of level of security and protection



4.5 Paired test

When comparing two sets of data, one may use the paired sample t-test—sometimes called the dependent sample t-test—to see whether the average difference is zero. To conduct a paired sample t-test, researchers take two measurements of each subject or object, yielding two sets of data. Research designs that include repeated measurements or case-control studies often use paired sample t-tests. When looking to gauge the success of an in-house training initiative. Utilize a paired sample t-test to examine the pre- and post-program performance of a subset of workers.

Table: 4.11Paired Samples Test on cloud based performance And on premises performance

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	cloud based performance	27.4619	223	7.34829	.49208
	on premises performance	24.4843	223	7.23346	.48439

Paired Samples Test

		Paired Differences					
		Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Pair 1	cloud based performance - on premises performance	2.97758	5.04167	.33762	8.819	222	.000

Cloud-based systems outperform on-premises systems by an average of 2.98 units. A p-value of 0.000 indicates a statistically significant difference in performance. The t-value of 8.819 exceeds the critical values for typical significance levels, providing additional evidence for the statistical significance of the difference. The results strongly indicate a significant performance difference between cloud-based and on-premises systems. Cloud-based systems generally surpass on-premises systems in the observed metric.

Table: 4.12Paired Samples Test on costs of cloud-based applications and costs of on premises applications

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	costs of cloud-based applications	26.4753	223	6.31230	.42270
	costs of on premises applications	25.9686	223	5.85823	.39230

Paired Samples Test							
		Paired Differences					
		Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Pair 1	costs of cloud-based applications - costs of on premises applications	.50673	6.05967	.40579	1.249	222	.213

The average cost differential between cloud-based and on-premises applications is around 0.51 units, with cloud-based applications having a slightly higher average cost. The p-value of 0.213 exceeds the conventional significance level of 0.05. This indicates that the disparity in costs observed is not statistically significant. The t-value of 1.249 is below the critical values for typical significance levels, suggesting that the cost difference is not statistically significant. According to the findings, there is insufficient evidence to indicate a notable cost disparity between cloud-based and on-premises applications. The small cost discrepancy observed is not statistically significant, indicating that both options are likely comparable in terms of cost. Other factors besides cost should be taken into account when deciding between cloud-based and on-premises applications.

4.6 Regression Analysis

Sarstedt et al. (2019) conducted a research wherein they highlighted that regression analysis is a statistical technique used to establish a mathematical model that captures the association among a dependent variable and many independent variables. The process of examination aids in the estimation of the values of the dependent variable, taking into consideration the independent variables values.

Table: 4.13 Regression test on cloud based performance and costs of cloud-based applications

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.462[a]	.214	.210	5.61037

a. Predictors: (Constant), cloud based performance

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1889.352	1	1889.352	60.025	.000[b]
	Residual	6956.263	221	31.476		
	Total	8845.614	222			

a. Dependent Variable: costs of cloud-based applications

b. Predictors: (Constant), cloud based performance

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	15.573	1.456		10.692	.000

	cloud based performance	.397	.051	.462	7.748	.000
a. Dependent Variable: costs of cloud-based applications						

Use of analysis of variance (ANOVA) in multiple regression analysis helps to establish the parameters for a significance test and to find the degrees of variability within a regression model. Statistical significance of the research variables is shown by the aforementioned table. We may infer this from a regression study of cloud application expenses and cloud performance. Cloud performance is 46% affected by application costs in the cloud, while the remaining variation is unknown. The Anova table shows that the R-value of 0.21 indicates that the Costs of cloud-based apps significantly affect cloud-based performance (F=60.02, sign. value = 0.00). This data suggests that "costs of cloud-based applications has a significant effect on cloud based performance."The coefficient table up there includes this variable. Conventionally, B-coefficients are positive and statistically significant. Avoid translating beta coefficients and instead use B-coefficients as all indicators have the same dimensions. “Costs of cloud-based applications has significant impact on cloud based performance” is the meaning of the significance value.

Table: 4.14 Regression Test on on premises performance and costs of on premises applications

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.516[a]	.267	.263	5.02822
a. Predictors: (Constant), on premises performance				

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2031.238	1	2031.238	80.340	.000[b]
	Residual	5587.542	221	25.283		

	Total	7618.780	222			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	15.730	1.191		13.209	.000
	on premises performance	.418	.047	.516	8.963	.000
a. Dependent Variable: costs of on premises applications						

a. Dependent Variable: costs of on premises applications

b. Predictors: (Constant), on premises performance

Use of analysis of variance (ANOVA) in multiple regression analysis helps to establish the parameters for a significance test and to find the degrees of variability within a regression model. Statistical significance of the research variables is shown by the aforementioned table. We may infer this from a regression study of cloud application expenses and cloud performance. By a margin of 51%, the costs of on-premises applications impact the performance of the premises; the remaining variation is not explained. There is a considerable influence of on-premises application expenditures on on-premises performance (F=80.34, sign. value = 0.00), as evidenced by the R value (0.26) in the Anova graph. According to these numbers, "Costs of on premises applications has a significant effect on on premises performance." According toThe coefficient table up there includes this variable. Conventionally, B-coefficients are positive and statistically significant. Avoid translating beta coefficients and instead use B-coefficients as all indicators have the same dimensions. It is clear that "Costs of on premises applications has significant impact on on premises performance" according to the significance value.

4.7 Discussion

Numerous techniques have been used to analyze the differences between cloud-based and on-premises applications, with a particular emphasis on a case study of an airline website. The researcher chose a descriptive research approach to collect data and statistics, utilizing the inherent interpretative nature of this design. Both primary and secondary sources were used to guarantee a thorough data collection process.

The investigation collected essential primary data using a carefully crafted questionnaire that included both closed- and open-ended questions. An online form was shared with respondents to overcome logistical constraints in collecting survey responses, enabling the efficient execution of the survey. Aside from primary data, secondary sources like published papers, articles, and publicly available individual investment patterns from various media provided valuable information for the study.

The researcher took into account the limitations on sample collection when deciding the sample size. 223 respondents were selected for the sample, representing a wide range of age groups from under 30 to over 45. The researcher intentionally chose convenience sampling methodology to strike a balance between practicality and representativeness in selecting the sample. The effectiveness of the sample methods used significantly improved the data collection process for this study.

5. Conclusion

The study provides a thorough examination of descriptive statistics, paired tests, and regression analysis concerning cloud-based and on-premises applications, with a focus on performance, costs, scalability, adaptability, and security. The descriptive statistics tables and graphs offer information on the mean, minimum, maximum, standard deviation, and variance of different aspects of cloud-based and on-premises application performance. Cloud-based applications were well-received across various metrics, whereas on-premises applications received average feedback. The paired sample t-test shows a statistically significant performance advantage for cloud-based systems compared to on-premises systems.

The regression analysis demonstrates how costs affect the performance of cloud-based and on-premises applications. The ANOVA results show the statistical significance of the factors in the study, highlighting the significant impact of costs on the performance of both types of applications. Both kind of applications are significantly impacted by expenses, according to the regression study. Positive and significant beta coefficients indicate the influence of costs on performance.

The study examines the scalability, adaptability, and security aspects of both types of applications, presenting descriptive statistics and graphical representations. Cloud-based applications provide superior scalability, adaptability, and security in comparison to on-premises solutions.

Ultimately, the study highlights the significant influence of costs on the efficiency of cloud-based and on-premises applications, stressing the importance of a thorough grasp of the intricate elements that affect IT infrastructure decisions. The evidence offered gives valuable insights for organizations assessing their IT infrastructure options, emphasizing the significance of considering performance, costs, scalability, adaptability, and security when choosing between cloud-based and on-premises applications.

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7. List of tables, Figures, graphs and Abbreviations

7.1 Tables

7.2 Graphs

7.3 Figures

7.4 Abbreviation

IT: Information technology

SPSS: Statistical package for the social sciences

FaaS: Function as a service

IoT: Internet of things

AWS: Amazon web services

MA: Microsoft azure

GCP: Google cloud platform

ML: Machine learning

AI: Artificial intelligence

SMEs: Small to medium-sized enterprises

GDPR: General data protection regulation

HIPA: Health insurance portability and accountability

SaaS: Software as a service

CI: Continuous integration

CD: Continuous deployment

IaaS: Infrastructure as a service

CapEx: Capital expenditure

OpEx: operational expenditure

PCI: Payment card industry

DSS: data security standard

CSPs: cloud service providers

VMs: virtual machines

CDN: content delivery networks

ROI: Return on investment

API: Application programming interfaces

NLP: Natural language processing

QoS: Quality of service

KPI: Key performance indicators

SLA: Service-level agreements