

SEEJSD

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Mirce Acev 4, VII floor, Skopje, North
Macedonia

Bank: Narodna Banka RM

Phone: +389 2 3161 004

E-mail: seejsd@unt.edu.mk

Web: www.seejsd.unt.edu.mk

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Editorial Foreword

Prof.Dr. Bekim Fetaji
Editor-in-Chief

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Welcome you to the new Issue of the SEEJSD Journal with ISSN: 2545-4471. The topics covered by this Issue are related to the current trends of research, original research that uncovers sustainable development.

SEEJSD Journal as an international journal that effectively provides a forum for academics, professionals, graduate and undergraduate students, fellows and associates to share the latest developments and advances in knowledge and practice of Economics and Business; Information Technology and Engineering, Technics and Technology; Humanities and Social Sciences. Our interest in promoting high-quality research is clearly reflected in having an established peer reviewing process and a high-profile expert group of Associate Editors and Editorial Board Members.

Hopefully you find this Issue valuable and we definitely look forward to receiving your high-quality studies for the next issue of the Journal.

Prof. Dr. Bekim Fetaji
Editor-in-Chief

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Review of the Usage of Cloud Technologies in the Covid-19 Pandemic Period

Aleksandar Velinov

Faculty of Computer Science, Goce Delcev University, Stip, North Macedonia, aleksandar.velinov@ugd.edu.mk

Aleksandra Nikolova

E-Learning Center, Goce Delcev University, Stip, North Macedonia, aleksandra.nikolova@ugd.edu.mk

Zoran Zdravev

Faculty of Computer Science, Goce Delcev University, Stip, North Macedonia, zoran.zdravev@ugd.edu.mk

ABSTRACT

Cloud technologies have a huge impact in the IT sphere. With their appearance, they made a significant contribution in various fields. They also provided a quick, easy and cost-effective access to services that significantly improved the availability of IT resources for companies and organizations. This was especially evident during the period of the Covid-19 pandemic. During this period, a large number of organizations experienced the benefits offered by the cloud. Many of them have migrated their applications to the cloud in order to cope with the increasing number of requests and insufficient resources of their servers. This paper presents a review for the usage of cloud technologies in different areas during the Covid-19 pandemic.

KEYWORDS

Cloud, cloud technologies, cloud services, Covid-19.

1 Introduction

The term cloud computing can be defined as access to IT resources and services over a network or the Internet. The access to resources is provided through a self-service manner by sending a request from the users. The services are provided by service providers also called cloud providers. They enable the use of services according to the previously defined prices. The users can choose multiple payment plans. They can pay only for the resources they use or pay-as-you-go plan or they can subscribe for a longer period. It all depends on their needs. If the users use the services for a shorter period of time for experimental purposes, in that case the pay-as-you-go plan is better. If they have applications that have a lot of users and need to be constantly available, then the subscription plan is better. The basic trends defined by the cloud computing are: IT efficiency and business agility [1]. The IT efficiency enables the use of the latest hardware and software technologies in a scalable and efficient manner. The business agility allows users to develop, test and implement applications that are used for business analysis, real-time calculations, parallel processing, etc.

The period of the Covid-19 pandemic brought significant challenges. IT technology played a big role in this period [2]. Here we can mention the technology that finds direct application in medicine and which significantly contributed to the fight against the Covid-19 virus [3, 4, 5, 6]. We can also mention the video conferencing programs as well as instant messaging applications that have significantly contributed to maintaining communication during the Covid-19 pandemic [2, 7, 8, 9, 10, 29]. The use of robots and drones has also increased during this pandemic period [11, 13, 14]. This contributed to the development of new applications that were specifically helpful in dealing with the pandemic [12]. Telepresence robots and their applications are widely used in education [16, 17].

Cloud technologies also significantly contribute to overcoming the situation with the Covid-19 pandemic [18, 23, 24, 25, 26, 27, 28]. Some of the contributions that cloud technologies have in this period are: providing adequate IT resources [19], access to services that enable communication and interaction [20], providing tools for developing applications and working with databases, access to services that have an advanced role in a specific area such as big data processing, Internet of Things, blockchain, etc [21, 22]. This is the reason why in this paper we present an overview of the usage of cloud technologies in various fields.

Some of the key contributions of this research are:

- Determining the areas in which cloud technologies are applied in the period of Covid-19 pandemic;
- Consideration of the used cloud service models and the specific cloud services;
- Determination of the benefits, recommendations and best practices of the usage of cloud services in different areas.

The rest of the paper is structured as follows. Section 2 outlines the different cloud service models that are used. Next, Section 3 presents the research methods and the research questions. In Section 4 we can see the findings and the results of our overview analysis. The last Section 5 is a conclusion of our work.

2 Cloud Services and Models

Lately, a lot of organizations and companies have decided to migrate their applications to the cloud. In this way, they

provide better infrastructure and accessibility for their software products that are used by them or other users. This is especially important when we have a large number of users. To deal with the large number of requests, we must have a good infrastructure in the background. Besides this, some organizations use centrally hosted cloud-based applications without the need to use their own hardware and other resources. In this way, they save money, because they do not have to purchase the hardware in advance. Additionally, they do not need to pay for IT people and maintenance. In the area of programming, special tools provided by the cloud providers are also increasingly used. This makes the programming process easier and saves time needed to fully develop and host the software applications.

There are basically three main models of cloud services that can be used:

- IaaS (Infrastructure as a Service) - This model includes cloud services that provide computing, storage and network resources to organizations and companies. The access to the allocated cloud infrastructure is provided through an Internet connection. In this way, the users have great flexibility in the process of execution of the standard working activities related to the infrastructure. Additionally, they have a complete control over the allocated hardware and the provisioned resources. What is also worth mentioning is the scaling feature of the cloud resources. This has great significance for companies. In cases where they need better infrastructure, they can scale up. In other cases where they have a reduced workload and do not need better performance, they can scale down. All this depends on the needs of the companies.
- SaaS (Software as a Service) - This is one of the most well-known and widely used models of cloud services. It enables hosting of a specific software application in the cloud that can be used by anyone and from anywhere, with Internet access. This means that the users do not need to install applications on their physical computers and worry about certain configurations, compatibility issues and updates. They simply get access to a pre-installed cloud-based application that can be used immediately. The services can be accessed as a pay-as-you-go or subscription plan.
- PaaS (Platform as a Service) – This model is mostly used in the field of programming in the process of software development. With it, the cloud service provider, in addition to the basic infrastructure, also provides database management tools, tools for development, middleware, etc. This provides access to tools for building and deploying applications that really help a lot in speeding up the development process.

Each of the listed models has its own characteristics and can be selected for use depending on the use cases and the area of application. We as users of the services must look at the features and determine which model best suits our needs. It is good to consider the recommendations and good practices from the implementation of the models in the same domain. Additionally, we could locate implementations that would fit our use case but they are used in another areas. This raises the need for a comprehensive overview of the application of cloud technologies in different areas.

3 Research Methods

With this review, we want to provide an overview of the usage of cloud technologies in the Covid-19 Pandemic Period. The main research questions are:

- What is the field of usage of cloud technologies in the Covid-19 pandemic period?
- Which cloud service models are used?
- What types of cloud services are used or are proposed by the stakeholders?
- What are the benefits of the usage of cloud technologies in the Covid-19 pandemic period?
- Are there any best practices or recommendations for the usage of cloud services in a specified field?

In our research, we used the published papers in Google Scholar during the period of the Covid-19 pandemic. The research papers are selected according to the following criteria:

- The papers must be published between March 11, 2020 and May 5, 2023 [22];
- The papers must include the usage of cloud technologies in the Covid-19 pandemic period.

We used the following criteria for excluding research papers that are inappropriate to the given topic and our point of interest:

- The research papers are not published in the Covid-19 pandemic period [22];
- The papers that cover cloud technologies, but not showing their application in a specific area;
- The type of research work is a review paper, thesis or dissertation;
- The papers that include informal context;
- Papers that cover introduction to cloud technologies and cloud services.

According to the stated criteria, we selected a total of 32 papers. The selected research papers can be seen in Appendix A at the end of the paper.

4 Findings and Results

- What is the field of usage of cloud technologies in the Covid-19 pandemic period?

According to our research for the usage of cloud technologies in the Covid-19 pandemic period, they are mostly used in the fields Education and Healthcare (Fig. 1). Out of the total of 32 reviewed papers, 14 cover application of cloud technologies in these two areas individually. The Accounting field is covered in 2 papers. The other fields that are found in 1 paper each individually are: Research, Programming, Sale, Robotics, Community, Banking and Finances, Manufacturing Sectors and Business. The detailed coverage by research papers is as follows:

- Education - [19, 31, 32, 33, 34, 37, 38, 39, 40, 48, 49, 52, 58, 59]
- Healthcare - [21, 30, 36, 42, 43, 44, 46, 47, 50, 51, 54, 55, 56, 57]
- Accounting - [45, 53]
- Research - [31]
- Programming - [31]
- Sale - [35]
- Robotics - [39]
- Community - [41]
- Banking and Finances - [47]
- Manufacturing Sectors - [47]
- Business - [52]

The fields Healthcare and Education were the most affected during the period of Covid-19 pandemic, that is the reason why most of the research papers are related to these two areas. Our opinion is that in addition to these areas, cloud technologies could significantly contribute in other areas as well. What really needs to be addressed in the future is the proper application of these technologies in appropriate domain.

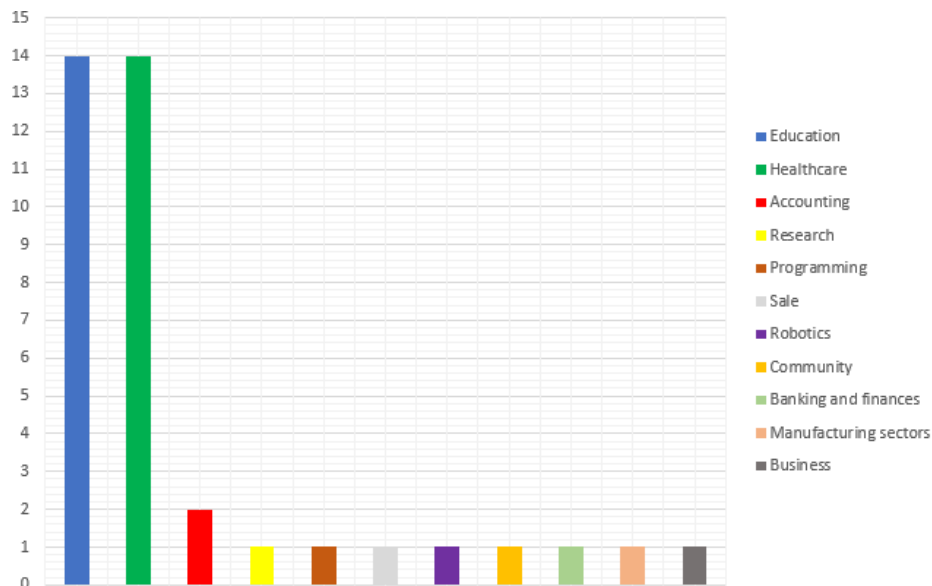


Figure 1. Field of usage of cloud technologies in the Covid-19 pandemic period

- Which cloud service models are used?

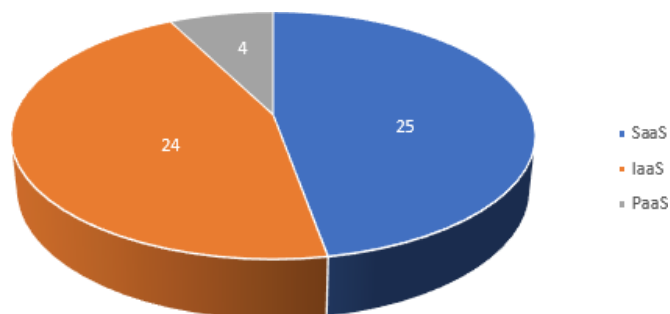


Figure 2. Used cloud service models

The most used cloud service models are SaaS and IaaS (Fig. 2). The SaaS model is found in a total of 25 research papers, while the IaaS is found in 24 papers. The least used model is PaaS, which is covered in only 4 papers. Our opinion is that we should pay attention to what exactly the cloud technologies are used in order to see which model is most suitable to be applied. If the need is to directly use applications over the Internet for different purposes, then the SaaS model is most appropriate, as it is in most scenarios. If we need storage, computing and network resources that we would like to use for a specific purpose, then the IaaS model is the best suited for this scenario. If we need tools for developing applications, in the area of programming, the most suitable model is PaaS. Of course, depending of the needs, several cloud models can be used.

What types of cloud services are used or are proposed by the stakeholders?

As can be seen in Figure 3, SaaS cloud applications are mostly used in the scenarios presented in the reviewed research papers. They are found in a total of 18 papers. They are followed by the storage services with 15 papers and virtualization services with 9 papers. The other types of services are found in 5 papers or less. The detailed analysis according to the papers is as follows:

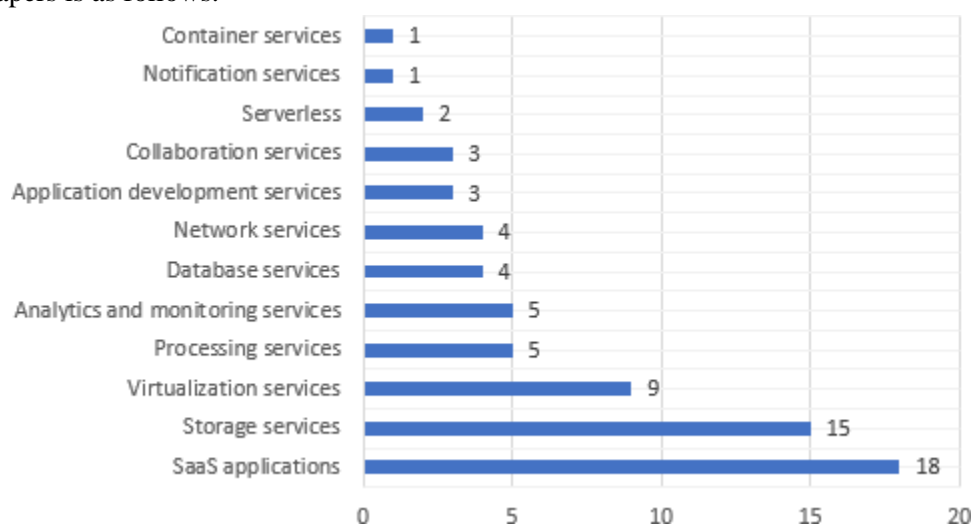


Figure 3. Type of cloud services that are used or proposed by the stakeholders

- SaaS cloud applications - [21, 31, 32, 33, 35, 37, 38, 39, 40, 45, 47, 48, 49, 52, 53, 54, 58, 59]
- Storage services - [19, 33, 34, 36, 38, 42, 44, 45, 46, 47, 50, 51, 52, 54, 57]
- Virtualization services - [19, 30, 31, 34, 46, 52, 55, 57, 58]
- Processing services - [34, 43, 44, 56, 57]
- Analytics and monitoring services - [30, 34, 36, 56, 57]
- Database services - [19, 30, 34, 52]
- Network services - [19, 34, 41, 52]
- Application development services - [31, 34, 52]
- Collaboration services - [34, 39, 50]
- Serverless - [41, 52]
- Notification services - [52]
- Container services - [41]

Although SaaS applications are the most used, the other categories of services can also find application in different use cases and scenarios.

- What are the benefits of the usage of cloud technologies in the Covid-19 pandemic period?

The general benefits of using the cloud technologies in different fields according to the reviewed papers are the following:

- On-demand self-service - We can use the services according to our requirements and needs. We access the services by self-service, by simply selecting them and stopping their operation when they are no longer needed.
- Efficient and cost-effective solution - The services offer efficient solutions in terms of performing their regular operations. In addition, the costs we incur for some of the services, depending of the features, are often small in relation with the work activities that we have.

- Availability - Cloud providers offer high availability of their services, something that is very important especially for the business critical and the real-time operations.
- Scalability - This is another benefit with which cloud technologies highlight the technological advances over physical solutions. In a very easy way, we can scale the resources in order to adapt them to our needs and use cases.
- Reliability - The resources provided by the cloud provider ensure reliability regarding the package that we receive. Anything we have as a resource configuration steps that we take ourselves is our responsibility.
- Flexibility – The access to the services and the provided resources can be done from anywhere. This allows us flexibility in terms of the activities that we have on the cloud platforms.
- Sustainability - The usage of cloud services from cloud providers enables the sustainability of our operations and regular activities. Cloud providers are responsible for updating and upgrading the resources according to the latest trends and modern flows. What is required of us as users is only certain adjustments and configurations regarding the updates, but not complete changes. The high availability of the services in turn enables a sustainable reputation.
- Portability - This is another important feature of the cloud services. The process of transferring resources from one cloud platform to another is significantly facilitated by using appropriate globally accepted cloud standards.
- High performance - The resources offered by cloud providers nowadays have impressive features. This significantly contributes to their use in fields that require high performance such as Big Data Processing, Data Analytics, Artificial Intelligence and so on.
- Useful services - Cloud providers offer services in a variety of categories that may find application in different use cases. With their proper application, the services can be very useful for our daily business operations and provide significant productivity.
- Collaboration - The collaborative services significantly help in terms of cooperation and maintaining contact between the users.
- Sharing - The sharing of data, analysis and reports is significantly facilitated by the emergence of cloud-based services.
- Security - What cloud providers pay a particular attention to is the security of the services they offer to the users. They provide a variety of security mechanisms to protect the services according to the latest security standards.
- Business continuity – The cloud features such as Backup and Disaster and Recovery significantly contribute to maintaining the business continuity of the organizations that use cloud-based services.
- Are there any best practices or recommendations for the usage of cloud services in a specified field?

Out of a total of 32 reviewed papers, 25 present the best practices and recommendations for the usage of cloud technologies. They differ in terms of their application. All of them provide a different approach and guidance to improve and facilitate the work operations in a specific field. The best practices and recommendations can be seen in Appendix A at the end of the paper.

The main limitation regarding our research is the limited number of analyzed papers and the use of a single source of papers. However, the results of this review and the perceived considerations could provide a guidance for future research regarding the usage of cloud technologies, especially in specific circumstances such as the Covid-19 pandemic period.

5 Conclusion

Cloud technologies have a significant application in the Covid-19 pandemic period. They are used in different fields such as Healthcare, Education, Accounting and so on. In this period, the SaaS is the mostly used cloud service model, which the users use to access the software applications directly via Internet. The IaaS model for acquiring computing, storage and network resources is also widely used. The least used is the PaaS model of cloud services. In terms of specific cloud services, the most used are the following categories of services: the SaaS applications, storage services and virtualization services. The usage of cloud services provides several benefits such as on-demand self-service, lower costs, availability, scalability, flexibility, sustainability and so on. All this confirms that cloud technologies could have an important role in various fields. In the future special attention should be paid to the usage of these technologies for appropriate needs especially in a specific period such as the Covid-19 pandemic. We will direct our further research to determination and detailed analysis of application of cloud technologies in different fields and use cases.

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