International Journal of Engineering Applied Sciences and Technology, 2022
Vol. 6, Issue 10, ISSN No. 2455-2143, Pages 195-201
Published Online February 2022 in IJEAST (http://www.ijeast.com)

DEVOPS FOR CLOUD COMPUTING: AN OVERVIEW

Karthik Srikanth
Bangalore, Karnataka, India.

***Abstract* -In the IT industry, we are living in the Cloud Computing Technology era. Cloud computing, which is based on the Internet, is the most popular computation architecture. It is made up of a networked and integrated collection of hardware, software, and internet infrastructure (1). It includes a lot of characteristics in addition to grid computing and other forms of computing. Cloud computing is the supply of computer resources as a service, with the cloud provider owning and controlling the resources rather than the end-user. These resources might range from web-based software to mobile apps (2). On the other hand, A DevOps method is one of several strategies used by IT professionals to carry out IT projects that fulfill business requirements. DevOps is the standard practice for the large majority of cloud development projects and enterprises. The benefits of utilizing DevOps with cloud initiatives are getting progressively outstanding (3). This paper provides an in-depth evaluation of cloud computing for DevOps. Firstly, the role of DevOps in the cloud, the different types of cloud computing, and the phases of DevOps are detailed. Secondly, the advantages of using the different types of cloud computing services for DevOps, and the features of using IaaS tools for and key market trends are briefed. Furthermore, a few of the open issues and research gaps for future investigations are discussed.**

***Keywords*: Cloud Computing; DevOps; IaaS; Web-based software; Grid computing;**

I. INTRODUCTION

The phrase "DevOps" was invented in 2009 by Patrick Debois. The concept of DevOps originated from a conversation between Patrick Debois and Andrew Clay. They were concerned about Agile's shortcomings and intended to create a better alternative. DevOps is a combination of the development and operations of the term that refers to a collaborative or shared approach to the work done by an organization's application development and IT operations teams (4). DevOps is one of the methodologies used by IT professionals to finish IT projects that meet business needs. Developers may now help with deployment, administrators can develop scripts, and quality assurance professionals can address issues that aren't connected to testing. Tasks can be performed automatically, and nobody will have to wait because they will be able to interact more closely and produce faster and more accurate results (5).

Start-ups and corporates may save expenses and expand their services by utilizing cloud computing instead of acquiring and managing all of the necessary gear and software. Independent developers now have the ability to create apps and internet services that are available worldwide. Researchers may now exchange and evaluate data at scales previously only available to large-scale operations (6). The centralized aspect of cloud computing supports DevOps automation by providing a standard and unified platform for testing, deployment, and production. Earlier, the distributed character of some business systems did never fit themselves well to centralized software delivery. A cloud platform can address a wide range of difficulties of varying impacts.

The cloud is becoming more important in DevOps automation. The majority of the public and private cloud computing service vendors facilitate DevOps in a concise format, consisting of tools for continuous integration and development. This intimate partnership lowers the cost of DevOps automation tools while simultaneously ensuring centralized governance and control to ensure a successful DevOps process (7). Some developers who are a part of this process realize that supervision keeps them out of trouble, it's also easier to accomplish this centrally through the cloud than it is to monitor departments individually.

With cloud-based DevOps, the need to account for resources spent is decreased. In cloud computing, utilization-based accounting is used to track resource use by software, developer, user, data, and so on. Most conventional systems do not provide this service. When we employ cloud-based resources, it is much easier to track and adapt development resource expenditures. Many various tools and methodologies are employed to create the best DevOps environment possible, which aids in communication, collaboration, and data transparency. One of the primary purposes of DevOps technologies is to use automation to help speed up repetitive tasks and reduce downtime (8). The purpose of DevOps is to have more work done quickly without exhausting the workers. The use of automation and transparency allows teams to focus on what is most important rather than wasting resources and time.

International Journal of Engineering Applied Sciences and Technology, 2022
Vol. 6, Issue 10, ISSN No. 2455-2143, Pages 195-201
Published Online February 2022 in IJEAST (http://www.ijeast.com)

1.1 The role of DevOps in cloud

For years, IT firms have kept development and operations teams separately. Despite having comparable corporate objectives, these parallel operating teams are frequently in conflict with one another. Organizations have now recognized the necessity to establish an integrated operating model, which has resulted in the creation of the DevOps approach (9). The DevOps methodology is considerably more than a straightforward application of agile ideas to infrastructure management. DevOps, according to John Willis and Damon Edwards (10), is described by the acronym CAMS, which stands for Culture, Automation, Measurement, and Sharing. DevOps has evolved into a method of encouraging collaboration between development and operations teams. As boundaries such as physical location, business goals, and business functioning are removed, both teams tend to become closer in a variety of ways. By removing the barriers between traditional developer and operational roles, DevOps reduces the inefficiencies. This provides company continuity, accountability, and the intended outcomes for all parties involved (11). In an environment intended for agility and flexibility, cloud solutions and DevOps complement each other effectively. When DevOps and the cloud are integrated, they may drastically improve the software development lifecycle. Companies that use DevOps in the cloud may improve software delivery performance by 81 percent on average. Over 900 IT professionals from across the world were polled as part of one research on how they accomplish success in today's environment. Those who adopted DevOps alone saw a 52 percent boost in performance. Those that used the cloud alone witnessed a 53 percent gain in performance. Companies that used both DevOps and the cloud, on the other hand, enhanced their performance by 81 percent. This shows how well both the cloud and DevOps work together.

1.2 The different types of cloud computing and the advantages of incorporating DevOps into each type of cloud computingThere are 4 types of cloud computing namely, private cloud, public cloud, hybrid cloud, and community/multi-cloud.

Private cloud: Cloud resources are made available to certain units within the perimeter of an organization. The organization maintains security and governance, and resources are shared among numerous business units within the same organization. Private clouds are dedicated completely to a single group or organization. The benefits of using the private cloud are improved security, customizability, and governance over the entire system. DevOps for the private cloud is important in terms of enhancing operational procedures in terms of maintainability, dependability, efficiency, and security. DevOps approaches have become a practice for development and QA teams, particularly when the private cloud is used as development or target platform.

Public cloud: The public can access cloud resources over the Internet. One may rent these resources to develop an IT infrastructure because they are located in one of the public cloud vendor's internationally dispersed and well-managed data centers. Traditional public clouds were traditionally run off-premises; however, today's public cloud companies are delivering cloud services on customers' on-premise data centers. One of the most appealing aspects of the public cloud is that the vendors can host, and maintain the underlying hardware. Because these resources are charged on a "pay-as-you-go" basis, they are a more cost-effective choice than purchasing them outright because you only pay for what you use. DevOps may benefit from the public cloud in two ways: one is organizational and process-oriented, and the other is technological. The time it takes to get access to infrastructure in the public cloud is typically much faster than it is in the private cloud.

Hybrid cloud: A hybrid cloud is a blend of public and private cloud components that are securely connected over the internet through a VPN (Virtual Private Network). The hybrid cloud is used by organizations where security is a top priority. To solve security issues and to make the most use of resources, many cloud deployment strategies are deployed. The flexibility of a hybrid cloud is its main advantage. The capacity to respond and alter course swiftly is a crucial prerequisite of a digital company. Implementing a Hybrid Cloud with DevOps allows businesses to take advantage of benefits like cloud-bursting while keeping control over their apps and data.

Community cloud: multi-clouds are used by a certain group of cloud users such as banks or government organizations. Organizations that have common business needs are members of a community cloud. These requirements are typically motivated by the necessity for shared data, services, or industry norms. This often refers to organizations in the same industry or departments within the same organizational body. Some of the benefits of using multi-clouds are cost-effectiveness, high availability, and regulatory compliance. DevOps gains more flexibility and speed by utilizing multi-cloud environments. It also has more benefits such as, keeping the cloud environment up and running in the case of a disaster, workload distribution to improve performance, scaling and moving as needed, Providing access to a larger set of performance monitoring, data analytics, and reporting capability tools.

International Journal of Engineering Applied Sciences and Technology, 2022
Vol. 6, Issue 10, ISSN No. 2455-2143, Pages 195-201
Published Online February 2022 in IJEAST (http://www.ijeast.com)

1.3 The different phases of DevOps

Figure – 1: The lifecycle of DevOps

For cloud-hosted apps and big distributed systems, DevOps architecture is employed. Agile Development is utilized in the DevOps architecture to provide seamless integration and delivery. For DevOps, both development and operations are required in order to provide applications. Analyzing requirements, designing, creating, and testing software components or frameworks are all part of the deployment process. When both Development and Operation are united to work collaboratively in a task, The architecture of DevOps comes into the picture (12). It is made up of several phases that collectively form the DevOps lifecycle. These are the primary components that guarantee DevOps optimizes all development processes, from proposal through production and delivery.

Development phase: The planning and software coding phases of the DevOps lifecycle take place in the first phase.Understanding the project's objective and imagining software based on such perceptions is part of the planning process. Choosing among a variety of programming languages to create the source code for an application, and storing the source code in a repository such as GIT, TFS, GitLab, and Mercurial. Etc. are used in this phase. Source Code Management (SCM) is used for maintaining the code, In the SCM process, GIT is primarily preferred as it provides distributed version control. During this phase, a stable version of the application code is produced with the support of a version control tool. The code can also be bundled into .exe files by the developers using Garden, Maven, and other similar technologies.

Integration and Testing phase: During this phase, flaws in the source code are discovered early on. The source code is updated on a weekly or daily basis, and the modifications are made numerous times. With the help of Docker containers, a test environment is created. Instead of manual testing, developers may save time and effort by adopting automated testing. By automating tests early and frequently, organizations may improve software quality while lowering risk. Development teams may run automated tests regularly, covering a variety of topics such as user interface testing, security scanning, and load testing. They also produce reports and data graphs that aid in the identification of any potential flaws. The test assessment process is aided by reports provided by automated testing. A few of the tools used in automation testing are Junit, TestNG, and Selenium. These tools are used by the quality assessors (QAs) to run parallel tests on several code bases.

Monitoring and Feedback phase: This phase comprises monitoring the application code's performance, and dependability. And each release is evaluated for its impact on the user experience, and the results are communicated back to the team in order to enhance future releases. Nagios, Sensu, and other tools are leveraged during this phase. These tools keep track of servers, switches, software, and other services and send out notifications when something goes wrong. If an issue occurs, the users are notified, and they are notified again after the problem is resolved. Pendo is a feedback software/ product-analysis platform that assists businesses in gathering client feedback to understand what are the user's expectations.

Deployment and Operations phase: In this phase, firstly the application is installed on the production server and made available to the desired users. AWS CodeDeploy, Octopus Deploy, Jenkins, and other technologies are utilized in this phase. AWS CodeDeploy is a software deployment tool that automates the deployment of software across several services. It allows businesses to quickly deliver new features while minimizing downtime, and it manages the deployment process's complexity. The operations phase entails minimizing or eliminating planned downtime, such as regular maintenance and releasing the application and the subsequent updates. Container management technologies such as Kubernetes or Swarm are used by businesses. When the team updates the software, Kubernetes automatically updates all of the containers on the server.

II. THE IMPORTANCE OF CLOUD COMPUTING SERVICES FOR DEVOPS

In an increasingly dynamic business environment, companies are attempting to acquire a competitive advantage. Cloud computing is a revolutionary breakthrough that has aided in the transformation of organizations in previously unimaginable ways. In dynamic business circumstances, 'as a service' models assist organizations in becoming more flexible and faster.

2.1 Cloud service models for DevOps

Software as a Service (SaaS): is a software distribution model in which a cloud provider hosts and distributes applications to end-users through the internet (13). In this

approach, an individual software vendor (ISV) may employ a third-party cloud provider to host the app. Alternatively, in the case of larger companies such as Amazon, Microsoft, and others, the cloud provider may also be the software supplier. SaaS apps are used by a wide spectrum of IT experts, commercial users, and consumer users. Personal entertainment, such as Netflix, to complex IT tools, are all available to both B2B and B2C customers. As per a recent McKinsey & Company analysis, the technology sector believes that the software as a service market will continue to grow, with the market for SaaS solutions expected to reach $200 billion by 2024. SaaS is delivered using the cloud delivery model. An ISV may hire a cloud hosting vendor to host the application and its related details in the provider's data center or a software provider may host the software and its related details employing its servers, databases, networking, and computing capabilities. The app will function on any device with a network connection. SaaS apps are frequently accessed using web browsers. SaaS applications and services are frequently multi-tenant, which means that each subscribing client or cloud tenant is served by a single instance of the SaaS application running on the host servers. The application will be used by all clients or renters in the same version and configuration. Despite the fact that various subscribing customers will run on the same cloud instance with a shared architecture and platform, Customers' data will continue to remain separated.
Businesses that incorporate SaaS no longer need to install and run software on their own PCs or data centers. This eliminates the expenditures of hardware procurement, deployment, and maintenance, as well as software licensing, installation, and support (14). Customizability (may be coupled with other company applications, particularly those from the same software source), automated updates, scalable consumption, and flexible fees are all advantages of the SaaS model.
Platform as a Service (PaaS): In 2019, as per the insights of Gartner analysis, there are over 360 providers in the PaaS industry, delivering over 550 cloud platform services across 21 categories. In 2022, These numbers will be double as the PaaS will become the most popular platform delivery type in the future. The goal of PaaS capabilities is to help a cloud platform fulfill its purpose. Regardless, all cloud services, including infrastructure as a service (IaaS) and software as a service (SaaS), may play a significant role in platform development. All of these services are combined to make the cloud platform. Every cloud strategy will eventually include looking for and recognizing possibilities for platform-based innovation across the whole spectrum of cloud services. Users acquire hardware and software tools via the internet from a third-party provider in PaaS (15). Application development often necessitates the use of these tools. The hardware and software are housed on the infrastructure of the PaaS provider. As a result, PaaS eliminates the need for developers to set up in-house gear and software in order to build or execute a new application. For software development, PaaS does not replace a company's complete IT infrastructure. It is made available through a cloud service provider's hosted infrastructure. A web browser is the most frequent way for consumers to access the services. PaaS can be used to supply services like application hosting via public, private, or hybrid clouds (16).
PaaS is also used in DevOps tools. PaaS can include functionality for application lifecycle management as well as features specialized to a company's product development methodology. The architecture also allows DevOps teams to use cloud-based continuous integration tools to add updates without downtime. Furthermore, organizations that use the Waterfall approach may deploy an update using the same interface that they use for day-to-day administration.
PaaS technologies are often used in the creation of mobile applications. Many developers and businesses, on the other hand, utilize PaaS to construct cross-platform apps since it gives a quick, flexible, and dynamic tool for creating apps that can run on practically any device. PaaS, at its heart, enables enterprises to create and execute apps more quickly and easily.
Infrastructure as a Service (IaaS): The rising volume of financial and commercial information, as well as other essential data, across many IT industries, is anticipated to accelerate the use of IaaS in many enterprises. The market for infrastructure as a service is expected to develop at a CAGR of 25% over the coming years (2021 - 2026). This increased need for high-speed interaction between numerous networks, quick access to data, and the ability to execute real-time queries may contribute to the expansion of the IaaS industry (17). IaaS is a cloud computing model in which virtualized computer resources are supplied across a wide area network (WAN), such as the internet. Customers can contact the firm to manage their IT infrastructure, including servers, networking, processing, storage, virtual machines, and other resources. Customers utilize the Internet to access these resources on a pay-per-use basis.
Organizations select IaaS because it is typically easier, quicker, and less expensive to run a task without having to purchase, administer, and support the underlying infrastructure. Using IaaS, a firm may easily rent or lease infrastructure from another organization. For workloads that are transitory, experimental, or change abruptly, IaaS is an appropriate cloud service model (17). Customers of IaaS often pay per use, usually on an hourly, weekly, or monthly basis. With certain IaaS providers, customers may be charged depending on the amount of virtual machine space they use. The upfront cost of implementing in-house equipment and software is eliminated with this pay-as-you-go approach.

International Journal of Engineering Applied Sciences and Technology, 2022
Vol. 6, Issue 10, ISSN No. 2455-2143, Pages 195-201
Published Online February 2022 in IJEAST (http://www.ijeast.com)

2.2 Benefits of using IaaS tools and key market trends

IaaS allows users to access computational resources via a virtual server instance that mimics the capabilities of a traditional data center. It also offers a wide range of services such as server space, security, load balancing, and higher bandwidth. IaaS is flexible and scalable, making it ideal for workloads that are infrequent or unpredictable (17). Essentially, you're renting the servers and networks of another company. The IT and telecom industries create massive volumes of data. As a result, managed hosting, DRaaS, and STaaS solutions help organizations save money on computing and storage. Telecommunications have been able to transfer to the internet thanks to cloud technology, and companies no longer need to invest in expensive infrastructure to stay connected to the rest of the world.

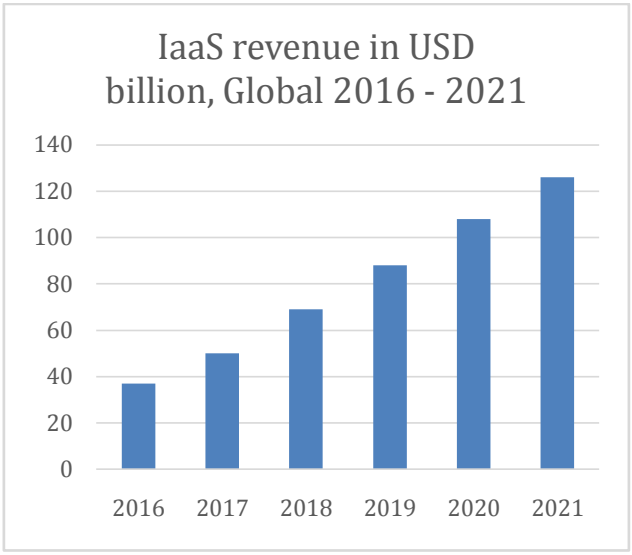

Chart 1 - IaaS revenue in USD billion

As shown in chart 1, Because of the rising acceptance of cloud-based services in the industry, the IaaS market in the IT and telecommunications sector is predicted to rise at a substantial rate. This business is one of the most important sectors since it generates vast amounts of personal, financial, and healthcare data. Many telecommunications companies want to be cloud IaaS providers. The revenue has increased dramatically from $37 billion in 2016 to $126 billion in 2021. These numbers might double in the near future.

Over the coming years, Asia-Pacific is predicted to grow significantly and dominate the IaaS market. High development in this field might be attributed to rising internet penetration and technological advancements in various economies, including China, India, and South Korea. Because of the growing economy, countries like Japan, China, and India are progressing, which will help the regional market flourish. Furthermore, the region's growing industry is a major driver of the IaaS market's expansion. The government in this region is increasing its ICT spending, which provides more opportunities for the industry.

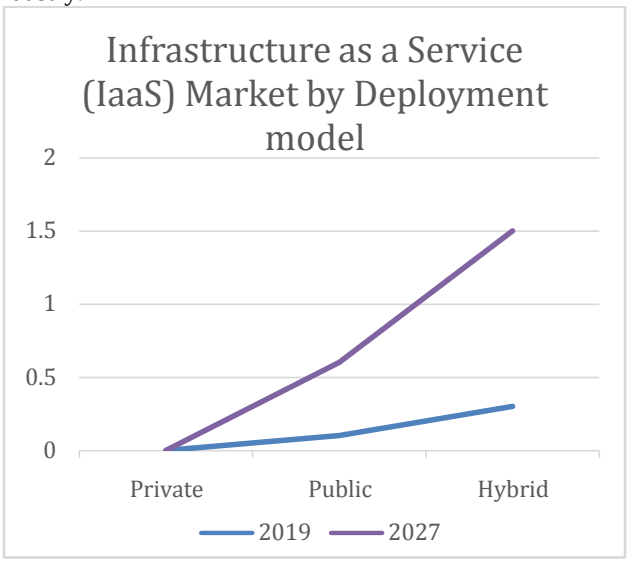

Chart 2 - IaaS market by deployment model

As mentioned in chart 2, The report analyses the market of IaaS by the different deployment models. The market of IaaS will significantly increase in the near future. The expansion of the infrastructure as a service market is being driven by rising demand for low-cost IT infrastructure and faster data access, as well as increased cloud usage across various industrial sectors. During the projection period, however, security concerns about private cloud adoption are projected to restrict the market growth. Furthermore, widespread cloud adoption among small and medium-sized businesses is likely to offer considerable revenue growth prospects for infrastructure as service providers. Several business sectors are rapidly embracing cloud services, including banking, financial services, and insurance, retail, healthcare, manufacturing, telecommunications and IT, news and entertainment, and many more. In addition, the banking industry is interested in IaaS because of cost reductions, data security, and disaster recovery services. In developed nations such as North America and Europe, technological breakthroughs in the IT industry and their applications in major organizations and SMEs provide ample room for market expansion. As a result, the growth of the infrastructure as a service market is primarily driven by the use of cloud services across various industrial sectors.

III. THE FUTURE OF DEVOPS AND CLOUD

By the end of 2023, more than 90% of infrastructure and operations (I&O) organizations will have the majority of their employees working remotely. COVID-19 may have accelerated this trend, but it is also a result of

infrastructure's changing character as a result of the shift to cloud and edge computing.

DevOps will enable a larger digital transformation by extending beyond product delivery to business value delivery and value stream delivery. This necessitates a backward-looking approach from the business objectives to the people, processes, and technology that enables them. As developers and IT professionals seek ways to expand IT infrastructures, they build new capabilities for this technology, reduce expenses, and prevent cloud vendor difficulties. These employees require a traffic strategy that considers the health of its infrastructure throughout data centers as well as end-user experiences.

Several firms that have adopted DevOps into their operational processes have seen a number of advantages. Given the widespread of app development, in the future, data science teams may use DevOps development methodologies. Data scientists who use DevOps may rebuild production models while testing previously developed models. As data scientists and app development teams collaborate to maintain track of several applications, the tendency will only become more well-known.

Machine Learning and Artificial Intelligence may assist firms in automating DevOps procedures more efficiently. People might move away from DevOps and toward "AIOps" and "DataOps", which focuses on learning from logs and monitoring data using machine learning and artificial intelligence in order to push DevOps in a more controlled manner. Artificial Intelligence is advancing DevOps, making life simpler for operations, development, and DevOps professionals.

The use of automation in the DevOps framework means that the DevOps structure may be updated on a regular basis as developers provide content to consumers, independent of changes. Automation will be at the top of the list of DevOps in the future. DevOps automation technologies will become increasingly prevalent as the industry matures. Here is where the developers will have to determine which functions and features can be automated and which require the support of an engineer.

Cloud computing is quickly becoming the most important need in software design, particularly given the numerous tools and complications that divide deployment and development. It is now more important than ever to have DevOps in place. DevOps will grow increasingly regardless of the adapting to the evolving technologies that manage these cloud platforms, as well as acceptance to guarantee that their software makes use of them. It will also require knowledge of native features available in such cloud platforms, as well as communication of these features to development teams, in order to save labor and work required during deployment.

IV. CONCLUSIONS

Bringing software into operation is critical to the growth of businesses in the digital world. With the certainty of providing value, digital transformation needs organizations to take the big step towards DevOps and Cloud. As the integration between cloud and DevOps grows clearer, the possibility of incorporating security into cloud development becomes essential. DevOps has revolutionized the way the industry used to operate. In these circumstances, companies have offered great quality software by incorporating automation into every step. Cloud-based solutions, on the other hand, have contributed to their own right by eliminating the need to download large amounts of software, various tools for functionality, and infrastructure maintenance.

To conclude, scalability will become an intrinsic aspect of application development when cloud computing and DevOps are combined, resulting in lower expenses and a wider global reach. Organizations could gain lots of new potential advantages by recognizing and prioritizing the use of DevOps in the cloud, along with increased agility and lower operating expenses.

V. REFERENCES

[1]. CLOUD COMPUTING AND PRIVACY REGULATIONS: AN EXPLORATORY STUDY ON ISSUES AND IMPLICATIONS. Vasista, Dr. Mohammed A. T. Sudiari and Dr. TGK. s.l. : Advanced Computing: An International Journal (ACIJ), 2012.

[2]. A Comprehensive Study on Cloud Computing. Raut, Suruchee V . Nandgaonkar and Prof. A. B. s.l. : International Journal of Computer Science and Mobile Computing (IJCSMC), 2014.

[3]. A Qualitative Study of DevOps Usage in Practice. Floris Erich, Chintan Amrit, M Daneva. s.l. : Journal of Software: Evolution and Process, 2017.

[4]. Mezak, Steve. DevOps.com. The Origins of DevOps: What's in a Name? [Online] 2018. https://devops.com/the-origins-of-devops-whats-in-a-name/.

[5]. Devops, A New Approach To Cloud Development & Testing. Battina, Dhaya Sindhu. s.l. : Journal of Emerging Technologies and Innovative Research (JETIR), 2020.

[6]. A Platform for Educational Cloud Computing. C. Justin, B. Ivan, K. Arvind and A. Tom. Seattle : s.n., 2009.

[7]. Dimensions of DevOps. Lucy Ellen Lwakatare, Pasi Kuvaja and Markku Oivo. 2015.

[8]. Devops, A New Approach To Cloud Development & Testing. Rawat, Prashant Agrawal and Neelam. Ghaziabad, India : IEEE, 2019.

[9]. A secure cloud service deployment framework for DevOps. V.Sucharita, P Ravinder Rao and. s.l. : Indonesian Journal of Electrical Engineering and Science, 2021.

[10]. Shimel, Alan. Damon Edwards and John Willis @ DOES London 2016. Devops.com. [Online] 2016. https://devops.com/damon-edwards-john-willis-london-2016/.

[11]. DevOps: A Definition and Perceived Adoption Impediments. Jens Smeds, Kristian Nybom and Ivan Porres. 2015.

[12]. Improve software quality through practicing DevOps. Pulasthi Perera, Roshali Silva and Indika Perera. s.l. : 2017 Seventeenth International Conference on Advances in ICT for Emerging Regions (ICTer), 2017.

[13]. A survey on Software as a service (SaaS) using quality model in cloud computing. Banerjee, Sarbojit. s.l. : International Journal Of Engineering And Computer Science (IJCES), 2014.

[14]. Growth Hacking: Strategies to overcome challenges and accelerate the growth of SaaS startups. Valles, Maria Eduarda Bogo do. 2021.

[15]. Cloud Business Intelligence. Nasr, Prof. Mona. s.l. : International Journal of Advanced Networking and Applications (IJANA), 2019.

[16]. Cloud Computing-Platform as Service. Gurudatt Anil Kulkarni, Prasad Khatawkar and Jayant Gambhir. s.l. : International Journal of Engineering and Advanced Technology (IJEAT) , 2011.

[17]. Infrastructure as a Service (IaaS): A Comparative Performance Analysis of Open-Source Cloud Platforms. Sonia Shahzadi, Muddesar Iqbal, Zia Ul Qayyum and Tasos Dagiuklas. Lund, Sweden. : 22nd IEEE International Workshop on Computer Aided Modeling and Design of Communication Links and Networks (CAMAD), 2017.