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Review Article

A Study on the Implementation of a Technological Service Infrastructure (IaaS) Through OpenStack for Small and Medium Enterprises

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Abstract: Thanks to technological advances, companies are increasingly shifting their Information Technology (IT) workloads to the cloud. These advances can be summarized in three environments: the use of virtualization, the use of physical devices and the use of cloud computing. In the academic environment, the use of cloud computing brings enormous advantages as a tool for carrying out virtual laboratories, therefore, the objective of this project is to investigate one of the aspects of cloud computing, called Infrastructure. as a Service (IaaS), creating a prototype with Openstack that enables the investigation of this technology, examining its advantages and disadvantages, in the same way, of proposing it as a tool for the Los Libertadores University Foundation that allows students their professional growth, which includes the basic requirements for the development of laboratory practices with services such as virtualization of operating systems, storage, development of programs, among others. According to what was previously stated, the main function is to manage those virtual machines with the tools available to reduce the physical resource of the institution taking into account its infrastructure through the public cloud, managing and configuring OpenStack environments for end users. The article is the result of research where measures of use will be established with the different technological tools that it offers us for its development and control.

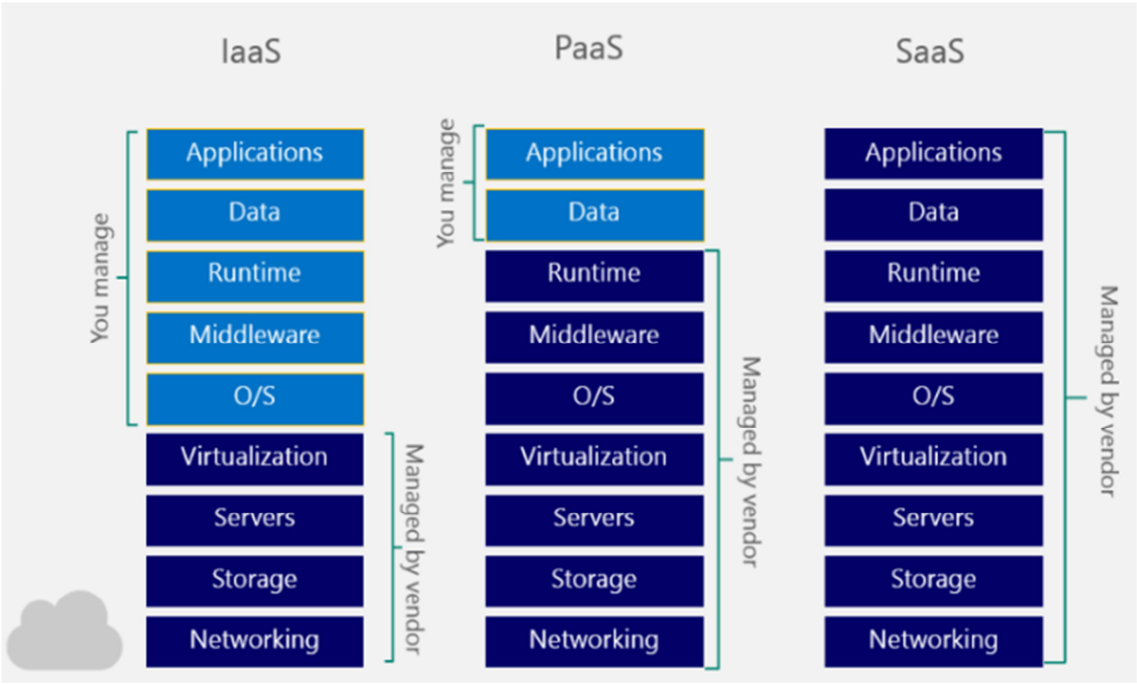
Keywords: Cloud Computing, Virtual Machine, Public Cloud, Automated Processes, Systematization of Final Resources, Virtualization

1. Introduction

A concept that acquires transcendental relevance every day, thanks to the continuous advance in technological features such as: mobility, portability and convergence at the hardware and software levels is, in effect, cloud computing. Cloud computing is a paradigm that enables low-demand input over a network or a shared pool of configurable computing resources, such as networks, servers, storage, programs, and services. that can be delivered quickly with minimal management or interrelation effort from the service provider [1]. Cloud computing presents three associated service models such as: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). Like all cloud services, IaaS provides access to computing requirements located in a virtualized environment, the cloud, through a public link, which can often be the Internet. In the case of IaaS, the computing requirements provided lie, in particular, in virtualized hardware, or, in other words, processing infrastructure [5, 29].

OpenStack is a free and open source software platform built on the foundations of Python [30]. With it it is possible to create a cloud operating system (public or private), used to manage various computing, storage and network resources [17, 33]. Therefore, OpenStack is used as infrastructure as a

service (IaaS). This is the most important component, as it is the basis on which the other two services are based, PaaS and SaaS, as can be seen in the following figure [13, 14]:



Source: Prepared by JMG Virtual Consulting [23].

Figure 1. *OpenSatck as IaaS, PaaS and SaaS Services.*

The definition of IaaS includes characteristics such as virtual server space, network links, bandwidth, IP addresses, and load balancers [47]. Specifically, the collection of usable hardware requirements comes from a large number of networks and servers, typically distributed across multiple data centers, for which the cloud service provider is responsible for maintaining [10]. The user, on the other hand, gains access to the virtualized devices to build their own computing environment with them [9].

The Infrastructure as a Service (IaaS) is a cloud service deployment model that delivers IT infrastructure resources over the Internet [32]. This approach allows organizations to rent or use resources such as virtual servers, storage, networking, and other components without the need to manage physical hardware. IaaS has become a key enabler for cloud adoption, and one of the popular options for implementing IaaS is OpenStack [11, 13, 40].

OpenStack is an open source project widely used to create and manage private and public cloud environments [41]. It provides a flexible and scalable platform for implementing IaaS and has become a popular choice for enterprises and service providers who want to offer cloud services [7, 44].

Today's companies, especially medium and small businesses, have to manage new services that help them with a more optimized process in the functions required to virtualize technologies and applications through the public cloud, considering the need to remain competitive in the computing industries [6].

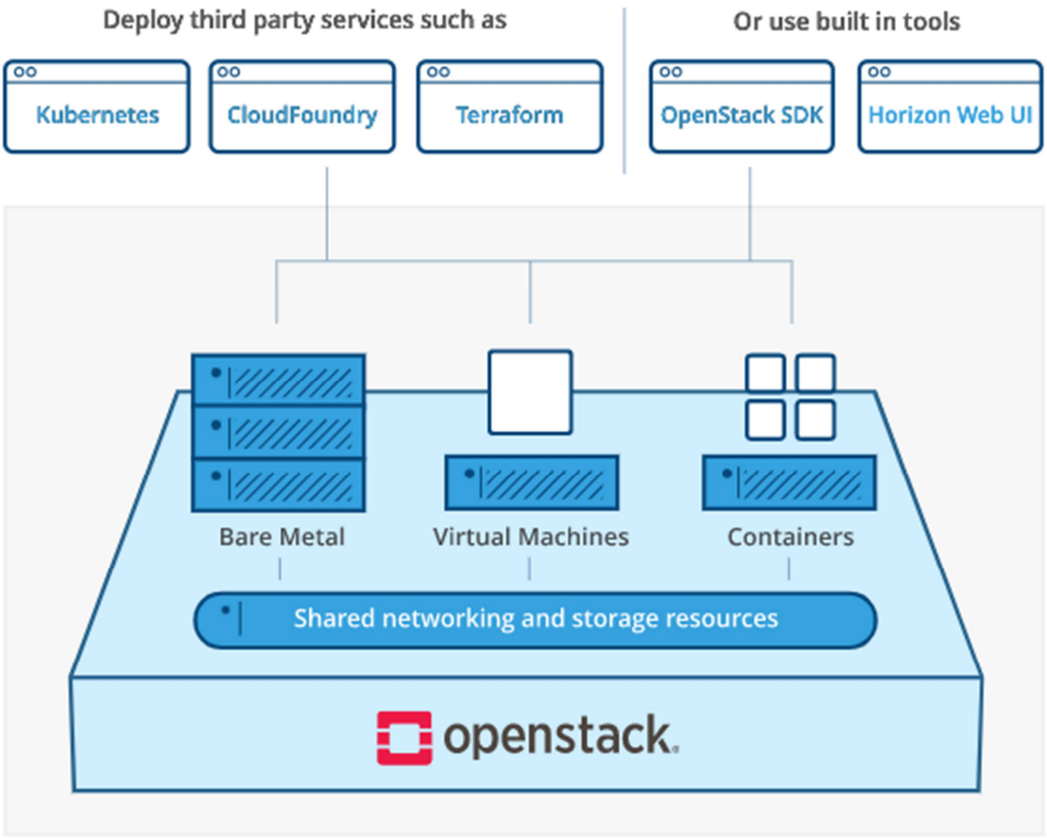
The computer technologies are increasingly advancing and as this happens, productivity in operations increases. This requires the use of applications that help promote resources with greater agility and scalability. OpenStack in network infrastructures and more in the business field, leads us to the services and applications currently used, meeting greater availability in environments or resources quickly and efficiently [15, 35, 36].

It’s necessary to keep in mind the applications that this entails, since they can face challenges in the IT infrastructure, becoming more efficient and scalable, becoming a real business for those companies that navigate their course in the digital era, improving their results and preparing them for the different functions that will be exercised in the future [5].

The function of the OpenStack method in public clouds provides us with an agile horizontally scalable infrastructure, using link or connection mechanisms (computers, network, and databases), automating activities and functions in a virtual environment, storing processes and interconnecting them. services with data centers, maintaining their security and confidentiality in the cloud guaranteed by standards and APIs [2, 16, 48].

Additionally, it has control of computing resources within the tool, for storage and data center network management, and the client can also manage the most common mechanisms used in the tool [3].

In the same way, real-time administrators are found that provide standard functionality on failures, services, among other anomalies, guaranteeing their high availability in user applications [4].



Source: Prepared by Openstack [40].

Figure 2. *OpenStack Software Overview.*

2. Methodology

Through this research, a solution will be implemented with OpenStack to automate the processes of SMEs, seeking to deploy the most fundamental activities that are managed within companies, using their own public cloud infrastructure, being available at all times regardless of the location [20, 25].

That is why this service leads to the implementation of virtualizing the different processes carried out within organizations to bring everything to a cloud computing network so that the systems are adaptable in their scope of development and have them in one place [17, 18].

According to what was previously stated, in the book [51], is the IT platform really ready for the cloud? About the importance of understanding how companies operate on Cloud Computing and the practices consistent with the processes carried out in the cloud [5].

The cloud services such as: Amazon (AWS), Google Compute Engine, and Microsoft Azure are proprietary platforms that automatically "lock" users into their platform. AWS, for example, has its own application programming interface (API) and its own set of software, meaning businesses couldn't easily migrate to a competing cloud provider. As we can imagine, this could be a big problem for a company developing a strategic application [6, 43, 49].

Source: Prepared by Become Hybrid [51].

Figure 3. *Public cloud.*

Consequently, cloud services offer a high level of service (SLA), and by opting for OpenStack, we would have a greater number of providers, who in turn offer a more adequate response time [42]. This helps us avoid loss of information in the cloud that may occur in the future; since companies are constantly reporting it and the restoration process is difficult [11, 19, 20].

Another important point for the development of information is the privacy, confidentiality and availability of data and more so taking into account the current information that is handled and more so in SME companies with reserved

information, web or internal use applications that are handled in public clouds [21].

With the OpenStack service it guarantees perfect functioning to work in the web environment, maintaining fluid communication and protected information [22]. It's important to use these steps for using infrastructure as a service in the cloud [18].

2.1. Workloads

We must keep in mind that when carrying out the implementation through OpenStack we must identify the workload that will be executed using the tool, starting with whether it is clear how we intend to virtualize [39].

The above is important that within the companies there is a staff that has high knowledge about the processes and understanding of flowcharts, who understands the dynamics of the activities in depth, since when automating we must be clear about the deployment and management in OpenStack and adaptation to your specific needs [37]. This step is essential since it significantly helps us make the use of this web mechanism easier and more attractive for companies and will also maximize the benefit offered by the implementation of the public cloud, beyond being able to have an environment manager. virtualization and cloud [27].

2.2. Use the Methodologies at Our Disposal

The entire implementation of what is intended to be achieved in the business infrastructure is to know how to work and distribute services in a better way to the providers of the OpenStack tool, since by managing extensive processes it uses them in a flexible way for the workers, giving it multiple functions or needs that must be performed in the most effective and secure cloud [34, 38].

Considering the complexity that this use entails, we adapt to the construction of any software application that companies plan to implement, based on the service around cloud computing and its infrastructure (IaaS), either by maintaining the processes that are used, as well as new developments or improvements that are going to be optimized within the processes of SMEs [28].

2.3. Benefits That Can Be Solved with OpenStack

The OpenStack service helps us carry out all the storage deliveries of the base, for the IT services that end users or clients need [45].

Bigelow comments that it helps us store the objects developed by companies at low cost, since it has an easier storage guarantee [2].

On the other hand, the important savings that use the OpenStack functionalities for all the control and economy of web applications, whether (contracting web licenses, applications, databases, etc.) since this can generate unnecessary expenses in the companies, when storing services in the cloud and even more so if we are going to convert physical machines to virtual ones [17].

Taking into account what has been previously presented, we can say that the implementation in OpenStack will use a series of components that provide API to be able to access the infrastructure resources as a service, taking into account the implementation of all the cloud resources that will be reported to end users and how we carry out internal usability in organizations [23], such as:

1. Calculation
2. Hardware life cycle
3. Storage
4. Networks
5. Shared services
6. Orchestration
7. Job load provisioning
8. Application life cycle
9. API proxies
10. Web interface

Based on the qualitative approach, which serves as a study basis to determine how viable and concise the project of implementing these services in public clouds is, a series of variables has been established that will help us corroborate how optimal the developments are. of management in the cloud taking into account that currently people better handle the tools implemented in the cloud such as Cloud computing, carry out said management processes more broadly and with better cost reduction for organizations that are just starting out [31, 50].

To manage this probability, a study was carried out with a deployment to 95 students on the knowledge of the object of the study on cloud computing and the management of cloud tools for an SME company [21, 46].

An interview is carried out on how many students see public cloud services as viable for all their content and applications without having hard disk space on conventional computers and take everything to virtualization and storage in the cloud, in which a coverage of some areas giving an opinion with carrying out SME companies that are in their stage of implementing these processes [8] [26].

Additionally, it is about determining worldwide statistics on the management we give to small companies and the usability of these technological tools in the cloud by using OpenStack [24].

Table 1. *Participation of students from the Los Libertadores University Foundation on knowledge of Cloud Computing and Cloud Tools.*

No	Programas	Stake	Viability	Statistics
1	Systems Engineering	43	Well	45.26%
2	Industrial Engineering	12	Regular	12.64%
3	Mechatronics Engineering	13	Well	13.68%
4	Electronic Engineering	15	Well	15.78%
5	Aeronautical Engineering	12	Well	12.64%

Source: self made.

3. Results

Based on the test studies on the extensive knowledge of Cloud Computing and working with them, the following analysis is established with respect to the sample carried out

on the students of the Los Libertadores University Foundation on the feasibility of using these media with OpenStack.

That is why a series of questions are determined in relation to how it is considered to work with OpenStack, seeing the point of view that is most feasible for the work and improves virtual storage vs. current memories.

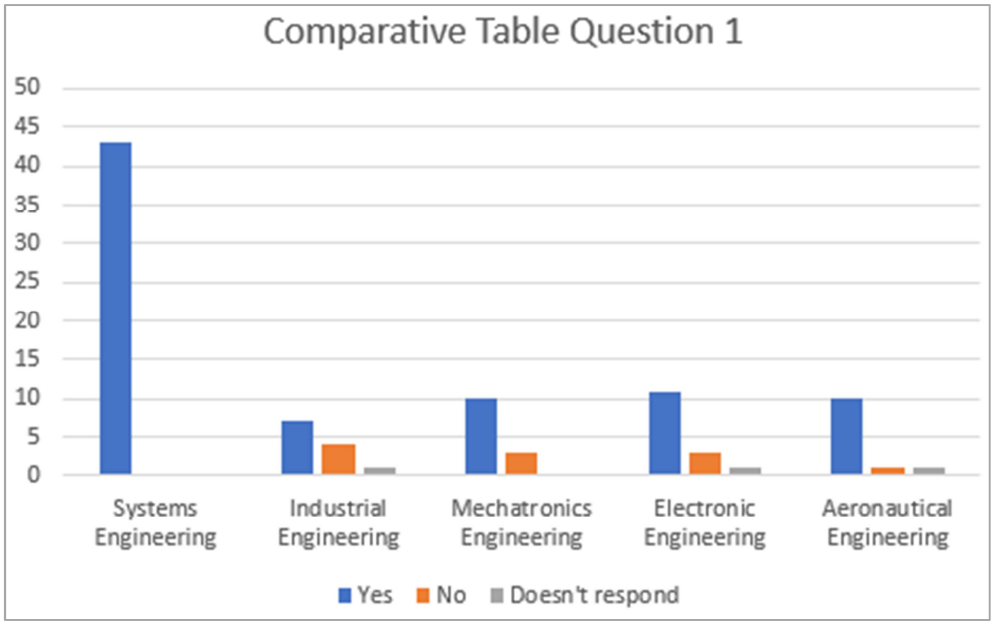
3.1. Workloads

The results of the evaluations applied to students from various programs within the Faculty of Engineering and Basic Sciences indicate that addressing work demands in early-stage companies represents a considerable challenge. This is because these responsibilities are managed by professionals trained in various virtualization tools. Consequently, we have concluded that it is essential that these personnel have specialized knowledge to face these tasks in a comprehensive manner. This allows us to effectively automate the resources of SME companies, taking advantage of new developments in the technological era and the adoption of infrastructure as a service.

Table 2. *Workloads.*

Question 1. Do you consider the automation of OpenStack processes in the cloud to be efficient for SMEs?					
Programs	**Stake**	**Yes**	**No**	**Doesn't Respond**	**Coverage**
Systems Engineering	43	43	0	0	100%
Industrial Engineering	12	7	4	1	100%
Mechatronics Engineering	13	10	3	0	100%
Electronic Engineering	15	11	3	1	100%
Aeronautical Engineering	12	10	1	1	100%

Source: self made.



Source: self made.

Figure 4. *Comparative Table Question 1.*

It's determined that there are variations with respect to other engineering, since for some they believe it is pertinent that these advances in virtualization and going beyond conventional development are very feasible for companies, not only in different processes, but in the activities themselves. That is why it is difficult for students of Systems Engineering and Aeronautical Engineering to carry out this virtual emphasis since their emphasis on what they do is executed directly from their same devices without any disturbance of the information or other mechanisms that today Cybercriminals carry out computer crimes in the cloud and the data or other information of companies that are exposed.

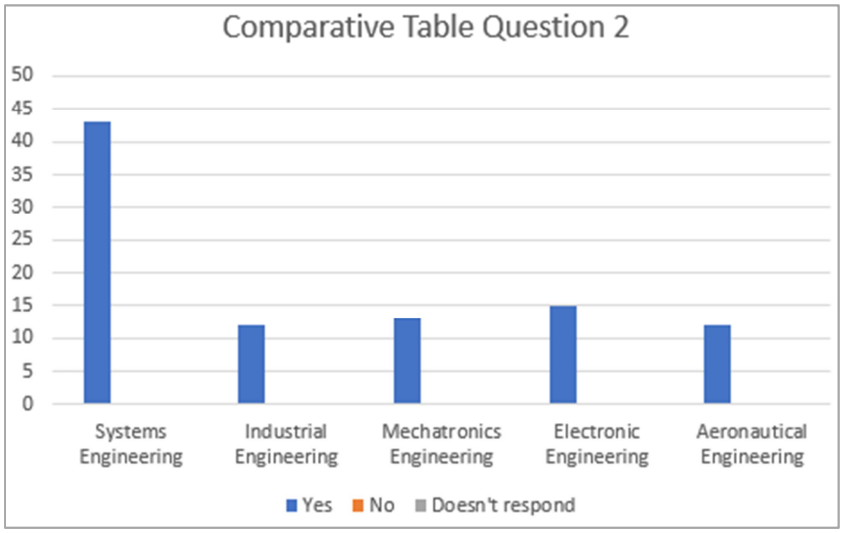
3.2. Use the Methodologies at Our Disposal

The results of the evaluations carried out on students from various programs within the Faculty of Engineering and Basic Sciences, with regard to the application of different available methodologies, reveal the following panorama:

Table 3. *Scope of the methodologies.*

Question 2. Do you think that workers should have extensive knowledge in the use of virtual tools?					
Programs	**Stake**	**Yes**	**No**	**Doesn't Respond**	**Coverage**
Systems Engineering	43	43	0	0	100%
Industrial Engineering	12	12	0	0	100%
Mechatronics Engineering	13	13	0	0	100%
Electronic Engineering	15	15	0	0	100%
Aeronautical Engineering	12	12	0	0	100%

Source: self made.



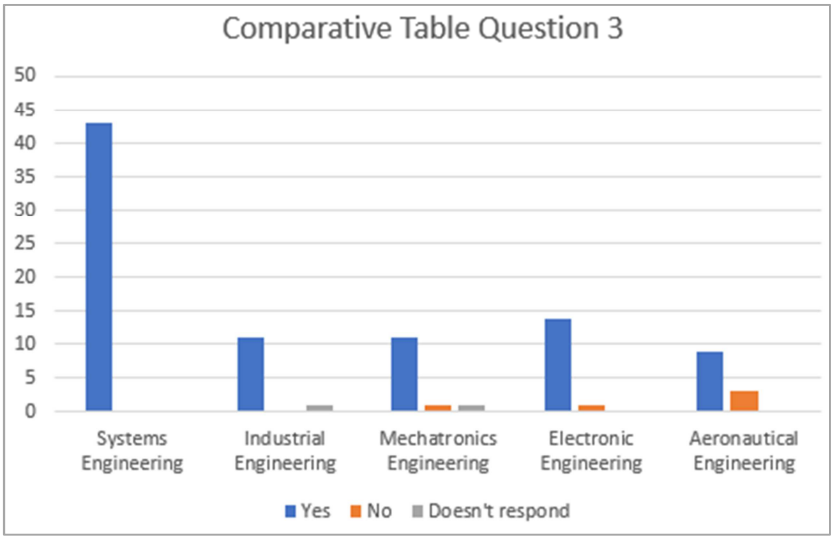
Source: self made.

Figure 5. *Comparative Table Question 2.*

It's observed that all students agree that it is crucial for professionals to have solid knowledge to function in various technological environments. In the specific case of implementing cloud systems, it is imperative that people acquire a deep understanding of Infrastructure as a Service (IaaS) and how it works. Although web developments and tasks are tailored to the worker's perspective, it is essential to demonstrate this skill from the beginning.

3.3. Benefits That Can Be Solved with OpenStack

The evaluations carried out on students from various programs of the Faculty of Engineering and Basic Sciences, focused on the benefits that can be addressed through OpenStack, show the following result:



Source: self made.

Figure 6. *Comparative Table Question 3.*

Table 4. *Benefits.*

Question 3. Do the functionalities provided by the tool help companies reduce their costs of storage, contracts, licenses and conventional software?					
Programs	**Stake**	**Yes**	**No**	**Doesn't Respond**	**Coverage**
Systems Engineering	43	43	0	0	100%
Industrial Engineering	12	11	0	1	100%
Mechatronics Engineering	13	11	1	1	100%
Electronic Engineering	15	14	1	0	100%
Aeronautical Engineering	12	9	3	0	100%

Source: self made.

It's possible to conclude that numerous students hold the perception that the expenses associated with production would be equivalent, whether or not they use a specific tool along with its functions. This opinion is based on the notion that conventional tools are considerably more accessible than cloud-based ones. This is because conventional tools are easily available, and their acquisition or use is subject to a monthly or annual payment model.

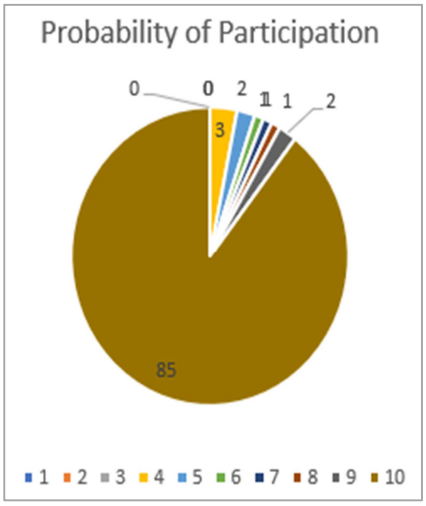
3.4. Cloud Infrastructure Using OpenStack Tools

The results of the evaluations applied to students from various programs within the Faculty of Engineering and Basic Sciences, in relation to the management of a cloud infrastructure using OpenStack tools, reveal the following:

Table 5. *Final clarification response.*

Question 4. In today's companies, will cloud infrastructures help SME companies be more profitable in the market using OPENSTACK tools? Rate 0 to 10 where 0 is low and 10 is high.												
Programs	**Stake**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Total Participants	30	0	0	0	0	3	2	1	1	1	2	20

Source: self made.



Source: self made.

Figure 7. *Probabilistic cake Question 4.*

In the previous question, an evaluation was made of the importance, on a scale of 0 to 10, of the implementation of cloud infrastructures in contemporary organizations. It explored how these infrastructures, leveraging OpenStack tools, can contribute to improving the profitability of small and medium-sized businesses (SMEs) in the market. Participants were rated according to their understanding and perspective on the current impact of this development.

4. Discussions and Conclusions

Nowadays, cloud computing is a very powerful tool to be able to improve many issues for workers who are in constant production. It leads us to the fact that, by evaluating the possibility of using Cloud Computing in SMEs, we reach the conclusion that adopting this technology does not require many resources and can develop this technology with short or medium-term investments.

In the study carried out, it was concluded that different organizations can benefit from the implementation of OpenStack as a service infrastructure since they can become much more profitable and can benefit more, with the use of OpenStack tools, where there may be an improvement in operational efficiency [25]. Where by migrating to a cloud-based infrastructure, SMEs can optimize resource usage, reduce hardware maintenance costs and improve scalability. OpenStack provides centralized and automated management of resources, simplifying daily operations and allowing companies to focus on their business objectives instead of worrying about infrastructure management [24].

Furthermore, the adoption of OpenStack brings significant cost reduction for SMEs. By eliminating the need to maintain expensive physical infrastructure, businesses can take advantage of pay-as-you-go models and avoid significant upfront investments. This democratizes access to cutting-edge technologies that might otherwise be out of an SME's financial reach.

Likewise, flexibility is key in a dynamic business environment. OpenStack enables SMBs to quickly adapt to changes in demand, scale resources as needed, and deploy new applications efficiently. This agile responsiveness facilitates innovation and adaptation to changing market conditions. Furthermore, the possibility of accessing resources on demand allows SMEs to adjust their computing

capabilities according to the specific needs of each project.

The implementation of OpenStack as a service infrastructure in an SME is a crucial step towards modernization and competitiveness in the digital economy. Operational efficiency, flexibility and cost reduction are just some of the tangible benefits that can transform the way an SME operates and meets the challenges of today's market.

By embracing service infrastructure, SMEs not only optimize their internal operations, but also lay the foundation for sustainable growth and greater capacity for innovation. OpenStack, with its robust and scalable approach, presents itself as a strategic ally for SMEs seeking to prosper in the digital era.

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Conflicts of Interest

The authors declare no conflicts of interest.

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