Cloud Computing as a New Paradigm for Academic Staff in Macedonian Universities

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Abstract: In the last few decades, is obvious impact of information technologies in all areas of life. This is particularly evident in higher education institutions due to the nature of the learning and teaching process. The development of information technology enabled the emergence of new models in terms of using information resources. One of those relatively new models is Cloud Computing. Cloud computing can provide Universities access to the necessary information resources, very quickly, efficiently and at relatively low prices.

The main goal of this paper is to answer the question, is a Cloud Computing a new paradigm for the academic staff in the Republic of North Macedonia? Data will be used from an on-line research that was conducted through a survey that was distributed to academic staff from most Universities in the Republic of North Macedonia. To create this questionnaire was used Google Forms, which offers excellent opportunities for creating this type of survey. Also, in this paper, will be made data analysis using the chi-square test for independence of variables. The results of this research will give an answer about the familiarity of the respondents with the concept of Cloud Computing and its dependence on several variables.

Key Words: Cloud computing, High education, Information resources

1. INTRODUCTION

Few decades ago, the limitations of traditional computer systems have been a problem for many individuals and companies, but for various reasons (mostly technological) these limitations have been difficult to overcome. However, with technological advances, especially in the field of network communication, computer giants such as Amazon, Google, Microsoft, IBM, Salesforce, etc., have provided a new model of offering computing resources. According to this model, the three main layers of computing resources, such as infrastructure, platform and application, can be delivered to users as ready-made services. Additionally, services are arranged and maintained by the service provider in order to relieve users of any tasks related to providing infrastructure, maintaining, delivering etc. This new model of offering computing resources is known as Cloud computing. The emergence of cloud computing represents a new revolutionary concept of offering computer resources, first of all, in terms of the advantages and benefits it offers. The concept of Cloud computing is becoming part of the daily activities of both individuals and companies. Millions of people around the world already use some kind of cloud service, and that number is growing exponentially. Perhaps the biggest contribution of the implementation of Cloud computing concept is the globalization of computing resources. The basic benefits offered by this concept, such as expanding the existing IT infrastructure without investing huge financial resources in hardware that would not be used efficiently, reducing IT staff and unnecessary licensing of new software, are increasingly motivating organizations to adopt and to implement the cloud computing concept in their operations.

All these advantages offered by Cloud Computing can be of great benefit to educational institutions, especially in higher education where learning and teaching processes are becoming more and more globalized. Expensive information resources that only a decade ago could only be afforded by the top Universities in the world today through the concept of Cloud Computing are available to all Universities everywhere in the world and for relatively low prices.

The main goal of this paper is to answer two basic questions:

- Does cloud computing represent a new paradigm for the academic staff in the Republic of North Macedonia?
- Is there any association between certain variables with respondents' familiarity with cloud computing?

Based on the answers to these questions, it will be possible to draw numerous other conclusions, especially facts that relate to the future of using Cloud Computing in higher education. In the following sections of this paper, all those findings will be presented.

2. MATERIAL AND METHODS

For this paper, will be used data from the research that was realized through a survey that was sent via e-mail to the academic staff of the 19 Universities in the Republic of North Macedonia. The survey contained different types of questions through which respondents could fully express their views on the loud Computing model. The survey was carried out during 2024 and twelve Universities from the Republic of North Macedonia were covered. One part of the paper will include a qualitative analysis of those questions that are of exceptional importance for the research. In the other part of the paper, a non-parametric test will be used to test the dependence of familiarity with Cloud Computing with several variables that were covered by the survey. As a non-parametric test, the chi-square test will be used, which gives quite good results in determining whether there is a significant association between two variables.

3. CONCEPTUAL FRAMEWORK OF CLOUD COMPUTING

Historically, the term "cloud" has been used as a metaphor for the Internet, originating from the common representation of network diagrams where the Internet was represented as a cloud. That is why very often the term "cloud" is used as a synonym for Cloud computing. This concept dates back to 1961 when Professor John McCarthy argued that time-sharing technology could in the future enable computing resources to be sold through a sales model similar to utilities (eg, electricity). This idea became very popular in the late 1960s, but already in the mid of 1970s the idea slowly began to "die" out when it became clear that the IT technologies of that time were not able to support such a futuristic model. However, at the beginning of this millennium, this concept was completely revitalized and the term cloud computing began to appear more and more frequently.

Today there are many definitions of Cloud Computing, but the most frequently mentioned is the one according to Gartner: "Cloud computing is style of computing which scalable and elastic IT-enabled capabilities are delivered as a service using Internet technologies". Cloud computing is already becoming a reality from a technical and social point of view, and at the same time it is a concept that is still in the phase of intensive development. Today we can only speculate how this relatively new paradigm will evolve in the future and what application it will have. According to the NIST (National Institute for Standard and Technology) model for Cloud Computing, this model, which is distinguished by five essential characteristics, implies three basic service models, and four basic deployment models. It can be seen from the following picture.

Figure 1. NIST Cloud computing model (Source: Helaimia R, 2023)
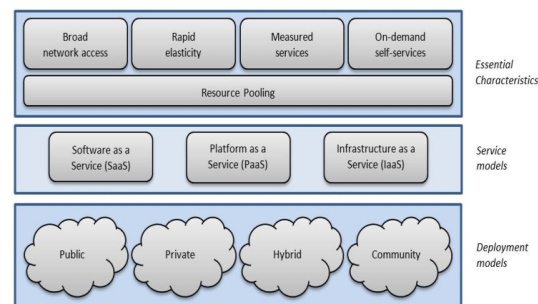
The five essential characteristics of this Cloud computing model are: broad network access, rapid elasticity, measured services, on-demand self-service, resources pooling. Although with the development of technology, new models of cloud computing such as Security as a service (SecaaS), Data as a service (DaaS), Business process as services (BPaaS), Robotics as a service (RaaS), etc. are also being developed, the three basic service models are:

- **Infrastructure as a service (IaaS)** –this is basic level of service offered to cloud computing users and provides controlled access to a virtual environment on which operating systems and application software can be deployed. Essentially this model refers to servers, networking and storage as services offered to the user.
- **Platform as service (PaaS)** –this model offers a scalable and flexible environment that allows users to develop, deploy, run, and manage apps. Users have the opportunity to upgrade the existing set of

tools that the platform contains, but the absolute control over the entire infrastructure is owned by the service provider.

- **Software as a service (SaaS)** – this is model that abstracts user from any infrastructure or platform, keeping their attention only at the application level. In some ways SaaS is the simplest form of using cloud computing. This model is very useful in situations where the provider offers some service to the user that can bring a lot of benefit in a short time. Applications are accessible through a client interface, such as web browsers or mobile phone applications.

In addition to these service models, there was also a deployment models, and according to this categorization, the four types of cloud computing are:

- **Public cloud computing** - cloud computing provider owns and manages the cloud computing infrastructure. The service provider owns all the necessary resources to provide the service, and rents this service to users, who pay for the service depending on the level of use or pay-as-you-go principle;
- **Private cloud computing** - this model implies that resources remain within the company, which means, resources are not shared with external entities, unlike public cloud computing where users are unrelated external entities. Such isolation provides greater data privacy and greater security for the entire computing environment;
- **Hybrid Cloud computing** – this model are combination of two or more models and hybrid cloud computing is acceptable for companies because it provides greater data security, on the one hand, and greater application availability, on the other hand;
- **Community cloud computing** – community cloud computing is a model where resources can be used by different parties who have a common interest or a common goal. According to NIST: The cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises.

With the permanent development of technology, other models of cloud computing are also being developed, regardless of whether they are service models or deployment models, but still the ones listed above represent the basic models of cloud computing.

4. Use of cloud computing in higher education

With the intense processes of globalization that have been taking place in the last few decades, Universities around the world had to adapt to these new trends. One of the ways to globalize higher education is through the use of information technology. In this way, the geographical and time barriers that students faced few decades ago can be overcome. Overcoming these barriers is made possible by new models such as Cloud computing, which are based on new information technologies. If once expensive information technology was a privilege only for rich countries and large Universities, today by using the concept of Cloud computing, this technology has become available to all Universities and all countries in the world.

The use of cloud computing can be of great benefit for the Universities of the Republic of North Macedonia. The benefits of using this concept can provide Universities and students greater access to learning resources, modern teaching and learning methods, flexible educational process, better communication between students and professors, access to a large number of new and modern tools for learning etc. All these benefits can be useful both for the students and for the academic staff in the Universities in Republic of North Macedonia. This paper refers to the familiarity of the academic staff with Cloud computing, but also gives an answer to the question of whether Cloud computing is a new paradigm for the academic staff in the Republic of North Macedonia.

The research was conducted through an online questionnaire created through Google Forms and sent to academic staff in the Republic of North Macedonia. Responses were collected from academic staff of 12 Universities from the Republic of North Macedonia that are best ranked by Webometrics. Survey covered 115 respondents and most of the answers were from the two largest Universities, from the University "St. Cyril and Methodius-Skopje" were 38,34% of the respondents, while from the University "St Kliment Ohridski"- Bitola was 35.32% of the respondents.

The first part of the questions refers to the demographic characteristics of the respondents such as gender, age, academic status, work experience, etc. The question that is of exceptional importance for this paper relates to familiarity of academic staff with the Cloud Computing model. The obtained results can be seen from Figure 2.

Figure 2. Familiarity of respondents with Cloud computing
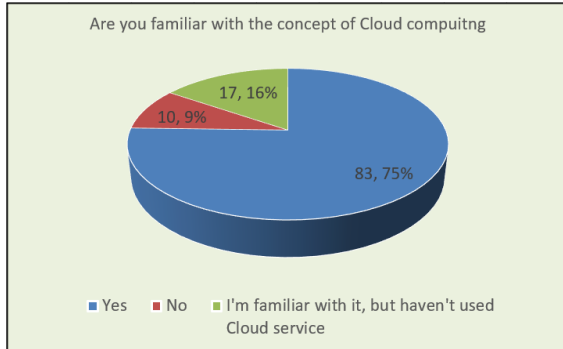
According to the results of the research, a large part of the respondents is familiar with the concept of Cloud Computing, or, only 10,9% of the respondents have never used Cloud Computing. Therefore, it can be concluded that Cloud computing does not represent a new paradigm for the academic staff in the Republic of North Macedonia, because most of them have already used some Cloud tool. It is also a result of the period during the pandemic with the Covid 19 virus, when Universities switched to full on-line teaching. It was probably that the advantages and benefits of Cloud Computing model as a tool for distance learning were especially noticed during the pandemic. After the end of the pandemic, a large part of the academic staff continued to use these tools for the realization of the learning and teaching process, which can be seen from the following figures.

Figure 3. Cloud platform that respondents have used (especially during pandemic)
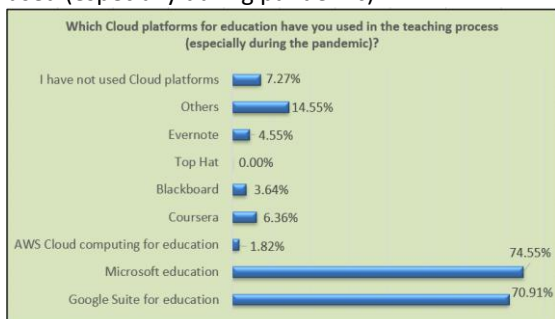
Figure 4. Cloud platform that respondents currently use
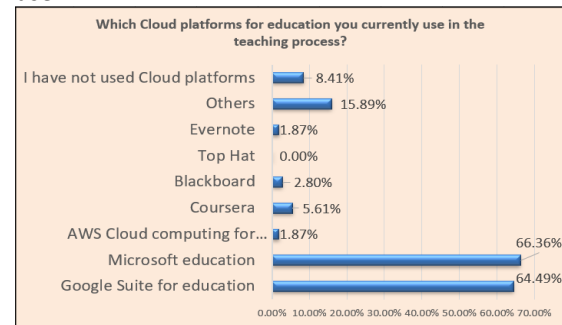
In this paper, the dependence of familiality with certain variables that are relevant to the research will be examined. For this purpose, the chi-square test for independence of variables will be applied. The chi-square test belongs to the group of non-parametric /tests whose main purpose is to determine if there is a dependence between two or more groups within the population i.e. to find out if there is dependence (independence) between two variables. This test of independence is used to analyze the contingency table formed by two categorical variables. The formula used in the chi-square test is (Singh, 2022):

$$\chi^2 = \sum_{i=1}^{n} \frac{(Oi - Ei)^2}{Ei}$$

Where,

O Stands for the observed frequency

E stands for the expected frequency

The general formula for calculating the expected counts from observed count for a particular cell is:

Expected cell frequency = $\frac{(raw\ total)*(column\ total)}{grand\ total\ of\ all\ cells}$

Testing using the chi square test is carried out through several basic steps. Those steps are:

- Defining Null hypothesis
- Creating contingency table
- Calculating the Expected values
- Calculating the difference between Observed values and Expected values for each of the observations
- Calculating the squared difference
- Calculating the component by the chi-square formula given above
- Calculating the Chi-square statistics
- Find the p-Value
- State the conclusion

In this paper, with the chi-square test, we will test several hypotheses in order to determine whether there is a dependence of respondents' familiarity with cloud computing with some other variables. First, we will define the main hypothesis from which seven null hypotheses will follow. In the context of this research, the main hypothesis will be:

There is no significant association between personal characteristics of respondents and familiarity with Cloud Computing.

Seven null hypotheses will follow from this general hypothesis:

1. *H0: There is no significant association between Age of respondents and Cloud compuitng familiarity*
2. *H0: There is no significant assotiation between Gender of respondents and Cloud compuitng familiarity*
3. *H0: There is no significant association between Scientific field of respondents and Cloud computing familiarity.*
4. *H0: There is no significant association between Academic rank of respndents and Cloud computing familiarity.*
5. *H0: There is no significant association between Number of employees in higher education institution and Cloud computing familiarity.*
6. *H0: There is no significant association between Working experience of respondents and Cloud computing familiarity.*
7. *H0: There is no significant association between Form of teaching and Cloud computing familiarity.*

In the following sections we will test all these hypotheses and based on the obtained results relevant conclusions can be drawn.

The first Null hypothesis refers to:

H0: There is no significant association between Age of respondents and Cloud compuitng familiarity

The results of testing the hypothesis are on Table 1. To determine whether the null hypothesis is accepted or rejected it is necessary to calculate the p value. If the p value is greater than 0,05, the hypothesis is accepted, and if the p value is less than 0,05, then the hypothesis is rejected. The analysis of the results in this paper was done in Microsoft Excel using the "chi-test" formula.

Table 1. Contingency table - Age of respondents and familiarity with Cloud computing

According to the results obtained by applying the chi-square test, it can be concluded that the null hypothesis is accepted i.e., there is no significant association between the age of the respondents and their familiarity with cloud computing. This would mean that age has no influence on whether the academic staff of the Universities in the Republic of North Macedonia is familiar with the concept of Cloud Computing.

Second null hypothesis is:

H0: There is no significant assotiation between Gender of respondents and Cloud compuitng familiarity.

Table 2. Contingency table - Gender of respondents and familiarity with Cloud computing

From the results of testing this hypothesis shown on Table 2, it is obvious that the hypothesis is rejected, which would mean that there is a significant association between the gender of the respondents and their familiarity with the Cloud computing model. Here we can mention the ratio of men and women who were covered by the survey, i.e. the survey covered 46% female respondents and 54% male respondents. Testing of this null hypothesis shows that the gender of the respondents has a great influence on how familiar they are with the Cloud computing concept.

The next null hypothesis is:

H0: There is no significant association between Scientific field of respondents and Cloud computing familiarity.

Table 3. Contingency table - Scientific fields of respondents and familiarity with Cloud computing

Actual	Agricultural Science	Medical and Health Science	Social Science	Natural science	Engineering and Technology	Humanities	Total
Yes	5	5	31		28	8	82
No	1	3	8	1	3	0	16
I'm familiar with it, but haven't used Cloud service	0	1	6	1	1	1	11
Total	6	9	45	8	32	9	109

Expected	Agricultural Science	Medical and Health Science	Social Science	Natural science	Engineering and Technology	Humanities	Total
Yes	4.5137615	6.770642202	33.85321	6.018349	24.0733945	6.7706422	82
No	0.8807339	1.321100917	6.605505	1.174312	4.697247706	1.32110092	16
I'm familiar with it, but haven't used Cloud service	0.6055046	0.908256881	4.541284	0.807339	3.229357798	0.90825688	11
Total	6	9	45	8	32	9	109

Degrees of freedom (r-1)*(c-1)=10
H0: There is no significant association between Scientific field and Cloud computing familiarity
P value > 0,05 Accept H0
P value < 0,05 Reject H0
P value 0.390356933 > 0,05
H0 is accepted it means there is no significant association between Scientific field and Cloud computing familiarity

The results of testing this hypothesis are shown in Table 3. Testing of this null hypothesis shows that there is no significant association between respondents Scientific Field and familiarity with Cloud Computing.

Fourth null hypothesis is:

H0: There is no significant association between Academic rank of respndents and Cloud computing familiarity.

Table 4. Contingency table - Academic ranks of respondents and familiarity with Cloud computing

Actual	Assistant	Docent	Associate professor	Full Professor	Total
Yes	3	20	15	44	82
No	1	1	5	3	10
I'm familiar with it, but haven't used Cloud service	3	2	3	9	17
Total	7	19	27	56	109

Expected	Assistant	Docent	Associate professor	Full Professor	Total
Yes	5.266055	14.29358	20.3119266	42.12844	82
No	0.642202	1.743119	2.47706422	5.1376147	10
I'm familiar with it, but haven't used Cloud service	1.091743	2.963303	4.21100917	8.733945	17
Total	7	19	27	56	109

Degrees of freedom (r-1)*(c-1)=6
H0: There is no significant association between Academic ranks and Cloud computing familiarity
P value > 0,05 Accept H0
P value < 0,05 Reject H0
p value 0.047954 < 0.05
H0 is rejected it means there is significant association between Academic ranks and Cloud computing familiarity

According to the results presented in Table 4, this null hypothesis is rejected. This means that there is a significant association between the respondents academic rank and familiarity with Cloud computing. It is obvious that familiarity with Cloud computing model is determined by the academic rank of the respondents i.e., depending on whether it is an assistant, docent, associate professor or full professor, it affects the use of cloud computing.*

The next null hypothesis is:

H0: There is no significant association between Number of employees in higher education institution and Cloud computing familiarity.

Table 5. Contingency table - Number of employees in higher education institution and familiarity with Cloud computing

Actual	0-10	20-30	30-40	Over 40	Total
Yes	5	8	18	51	82
No	2	2	1	5	10
I'm familiar with it, but haven't used Cloud service	1	1	3	12	17
Total	8	11	22	68	109

Expected	0-10	20-30	30-40	Over 40	Total
Yes	6.018349	8.275229	16.55046	51.1559633	82
No	0.733945	1.009174	2.018349	6.23853211	10
I'm familiar with it, but haven't used Cloud service	1.247706	1.715596	3.431193	10.60550459	17
Total	8	11	22	68	109

Degrees of freedom (r-1)*(c-1)=6
H0: There is no significant association between Number of employees and Cloud computing familiarity
P value > 0,05 Accept H0
P value < 0,05 Reject H0
p value 0.568331 > 0,05
H0 is accepted it means there is no significant association between Number of employees and Cloud computing familiarity

According to the results shown in Table 5, it can be concluded that this null hypothesis is accepted, that is, there is no significant association between the number of employees and familiarity with Cloud Computing. This indicates the fact that access to information resources is not conditioned by the size of the organization, i.e., today, both small and large Universities have equal chances to access information resources.

We test the following null hypothesis:

H0: There is no significant association between Working experience of respondents and Cloud computing familiarity.

Table 6. Contingency table - Working experience of respondents and familiarity with Cloud computing

Actual	0-5 years	6-10 years	11-20 years	Over the 20	Total
Yes	8	41	10	23	82
No	3	2	2	2	9
I'm familiar with it, but haven't used Cloud service	5	5	1	6	17
Total	16	48	13	31	108

Expected	0-5 years	6-10 years	11-20 years	Over the 20	Total
Yes	12.14815	36.444444	9.87037037	23.53703704	82
No	1.333333	4	1.08333333	2.583333333	9
I'm familiar with it, but haven't used Cloud service	2.518519	7.5555556	2.0462963	4.87962963	17
Total	16	48	13	31	108

Degrees of freedom (r-1)*(c-1)=6
H0: There is no significant association between Working experience and Cloud computing familiarity
P value > 0,05 Accept H0
P value < 0,05 Reject H0
p value 0.120826 > 0,05
H0 is accepted it means there is no significant association between Working experience and Cloud computing familiarity

The results of testing this hypothesis are shown in Table 6. Testing of the null hypothesis of dependence between the respondents' work experience and familiarity with Cloud Computing is accepted. There is no significant association between these two variables.

The last null hypothesis is:

H0: There is no significant association between Form of teaching and Cloud computing familiarity.

Table 7. Contingency table - Form of teaching and familiarity with Cloud computing

Actual	Conventional (traditional) way of teaching	Conventional way of teaching with minimal support of information technology	Teaching with the support of information technology	Teaching based exclusively through using information technology	Total
Yes	0	22	11	50	83
No	2	4	0	4	10
I'm familiar with it, but haven't used Cloud service	0	7	1	9	17
Total	2	33	12	63	110

Expected	Conventional (traditional) way of teaching	Conventional way of teaching with minimal support of information technology	Teaching with the support of information technology	Teaching based exclusively through using information technology	Total
Yes	1.509090909	24.9	9.054545455	47.53636364	83
No	0.181818182	3	1.090909091	5.727272727	10
I'm familiar with it, but haven't used Cloud service	0.309090909	5.1	1.854545455	9.736363636	17
Total	2	33	12	63	110

Degrees of freedom (r-1)*(c-1)=6
H0: There is no significant association between Form of teaching and Cloud computing familiarity
P value > 0,05 Accept H0
P value < 0,05 Reject H0
p value 0.000525 < 0,05
H0 is Rejected it means there is significant association between Form of teaching and Cloud computing familiarity

According to the results obtained for testing this null hypothesis presented in Table 7, it can be concluded that this hypothesis is rejected, which would mean that there is a significant association between the form of teaching and familiarity with Cloud Computing. This would mean that the form of teaching applied by the academic staff has a great influence on the familiarity with Cloud computing.

5. RESULTS and DISCUSSION

Today we live in a time where technology is an integral part of our lives. Information technology has penetrated into all areas of society's functioning. Whether it is economy, health, education, agriculture, etc. information technologies are already an essential part of any sector, especially new models such as Cloud computing, which appear and develop based on new information technologies that offer users almost unlimited information resources at relatively low prices. Such models have given users access to a large number of applications and information infrastructure so that today users no longer have to invest in expensive hardware resources whose capacity often remains unused.

A number of relevant conclusions can be drawn from the analyzes that were made in this paper.

- First of all, most of the academic staff in the Republic of North Macedonia are familiar with the concept of cloud computing, which means that for the academic staff this concept is no longer something new that they encounter for the first time.
- Probably one of the benefits of the Covid-19 pandemic (if anything can be a benefit of dealing with a pandemic) is the opportunity to see that technology and new models of information resource provision can be of great benefit. For the period of the pandemic, there was no question whether to work on-line or not, it was simply the only way. Then Universities noticed that they can have great benefits from using models like Cloud Computing, so even today they continued to use the concept of Cloud Computing in order to use those benefits.

In the paper, several null hypotheses were tested using the chi-square test in order to determine if there is a significant association of certain variables with the respondents' familiarity with Cloud Computing. With those tests, several interesting results were determined, on the basis of which relevant conclusions can be drawn:

- There is no dependence between the Age of the respondents and their familiarity with Cloud computing. It indicates the fact that regardless of the Age of the respondents, it has no influence on the level of familiarity with Cloud computing.
- There is a significant association between the Gender of respondents and their

familiarity with Cloud computing. The survey included 54% male and 46% female and the chi-square test showed that gender had an impact on whether the respondents were familiar with cloud computing.

- There is no dependence between the Scientific field in which the respondents work and familiarity with Cloud computing. This confirms the statement in the above lines that those new technologies and models are applied regardless of the field and area of work. Regardless of the scientific field, these models find wide application in higher education.
- There is a significant association between the Academic rank of the respondents and the level of familiarity with Cloud computing. This points to the fact that the familiarity with Cloud Computing is largely determined by whether the respondents are assistants, docents, associate professors or full professors. It is generally accepted that younger academic staff more easily accept new learning and teaching methods than older ones. but that is not always the rule. However, this research shows that there is a dependence between these two variables.
- There is no association between the size (number of employees) of the higher education institution and familiarity with Cloud computing. This means that no matter how big is institution where the respondent works, it has no impact on his familiarity with Cloud computing. It has already been mentioned that the Cloud computing model offers both large and small Universities equal opportunities to use information resources.
- There is no dependence between the Work experience of respondents and their familiarity with Cloud computing. This would mean that no matter how much work experience the respondents have, it has no influence on their familiarity with Cloud computing.
- There is a significant association between the Form of teaching used by respondents and familiarity with Cloud computing. In this case, it would be logical to have such a connection because those who apply only a traditional way of teaching are probably not familiar with the Cloud computing concept. On the other hand, those academic staff who apply information technology are highly likely to use some

Cloud tool in the way of implementing the curriculum.

Taking into account all the facts highlighted in this paper, the general conclusion is that cloud computing has a bright future. It is a concept that is increasingly popular in all areas, including higher education, because the benefits it offers are far greater than the challenges this concept faces. In addition to many studies that confirm this fact, in this study the respondents gave their opinion regarding the future of Cloud Computing. The results can be seen in figure 5.

Figure 5. The future of Cloud computing in higher education
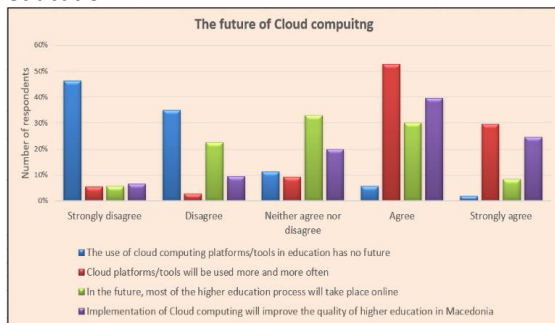
Most of the respondents agree that cloud computing will be a model that will be used more often in higher education in the future. Also, the academic staff mostly agree that the implementation of this concept will improve the quality of higher education in the Republic of North Macedonia. All this points to the fact that Cloud computing as a model based on new information technologies will be used more and more often as a tool to support teaching and learning processes in higher education.

6. CONCLUSION

Based on the results of this research, several general conclusions can be drawn. First of all, it can be stated that Cloud computing is no longer a new paradigm for the academic staff in the Republic of Macedonia. It is probably also a consequence of the conditions that were created during the pandemic when the entire educational process had to take place on-line. A large part of those Cloud tools is still used by the academic staff today because they offer numerous benefits. According to general hypothesis defined in this paper, familiarity of the academic staff with Cloud computing depends on several parameters such as the Gender of the respondents, Academic rank of the respondents and Form of teaching that is applied.

In any case, Cloud computing is a concept that will be increasingly applied in higher education and this fact is supported not only by this research but also by a large number of other researches.

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