Zdraveski, Dejan; Sotiroski, Kosta; Janeska, Margarita; Avramovski, Petar

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Benefits and Challenges of Using Cloud Computing in Higher Education

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Dejan Zdraveski, PhD
Faculty of Economics - Prilep, University "St. Kliment Ohridski" Bitola, North Macedonia
E-mail: dejan.zdraveski@uklo.edu.mk

Kosta Sotiroski, PhD
Faculty of Economics - Prilep, University "St. Kliment Ohridski" Bitola, North Macedonia
E-mail: kosta.sotiroski@uklo.edu.mk

Margarita Janeska, PhD
Faculty of Economics - Prilep, University "St. Kliment Ohridski" Bitola, North Macedonia
E-mail: margarita.janeska@uklo.edu.mk

Petar Avramovski, MD PhD
Clinical Hospital, Dept. of Internal Medicine, UKLO, University "St. Kliment Ohridski" Bitola, North Macedonia
E-mail: avramovski@gmail.com

BENEFITS AND CHALLENGES OF USING CLOUD COMPUTING IN HIGHER EDUCATION

ABSTRACT

Higher education is one of the pillars of development and prosperity of any society. Its role has become even more critical in the contemporary era, characterized by a globalized economy and an increasingly mobile workforce driven by rapid technological advancements. Consequently, the integration of modern information technologies—such as artificial intelligence, cloud computing, and big data—into higher education is no longer optional but a necessity.

One of the models that allows universities to access large amounts of information resources is Cloud Computing. This is particularly significant for developing countries, where cloud-based solutions facilitate quick and affordable access to modern educational tools. Built upon innovations such as virtualization and Internet technologies, cloud computing provides higher education institutions with enhanced opportunities for teaching, learning, and research.

The main goal of this paper is, on the one hand, to highlight the benefits of using Cloud tools in higher education, and on the other hand, to identify the problems and risks that arise when using these tools. To achieve this goal will be used data from a survey conducted across the majority of universities in the Republic of North Macedonia. Both qualitative and quantitative analyses will be presented, focusing on the advantages, problems, and risks of adopting cloud computing in higher education. A Likert scale was used to assess the benefits and challenges, while the analysis of these issues will provide an answer to the effect of using Cloud computing tools in higher education. The findings of this analysis contribute to a better understanding of the overall impact of cloud computing tools on higher education in the Republic of North Macedonia.

Keywords: *Cloud computing, high education, information resources, benefits, challenges.*
JEL: I23, I25, D83, L86

1. INTRODUCTION

Cloud computing emerged because of the need to increase the capacity and capabilities of existing information infrastructures, without investing in new hardware equipment and additional staff. It allows users to access advanced computing resources using only Internet. This achieves great flexibility, scalability and cost-effectiveness, since organizations and individuals only pay for the resources, they use.

One of the main advantages of cloud computing is its user-friendliness and the wide range of services it offers. These services can include additional data storage, information processing tools, access to various applications, etc. Users can quickly adapt their information infrastructure to current needs without spending time and money on purchasing new systems or training staff.

Definition of cloud computing comes from the National Institute of Standards and Technology (NIST): "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Chandrasekaran, 2015; Mell & Grance, 2011). When analyzed the definitions, there is a consensus on few key points: Cloud Computing ensure on-demand access to a pool of computing resources, dynamically scalable services, device and media independency and easier maintenance of applications due to do not need to be installed on users' computers (Palaniappan, 2014). According to the NIST (National Institute for Standard and Technology) model for Cloud Computing, the five essential characteristics are: broad network access, rapid elasticity, measured services, on-demand self-service, resources pooling. Also, the three basic service models are: Infrastructure as a service (IaaS), Platform as service (PaaS), Software as a service (SaaS), while four types of cloud computing deployment models are: Public cloud computing, Private cloud computing, Hybrid Cloud computing, Community cloud computing (Huawei Technologies Co., Ltd., 2023; Marinescu, 2018; Mell & Grance, 2011).

The benefits offered by the Cloud Computing model can be of great importance in educational and teaching processes. This was especially evident during the COVID-19 pandemic, when the normal functioning of the education system was disrupted and teaching had to be quickly adapted to an online format. Thanks to cloud solutions, educational institutions were able to continue their work, providing teachers and students with access to teaching materials and communication in real time.

2. LITERATURE REVIEW

The emergence of Cloud computing in the world of IT has made a breakthrough and resulted in a revolutionary change in the way information and communication are treated (Helaimia, 2023). Cloud computing is delivering on demand computing resource from applications to data centers over the Internet. Therefore, we can say that cloud is a service over the Internet (Munjal, 2015). In this research, according to Munjal (2015), educational institutions can take the benefit of cloud computing and its services to fulfill their complex operations which will automatically reduce the cost and provide more powerful functional capabilities. The incorporation of cloud computing technology in education has created various opportunities in the sector (Baldassarre et al., 2018; Kanj et al., 2025). Cloud computing has emerged as a viable solution for numerous areas, including education, owing to its dynamic scalability and the provision of virtualized resources as a service over the Internet (Alakuu & Dake, 2025). Cloud computing will enable learners to come out from the walled classrooms and explore the whole world (Tsalko & Nevmerzhytska, 2023). In addition to the benefits, there are also certain problems in the implementation of the cloud concept in higher education (Dimauro et al., 2016; El Mhouti et al., 2018). The cloud computing adoption issues in the university may be reduced by knowing and understanding the influencing factors during the adoption process. For example, proper planning and conducting cloud adoption analysis based on the identified factors would help the organization to choose suitable deployment and service models as well as the cloud

provider (Isa et al., 2020). Many cloud service providers offer publicly accessible cloud-based services, making them accessible to anybody with a subscription and a support plan (Singhal & Ahuja, 2023). Singhal and Ahuja emphasize that cloud provider takes fantastic care of all the heavy work when it comes to cloud computing, including growing both horizontally and vertically, maintaining the underlying hardware and architecture, and maintaining security.

3. MATERIAL AND METHODS

This paper will use data that are the result of a survey conducted at majority of the Universities in the Republic of North Macedonia. This questionnaire was implemented using Google Forms while the results were analyzed using Microsoft Excel. In addition, the survey contains different types of questions, and for certain types of questions, a Likert scale is used where respondents are asked to express their views and opinions. This paper will use qualitative and quantitative analysis of the questions that specifically relate to the benefits and challenges of using Cloud Computing in higher education. Two main hypotheses will be defined, from which several additional hypotheses will be derived. The ANOVA method will be applied in this study to confirm or reject these hypotheses. All analyses will be conducted using Microsoft Excel, one of the most powerful tools for data analysis.

4. RESEARCH RESULTS

For this research was created a questionnaire through Google Forms that containing different types of questions. It was sent to the academic staff of 12 largest universities in the Republic of North Macedonia, while 115 respondents answered the questionnaire, which is an appropriate and representative sample based on which relevant conclusions can be drawn. The first part of the questionnaire concerns the personal/demographic characteristics of the respondents (Zdraveski et al., 2024). Due to the limited size of the paper, we will present only those issues that are relevant to the research and that primarily relate to the benefits of using Cloud Computing and the challenges/problems faced by Cloud Computing users.

This paper explores the perceptions and opinions of academic staff regarding the benefits and capabilities of cloud computing. For this aim, a Likert scale was used to examine the perceptions of the respondents. The results of such research are shown in the following figure.

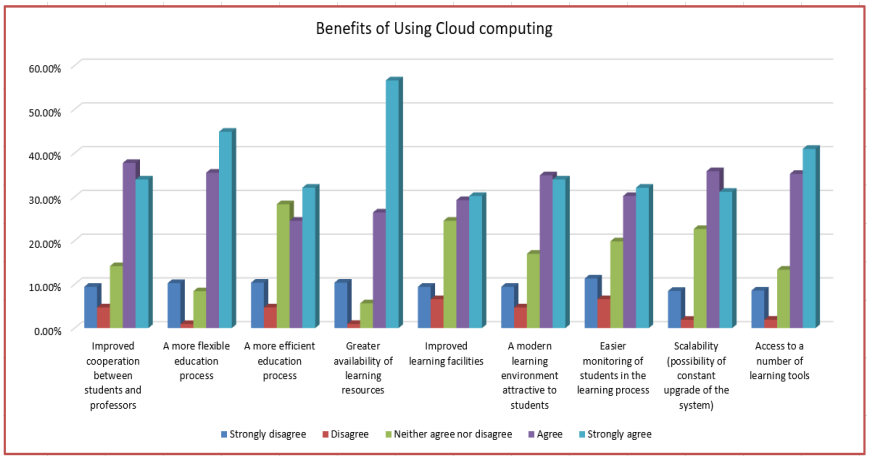


Fig. 1. Benefits of using Cloud computing model

According to the results, the majority of respondents recognize the benefits offered by the cloud computing model. More than 50% of respondents provided affirmative responses for all listed benefits, with the highest agreement observed for "Greater availability of learning resources" (83.02%), while the lowest agreement

was observed for "A more efficient education process" (56.60%). These results show that the application of Cloud Computing in higher education can provide numerous benefits, which are also recognized by the academic staff of the universities in the Republic of North Macedonia. The benefits offered by this model can contribute to the improvement and modernization of teaching and learning processes.

In addition to the benefits and capabilities offered by Cloud Computing, this model also faces certain challenges and problems. The results obtained from this research regarding the challenges/problems faced by Cloud Computing are shown in Figure 2.

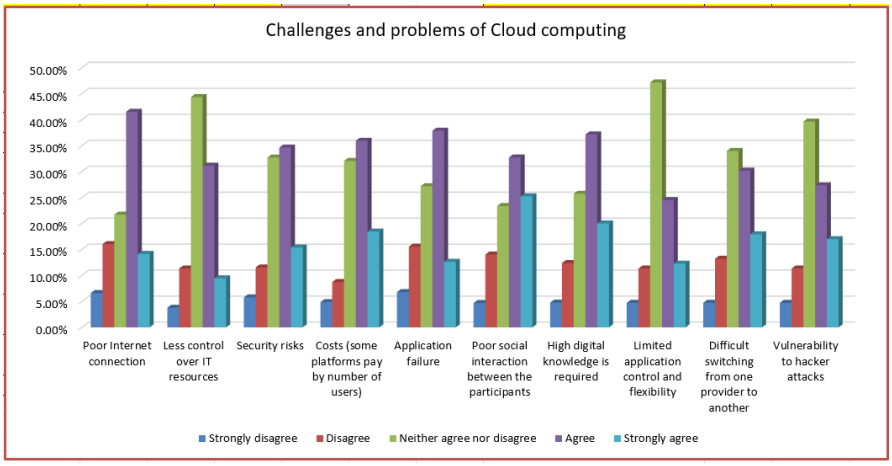


Figure 2. Challenges and problems of using Cloud computing

According to the research findings, presented in Figure 2, the most significant challenges identified by the respondents are "Poor social interaction between participants" or 57.94% and "High level of digital knowledge required" or 57.14%. Other relatively important issues that may hinder the implementation of this model include "Poor internet connection" (55.66%) and Costs associated with certain platforms that charge based on the number of users (54.37%).
In this paper, will be conducted data analysis using ANOVA-single factor for those variables that we consider important for the research. In this case, will be formulated two general hypotheses:

1. There are no statistically significant differences in benefits of using Cloud Computing between different scientific fields.
2. There are no statistically significant differences in challenges and problems of Cloud Computing between different scientific fields.

Within these general hypotheses, will be developed several sub-hypotheses, each addressing specific aspects of the benefits and challenges of Cloud Computing in relation to the scientific field of the respondents. Our thesis is that the variable Scientific Field is quite significant in terms of the benefits and challenges of Cloud Computing.

First general hypothesis: *There are no statistically significant differences in the benefits of using Cloud computing between different scientific fields.*

Several null hypotheses will follow from this general hypothesis:

- H0 - There is no statistically significant difference in the mean (average) of **Improved cooperation between students and professors** among the different Scientific Fields.

- H0 - There is no statistically significant difference in the mean (average) of **A more flexible education process** among the different Scientific Fields.
- H0 - There is no statistically significant difference in the mean (average) of **A more efficient education process** among the different Scientific Fields.
- H0 - There is no statistically significant difference in the mean (average) of **Greater availability of learning resources** among the different Scientific Fields.
- H0 - There is no statistically significant difference in the mean (average) of **Improved learning facilities** among the different Scientific Fields.
- H0 - There is no statistically significant difference in the mean (average) of **A modern learning environment attractive to students** among the different Scientific Fields.
- H0 - There is no statistically significant difference in the mean (average) of **Easier monitoring of students in the learning process** among the different Scientific Fields.
- H0 - There is no statistically significant difference in the mean (average) of **Scalability (possibility of constant upgrade of the system)** among the different Scientific Fields.
- Ho - H0-There is no statistically significant difference in the mean (average) of **Access to a number of learning tools** among the different Scientific Fields.

Anova: Single Factor	Improved cooperation between students and professors			
SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
Strongly disagree	6	9	1.5	1.5
Disagree	6	5	0.833333	0.566667
Neither agree nor disagr	6	15	2.5	5.9
Agree	6	40	6.666667	49.46667
Strongly agree	6	36	6	33.6
ANOVA				
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	170.3333	4	42.58333	2.338887	0.08281918	2.75871047
Within Groups	455.1667	25	18.20667			
Total	625.5	29				

Fig. 3. ANOVA- Improved cooperation students and professor/ Scientific field

Anova: Single Factor	A more flexible education process			
SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
Strongly disagree	6	10	1.666667	1.066667
Disagree	6	1	0.166667	0.166667
Neither agree nor disagr	6	9	1.5	1.9
Agree	6	38	6.333333	37.86667
Strongly agree	6	48	8	80.4
ANOVA				
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	280.4667	4	70.11667	2.887836	0.042914	2.75871
Within Groups	607	25	24.28			
Total	887.4667	29				

Fig. 4. ANOVA - A more flexible education process/Scientific field

Anova: Single Factor	A more efficient education process			
SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
Strongly disagree	6	10	1.666667	1.066667
Disagree	6	5	0.833333	0.566667
Neither agree nor disagree	6	30	5	35.2
Agree	6	26	4.333333	18.66667
Strongly agree	6	34	5.666667	28.26667
ANOVA				
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	108.6667	4	27.16667	1.621568	0.199993	2.75871
Within Groups	418.8333	25	16.75333			
Total	527.5	29				

Fig. 5. ANOVA- A more efficient education process/Scientific field

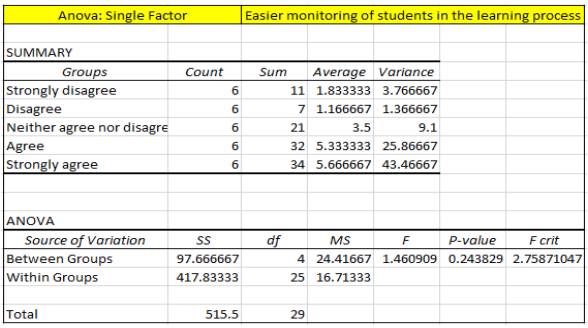
Anova: Single Factor	Greater availability of learning resources			
SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
Strongly disagree	6	11	1.833333	0.966667
Disagree	6	1	0.166667	0.166667
Neither agree nor disagree	6	6	1	0.8
Agree	6	28	4.666667	25.46667
Strongly agree	6	60	10	108.8
ANOVA				
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	382.4667	4	95.61667	3.510157	0.020907	2.75871
Within Groups	681	25	27.24			
Total	1063.467	29				

Fig. 6. ANOVA- Greater availability of learning resources/Scientific field

Anova: Single Factor	Improved learning facilities			
SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
Strongly disagree	6	9	1.5	2.3
Disagree	6	7	1.166666667	0.566666667
Neither agree nor disagree	6	26	4.333333333	11.46666667
Agree	6	31	5.166666667	39.36666667
Strongly agree	6	31	5.166666667	33.36666667
ANOVA				
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	94.13333	4	23.53333333	1.351454824	0.278910957	2.75871
Within Groups	435.3333	25	17.41333333			
Total	529.4667	29				

Anova: Single Factor	A Modern learning environment attractive to students			
SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
Strongly disagree	6	9	1.5	1.5
Disagree	6	5	0.833333	1.366667
Neither agree nor disagre	6	18	3	4.4
Agree	6	37	6.166667	41.36667
Strongly agree	6	36	6	48.8
ANOVA				
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	148.3333	4	37.08333	1.903011	0.14127	2.75871047
Within Groups	487.1667	25	19.48667			
Total	635.5	29				

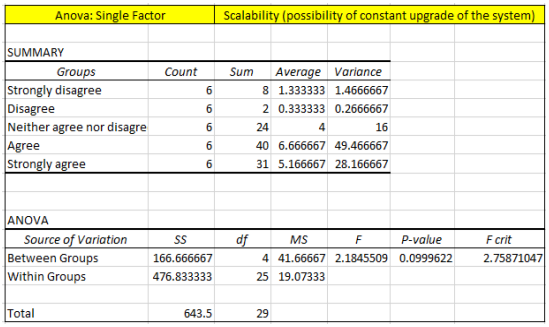
Fig. 7. ANOVA- Improved learning facilities/Scientific field



Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Strongly disagree	6	11	1.833333	3.766667		
Disagree	6	7	1.166667	1.366667		
Neither agree nor disagre	6	21	3.5	9.1		
Agree	6	32	5.333333	25.86667		
Strongly agree	6	34	5.666667	43.46667		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	97.666667	4	24.41667	1.460909	0.243829	2.75871047
Within Groups	417.83333	25	16.71333			
Total	515.5	29				

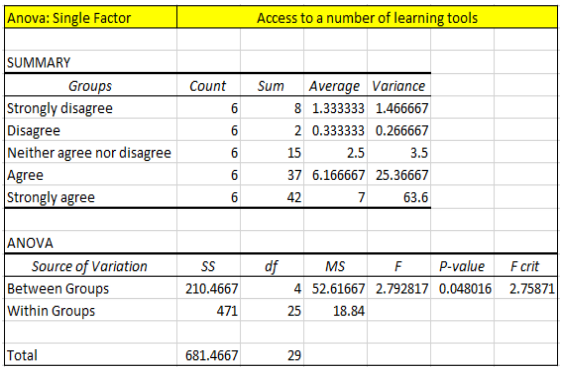
Figure 9. ANOVA- Easier monitoring of students in learning process/Scientific field

Fig. 8. ANOVA- Modern learning environment attractive to students/ Scientific field



Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Strongly disagree	6	8	1.333333	1.4666667		
Disagree	6	2	0.333333	0.2666667		
Neither agree nor disagre	6	24	4	16		
Agree	6	40	6.666667	49.466667		
Strongly agree	6	31	5.166667	28.166667		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	166.666667	4	41.66667	2.1845509	0.0999622	2.75871047
Within Groups	476.833333	25	19.07333			
Total	643.5	29				

Figure 10. ANOVA- Scalability/Scientific field



Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Strongly disagree	6	8	1.333333	1.466667		
Disagree	6	2	0.333333	0.266667		
Neither agree nor disagree	6	15	2.5	3.5		
Agree	6	37	6.166667	25.36667		
Strongly agree	6	42	7	63.6		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	210.4667	4	52.61667	2.792817	0.048016	2.75871
Within Groups	471	25	18.84			
Total	681.4667	29				

Figure 11. ANOVA- Access to a number of learning tools/Scientific field

The results of the ANOVA test show a statistically significant difference among the groups in relation to A more flexible education process (Figure 4), Greater availability of learning resources (Figure 6) and Access to a number of learning tools (Figure 11). Since the calculated F-value is greater than the critical value and the p-value is below 0.05, the null hypothesis is rejected in all three cases or there is statistically significant difference in the mean regarding these benefits. This indicates that respondents from different scientific fields do not share the same perceptions regarding all three benefits. In other words, these benefits vary significantly depending on the scientific field. In all other cases null hypothesis not rejected. This indicates that the differences in group means are not large enough to be considered statistically significant. In other words, respondents from different scientific fields share relatively similar perceptions regarding all benefits where hypothesis is accepted.

Second general hypothesis: *There are no statistically significant differences in the Challenges and problems of using Cloud computing between different scientific fields.*

Several null hypotheses will follow from this general hypothesis:

- H0 - There is no statistically significant difference in the mean (average) of **Poor Internet connection** among the different Scientific Fields.
- H0 - There is no statistically significant difference in the mean (average) of **Less control over IT resources** among the different Scientific Fields.
- H0 - There is no statistically significant difference in the mean (average) of **Security risks** among the different Scientific Fields.

- H0 - There is no statistically significant difference in the mean (average) of **Costs (some platforms pay by number of users)** among the different Scientific Fields.
- H0 - There is no statistically significant difference in the mean (average) of **Application failure** among the different Scientific Fields.
- H0 - There is no statistically significant difference in the mean (average) of **Poor social interaction between the participants** among the different Scientific Fields.
- H0 - There is no statistically significant difference in the mean (average) of **High digital knowledge is required** among the different Scientific Fields.
- H0 - There is no statistically significant difference in the mean (average) of **Limited application control and flexibility** among the different Scientific Fields.
- Ho - There is no statistically significant difference in the mean (average) of **Difficult switching from one provider to another** among the different Scientific Fields.
- Ho - There is no statistically significant difference in the mean (average) of **Vulnerability to hacker attacks** among the different Scientific Fields.

Anova: Single Factor	Poor Internet connection					
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Strongly disagree	6	7	1.166667	3.766667		
Disagree	6	16	2.666667	9.466667		
Neither agree nor disagree	6	23	3.833333	4.566667		
Agree	6	44	7.333333	48.66667		
Strongly agree	6	15	2.5	7.9		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	131.6667	4	32.91667	2.213133	0.096531	2.75871
Within Groups	371.8333	25	14.87333			
Total	503.5	29				

Fig. 12. ANOVA-Poor Internet connection/Scientific field

Anova: Single Factor	Less control over IT resources					
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Strongly disagree	6	4	0.666667	1.466667		
Disagree	6	12	2	7.6		
Neither agree nor disagree	6	46	7.666667	26.26667		
Agree	6	33	5.5	33.1		
Strongly agree	6	10	1.666667	3.866667		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	210	4	52.5	3.630705	0.018252	2.75871
Within Groups	361.5	25	14.46			
Total	571.5	29				

Fig. 13. ANOVA-Less control over IT resources/ Scientific field

Anova: Single Factor	Security risks					
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Strongly disagree	6	6	1	2.4		
Disagree	6	12	2	12.4		
Neither agree nor disagree	6	34	5.666667	20.26667		
Agree	6	35	5.833333	29.36667		
Strongly agree	6	16	2.666667	5.866667		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	115.8667	4	28.96667	2.060218	0.116417	2.75871
Within Groups	351.5	25	14.06			
Total	467.3667	29				

Fig. 14. ANOVA-Security risks/ Scientific field

Anova: Single Factor	Costs (some platforms pay by number of users)					
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Strongly disagree	6	5	0.833333	1.366667		
Disagree	6	9	1.5	1.9		
Neither agree nor disagree	6	33	5.5	13.9		
Agree	6	36	6	35.6		
Strongly agree	6	19	3.166667	20.56667		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	128.5333	4	32.13333	2.190909	0.099188	2.75871
Within Groups	366.6667	25	14.66667			
Total	495.2	29				

Fig. 15. ANOVA-Costs/ Scientific field

Anova: Single Factor	Application failure					
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Strongly disagree	6	7	1.166667	2.566667		
Disagree	6	16	2.666667	9.466667		
Neither agree nor disagree	6	28	4.666667	3.866667		
Agree	6	39	6.5	53.9		
Strongly agree	6	13	2.166667	6.966667		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	109.5333	4	27.38333	1.783543	0.163718	2.75871
Within Groups	383.8333	25	15.35333			
Total	493.3667	29				

Fig. 16. ANOVA-Application failure/ Scientific field

Anova: Single Factor	Poor social interaction between the participants					
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Strongly disagree	6	5	0.833333	2.566667		
Disagree	6	14	2.333333	3.866667		
Neither agree nor disagree	6	25	4.166667	12.56667		
Agree	6	35	5.833333	33.36667		
Strongly agree	6	27	4.5	13.5		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	92.13333	4	23.03333	1.748482	0.170965	2.75871
Within Groups	329.3333	25	13.17333			
Total	421.4667	29				

Fig. 17. ANOVA-Poor social interaction between participants/ Scientific field

Anova: Single Factor	High digital knowledge is required					
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Strongly disagree	6	5	0.833333	2.566667		
Disagree	6	12	2	6		
Neither agree nor disagree	6	27	4.5	10.7		
Agree	6	39	6.5	36.7		
Strongly agree	6	21	3.5	21.9		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	116.1333	4	29.03333	1.864298	0.148181	2.75871
Within Groups	389.3333	25	15.57333			
Total	505.4667	29				

Fig. 18. ANOVA-High digital knowledge/ Scientific field

Anova: Single Factor	Limited application control and flexibility					
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Strongly disagree	6	5	0.833333	0.966667		
Disagree	6	12	2	6.4		
Neither agree nor disagree	6	49	8.166667	32.56667		
Agree	6	26	4.333333	23.46667		
Strongly agree	6	13	2.166667	8.566667		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	201.6667	4	50.41667	3.502779	0.021083	2.75871
Within Groups	359.8333	25	14.39333			
Total	561.5	29				

Fig. 19. ANOVA-Limited application control and flexibility/ Scientific field

Anova: Single Factor	Difficult switching from one provider to another					
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Strongly disagree	6	5	0.833333	1.366667		
Disagree	6	14	2.333333	15.06667		
Neither agree nor disagree	6	36	6	27.2		
Agree	6	31	5.166667	19.36667		
Strongly agree	6	19	3.166667	19.76667		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	105.6667	4	26.41667	1.595852	0.206448	2.75871
Within Groups	413.8333	25	16.55333			
Total	519.5	29				

Fig. 20. ANOVA-Difficult switching from one provider to another/ Scientific field

Anova: Single Factor	Vulnerability to hacker attacks					
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Strongly disagree	6	5	0.833333	0.966667		
Disagree	6	12	2	6.4		
Neither agree nor disagree	6	47	7.833333	42.96667		
Agree	6	25	4.166667	17.76667		
Strongly agree	6	16	2.666667	5.866667		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	175.6667	4	43.91667	2.96868	0.039022	2.75871
Within Groups	369.8333	25	14.79333			
Total	545.5	29				

Fig. 21. ANOVA- Vulnerability to hacker attacks/ Scientific field

According to the results of ANOVA testing for the challenges Less control over IT resources (Figure 13), Limited application control and flexibility (Figure19), Vulnerability to hacker attacks (Figure 21) it can be concluded that the hypothesis is rejected, i.e., there are statistically significant differences in the mean values of these variables (calculated F-value is greater than the critical value and the p-value is below 0.05). This suggests that respondents from various scientific fields hold differing perceptions of the three identified challenges, or challenges vary significantly across scientific fields. In all other cases, the null hypothesis is not rejected, indicating that there is no statistically significant difference in the mean values regarding the challenges associated with the use of Cloud Computing in higher education institutions.

5. CONCLUSION AND RECOMMENDATION FOR FURTHER RESEARCH

Cloud computing has proven to be a highly effective tool for facilitating remote learning and teaching in recent years. Its advanced capabilities allow educational institutions, especially universities to maintain educational activities without any problems while offering a range of additional benefits that enrich the overall learning experience.

In this paper, we applied ANOVA testing to determine whether there are statistically significant differences between the means of three or more independent groups. In the case where hypothesis rejected regarding the benefit of use Cloud computing in higher education conclusion is that different groups perceive these benefits differently. These differences may arise due to the specific requirements, methodologies, or technological resources associated with each discipline. Consequently, it can be concluded that the scientific field has a significant impact on how respondents evaluate benefits, A more flexible education process, Greater availability of learning resources and Access to a number of learning tools. When the hypothesis not rejected (accepted) can be concluded that observed variations among the groups may be due to random differences rather than real disparities between scientific field. Therefore, it can be concluded

that the scientific field does not have a significant influence on respondents' opinions about these benefits where hypothesis not rejected.

Regarding the challenges and problems of Cloud Computing in cases where the hypothesis is rejected, it suggests that respondents do not share the same level of agreement regarding the examined statement. This indicates that the participants do not share uniform perceptions regarding the analyzed statement, and that the variable has a measurable effect on their opinions. In the case where hypothesis not rejected indicate that the differences observed between the groups are not statistically meaningful and are likely due to random variation. Therefore, it can be concluded that the respondents, regardless of their level of agreement, hold relatively similar opinions toward the analyzed variable.

According to the results of our research, it can be concluded that the benefits of using Cloud Computing in the education and teaching process are far greater than the challenges and problems. This finding supports the growing adoption of modern technological models such as Cloud Computing within higher education institutions. By leveraging the advantages that Cloud Computing provides, universities can overcome many of the long-standing barriers they have faced in implementing and enhancing the educational and teaching process. In addition, many of the challenges will be overcome in the future, which would mean that the positive effects of using Cloud computing by universities in the Republic of North Macedonia would be even greater.

Further research could focus on a sample that would include a larger number of universities and a larger number of respondents in order to determine whether the observed differences in respondents' perceptions of cloud computing persist in larger populations. Further analysis could examine how these perceptions evolve over time as universities increasingly adopt new technologies and modern educational models to enhance the teaching and learning process. It is also important to investigate the factors that influence respondents' perceptions such as digital literacy, technological readiness, teaching methods, etc. The use of different models of Cloud Computing in certain segments of the teaching and learning process could also be investigated and how all this could affect learning outcomes. As a separate direction for further research, it would be valuable to conduct a comparative analysis between the Republic of North Macedonia and EU member states, given the country's aspiration for membership. Such a comparison would help identify broader international trends in higher education and determine how Macedonian universities can adapt to them.

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