International Conference "Risk in Contemporary Economy" ISSN-L 2067-0532 ISSN online 2344-5386
XXIIth Edition, 2021, Galati, Romania,
"Dunarea de Jos" University of Galati, Romania – Faculty of Economics and Business Administration

DOI https://doi.org/10.35219/rce20670532103

IoT Implications on Adapting the Educational Offer of Universities

Rodica Pripoaie
rodica.pripoaie@ugal.ro
Irina Olimpia Susanu
irinasusanu@gmail.com
Dunarea de Jos University of Galati, Romania
Abitbul Shimon Eliyahu
West University Timisoara, Timisoara, Romania.

The adoption of IoT technologies in more and more fields of activity in the following years will have multiple implications and will represent a challenge for universities in terms of adapting their educational offer. Thus, higher education institutions must adapt their study programs to train future specialists in the field, as well as to develop the digital skills of all graduates, regardless of the specialization chosen by them. The paper aims at highlighting how this IoT field is viewed by a sample of final year students of university. The enquiry was completed online by the students - responders to the invitation to fill it in, sent through Microsoft Teams, Google Classroom and Facebook platforms. The research method used was empirical and we used Eviews 10 software - with its help, we obtained the correlation between the IoT field and the need to develop students' digital skills by adapting and modernizing the educational offer of universities.

Keywords – IoT, educational offer, digital competences, IoT Consumer, Commercial IoT, Industrial IoT.

JEL Classification: I21, C19.

1. Introduction

Given the unprecedented development of technology and communications, the so-called "Internet of Things" (IoT) has emerged. Thus, IoT is the basis for the development of a multitude of solutions both for consumers and for the commercial and industrial area. Therefore, IoT technologies will be used more and more in the near future in many fields of activity - this will be a challenge for universities as they have to adapt their educational offer in this regard. Accordingly, the Universities need to develop new bachelor and / or master's degree programs to prepare future specialists in this field, as well as to develop digital skills for all students and graduates, by introducing new disciplines to keep pace with the labor market developments in this field.

The present paper aims at highlighting the way in which this IoT field is currently regarded, i.e., the reality compared to its development perspectives, in a sample of students from the last year of bachelor studies from different fields. The enquiry was completed online by the 35 students who responded to the invitation to fill it in, through Microsoft Teams, Google Classroom and Facebook platforms.

The research method used was empirical and we used Eviews10 software - with its help, we obtained the correlation between the IoT field and the need to develop students' digital skills by adapting and modernizing the educational offer of universities.

2. Short literature review

The emergence of the Internet has led to a total change in the way people are living, as well as in the way they communicate. Today, social life has shifted more and more to the online environment, especially in the current context of the Sars-Cov2 coronavirus pandemic. Thus, the Internet has made it possible to carry out activities in the online environment, and we can say that the pandemic has forced us to digitize at a much faster pace. Luigi Atzori et al. (2010) shows that "The IoT has the potential to add a new dimension to this process, by enabling communications with and among smart objects".

Feng Xia et al. (2012) considers that "IoT creates extraordinary opportunities for a large number of new applications that promise to improve the quality of our lives".

Popkova E.G. et al. (2019) states that IoT requires social adaptation, but also financial resources and a certain technological training that is currently insufficient; it also states that it involves a number of risks, such as security assurance risk.

Therefore, current students and future graduates must have digital skills allowing them to use IoT applications, but also to develop new applications. Universities must also adapt their educational offer in order to offer students the opportunity to develop such skills, either by introducing new bachelor and / or master's degree programs or by adapting the curricula of those already in line with labor market requirements in this area. The main concern of universities is students, because "recently, students have become the main category of university stakeholders and consequently they are given increased attention on various levels" (Prelipcean and Bejinaru, 2018)

3. Research methodology

The study aims to outline an opinion on how the IoT field is currently perceived by a sample of students currently in their last year of bachelor studies in various fields, such as: technical, economic, medical and others. They completed online on Google Classroom an enquiry about digital skills, their importance and IoT, but also about how they think they will develop these skills in the future.

In what concerns Question no. 1 referring to the usefulness of digital skills, the centralization of the 35 answers showed 100% that students consider that such skills are absolutely necessary for their future professional activity.

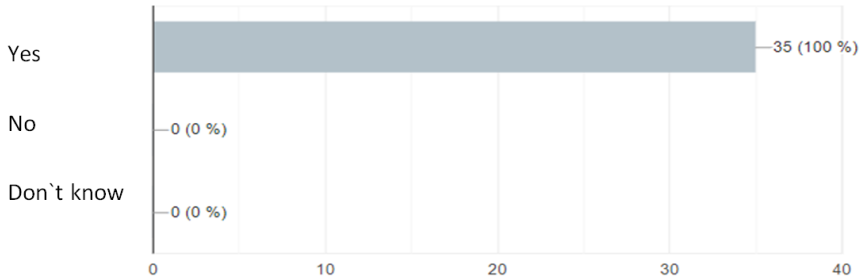

Figure no. 1: Distribution of answers to question Q1

However, when asked Question no. 2, "Do you believe you have digital skills?", the students gave unexpected answers, 2 of them (5.7%) considered that they do not have such skills, and one student (2.9%) did not know if it had such skills. The result was all the more surprising, given that students are in their final year of a bachelor's degree program, and

computer science subjects have already been studied. The explanation could be that among those who completed the enquiry was also a student of Philology or a student from study programs in various other fields, such as Theology.

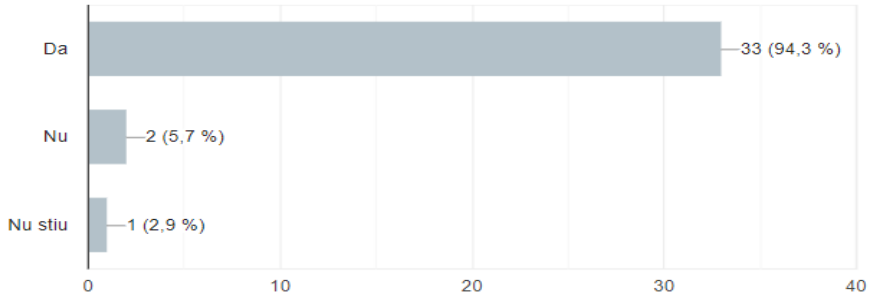

Figure no. 2: Distribution of answers to question Q2

To the Question no. 3 on how well they know how to use the computer, the results were as follows:

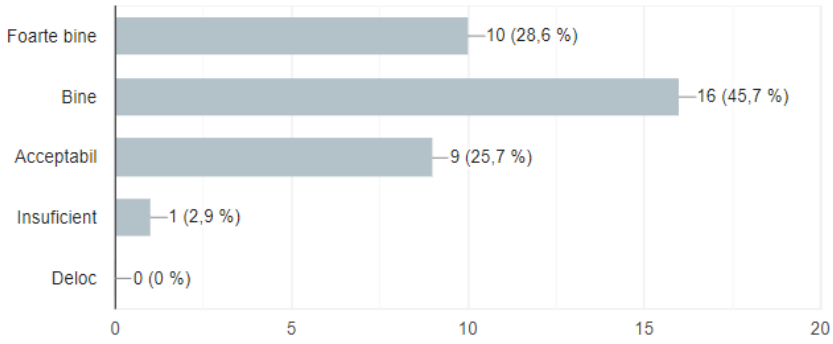

Figure no. 3: Distribution of answers to question Q3

Question no. 4 deals with whether they consider that they will constantly need digital skills at their future job, 85.7% considered that they will surely carry out activities where they will need such skills.

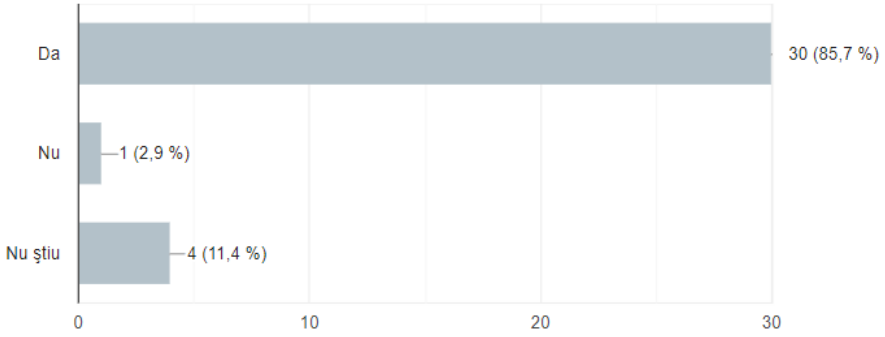

Figure no. 4: Distribution of answers to question Q4

Although one student answered that it has been using the computer in an unsatisfactory way at Question no. 3, all the students answered to the Question no. 5 that they know how to use Microsoft Office important applications.

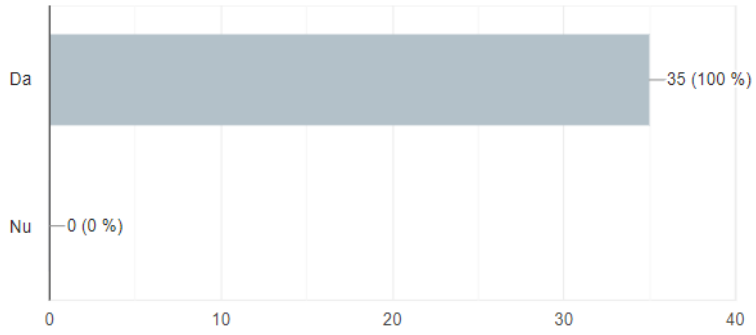

Figure no. 5: Distribution of answers to question Q5

And to the Question no. 6 regarding whether they use any specialized computer program, 54.3% answered in the affirmative.

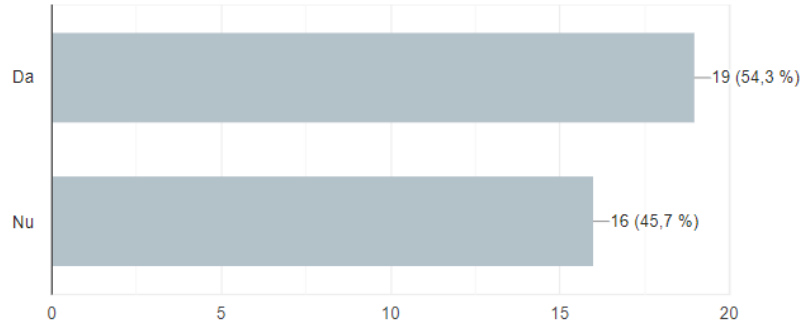

Figure no. 6: Distribution of answers to question Q6

Regarding IoT (Internet of Things), only 31.4% said they know what it represents, while an alarming proportion of approx. 68% said they knew nothing about it.

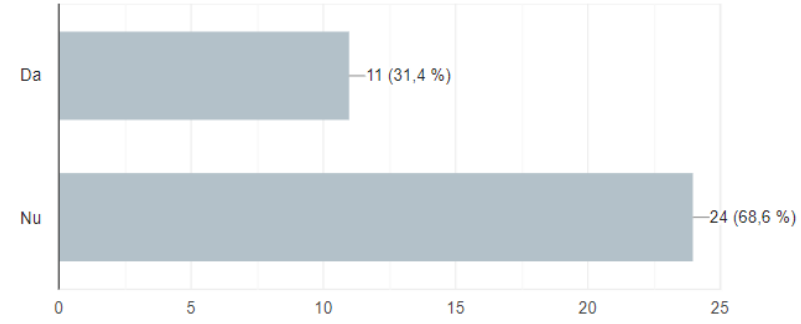

Figure no. 7: Distribution of answers to question Q7

To Question no.8, if the concept of „smart home" will be encountered frequently in the near future, i.e., in the next 10 years, the affirmative answers were 82.9%.

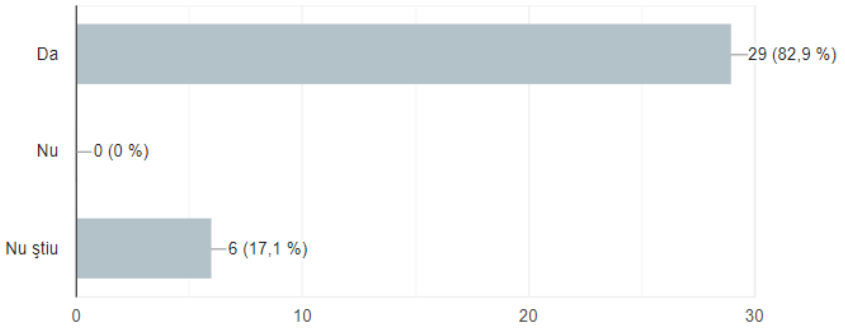

Figure no. 8: Distribution of answers to question Q8

Regarding Question no. 9 on the use of smart applications, the answers recorded were as follows:

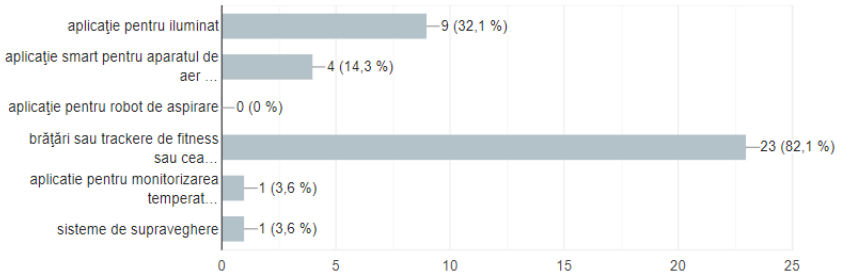

Figure no. 9: Distribution of answers to question Q9

Question no. 10 on students' opinion on how intelligent solutions in buildings, halls, warehouses, hotels etc. for the automation and monitoring of water, gas, electricity or heat installations, generically called Commercial IoT, will be used frequently in the near future, the affirmative answers were over 91%, as can be seen from the following chart:

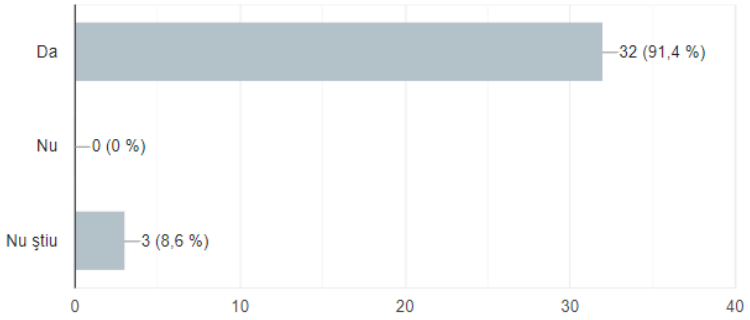

Figure no. 10: Distribution of answers to question Q10

Question no. 11 asked students whether the use of industrial IoT (IIoT), i.e., the interconnection of work equipment through M2M (machine-to-machine) technologies and the

reduction of human factor intervention will be done on a large scale, even if this initially requires additional costs, and only subsequently the labor costs will be reduced, and the answers recorded were:

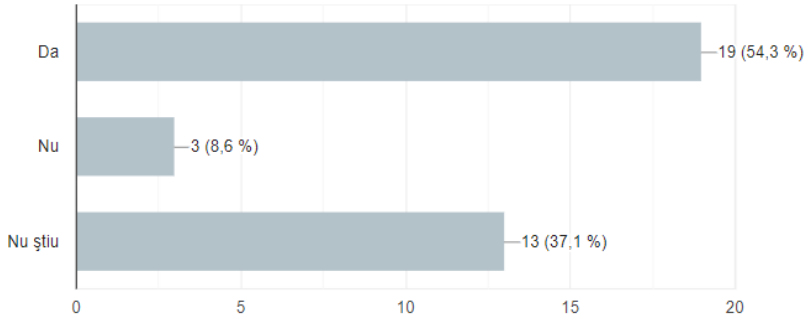

Figure no. 11: Distribution of answers to question Q11

Question no. 12 referred to the reluctance to adopt IoT applications due to potential security issues, and the centralized responses are as follows:

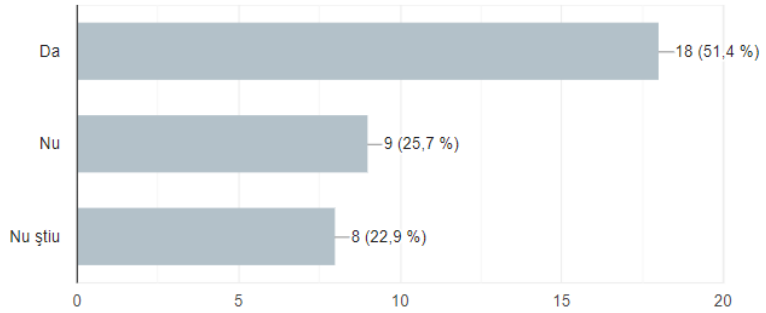

Figure no. 12: Distribution of answers to question Q12

In what concerns Question no. 13, students were asked to complete whether they have knowledge on the use of IoT solutions in agriculture, industry, transportation, HORECA or in other fields of activity, and only 8.3% said that they know that such solutions are used in the transport field. Also, 80% answered to Question no. 14 that they intend to develop their digital skills.

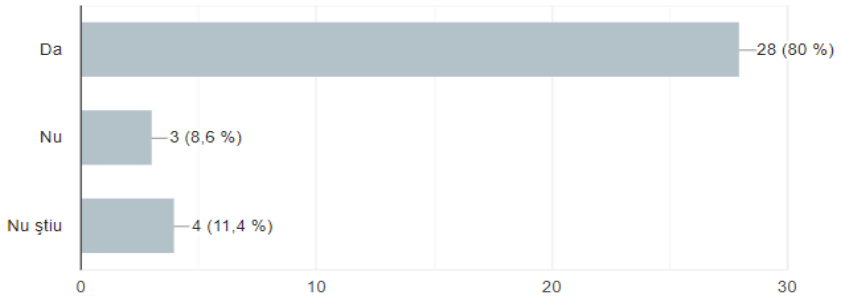

Figure no. 13: Distribution of answers to question Q13

Regarding their professional plans and if they consider working in a field where ICT is currently used, more than two thirds answered in the affirmative to Question no. 15, over 66.67 % are answered affirmative. Question no. 16 dealt with the possibility that certain jobs will to be replaced by robots in a number of areas, and centralized responses have shown that 77.1% of them are considering this possibility.

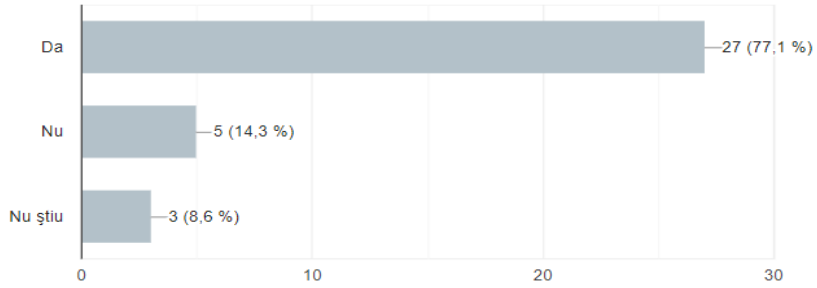

Figure no. 14: Distribution of answers to question Q16

And also approx. 85% believe that robots are perceived as a potential danger by humans because they could replace them at their workplace. In Question no. 18, 77.1% of the students in the sample believe that ICT and IoT will lead to the emergence of other professions over time.

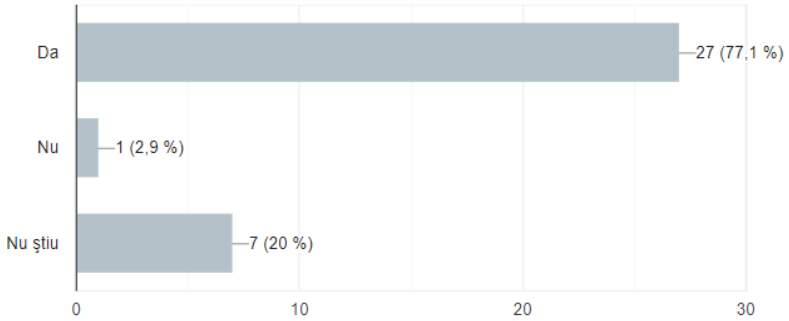

Figure no. 15: Distribution of answers to question Q18

In terms of their programming skills, only 17.1% answered to Question no. 19 that they have such skills. These could be correlated with the answers to Question no. 20, as 17.1% students from the sample belong to a technical study program.

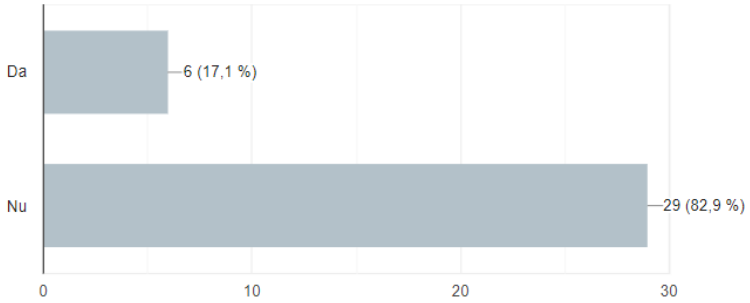

Figure no. 16: Distribution of answers to question Q19

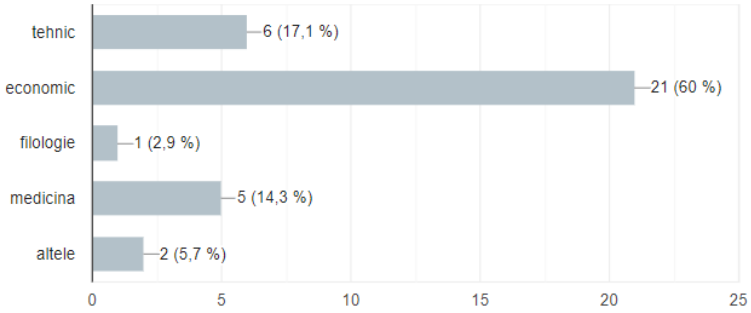

Figure no. 17: Distribution of answers to question Q20

4. Analysis of the need to adapt the educational offer of universities according to the evolution of IoT using Eviews10

Regarding the need to adapt the educational offer by universities in line with developments in the IoT field in order to provide curricula to provide students and graduates with competencies in the field, the analysis of the questionnaires highlighted the following structure of components, ie Q8 is influenced by Q4, Q6, Q10, Q11, Q14 and Q19.

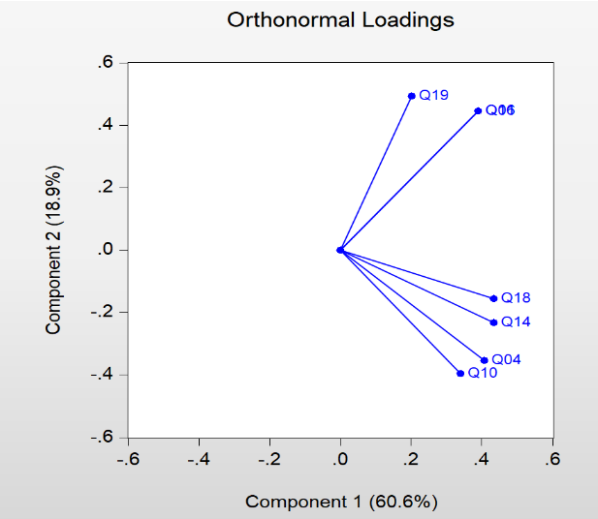

Figure no. 18: Component structure analysis

Source: Authors, by using the EViews 10

These sets of questions were tested for equality of averages and the following values were obtained:

Table no. 1: Test for Equality of Means Between Series

	Q04	Q06	Q10	Q11	Q14	Q18	Q19
Mean	0.857143	0.542857	0.914286	0.542857	0.800000	0.771429	0.171429
Median	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	0.000000
Maximum	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
Minimum	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Std. Dev.	0.355036	0.505433	0.284029	0.505433	0.405840	0.426043	0.382385
Skewness	-2.041241	-0.172062	-2.959800	-0.172062	-1.500000	-1.292786	1.743626
Kurtosis	5.166667	1.029605	9.760417	1.029605	3.250000	2.671296	4.040230

	Q04	Q06	Q10	Q11	Q14	Q18	Q19
Jarque-Bera	31.15162	5.834612	117.7530	5.834612	13.21615	9.906796	19.31271
Probability	0.000000	0.054079	0.000000	0.054079	0.001349	0.007059	0.000064
Sum	30.00000	19.00000	32.00000	19.00000	28.00000	27.00000	6.000000
Sum Sq. Dev.	4.285714	8.685714	2.742857	8.685714	5.600000	6.171429	4.971429
Observations	35	35	35	35	35	35	35

Source: Authors, by using the EViews 10

The descriptive indicators for the Q4, Q6, Q10, Q11, Q18 and Q19 series and the analysis of the main components for them using Eviews 10 are as follows:

Table no. 2: Principal Components Analysis

Principal Components Analysis
Date: 12/30/20 Time: 17:14
Sample: 1 35
Included observations: 35
Computed using: Ordinary correlations
Extracting 7 of 7 possible components

Eigenvalues: (Sum = 7, Average = 1)

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	4.242741	2.919011	0.6061	4.242741	0.6061
2	1.323730	0.614233	0.1891	5.566471	0.7952
3	0.709497	0.238723	0.1014	6.275968	0.8966
4	0.470774	0.289078	0.0673	6.746741	0.9638
5	0.181696	0.110133	0.0260	6.928437	0.9898
6	0.071563	0.071563	0.0102	7.000000	1.0000
7	1.11E-16	---	0.0000	7.000000	1.0000

Eigenvectors (loadings):

Variable	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7
Q04	0.406398	-0.353229	0.123347	0.065539	-0.807852	0.194773	1.66E-15
Q06	0.388806	0.445335	-0.329165	0.200486	-0.038435	-0.022038	-0.707107
Q10	0.339842	-0.395704	0.241311	0.695464	0.430359	-0.028567	-6.44E-16
Q11	0.388806	0.445335	-0.329165	0.200486	-0.038435	-0.022038	0.707107
Q14	0.434103	-0.232148	-0.024044	-0.428888	0.100508	-0.750358	-3.64E-16
Q18	0.433540	-0.154699	-0.079986	-0.485164	0.386122	0.630269	-7.08E-16
Q19	0.201511	0.494143	0.838379	-0.110976	0.004526	0.000873	-3.50E-17

Ordinary correlations:

	Q04	Q06	Q10	Q11	Q14	Q18	Q19
Q04	1.000000						
Q06	0.444878	1.000000					
Q10	0.750000	0.333659	1.000000				
Q11	0.444878	1.000000	0.333659	1.000000			
Q14	0.816497	0.544862	0.612372	0.544862	1.000000		
Q18	0.750000	0.593171	0.562500	0.593171	0.918559	1.000000	
Q19	0.185695	0.417407	0.139272	0.417407	0.227429	0.247594	1.000000

Source: Authors, by using the EViews 10

The correlation coefficients show the intensity of the connection between the series. Ordinary correlation and covariance recorded the values in the following tables:

Table no. 3: Analysis of correlation coefficients

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Correlation

	A	B	C	D	E	F	G	H	I	J
1		Q04	Q06	Q10	Q11	Q14	Q18	Q19		
2										
3	Q04	1.000000	0.444878	0.750000	0.444878	0.816497	0.750000	0.185695		
4	Q06	0.444878	1.000000	0.333659	1.000000	0.544862	0.593171	0.417407		
5	Q10	0.750000	0.333659	1.000000	0.333659	0.612372	0.562500	0.139272		
6	Q11	0.444878	1.000000	0.333659	1.000000	0.544862	0.593171	0.417407		
7	Q14	0.816497	0.544862	0.612372	0.544862	1.000000	0.918559	0.227429		
8	Q18	0.750000	0.593171	0.562500	0.593171	0.918559	1.000000	0.247594		
9	Q19	0.185695	0.417407	0.139272	0.417407	0.227429	0.247594	1.000000		
10										
11										

Source: Authors, by using the EViews 10

Tabel nr. 4: Covariance

Covariance

	A	B	C	D	E	F	G	H	I	J
1		Q04	Q06	Q10	Q11	Q14	Q18	Q19		
2										
3	Q04	0.122449	0.077551	0.073469	0.077551	0.114286	0.110204	0.024490		
4	Q06	0.077551	0.248163	0.046531	0.248163	0.108571	0.124082	0.078367		
5	Q10	0.073469	0.046531	0.078367	0.046531	0.068571	0.066122	0.014694		
6	Q11	0.077551	0.248163	0.046531	0.248163	0.108571	0.124082	0.078367		
7	Q14	0.114286	0.108571	0.068571	0.108571	0.160000	0.154286	0.034286		
8	Q18	0.110204	0.124082	0.066122	0.124082	0.154286	0.176327	0.039184		
9	Q19	0.024490	0.078367	0.014694	0.078367	0.034286	0.039184	0.142041		

Source: Authors, by using the EViews 10

The t test Statistics for the analyzed series and the probability for the H0 hypothesis and the test for the equality of the variance of the analyzed series were calculated using EViews 10 and are shown in the following tables:

Tabel nr. 5: Testul t Statistic

t-statistic

	A	B	C	D	E	F	G	H	I	J
1		Q04	Q06	Q10	Q11	Q14	Q18	Q19		
2										
3	Q04	NA	2.853569	6.513722	2.853569	8.124038	6.513722	1.085620		
4	Q06	2.853569	NA	2.033240	NA	3.732738	4.232527	2.638681		
5	Q10	6.513722	2.033240	NA	2.033240	4.449719	3.908233	0.807928		
6	Q11	2.853569	NA	2.033240	NA	3.732738	4.232527	2.638681		
7	Q14	8.124038	3.732738	4.449719	3.732738	NA	13.34916	1.341641		
8	Q18	6.513722	4.232527	3.908233	4.232527	13.34916	NA	1.468027		
9	Q19	1.085620	2.638681	0.807928	2.638681	1.341641	1.468027	NA		
10										

Source: Authors, by using the EViews 10

Tabel nr. 6: Probability H0

Probability H0: Pearson |t| = 0

	A	B	C	D	E	F	G	H	I	J	K
1		Q04	Q06	Q10	Q11	Q14	Q18	Q19			
2											
3	Q04	NA	0.007411	2.14E-07	0.007411	2.23E-09	2.14E-07	0.285514			
4	Q06	0.007411	NA	0.050136	NA	0.000714	0.000173	0.012603			
5	Q10	2.14E-07	0.050136	NA	0.050136	9.24E-05	0.000436	0.424918			
6	Q11	0.007411	NA	0.050136	NA	0.000714	0.000173	0.012603			
7	Q14	2.23E-09	0.000714	9.24E-05	0.000714	NA	7.45E-15	0.188872			
8	Q18	2.14E-07	0.000173	0.000436	0.000173	7.45E-15	NA	0.151565			
9	Q19	0.285514	0.012603	0.424918	0.012603	0.188872	0.151565	NA			
10											

Source: Authors, by using the EViews 10

Table no. 7: Test for equality of variances between series

Test for Equality of Variances Between Series
Date: 12/30/20 Time: 17:21
Sample: 1 35
Included observations: 35

Method	df	Value	Probability
Bartlett	6	15.59886	0.0161
Levene	(6, 238)	12.96752	0.0000
Brown-Forsythe	(6, 238)	4.501852	0.0002

Category Statistics

Variable	Count	Std. Dev.	Mean Abs. Mean Diff.	Mean Abs. Median Diff.
Q04	35	0.355036	0.244898	0.142857
Q06	35	0.505433	0.496327	0.457143
Q10	35	0.284029	0.156735	0.085714
Q11	35	0.505433	0.496327	0.457143
Q14	35	0.405840	0.320000	0.200000
Q18	35	0.426043	0.352653	0.228571
Q19	35	0.382385	0.284082	0.171429
All	245	0.475636	0.335860	0.248980

Bartlett weighted standard deviation: 0.415775

Source: Authors, by using the EViews 10

5. Results and discussions

The study wanted to see how the IoT field is currently perceived by students from various fields. Following the centralization and processing of questionnaires distributed and completed by students, information was obtained on digital skills, which answered 100% that they consider them absolutely necessary for their future professional activity. Also, 85.7% of students answered that they will probably need digital skills in their future job. 54.3% of them stated that they use a specialized computer program, they answered in the affirmative and only 17.1% consider that they have programming skills.

The opinion of the respondent students regarding the use in the near future of intelligent solutions for the automation and monitoring of installations was affirmative in proportion of over 91% and 80% of them have that they intend to develop their digital skills. Regarding their professional plans and if they consider working in a field where ICT is currently used, more than two thirds of students answered in the affirmative as 77.1% of the students in the sample consider that ICT and IoT will lead in time to the emergence of other professions.

All this highlights the need to adapt and modernize the educational offer of universities in line with developments in the field of IoT in order to provide curricula that provide students and graduates with skills in the field.

6. Conclusions

The development of the IoT field has implications at all levels, including the university field, in the sense that higher education institutions will have to adapt and modernize their educational offer as soon as possible to prepare future specialists in this field. Universities have a mission to develop students' digital skills and abilities so that they are as close as possible to the requirements of IoT employers, and they are able to adapt as easily as possible to the future labor market.

Acknowledgment

This work is supported by the project POCU, in the framework of Human Capital Operational Programme 2014-2020, financed from the European Social Fund under the contract number 47331/26.06.2019 HRD OP /379/6/21 – SMIS Code: 124388

References

1. Agresti, A., 2002. Categorical Data Analysis. New York: Wiley-Interscience
2. Atzori, L., Iera, A., Morabito, G., 2010. The Internet of Things: A survey. Computer Networks. Elsevier
3. Cromwell, J. et. al., 1994. Multivariate Tests for Time Series Models, Issue 100. Sage University.
4. Hoover, K., 2001. Causality in Macroeconomics. Cambridge University Press.
5. Popkova, E.G., Egorova, E.N., Popova, E., Pozdnyakova, U.A., 2019. The Model of State Management of Economy on the Basis of the Internet of Things. In: Popkova E. (eds) Ubiquitous Computing and the Internet of Things: Prerequisites for the Development of ICT. Studies in Computational Intelligence, vol 826. Springer.
6. Prelipcean, G. and Bejinaru, R., 2018. University agenda for developing students' skills in the knowledge economy, Strategica – International Conference – Sixth Edition,"Challenging the Status Quo in Management and Economics", Bucharest: 11th - 12th October, pp.600-610.
7. Xia, F., Yang, L.T., Wang, L., Vinel, A., 2012. Internet of Things. International Journal of Communication Systems.