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A MODEL FOR PREDICTING FUTURE DEMANDFOR ICT SPECIALISTS IN ROMANIA

Abstract: *In the late 1990s, Romania became an attractive area for large and medium international information and communication technology(ICT) companies interested in establishing a base in the region. This article explains the factors that led to the creation of an astonishing number (i.e., almost 15,000) active ICT companies and presents a model for forecasting the future demand of ICT specialists in the Romanian labor market. By using this model, decision makers will be able to design educational programs according to trends in the labor market. A large set of data is also included in the article as a foundation for the analysis.*

Keywords: *innovation, cluster, fourth industrial revolution, cloud computing, big data, social networks, mobile programming and cybersecurity*.

JEL Classification: C53, I25, J23, J60, O33

Introduction

In Romania, the development of the information and communication technology (ICT)industry started as early as 1957 when the first CIFA computer was built in Bucharest under the name CIFA-1[2].Following this early start, someICT companies were created in Bucharest and other major university centers in Romania. Other companies started to cluster in Romania's largest cities. Clusters are defined as industrial organizations based in territories that promote the development of innovative business [1].

During the communist period, there was a small number of large companies, in accord with the standards of the communist system. After 1990, a large number of smaller companies started to be incorporated. Initially, these companies were mostly hardware resellers. However, since the early 2000's, software companies have been created. At that time, these companies were competitive due to the lower cost of labor.

Since the early 2000s, the Romanian ICT industry has attracted foreign investments due to the comparatively low cost of the labor force. It was a near shore destination where cost centers were established. The players that built centers locally included both large corporations, such as IBM and Oracle, and smaller companies. Many of these smaller companies started from scratch, as there were no companies to be acquired. The local educational system produced large numbers of ICT-skilled graduates. The area's reputation in the ICT sector has grown over the years[7].

As of 2015, the fourth industrial revolution has started to have a serious social impact. The labor market is suffering structural changes and the future of jobs is uncertain. Significant changes in the structure of the labor market are expected to occur until 2020. Jobs that are related to computer programming are becoming increasingly requested while other jobs are disappearing[5].

The impact of the fourth industrial revolution started to be felt in the Romanian ICT industry after 2014. Many companies that were accustomed to lower labor costs started to have difficulties in offering the salaries required by the market. For many, this came as a surprise. Areas such as big data and business intelligence suffered the most. Many professionals who were just starting out their careers were showered with job offers. In some cases, the salaries offered were slightly above the European Union (EU) average. The lack of skilled resources in countries such as the UK and Germany started to be felt in Romania as well. In response, companies from these countries began to open centers of expertise. These centers were not necessarily focused on cost and were willing to accept costs that were at the European average. One of the most recent companies to set up an expertise center in Bucharest was Deloitte.

A regional impact became noticeable. Countries such as the republic of Moldova were copying the Romanian model with a certain measure of success. They also attracted branches of near shore companies located in Romania. A number of medium-size players have started to set up a base in Chisinau as of 2015.

The purpose of this article is to identify trends in the development of the local ICT industry in Romania and the region. It focuses on two main issues: the geographical concentration of companies and the estimated number of employees that would be required to sustain the presumed growth.

In the first part, the article presents an analysis of the market based on statistical data. Gathering statistical data was not easy, as there are many informal arrangements in the Romanian ICT industry. The data were obtained from a database made public by the Romanian Ministry of Finance, and it obviously has limitations.

In the second part, the article analyzes the trends. It identifies the geographical concentration of companies, correlates them with the main academic centers and uses a mathematical model to identify likely future developments. The primary objective of this analysis is to quantify the amount of necessary human resources to be educated by the local universities.

As the demand for information technology experts increases, a model for estimating the demand for human resources is required. The purpose of the current research is to make an estimation based on a mathematical model described in the last part of the article.

Problem formulation

The objectives of the article are to analyze current developments in the Romanian ICT industry and create a model for estimating the maximum future demand for ICT specialists in Romania in 2020. The data have been acquired during the years 2005-2015(when available).To identify the maximum demand, we shall theoretically assume that the supply of ICT specialists will always be sufficient. The article attempts to answer the following question: how many Romanian ICT specialists could the EU labor market absorb in 2020?

The key outcome of the current research is the creation of a model capable of predicting the necessary workforce to support the development of the Romanian ICT industry up to the year 2020. The results also indicate the total number of graduates that are needed every year in order to support the growth of the local ICT industries.

By obtaining such data, local universities and political decision makers will be able to create educational policies that will support the development of the local ICT industry. The analysis provided in this article will be an important resource for making decisions.

The data are analyzed to identify trends during 2005-2015. After that, we describe a model proposed for predicting the future trend. This model can be fed with new data in the future and it will extend the expected results.

Methodology

The research framework used here has been developed by the authors at Bucharest University of Economic Studies based on a workforce forecasting models inspired by Roberfroid(2009).

The abovementioned study explains the accuracy of forecasting methods used for the medical industry to forecast the supply of physicians. The article contains a valuable comparative analysis of the accuracy of the main methods used to anticipate the need for healthcare workers.

We selected our method for forecasting based on a comparative analysis presented in Table 1. Although information technology and healthcare are different domains, we think that the dynamics of the labor forces are similar because both require long learning cycles to educate new specialists.

Table 1: Projected and actual physician headcounts in selected countries (Source: [11])

Author Country	Work-force	Models and analysis	Base year	Time lag	Projected	Actual	Error margin	Source of data
Persaud et al. Ontario, Canada	Ophthal-mologists	Multiple regression	2005	10	418 ± 10	387	-5.4%	Ontario Physician Human Resource Data Centre https://www.ophrdc.org/
Joyce Australia	All MDs	Stochastic modelling	2001	2 3	54 294 55 000	56 207 59 004	3.5% 7.3%	Australian Institute of Health and Welfare http://www.aihw.gov.au/
Doan France	All MDs	Determi-nistic	1982	6	180 691	164 667	9.7%	National Medical Council
			1985	9	193 160	184 156	4.7%	National Medical Council
			1988	9	197 406	189 802	4.0%	National Medical Council
			1992	2	185 260	184 516	0.4%	National Medical Council
				7	192 779	196 968	-2.0%	National Medical Council
				12	195 714	211 425	-7.4%	National Medical Council

Based on the data from Table 1, it can easily be seen that the most efficient method for estimating the workforce is the classical multiple regression algorithm. We use this same method to generate estimates. A similar model is used by Voineagu (2016) in an analysis of the Romanian e-commerce trade trends.

Our analysis groups companies based on geographical location and number of employees. A correlation between the main clusters of companies and the main academic centers is also provided by the current research.

Innovation barriers are also part of our methodology. Resource scarcity, organizational rigidity, lack of infrastructure, and inappropriate academic curricula are taken into consideration when analyzing the clusters from the main Romanian regions.

Presentation of regression models

We take advantage of classical multiple regression models and use similar ones in our process. The following formulas present the classical regression model used in econometrics according to [10].

"Given a random variable Y considered in a one-dimensional context, represented by its marginal distribution, the best prediction $\tilde{y}$for the values of this random variable is represented by the mean of that random variable:

$$\tilde{y} = E(Y).$$

In a more complex informational context, represented by the multi-dimensional (simultaneous) distribution of random variables $Y, X_1, X_2, \dots, X_n$, and given that the values of the random variables $X_1, X_2, \dots, X_n$ are known, the best prediction for the values of the random variable Y is represented by conditional mean of the random variable, namely

$$\tilde{y} = E[Y \mid (X_1 = x_1, X_2 = x_2, \dots, X_n = x_n)].$$

Indeed, it can be shown that the prediction based on the conditional mean has several approximant properties that are better for the unknown values of the predicated variable Y, such as the minimum mean square error property.

n the context of econometrics, the problem of behavioral prediction of the dependent variable Y can be formulated as follows: assuming additional information is known about the values of the n independent values $X_1, X_2, \dots, X_n$, information represented by the known errors $\tilde{x}_{T+1;1}, \tilde{x}_{T+1;2}, \dots, \tilde{x}_{T+1;n}$, which are also called *prediction values* and which differ from the values of the rows of the matrix of observations $\boldsymbol{X}_{Txn}$, is required to determine an approximation $\tilde{y}_{T+1}$of the corresponding value of the dependent variable Y, called the *predicted value*." [10].

Statistical data

The data are based on annual accounting records officially declared by local ICT companies during 2005-2015 at the local Ministry of Finance. The data include the number of employees in corporations that have information technology as their main activity. Public sector employees are excluded. The ICT specialists working in companies that do not have information technology as their mission are also excluded. Such data might be limited in terms of accuracy due to the fact that in the EU, capital and labor force are free to flow across traditional borders. However, these data represent the best available to analyze the regional clustering of ICT companies in Romania. The main limitation of this data set is the fact that many Romanian freelancers are not included in the analysis.

Even if freelancers are part of a widespread phenomenon in Romania, the data reported at the Ministry of Finance remains relevant due to the fact that almost all university graduates are expected to be hired immediately after graduation. They become freelancers after accumulating a certain amount of experience working in an established company. Although we do not have sufficient data to count the freelancers, we can reasonably assume that the number of freelancers is directly proportional to the number of employees reported by local companies.

This assumption is based on the fact that one can only become a freelancer after he or she works as an employee for a number of years. The permanent post-graduation jobs are a port-of-entry to the higher-paid freelancing contracts. A correlation between temporary jobs and permanent employment has also been confirmed by Breton(2011).

The model uses data obtained from public sources for a period of ten yearswhen available. The data extracted for each company include the number of employees and geographical location. The multiple regression is applied only to the number of employees. The data are divided into six main geographical regions: Bucuresti-Ilfov, Cluj, Timisoara, Iasi, Dolj and Brasov.

The objective of the analysis is to identify trends in the growth of the workforce in each region and predict the size of the workforce for the next three years. The data are expected to be used to plan the development of local educational programs.

Table 2: Total corporate employees in Bucuresti-Ilfov, Cluj, Dolj, Iasi, Brasov, Timis

Year	All sectors	ICT employees	Percent
2005	1 877 431	39 898	2.13%
2006	2019220	52 192	2.58%
2007	2224212	60 773	2.73%
2008	2197068	66089	3.01%
2009	2276338	70916	3.12%
2010	1916804	68541	3.58%
2011	1887195	79280	4.20%
2012	1946378	88803	4.56%
2013	1947509	97318	5.00%
2014	1933166	106841	5.53%
2015	1931723	120076	6.22%

Table 3: Total corporate employees in Romania

Year	All sectors	ICT employees	Percent
2008	4755102	79501	1.67%
2009	4980817	112187	2.25%
2010	3911812	83071	2.12%
2011	3 992 194	95783	2.40%

2012	4 041 160	107321	2.66%
2013	4028549	117324	2.91%
2014	4015844	128174	3.19%
2015	3982584	143464	3.60%

Table 4: ICT corporate employees in Bucuresti-Ilfov

Year	Total corporate employees at national level	ICT corporate employees in Bucuresti-Ilfov
2005	4 155180	32304
2006	4 331 802	42 850
2007	4 778925	49 593
2008	4 755 102	53 053
2009	4 980817	57 446
2010	3 911812	54099
2011	3 992 194	61 561
2012	4 041160	68 269
2013	4 028 549	73 275
2014	4 015844	78 470
2015	3 982 584	86 500

Table 5: ICT corporate employees in Cluj, in Timis, in Iasi, in Dolj and in Brasov

Year	Total corporate employees at national level	ICT corporate employees in				
		Cluj	Timis	Iasi	Dolj	Brasov
2008	4 755102	4 384	3 028	2099	1141	2384
2009	4 980 817	4330	3273	2 190	1 308	2 369
2010	3 911812	5132	3 406	2 332	1 380	2 138
2011	3 992 194	6 333	3 858	2 796	1 940	2 792
2012	4 041160	8142	4 233	3 188	2 281	2 690
2013	4 028 549	9 679	4 723	3 946	2 688	3 007
2014	4 015844	11523	4941	5 026	3 466	3 415
2015	3982584	13789	6040	6117	3797	3833

Table 6: Number of companies

Year	Total companies in Romania	ICT companies with a minimum turnover of 10,000 lei	Percent
2008	662678	7548	1.14%
2009	631901	8170	1.29%
2010	614448	8513	1.39%
2011	644945	9676	1.50%
2012	652334	10793	1.65%
2013	656313	12006	1.83%
2014	663584	13376	2.02%
2015	640843	14919	2.33%

Source Table 2 -Table 6: Romanian Ministry of Finance. Public sector employees are not included. Some private corporations do not disclose the number of employees. Freelancers are not included. Data are only from companies that define ICT as their mission.

By applying a multiple regression model, we can make estimations at both the national and regional levels. We chose certain regions of Romania for regional estimations. These regions represent 83.6% of the total national workforce in information technology. Therefore, the chosen regions are representative for the current analysis.

We make a few observations regarding the data that help guide the way the regression should be undertaken:

- The number of corporate employees from Romania has decreased between 2005 and 2015 while the number of employees in the IT sector has nearly doubled in that period. This indicates that the increase in the number of ICT employees is not linked to an increase in the number of employees in Romania in general.
- The growth trend has been present in all regions. The number of ICT employees has increased in all key regions in Romania.

The above two observations indicate that the increase in the number of employees seems to be caused by demand coming from markets outside Romania. This assumption is also supported by the fact that Romania joined the EU in 2007.

To understand the growing need of ICT specialists in the Romanian market, we must correlate this with international data available at the EU-28 level. The following data are available from EUROSTAT(2015):

Table 7: ICT specialists employed in the EU(28 countries)

Year	2005	2006	2007	2008	2009
Specialists x 1000	5557.2	5891.4	6158.8	6280.2	6320.5
Year	**2010**	**2011**	**2012**	**2013**	**2014**
Specialists x 1000	6334.3	6847.9	7464.9	7750.0	7997.0

Source: EUROSTAT (2015)

There was a substantial increase in the number ICT specialists employed in the EU. In a period of ten years, the number of employees in the European ICT sector grew by 30%. Our model assumes that the growth of the ICT market in Europe has caused a growth in the demand for labor force in Romania.

In order to forecast the demand for labor in Romania, we perform a multiple regression analysis on the data that we have from the Romanian Ministry of Finance and the data from EUROSTAT. Based on this regression and on the forecasts available at the EU level, we are able to predict the demand for ICT specialists in Romania.

By applying a regression model for the years 2008-2014, we obtain the following results:

Table 8: Summary Output for Regression Analysis

Regression Statistics	
Multiple R	0.795307
R Square	0.632513
Adjusted R Square	0.559015
Standard Error	11949.01
Observations	7

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1228742167	1.23E+09	8.605916	0.032497394
Residual	5	713893894	1.43E+08		
Total	6	1942636061			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-33409.9	46832.63721	-0.71339	0.50751	-153797	86977.25	-153797	86977.25282
X Variable 1	0.019537	0.006659917	2.933584	0.032497	0.002417565	0.036657	0.002417565	0.036657287

By analyzing the results from Table 8, we see that the correlation between the number of corporate ICT specialists in Romania and the number of ICT specialists in Europe has a Multiple R coefficient of 0.795, which is relatively good. However, the p-value of the ANOVA test is low, which means that there are also other factors that have to be taken into consideration.

For a more detailed analysis, we consider IT_Rom to be the total number of experts in Romania while IT_EUR is the total number of IT experts in the EU. A graphical representation obtained with the EVIEWS package looks like this:

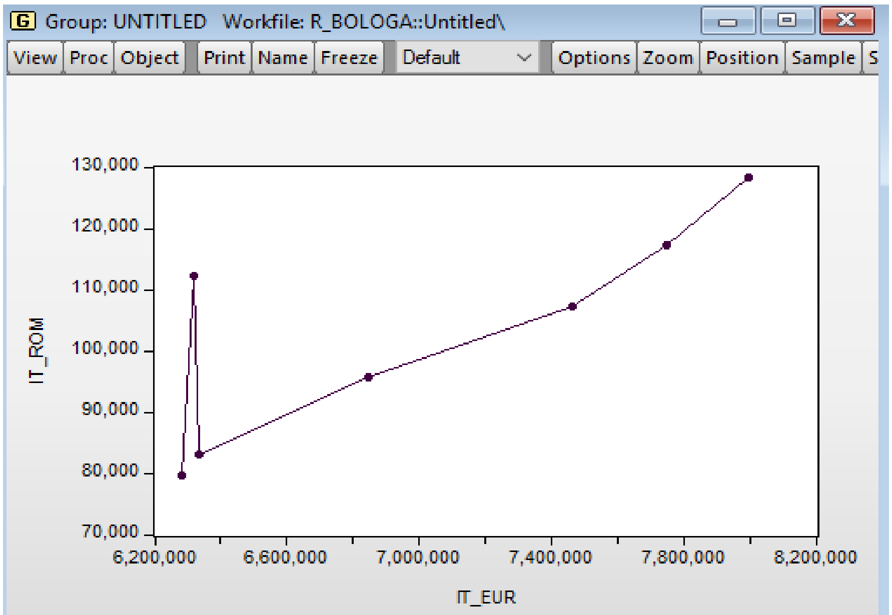

Figure 1. Graphical representation of data

The model's general form (with and without free term) is
$Y = \beta_0 + \beta_1 X + \varepsilon$, $Y = \beta\, X + \varepsilon$, where Y is IT_ROM, X is IT_EUR and ε is a perturbation. The estimation for the model with a free term is:

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: IT_ROM
Method: Least Squares
Date: 07/26/16 Time: 07:12
Sample: 1 7
Included observations: 7

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-33415.03	46835.36	-0.713457	0.5075
IT_EUR	0.019538	0.006660	2.933523	0.0325

R-squared	0.632503	Mean dependent var	103337.3
Adjusted R-squared	0.559004	S.D. dependent var	17993.68
S.E. of regression	11949.17	Akaike info criterion	21.84967
Sum squared resid	7.14E+08	Schwarz criterion	21.83421
Log likelihood	-74.47383	Hannan-Quinn criter.	21.65866
F-statistic	8.605557	Durbin-Watson stat	2.723596
Prob(F-statistic)	0.032500		

Figure 2. Output values(part 1)

Since the probability is greater than 0.05 (0.5075), the free term is insignificantly different from 0. Therefore, the model is re-estimated without the free term.

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: IT_ROM
Method: Least Squares
Date: 07/26/16 Time: 07:13
Sample: 1 7
Included observations: 7

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IT_EUR	0.014808	0.000615	24.06243	0.0000

R-squared	0.595090	Mean dependent var	103337.3
Adjusted R-squared	0.595090	S.D. dependent var	17993.68
S.E. of regression	11449.83	Akaike info criterion	21.66090
Sum squared resid	7.87E+08	Schwarz criterion	21.65317
Log likelihood	-74.81316	Hannan-Quinn criter.	21.56540
Durbin-Watson stat	2.550741		

Figure 3. Output values(part 2)

The statistical analysis performed reveals an R-squared coefficient of only 59%. This indicates that, apart from the general growth of the IT industry in the EU, there are additional elements to be taken into consideration when making the prediction. To identify these other influences, we perform a more detailed analysis of the elements to be considered.

Considerations for a new model

Given the results of the previous analysis, we propose a refined model for making more accurate estimates. The major reduction in the number of ICT corporate employees that took place in Romania between 2010 and 2009 can be explained by the 2008 crisis that had a major impact in Europe. A slowdown in the growth of ICT specialists can also be seen in Eurostat's data. In Romania, many ICT specialists emigrated or became freelancers after the 2009.In our opinion, this explains the substantial reduction in corporate ICT employees that took place in Romania in 2009. The numbers started to grow again after 2011.

The regression analysis performed above has established that there is a correlation between the number of ICT specialists in the EU and the specialists from Romania. However, there is a moderate correlation due to the fact that other factors, such as migration, can greatly interfere with the local demand for workforce in Romania.

To estimate the number of ICT specialists from Romania, we attempt to estimate the impact of migration. For this, we use two sets of data provided by Husing (2015)for estimating the number of ICT specialists in the EU-28 and the number of unfilled ICT vacancies (the so-called deficit of ICT specialists). In our opinion, unfilled vacancies in the EU result in migration from Romania toward Western Europe.

Table 9: Development of ICT Professional-skills Demand Potential in Europe 2014–2020

EU28(millions)	2014	2015	2016	2017	2018	2019	2020
ICTManagement	1880000	1898000	1994000	2092000	2189000	2284000	2375000
ICTPractitioners	6020000	6 152 000	6244000	6352000	6452000	6529000	6589000
Total	7900000	8049000	8239000	8444000	8641000	8812000	8964000
%Growth	+4.0%	+1.9%	+2.4%	+2.5%	+2.3%	+2.0%	+1.7%

Source: IDC Europe via Husing (2015)

The results (see Table 9) show a constant increase in the number of ICT specialists in Europe. The growth is moderate, staying at approximately 2% per year until 2020. An important element in forecasting the number of ICT specialists in the EU is the deficit of ICT specialists. The official data announced by the European Commission is that the deficit of ICT specialists is estimated to be 825,000 persons. The estimates of Husing (2015) are close to this number, and they provide additional details in Table 10.
The data regarding vacancies is important because Romania and Bulgaria have the lowest salaries in ICT among the EU countries. Because of this, the demand from richer western markets is expected to be redirected towards poorer Eastern regions as companies are constantly looking for new employees. Because of this, we are assuming that the demand for ICT specialists in Romania will grow faster than the EU average as long as the salaries in this area remain below the EU average.

Table10:e-SkillsVacanciesEstimate-Summing-up of National ICT Professional Excess Demand in Europe 2014–2020

EU27	2014	2015	2016	2017	2018	2019	2020
ICT Management	57000	58000	143000	180000	203000	218000	226000
ICT Practitioners	307000	315000	329000	396000	465000	504000	530000
Total	365000	373000	472000	576000	668000	722000	756000
% Growth	+35.2%	+2.2%	+26.5%	+22.0%	+16.0%	+8.1%	+4.7%

Source:Empirical modelforecast via Husing(2015)

The conclusion after applying the regression model is that we cannot precisely quantify all factors that influence the demand for ICT specialists on the Romanian labor market. The increase in the number of employees in the EU and the deficit of EU specialists is a clear indication that the demand for skilled workforce will increase in Romania.
The demand for ICT specialists will grow in Romania at a rate higher than the EU average because salaries in Romania are still considerably less than the EU average. This will attract more demand to Romania and will also produce an increase in salaries which, in the long run, will decrease the demand.

The model

The main factors considered to influence the demand for ICT specialists in Romania are as follows:

- The total number of ICT specialists that are expected to be employed in EU countries. From a demographic point of view, Romania will have a share of the ICT workforce which is proportional to its population;
- The deficit of ICT specialists that exists in the EU. Such deficits have been around for many years in the USA where they are expected to last until 2030 according to Cooper[4]. In a world where the near-shore and offshore delivery models can be easily implemented, such deficits do impact the demand for ICT specialists in Romania;
- The lower salaries that Romania has compared to the EU average. However, as the demand grows, the salaries will also grow, which means that the demand for ICT specialists in Romania will decrease in the long run because the salaries are expected to move closer to the EU average.

Based on the above observations, we propose the following model for calculating the demand for IT specialists in Romania:

$$D = e\frac{RP}{IP}IE + m\frac{AIS}{ARS}ID \qquad (1),$$

where:
D=demand for ICT specialists in the Romanian market;
IE=ICT specialists employed in international areas where Romanian ICT specialists can work from a political point of view(includes Romania). In our current analysis, the area considered is the EU. The demand generated by the Romanian national projects is included here;
RP=population of Romania;
IP=population of the international areas where the demand for ICT specialists is coming from;
e=a constant which quantifies the ability of the Romanian society to direct the younger generation towards ICT educational and training programs as compared to the average level of the EU;

AIS=average international salary (for ICT) in the area that generates demand on the Romanian ICT labor market;
ARS=average Romanian salary (for ICT);
ID=international deficit of ICT specialists in the area that induces demand for ICT specialists in Romania;
M= a constant that indicates the mobility of work towards Romania from the international area considered. This depends on many factors such as labor politics, language, cultural affinity, distance, and time differences among others.
We use the above model to obtain an estimate for the demand for ICT specialists in Romania. The following assumptions are made to simplify the prediction:
e*:* This quantity depends on a very large number of elements, including the interest of students in ICT, governmental support, social perception of ICT specialists, and many others. We consider it to be 1 because we assume the Romanian educational system has the capability to educate ICT specialists in a percentage which is equal to the EU average;
IE*:* We consider the EU as the only international area that induces demand on the ICT labor market in Romania. The values are available in Table 9.
RP: The population of Romania is set at 22,279,000 persons on 1 January 2015 according to INSSE. We consider this value to remain constant until 2020.
IP*:* The population of the EU on 1 January 2015 was 508,200,000 according to Eurostat. We consider this value to remain constant until 2020.
AIS: The average international salary was estimated based on the EU. In the analysis, we consider the full salary cost, which includes the net salary plus all taxes and social benefits. Calculating the average EU labor cost for an ICT specialist is not an easy task because the data are considered confidential by EUROSTAT. In EUROSTAT's database, some countries report labor costs as confidential. However, most influent countries do report data, and these are available in Table 11. By computing an average on the available data, we have find the mean wage to be 31.6 euro/hour for 2015. We consider a growth of 5% for this value by 2020, so the new value will be 33.18 euro/hour.
ARS: We also use EUROSTAT's value for 2015, 10.1 euro/hour. We consider a growth of 30% by 2020,so the new value will be 13.13 euro/hour.

Table 11:Labour cost levels

Source of data	Eurostat
LCSTRUCT	Total labour costs (EUR)
NACE_R2	Information and communication

GEO/TIME	2000	2004	2008	2012	2013	2014	2015
EU (28 countries)	:	:	:	:	:	:	:
EU (27 countries)	:	:	:	:	:	:	:
Euro area (19	:	:	:	:	:	:	:

countries)							
Euro area (18 countries)	:	:	:	:	:	:	:
Euro area (17 countries)	:	:	:	:	:	:	:
Belgium	:	:	:	54.7	55.7	56.2	56.3
Bulgaria	:	:	:	7.4	8.3	8.3	9.1
Czech Republic	:	:	:	18.3	18.1	17.6	18.5
Denmark	:	:	:	49.4	50.6	51.4	52.4
Germany (until 1990 former territory of the FRG)	:	:	:	41.3	41.5	42.8	44.3
Estonia	:	:	:	14.8	16.1	16.2	17.3
Ireland	:	:	:	39.4	41.6	40.6	43.0
Greece	:	:	:	18.9	17.0	16.0	:
Spain	:	:	:	27.3	27.7	27.3	27.0
France	:	:	:	45.6	45.9	46.4	47.2
Croatia	:	:	:	14.5	14.4	14.1	14.3
Italy	:	:	:	35.2	35.8	36.1	36.1
Cyprus	:	:	:	23.9	:	:	:
Latvia	:	:	:	11.2	11.3	11.9	12.8
Lithuania	:	:	:	9.9	10.6	11.5	12.1
Luxembourg	:	:	:	42.1	43.0	44.3	45.2
Hungary	:	:	:	13.8	13.8	13.9	14.2
Malta	:	:	:	:	:	:	:
Netherlands	:	:	:	40.6	40.7	41.8	:
Austria	:	:	:	43.2	43.2	42.2	44.9
Poland	:	:	:	13.1	13.7	14.0	14.6
Portugal	:	:	:	21.8	:	:	:
Romania	:	:	:	8.0	8.2	9.0	10.1
Slovenia	:	:	:	22.7	21.9	21.8	23.3
Slovakia	:	:	:	16.9	17.0	17.5	18.9
Finland	:	:	:	41.0	41.8	42.6	44.3
Sweden	:	:	:	50.4	51.1	48.8	49.6
United Kingdom	:	:	:	34.3	32.8	34.7	40.7
Iceland	:	:	:	:	:	:	:
Norway	:	:	:	68.4	69.1	66.0	63.2
Turkey	:	:	:	:	:	:	:

Source of data: EUROSTAT

ID: The values are presented in Table 10. We use these estimations.
m:Mobility is difficult to estimate as it depends on political, cultural, and demographic elements that are hard to quantify. We consider an approximate value of 0.1, which means that we assume that Western companies are willing to move towards Romania in 10% of the cases where they have vacancies. IMPORTANT: The value of $\boldsymbol{m}\frac{AIS}{ARS}$ must be smaller than 1.
Using the above data, we can estimate that by 2020 in Romania, there will be a demand of ICT specialists of$D2020 = 392973+191044$.
This means that in 2020, the Romanian ICT labor market will have a demand of $\boldsymbol{D} = 584017$ ICT specialists coming from the EU alone. According to our calculations, if the Romanian educational system could produce the required number of graduates in 2020, they would find jobs. The estimation assumes that 10% of the vacant ICT jobs at the EU level will move towards Romania because of the lack of local candidates in other EU regions.
We can also distribute $\boldsymbol{D}$among the main geographical regions in Romania according to the average percentages of IT specialists (see Table 2-6). The estimates are presented in Table 12.

Table 12: Forecasted distribution of the 2020 demand for ICT specialists in Romania's main regions

Region	Average percentage of corp. ICT specialists 2008-2015	Demand of ICT jobs forecasted for 2020
Bucuresti-Ilfov	61.86%	361299
Cluj	7.08%	41320
Timis	3.86%	22550
Iasi	3.10%	18132
Dolj	2.01%	11721
Brasov	2.63%	15334
Others	19.46%	113662
National level	100.00%	584017

Limitations of the model

The proposed model offers a more accurate estimation than conventional multiple regression. However, it has certain limitations due to the following assumptions that are made:

- It considers only the territory of the EU. However, there are other parts of the world that influence the Romanian ICT labor market such as the USA and the Middle East.

- The values of e and m are assumed to be set at certain levels based on the experience of the authors. However, a more detailed measurement should be conducted to obtain a more accurate estimation.

Conclusion

The increasing deficit of ICT specialists in the EU will create a growing demand on the Romanian ICT market. The unfilled vacancies from Western Europe will create a substantial demand in the Romanian labor market. The current article proposes a model that is based on a statistical analysis of the key influential factors.
The model can be applied using statistical data from Eurostat and the ministry of Finance in Romania. In spite of the difficulties induced by the limitations of the data available, the model proves to be useful in identifying the expected number of openings that the local educational system should consider when designing educational programs in Romania.
The main conclusion of the article is that there will be a major increase in demand in the Romanian ICT labor market. This demand will originate mainly from the demand existing at the level of the EU. However, other geographical areas such as the USA will induce demand as well.
A second conclusion is that the local Romanian educational system needs to be prepared for an increasing number of students. More and more high school graduates will move towards ICT academic programs, attracted by good salaries. It is, in my opinion, nearly impossible for the Romanian academic system to increase its capacity to meet the demand that will exist on the local labor market by 2020. However, a substantial increase is required by the labor market conditions.

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