

Occupation Areas, Specialization Sectors and Professions in ICT: an Overall Analysis and Selection Methodology

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Abstract. In this study we investigate three of ICT labour market's main components, directly related to the vocational directions of enterprises and the jobs exercised by the individuals. The elements of analysis, namely "occupation areas", "specialization sectors" and "professions", are initially theoretically determined. A new selection methodology is introduced and implemented for the Greek ICT labour market. The approach used for the selection of the elements' components and their interrelationships consists of the formation and personal interviewing of a group of 20 ICT scientists. Statistical analysis of the answers aided by the use of inclusion criteria produced finally selected items and professions' allocations. Final conclusions show this work's usefulness and contribution. Further research aspects are also discussed, concerning the use of the results as an application tool for an extensive labour market investigation.

1 Introduction

Among the major phenomena of today's social and economic activity is the rapid evolution of Informatics and its relative technologies. For the definition of all these technologies the Council of European Professional Societies (CEPIS) uses the term "Information and Communications Technologies" (ICT), which has been adopted internationally. The changes owed to the ICT expansion affect not only the dynamics of the several fields of financial activity, but also and most importantly the relevant labour market that is continuously growing and altering [1]. Moreover these changes diversify significantly the ICT enterprises occupation and directly affect the professions' profiles [17].

ICT labour market's main indicators, such as demand, supply, occupation and unemployment, have been investigated extensively. Nevertheless there is lack of research in the examination of other relevant important aspects related to the occupation objects of ICT enterprises and individuals.

This study focuses on labour market's three main components, concerning the vocational directions of enterprises, the classifications of professions and the jobs themselves respectively. The first stage of the work deals with the theoretical analysis of these components based on international bibliography. A new selection methodology is introduced and implemented for the Greek ICT labour market through the forma-

tion and interview of a group of scientists. The results obtained from the statistical analysis are considered as an application tool for a further investigation. This will be accomplished through the forwarding of a structured questionnaire to ICT enterprises at national level. Finally the conclusions drawn, the utility of the proposed methodology and aspects of further research are discussed.

2 The Elements of Analysis

The labour market of a so rapidly expanding science such as Information Technology (IT) is a complex concept containing a mass of components that define and characterize it. Therefore a relevant analysis cannot possibly include all its components due to their multitude and should focus on certain aspects having each other a direct logical relation. On the other hand a study's implementation, in order to be more accurate and valid, should concentrate on a certain geographical area with common economic and social characteristics. This work focuses on the occupational point of view of ICT's labour market. The elements chosen for analysis deal with the activity directions of organized entities and the occupation of the specialized individuals.

2.1 Occupation Areas

The term "occupation area" refers mainly to vocational directions of ICT enterprises or IT departments of large companies. Very few research efforts have been accomplished in European level concerning the determination of the most important occupation areas. The obvious reason is they may be different in each country and can each time depend on the degree and rate of accession of new technologies in the production process [17].

CEPIS conducted through a large study with title "European Structure of Information Technology Competences" one of the first major attempts. This research study has been accomplished by a work group composed of representatives of 12 National Computer Societies, all members of CEPIS. A total of standards and characteristics of IT professions has been developed aiming to help mobility of professionals across Europe and co-operation between relevant bodies, organizations and enterprises. According to it 11 independent vocational directions were developed, containing 35 different specialities. These occupation areas were proposed for use of all CEPIS members, after taking into account each country's particularities. Additionally 10 levels of professional advancement were defined, with codes from zero to nine, corresponding from beginner up to mature professional respectively. Each of the 35 specialities corresponded to some of the above levels, depending on its work content and on the experience of each ICT professional [3].

The Greek Computer Society elaborated CEPIS' proposal and adapted it in the current situation of the Greek society with respect to the local ICT development and educational system. A study with title "Development of Qualifications/Tasks Index for Professionals in Information and Telecommunications Technologies of the Public Sector" has been elaborated during 1996. As a result of it a subtotal of CEPIS' proposal has been defined and described. It consists of seven vocational directions and is

adapted to the needs of the public sector. Moreover five levels of professional advancement and a large number of distinct specialities are named [4]. Other relevant attempts did not focus on the ICT sector but on the total of existing professions' classifications or distinct professions in the Greek labour market. Katsanevas identifies in [8] totally 545 professions and attempts to measure their demand-offer balance. Between them a number of professions are directly assigned to the general field of IT. The same researcher classifies later IT jobs in two occupation areas; namely "hardware" and "software", in which 14 and 24 professions are assigned respectively [9]. This is a satisfactory division when dealing with the total labour market; however not adequate for a deeper analysis of the particular sector. Several other studies identify various IT professions, but no one of them defines or uses any kind of relevant occupation areas.

Therefore [4] can be considered as the unique so far complete approach in Greece in defining and analyzing the current ICT occupation areas. Nevertheless there are two serious reasons preventing from adopting without further consideration this proposal: a) the lack of renewal or repetition of this research during the last seven years, b) its orientation primarily to the public sector and not to the private one, which represents more precisely the labour market characteristics and c) the fast evolution of ICT meanwhile has probably created new occupation areas for the relevant enterprises.

From the above analysis arises the need for re-examination and possibly for re-definition of new occupation areas representing more accurately the present situation of the labour market. This is attempted through a proposed selection methodology described in section 3 of this paper.

2.2 Specialization Sectors

Specialization sectors refer directly to individuals, i.e. to the professionals working in the ICT field. They are clearly more closely related to ICT jobs than occupation areas. Therefore they are usually considered as "classifications of professions".

Research work in determining specialization sectors has been very little so far and almost all of it has been produced in USA, due to the fact that the local labour market is more job-oriented than the European one. The US Northwest Center for Emerging Technologies elaborated a study proposing eight specialization sectors (named as IT profession groups), each one analyzed further in distinct specialities. The proposed grouping corresponds to the organizing of the assignment under the actual conditions and the particular social-economic conditions in the USA [15]. The multinational IT training company New Horizons identifies six distinct specialization sectors, further divided in major jobs [14]. Several professional bodies and educational institutions have also reported ICT specialization sectors; usually with the meaning of groups or categories of professions the former and titles of offered specialized courses the latter. It has however become clear that in defining specialization sectors there is a quite large degree of discrepancy; main factors being the locality and the exact time period of the relevant report. It is therefore important to adapt them in order to reflect as accurately as possible any country's real current labour market conditions. A panel of prominent scientists has selected the main ICT specialization sectors, which appear in Greece. The relevant methodology and results obtained are presented in sections 3 and 4 of this work.

2.3 Professions

In contrast to occupation areas and specialization sectors, several bodies and independent researchers have investigated ICT professions more extensively. It is not difficult to identify the reasons: The distinct jobs of any professional sector reflect directly to the current situation and the trends of the relevant labour market. Even more in the rapidly evolved ICT field their significant dissimilarities between countries or regions reveal the great existing differences in its development [6]. Also the definition of distinct professions is the first essential step in calculating their balance of supply and demand, an important issue in job selection [9].

One of the main priorities of this work is the determination of the current ICT professions in Greece. The examination of a great number of sources has proved that some hundreds of different ICT professions have so far been determined and profiled. The remaining of this section contains a presentation of the most important bibliographical sources, which determined or used ICT professions, in conducting a relevant research.

The European Commission has elaborated one of the first major relevant attempts in Europe. A large table has been composed naming all different economic activities. Its adaptation to every country's specific situation forms the corresponding table of National Nomenclature of Economic Activities. According to the adapted table for Greece 11 distinct occupations in the form of activity directly related to IT were determined [2]. As with the other main labour market elements USA bodies and researchers have investigated ICT professions more thoroughly. The Northwest Center for Emerging Technologies in its study on definition of forthcoming skills and standards for Information Technology determines 128 distinct specialities/professions, which have so far been widely used in USA [15]. For the determination and classification of IT professions the Ministry of Labor of the USA is based methodologically on the Dictionary of Occupational Titles-O*NET. This does not refer to employees but describes the content of specialities by upgrading the requirement of each profession separately. According to O*NET 17 major distinct ICT professions are determined [18]. Also the IT training company New Horizons published recently the detailed profiles of 15 IT distinct professions [14]. Furthermore independent researchers have widely used IT professions in their publications. Vazzana and Bachmann in their study on CAD salary and employment use seven distinct managerial ICT professions [19]. Farr and Ludden in [5] examine and profile in detail nine ICT jobs, showing a very high average yearly growth in expected job positions. Another recent survey on ethical attitudes of IT professionals uses seven distinct professions [16].

Several studies accomplished in Greece have also determined or used IT professions. The last published national statistical classification of professions based on data of year 1992 includes only five major IT jobs [13]. The first relevant attempt by an official scientific body was carried out later. According to Greek Computer Society's study, based on CEPIS's previous work, 46 distinct, existing in Greece, specialities have been determined [4]. Most other relevant works try to forecast the prospects of various professions and therefore derive the IT professions they use from the educational system. Katsanevas who worked extensively on calculating the balance of supply and demand of most existing professions initially determines 34 IT jobs [8] and very recently 38 jobs [9], all of them directly correlated to the corresponding mini-

mum required education level. Another recent labour market's investigation dealing with the demand of higher education specialities examines 16 IT professions [10]. At the same time the Industrial Training Authority of Cyprus in his annual report [7] uses six IT professions. Finally Kostopoulos in [11] attempting to work out the prospects of several professions in Athens examines nine distinct IT professions.

Some worth mentioning remarks rise from the bibliographical search. Although professions are concepts much more explicit than occupation areas and specialization sectors, the observed differences between the bibliographical sources are very large in both; titles and numbers of determined or used professions. The factors affecting these discrepancies are the locality, the time period, the degree of accession of ICT in the production process and obviously the way each scientific body or researcher approaches this issue [17].

The above remarks lead to some undisputed conclusions. It is not wise, perhaps not even possible, to attempt a general everywhere valid determination of ICT professions based on international terminology. One should focus on a specific geographical area, probably a country, which contains common characteristics in the ICT labour market and the relevant educational system. It is also clear that any determination or selection of professions is valid for only a short time period mainly due to the fast evolution of these technologies. Therefore any attempt to determine ICT professions should take seriously into account the local conditions and be repeated in frequent time intervals. It is finally evident that a complete determination approach, in order to be unbiased, should use data from both ends of the system; labour market and education.

3 Selection Methodology

The foregoing analysis showed that in order to investigate labour market's elements, it is essential to choose titles, which are in respect of place and time valid. Main objective of this work is the determination of these elements in today's Greek ICT labour market. For this purpose a three-stage selection methodology is introduced. This paper contains the results of the first two stages, while the third one is currently under implementation.

The initial stage, which has been described in the preceding section, consists of the collection and study of a large number of bibliographical sources. The relevant findings show a large degree of discrepancy for every element and prove the necessity of their localization taking seriously into account the local conditions and labour market characteristics.

The second stage of the proposed methodology is based on our acknowledgement that any relevant selection or definition by the authors of this paper or by any single person would be largely based on personal point of view and therefore risky. The approach used for overtaking the obvious disadvantages of an arbitrary definition consists of the formation of a panel of ICT specialists. A group of 20 distinguished scientists was selected, having set as minimum requirement for participation a 15 years active working experience in the IT sector and relevant higher education studies (actually 80 per cent of the participants hold a PhD degree in IT). All group members

were individually interviewed. Complete lists of all gathered information by the bibliographical search, four written questions and appropriate instructions were given to all participants. The first three questions posed, asked for their personal opinion about the presently existing occupation areas, specialization sectors and professions in the Greek ICT labour market. The fourth question asked for the allocation of the selected professions in the specialization sectors.

All 20 groups of answers were coded and analyzed, through the calculation of several appropriate statistical measures. An important step of the procedure has been the definition of appropriate criteria for inclusion of a selected item in the final list. The relative frequency of every proposed item, i.e. the percentage of the positive corresponding answers by the group members, has been chosen as the decisive selection criterion. Additionally was recognized the need of setting a lower limit for inclusion in the final list. As such has been set a minimum required value of the relative frequency.

The final results of the above selection procedure have been considered as a powerful tool for further analysis. This is exactly the main object of the third research stage, which is currently under elaboration. Its aim is the thorough investigation of the Greek ICT labour market. For this purpose a structured four-section questionnaire has been designed and tested through the use of a pilot sample. It has been sent to all active Greek ICT enterprises, in order to find out - between several other information - the opinions of the labour market primary representatives about its three main elements. All informants are given the final lists selected by the ICT scientists' panel. Four question groups are directly related to labour market's main elements: a) the occupation areas in which is activated the enterprise, b) the prediction of the demand's degree for every specialization sector for the next five years, c) the assignment of employed personnel in all existing ICT professions and d) the opinion for the easiness's or difficulty's degree of finding and employing a specialist in every one of 30 distinct ICT professions.

4 Results

The four tables presented in this section contain the final results of methodology's implementation. As all group members were given a large number of titles collected by the bibliographical search, most of them were selected even by a small number of scientists. It has therefore been considered as necessary to set a lower limit in the value of the relative frequency, in order to put a selected item in the corresponding final list. Taking into account the statistical analysis of the answers, it has been decided that any title put in the final list should have been selected by more of one third of the group members. This decision led to a lower acceptance limit of 35% of the corresponding relative frequency value. Two more problems arose during the elaboration of the results and the formation of the final tables. The first one had to do with the actual number of titles, which would be included in each final list. The second was related with the occurrence of several items with nearly identical meaning, which have been used with different names by the bibliographical sources. They have been

overcome by taking into account the statistical means of group member's selections and by careful unifications of overlapping or synonymous titles respectively.

Regarding occupation areas, group members were given a list of 15 titles. The basic statistical measures of panel's selections (mean number of selected titles: 5,85 and standard deviation: 2,17) and the acceptance limit set, led to the final selection of seven occupation areas presently existing in the Greek ICT labour market, as illustrated in Table 1.

	Occupation Areas	Response Frequency (%)
1	Technical Support	90
2	Service Delivery	65
3	Sales, Provisions and Market Research	55
4	Information Systems Development	50
5	Education and Further Training	50
6	Research	50
7	Information Systems Support and Maintenance	40

Table 1. Selected ICT occupation areas with relative frequencies of responses

From the 17 given specialization sectors, group members selected on average seven sectors valid for the Greek ICT market (mean: 7,3 and standard deviation: 3,21, showing a degree of significant divergence opinions regarding the appropriate final number). Table 2 shows the finally selected specialization sectors in order of preference by panel participants.

	Specialization Sectors	Response Frequency (%)
1	Technical Support	90
2	Network Design and Administration	90
3	Web Development and Administration	90
4	Database Administration and Development	85
5	Enterprise Systems Analysis and Integration	45
6	Programming and Software Engineering	35
7	Multimedia	35

Table 2. Selected ICT specialization sectors with relative frequencies of responses

The formation of the ICT professions' final table presented more difficulties due to three main reasons: a) the large number of titles (actually 217) which had been given to panel members, b) the significant discrepancies between the 14 studied relevant bibliographical sources and c) the occurrence of many overlapping or nearly synonymous titles. An additional issue was related with the actual number of professions, which had to be included in the proposed final list. The above problems were overcome by making some appropriate assumptions. Careful unifications of highly selected professions with similar meaning and taking seriously into account the corre-

sponding job profiles have been the two principle measures used, in order to avoid including in the list professions with identical or very similar content. Regarding the recommended length of the final professions list, it has been decided to form a flexible, not very long list, in order to be used as a labour market investigation tool. Table 3 shows the 30 top selected ICT professions by panel members.

The final number selected is not far of the average number of 25 professions being defined or used by the bibliographical sources. The lower acceptance limit of 35% has been applied for all candidate professions titles, with an exception for the last three members of the final list. They were included because it was considered that they really exist in the Greek ICT labour market and also for the completion of a 30-item table.

The close interrelationship between ICT specialization sectors and professions leads to a further appropriate analysis. This is the allocation of the professions into their classifications, i.e. the sectors in which are specialized the professionals. The utility of such an allocation is obvious. The popularity of a profession, expressed by the degree of its demand by the labour market, reflects directly to the specialization sector it belongs to and vice-versa. On the other hand specializations to individuals are provided by the educational system. It is therefore evident that a two-sided further investigation of these two elements, independently and simultaneously, can reveal important aspects of the correlation and the achieved connection between the ICT labour market and the educational system.

The allocation illustrated in table 4 is primarily based on the opinions of the scientists who participated in the group and secondarily on the job profiles. It is worth noting that a significant percentage of the selected professions (40%) have been allocated to more than one specialization sectors. Table's last line presents the cumulative number of ICT professions belonging to every one of the seven specialization sectors. Results show some degree of overlapping between the professions' classifications.

	Professions	Response Frequency (%)
1	Database Administrator	95
2	Systems Analyst	90
3	Network Technician	80
4	Webmaster	70
5	Database Analyst	70
6	Programmer	70
7	Network and Computer Systems Administrator	65
8	Computer Science Lecturer / Trainer	65
9	Information Technology Engineer	65
10	Information Technology Project Leader	65
11	Web Producer	60
12	Computer and Network Security Specialist	60
13	Communications and Network Engineer	60
14	Database Developer	60

15	Network Analyst	55
16	PC Technician	55
17	Technical Services Manager	55
18	Database Security Expert	50
19	Applications Analyst	45
20	Multimedia Specialist	45
21	E-Business Specialist	45
22	E-Publishing Specialist	45
23	System Programmer	45
24	Computer Operator	45
25	Customer Service Representative	40
26	IS Services Director/Manager	40
27	Geographic Information System (GIS) Specialist	35
28	Business Analyst	30
29	Information Systems Planner	25
30	Operating Systems Programmer/Analyst	20

Table 3. Top 30 selected ICT professions with relative frequencies of responses

	Specialization Sectors	Technical Support	Network Design & Administration	Web Development & Administration	Database Administration	Enterprise Systems Analysis & Integration	Programming & Software Engineering	Multimedia
	Professions							
1	Database Administrator				√			
2	Systems Analyst	√			√	√	√	
3	Network Technician	√	√	√				
4	Webmaster			√				
5	Database Analyst				√			
6	Programmer						√	
7	Network and Computer Systems Administrator		√			√		
8	Computer Science Lecturer / Trainer							
9	Information Technology Engineer	√	√			√	√	

10	Information Technology Project Leader					√	√	
11	Web Producer			√				
12	Computer and Network Security Specialist		√	√	√	√		
13	Communications and Network Engineer		√					
14	Database Developer				√	√		
15	Network Analyst		√					
16	PC Technician	√						
17	Technical Services Manager	√						
18	Database Security Expert				√	√		
19	Applications Analyst	√		√	√	√	√	
20	Multimedia Specialist							√
21	E-Business Specialist			√	√	√		
22	Electronic Publications Specialist							√
23	System Programmer		√				√	
24	Computer Operator	√						
25	Customer Service Representative	√						
26	Director/Manager of IS					√		
27	Geographic Information System (GIS) Specialist					√		
28	Business Analyst					√		
29	Information Systems Planner					√		
30	Operating System Programmer/Analyst		√				√	
Number of professions per specialization sector		8	8	6	8	13	7	2

Table 4. Selected ICT professions allocation in specialization sectors

5 Conclusions and Further Research

This paper studies the development of ICT labour market's main components in Greece. The study is based on analysis of the existing bibliography and the expert opinions of a panel of professionals.

Three worth mentioning remarks arise from the first stage of this work, described in the second section:

- 1) A large degree of discrepancy occurs in the definition or use of all three main ICT labour market elements. The most significant diversifications appear in numbers of selected items and in professions' titles.

- 2) The principal factors affecting the observed differences are implementation time period, place and research objectives and
- 3) The analysis of any country's ICT labour market requires selection or redefinition of titles at local level. The use of international terminology is probably not adequate for explaining local ICT environment and particularities.

The proposed selection methodology, which introduces the formation and personal interview of a 20-member panel of ICT scientists, is implemented for the selection of the current composition of labour market elements in Greece. Its advantage is the independence of time period and locality, as it can be used with nearly identical manner at any time period and for any country.

One of methodology's aims is the formation of a reliable investigation tool for a thorough analysis of the ICT labour market. This analysis will be achieved by a third research stage, which is the extension of this work. The accomplishment of a survey to Greek ICT enterprises will rank and finalize the items of labour market components.

Nevertheless the main contribution of this work is the usefulness of the results obtained. The relevant tables can be considered as a guide for the explanation of Greek labour market's direction. Moreover the selected professions and their allocations to specialization sectors are related to the ICT educational system. They can be used as a guide for both; candidate students and graduates, in order to make a more correct decision regarding their studies and career respectively.

The methodology introduced in this paper can be repeated frequently for the discovery of any relevant changes. Our suggestion is that the time interval elapsed between two successive analyses of a country's ICT labour market should not exceed three years. Regarding other aspects of further research, a comparison study of labour market's composition in European level would be interesting and useful.

Finally we consider that the investigation of the dynamics of the main elements that constitute the ICT labour market is an important issue. It can be considered as a detection tool for labour market's trends and prospects, able to reveal where it should converge on the educational system and vice versa.

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