A step towards human capital management in the software industry based on generic competencies

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Abstract

The definition of generic competency levels in a complete career ladder devoted to software profession presents a novel contribution to the literature with added value both for practitioners and industry.The aim of this paper is to identify generic competency levels relevant to software professionals in working environments with respect to a specific professional ladder. The empirical study employed a questionnaire approach. The sample consisted on 50 professionals working in software development within large enterprises for a period of time equal or higher than five years. Results show the importance of competencies like Quality concern and Teamwork and the higher significance that, in average, generic competencies take for the higher positions in the career ladder.

Keywords: Generic Competencies; IT professionals; Quantitative Study; Professional Ladder

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1 Introduction

The use of IT solutions has become a key issue in many organizations worldwide, and due to its importance, technology is seen as an enabler of the Knowledge Society. In these societies, knowledge must present a tacit structure for sustainable advantage (Sharma et al., 2010). In this environment, the power of knowledge in our contemporary life has produced many new terms and concepts including: "knowledge society"; "knowledge economy", "knowledge management", and "knowledge culture" (Bakry & Alfantookh, 2010). Given this requirement, competencies and competency structures for IT professionals can be seen as enablers for the Knowledge Society, needed also of intellectual capital and competent IT workers (Hernández-López et al., 2010). Whatever the scope of the work, training and education is a key element to survive in knowledge society, as it facilitates the competencies development in professional activities (Bodea, Dascalu, & Coman, 2010).

Advances in technology, emergence of new business practices, and shifting social and geopolitical circumstances have combined to create a "brave new IT world" for organizations (Goles, Hawk & Kaiser, 2008). IT has been considered fundamental for the development of productivity and knowledge-intensive products and services (Soto-Acosta, Martínez-Conesa & Colomo-Palacios, 2010). In IT, a knowledge intensive activity in which organizations support their activities (Trigo, Varajao & Barroso, 2009), the importance of people is unquestionable. According to López-Fernández, Martín-Alcázar and Romero-Fernández (2010), IT human resources are gaining importance in an environment more and more competitive and changeable. IT workers professional practice must be continually revised and improved in order to adapt workers' competencies to technical innovations and soft skills to evolving markets (Casado-Lumbreras et al., 2009). These competencies may be crucial for a wide range of organizational contexts including all knowledge workers (Rimbau-Gilabert et al., 2009). But, in spite of its importance, some authors (e.g. Turner & Müller, 2005) have indicated that the influence of competencies on project success has not been successfully explored.

To shed some light on this issue, in this paper, via an empirical research, it is established the generic competency levels for every role in that professional ladder defined by Colomo-Palacios et al. (2010).

This paper is structured as followed. Section 2 describes related work on competency models and its influence in the IT sector. Section 3 details the main results of the study conducted. Section 4 describes the competency structure. Conclusions and future work are discussed in Section 5.

2 Competency and IT Professionals: Literature review

Competencies are defined as behaviour models (Roberts, 1997), as hidden characteristics of personality with an effect on the performance at work (Spencer and Spencer, 1993), as traits or features of human being (Zwell 2000) and as features related to an effective working performance (Boyatzis 1982). That could be the reason why, competency is often used in the sense of performance, however, this is not entirely accurate (Bassellier, Horner Reich, & Benbasat, 2001). A classic definition of the term is given by McClelland, (1973). For this author, competency is comprehended as the relation between humans and work tasks, that is, the concern is not about knowledge and skills in itself, but what knowledge and skills are required to perform a specific job or task in an efficient way. Competencies are linked to individual and organizational performance, or in a more specific level as it is the training outcome. McClelland (1987) suggested that competency ought to become the basis for a more effective method to predict individual performance in organizations. The term "competency" has been applied in reference to many different behaviour domains (Waters & Sroufe, 1983). The competency approach was a major innovation in the human resource development field in the 1990s (Collin & Holden, 1997). Due to this, competency frameworks, models, instruments and thinking have long been ingrained and utilized in management and organizational life (Carroll, Levy & Richmond, 2008).

Several authors (e.g. Levy-Levoyer, 1996; Martin & Staines, 1994) set up taxonomies in which particular or technical competencies are established as those necessary to carry out a very specific task of a particular job position and include knowledge, abilities, and skills. On the other hand, universal or generic competencies constitute those that, though not linked to a specific activity or function, do make possible the competent performance of the tasks related to the work position, inasmuch as they refer to characteristics or abilities of the individuals' general behaviour.

There is a lengthy history of studies that confirm IT workforce issues as a key concern of practitioners (Goles, Hawk & Kaiser, 2008). In the IT area there are many attempts to adopt and study the competency paradigm in various fields (e.g. Acuña & Juristo, 2004; Colomo-Palacios et al., 2010; Luftman, Kempaiah & Nash, 2006; Marks & Scholarios, 2008; Ruano-Mayoral et al., 2010; Trigo et al., 2010; Turley & Bieman, 1995). Even generic and soft skills definition in the IT domain have been conducted (e.g. Callahan & Pedigo, 2002; Denning & Durham, 2001; Goles, Hawk & Kaiser, 2008; Joshi & Kuhn , 2007; Litecky, Arnett, & Prabhakar, 2004; Scheibe, Mennecke & Zobel, 2006; Simon et al., 2007; Wu, Chen & Chang, 2007). However, none of the works have addressed the issue of leveraging generic skills according to a given professional ladder. In order to do so, in this paper is established the generic competency levels for professional roles defined by Colomo-Palacios et al. (2010) in their professional ladder proposal.

3 A study of generic competencies for IT professionals

The literature is full of studies about generic and soft competencies for IT professionals. However, the aim of our study is to find out what level of generic competency is required for every professional role defined by Colomo-Palacios et al. (2010). To accomplish this, in first term, there is a need to describe software engineering career ladder portrayed by referred authors. The professional ladder is based on an analysis aimed to extract similarities between definitions for each professional profile

among all of the research sources, which includes industry practices, employment reports and technical literature. Figure 1 shows the seven steps of the career and the mappings to People-CMM sample software engineering technical career:

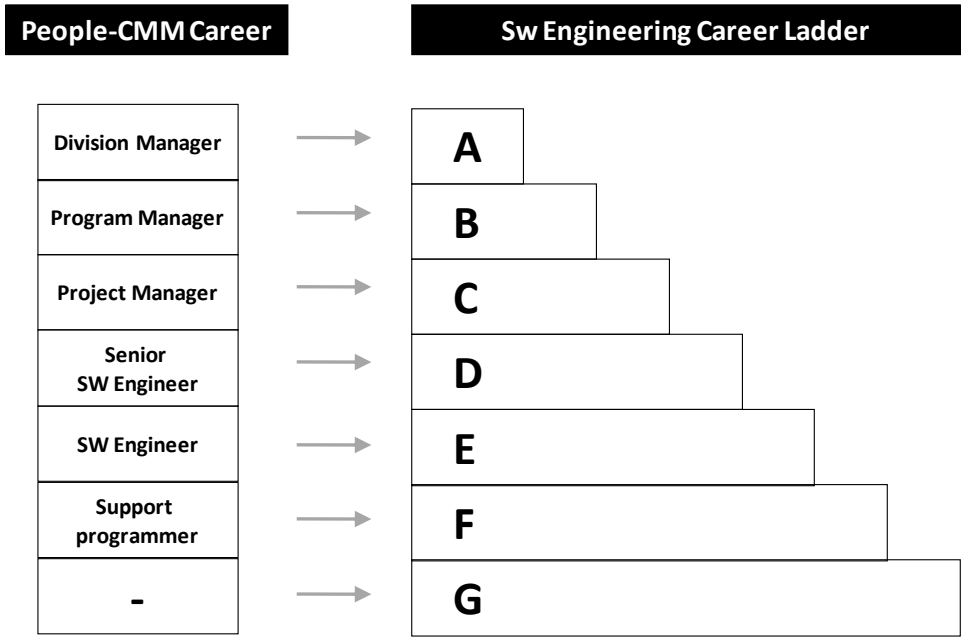

Fig. 1. Average sums of different generic competencies

In second term, it is required to specify the set of generic competencies used for the study. "The white book on computer science degrees in Spain" (Casanovas, Colom, Morlán, Pont, & Ribera, 2004)—grades both technical and generic competencies on a Likert 1-4 scale in order to determine competency levels needed for a computer science degree. This initiative is overseen by the governmental accreditation agency of Spain (ANECA).This competency level was established based on a vast study, which included 1,143 interviews with professionals and computer science researchers all over Spain. These competencies were, therefore, chosen as the focus of the current paper. Table 1 displays a list of generic competencies for computer science, weighted according to Casanovas et al. (2004).

Table1. Set of generic competencies for computer science

Competency	#
Capacity for analysis and synthesis	1
Organization and planning	2
Oral and written communication in mother tongue	3
Problem solving	4
Decision-making	5
Critical thinking	6
Team work	7
Interpersonal skills	8
Ability to work on an interdisciplinary team	9
Information management	10
Ability to work in an international context	11
Ethical commitment	12
Environmental sensibility	13
Adaptation/flexibility	14
Creativity	15
Leadership	16
Understanding of other cultures and customs	17
Ability to work in an autonomous way	18
Initiative and enterprise	19
Quality concern	20

3.1. Research design

The study consists of the application of a questionnaire. This tool was designed to define generic competency levels for the given professional roles. Every competency was defined using less than 50 words. The scale used was Likert style. It presents an even number of values ranging from 1 to 4 points. The description of the scale will be generic for all competencies, showing the following order of values and descriptions:

1= Low Level
2= Medium Level
3= High Level
4= Very High Level

A pilot application was made prior to the final implementation. The sample for this pilot implementation was composed by two IT professionals with "C" profile. The objective of this pilot study was the improvement and assurance of the associated documentation. This resulted in slight changes in formats and tables in the wording of some texts.

Once final formats were edited, subjects received their questionnaires through email and sent back their responses in a fixed period of time.

3.2. Sample

The sample consists of 50 professionals working in software development within large enterprises (over 500 employees) during a period of, at least, five years. Under the assumption that these professionals held relevant industry experience, they were interviewed a priori with the objective of verifying their discipline knowledge, as well as determining whether their knowledge was sufficiently adequate for the aims of the study. As a consequence, three subjects were eliminated from the sample. The distribution of subjects within the categories previously identified was subsequently established, based on the interviews: 21 "D" (42%), 20 "C" (40%), 5 "D" (10%) and 4 "A" (8%).

The distribution of experimental subjects shows that it was comprised of 6 women (12 %) and 44 men (88 %). The average age was 35.4, with an average experience in the business of 10.32 years.

3.3. Results

Table 2 shows the results obtained in relation to the scores relative importance, including for every professional role average and standard deviation.

Table2. Results of the study (Average and Standard Deviation).

Com#	G		F		E		D		C		B		A	
	A	St	A	St	A	St	A	St	A	St	A	St	A	St
1	1.66	0.90	2.34	0.80	3.26	0.63	3.84	0.37	3.74	0.43	3.34	0.75	3.12	1.00
2	1.58	0.76	2.08	0.83	2.78	0.76	3.30	0.61	4.00	0.00	3.90	0.36	3.76	0.52
3	2.02	1.02	2.28	0.93	2.88	0.77	3.22	0.71	3.64	0.60	3.86	0.54	3.78	0.71
4	2.06	0.91	2.64	0.90	3.18	0.83	3.58	0.61	3.62	0.53	3.46	0.76	3.42	0.86
5	1.26	0.60	1.68	0.74	2.48	0.68	2.98	0.69	3.74	0.44	3.90	0.30	3.94	0.31
6	2.10	0.95	2.48	0.89	3.04	0.81	3.48	0.71	3.62	0.64	3.50	0.68	3.44	0.86
7	3.18	0.90	3.46	0.71	3.72	0.54	3.80	0.45	3.78	0.47	3.12	0.77	2.76	1.10
8	1.84	0.87	2.08	0.83	2.46	0.71	2.98	0.77	3.68	0.47	3.76	0.48	3.78	0.51
9	2.32	1.02	2.64	0.96	3.14	0.81	3.48	0.68	3.70	0.58	3.40	0.73	3.14	0.97
10	1.64	0.66	2.12	0.77	2.94	0.77	3.48	0.58	3.74	0.49	3.70	0.54	3.60	0.73
11	1.48	0.73	1.80	0.76	2.18	0.75	2.64	0.75	3.18	0.72	3.56	0.71	3.70	0.68
12	2.62	1.09	2.78	0.95	3.04	0.83	3.30	0.79	3.60	0.67	3.66	0.59	3.58	0.76
13	1.88	0.96	1.96	0.95	2.06	0.94	2.16	0.98	2.34	1.00	2.34	1.03	2.86	1.13
14	2.54	1.07	2.78	1.00	3.18	0.75	3.44	0.58	2.64	0.56	3.46	0.79	3.40	0.81
15	2.38	0.99	2.72	0.93	3.28	0.76	3.58	0.61	3.32	0.77	3.00	0.93	2.88	1.06
16	1.18	0.44	1.62	0.67	2.32	0.65	3.02	0.69	3.70	0.46	3.78	0.42	3.90	0.36
17	1.56	0.81	1.76	0.87	1.92	0.85	2.18	0.77	2.64	0.90	2.96	0.94	2.82	0.90
18	3.08	0.94	3.30	0.79	3.46	0.68	3.36	0.72	3.16	0.87	2.98	0.94	2.82	1.08
19	2.08	0.99	2.46	0.89	2.72	0.81	3.04	0.73	3.38	0.60	3.40	0.65	3.60	0.68
20	2.90	1.00	3.30	0.79	3.54	0.61	3.82	0.39	3.86	0.41	3.58	0.54	3.46	0.76

In order to clarify in a more specific way the results given in Table 2 and shed some light on the analysis of such data, three different questions must be addressed, namely the variability of answers, the most important generic competency and the role requiring the most generic competency. The answers to these questions are depicted bellow.

VARIABILITY OF ANSWERS

Given the scores of standard deviations, the answers variability is limited. The cases of significant variability, for a total of thirteen, are presented five times in "A" and "G" figures, and one in "B", "C" and "F" figures. With regards to competencies, two roles present standard deviations greater than the unity for "Environmental sensibility", the generic competency with higher variability.

MOST IMPORTANT GENERIC COMPETENCY

The most important competency for all professional figures, according to the sum of their averages, is "Quality concern" followed by "Team Work". The competency less valuated by the subjects is "Environmental sensibility" followed by "Understanding of other cultures and customs". Figure 2 includes a comparison of the averages for every generic competency according to the subjects.

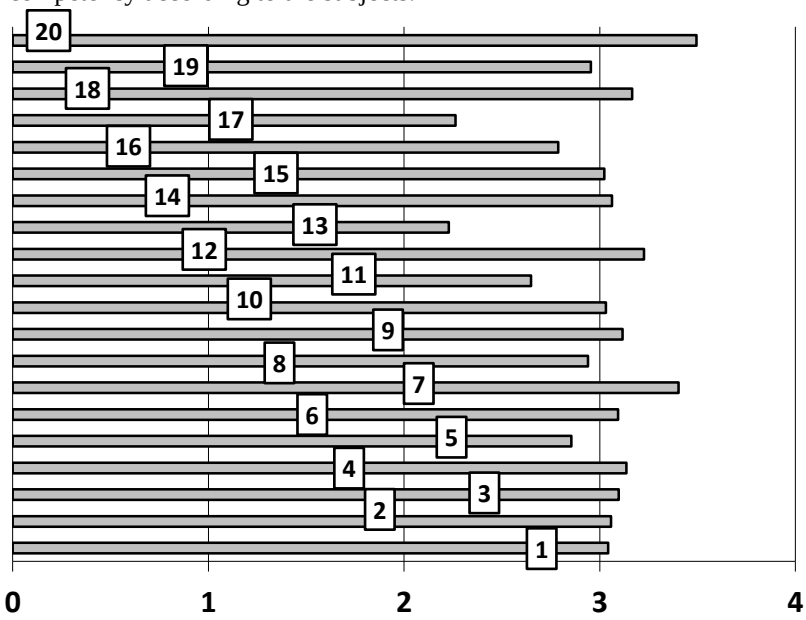

Fig. 2. Average sums of different generic competencies

ROLE THAT REQUIRES THE HIGHER LEVEL OF GENERIC COMPETENCY

Concerning professional figures, the one that requires more generic competency, according to the respondents is "C" followed by "B" and "A", presenting just slight differences among them. In contrast, figure G, according to subjects' answers, is the professional role with lower levels of generic competency. Figure 3 shows a comparison of the sum of generic competencies averages:

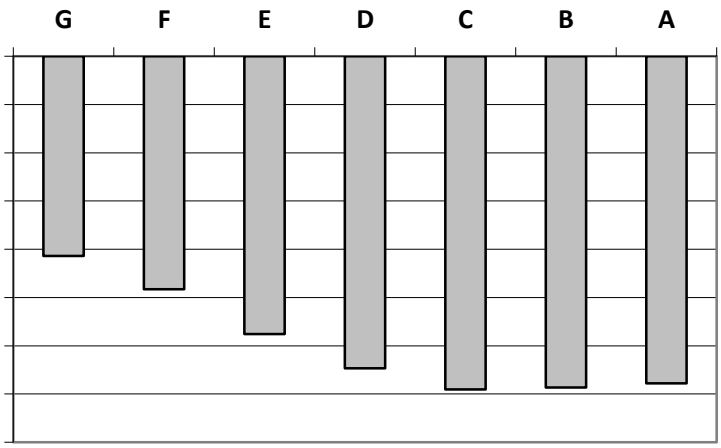

Fig. 3. Average sums for different roles

3.4. Discussion

Team work is one of the leading competencies of the study. This competency has been highlighted as crucial for IT professionals throughout the literature (e.g. Bassellier & Benbasat, 2004; Bassellier, Benbasat & Reich, 2003; Coombs, 2009; Grugulis & Vincent, 2009; Martin, 2007) and this study concurs with previous works. According Cox & Kreger (2005), in order to increase the productivity of information professionals, organizations are seeking paths to improve collaboration and teamwork by creating a work environment without borders, reliable and secure, and providing the connection and access to information anytime, anywhere. In a new Knowledge society, these means are highly indicated to enable teamwork in high performance environments.

The competency with the highest importance is "Quality concern". Various empirical investigations in the technology field reveal that this characteristic is one of the competencies that differentiate exceptional workers from those that are not (Turley & Bieman, 1995). It allows effective management of the information technology function (Jaska & Hogan, 2006), and brings about an improved maturity for organizational processes (McGuire, 1996). Quality is recognized as fundamental in our study. It is the most valuable generic competency and is present with grandness in every professional role within defined career ladder.

"Environmental sensibility" is the less valued competency across profiles. However, this fact goes against one of the most recent trends in IT: environmentally responsible computing. This movement aims to reduce IT's environmental impact and to create a sustainable environment (Jenkin, Webster & McShane, 2011; Meyer, 2009)—making IT part of the solution to current environmental problems. To do so, the IT sector, IT professionals, and IT users must develop a positive attitude toward addressing environmental concerns and adopt forward-looking, green-friendly policies and practices (Murugesan, 2008). green IT" assesses the twin issues of making ICT itself "greener" by improving its energy-related performance, and of using ICT to "green" other aspects of an organisation's activity (Pattinson, Oram & Ross, 2011).

4 A proposal of generic competency ladder for IT professionals

Table 3 shows the generic competency level proposal. Competency values have been derived from the scores given by the experimental subjects, reflecting competency requirements for the given professional roles. Scores, expressed in a Likert scale ranging from 1 to 4, have initially been assigned by rounding the average scores for different professional profiles. Subsequently, they have been refined according to competency scales previously defined, in order to finally establish the evolution of competencies of employees in the business environment defined. This proposal is different in a sense from sample opinions. According to them, the top generic competency level is reached in "C". Our proposal is to reach this rank #1 in A, due the conviction that, opposite from

technical competency as stated in Colomo-Palacios et al. (2010), generic competency improves with the passing of time.

Table3. Generic competency level proposal.

Competency	A	B	C	D	E	F	G
Capacity for analysis and synthesis	4	4	4	4	3	2	2
Organization and planning	4	4	4	3	3	2	2
Oral and written communication in mother tongue	4	4	4	3	3	2	2
Problem solving	4	4	4	4	3	3	2
Decision-making	4	4	4	3	2	2	1
Critical thinking	4	4	4	4	3	3	2
Team work	4	4	4	4	4	3	3
Interpersonal skills	4	4	4	3	2	2	2
Ability to work on an interdisciplinary team	4	4	4	3	3	3	2
Information management	4	4	4	4	3	2	2
Ability to work in an international context	4	4	3	3	2	2	1
Ethical commitment	4	4	4	3	3	3	3
Environmental sensibility	4	3	2	2	2	2	2
Adaptation/flexibility	4	4	4	4	3	3	2
Creativity	4	4	3	4	3	3	2
Leadership	4	4	4	3	2	2	1
Understanding of other cultures and customs	4	4	3	2	2	2	1
Ability to work in an autonomous way	3	3	3	3	3	3	3
Initiative and enterprise	4	4	3	3	3	2	2
Quality concern	4	4	4	4	4	3	3

5 Conclusions and future work

In nowadays organizations, the importance of knowledge and competency is unquestionable. In a scenario in which the Knowledge Society is important to high technology industries, knowing which competencies are important for IT professional will also contribute to develop the Knowledge Society.

This paper aims at the identification of those levels using two known tools. On the one hand, the pyramidal model for professional careers, identifying one single professional track going from Junior Programmer (G) to CIO (A), identified by Colomo-Palacios et al. (2010). On the other hand, generic competencies provided by Casanovas et al. (2004). The result of the study conducted states generic competency levels for the ladder. According to its results, generic competency excellence is reached in a determined professional profile, in this case “C”, followed by “B” and “A”. The reason why “C” and not “A” is the top of the competency ranking can be found in the generic competencies list provided by Casanovas et al. (2004) and designed to be applied in a computer science academic context, without including management related competencies. One of the characteristics of CIOs is the proximity of this role to the senior management of a company. Typically, the primary focus of the CIO is strategic information systems planning and his/her responsibilities cover a broad technical and organizational scope (Lindström et al., 2006). Moreover, there is a consensus among researchers about the cross-functionality of the IT strategy, as it encompasses product, process, and human resources and is intertwined with corporate strategy (Lefebvre, Mason & Lefebvre, 1996).

Finally, regarding the most valued generic competencies, "Quality concern" and "Team Work" can be seen as the most valued ones for software engineering professionals.

To sum up, agreeing with Zampetakis and Moustakis (2010), that organization's capacity to innovate links with employee competency, knowing to what extent workers present competency gaps could enable organizations to innovate that is the warranty of their continuity.

Future lines of research can be drawn from the results of this study. Apart from being applied in other IT fields different from Software Engineering, there are those related to the inclusion of manager like competencies that can draw in a more accurate way higher roles, namely CIOs. Another research line may be focused on defining a method to evaluate competencies for IT professionals, including the assessment of several profiles and environments.

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