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# Culture dimensions in software development industry: The effects of mentoring

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**Software development is a human centric and sociotechnical activity and like all human activities is influenced by cultural factors. However, software engineering is being further affected because of the globalization in software development. As a result, cultural diversity is influencing software development and its outcomes. The software engineering industry, a very intensive industry regarding human capital, is facing a new era in which software development personnel must adapt to multicultural work environments. Today, many organizations present a multicultural workforce which needs to be managed. This paper analyzes the influence of culture on mentoring relationships within the software engineering industry. Two interesting findings can be concluded from our study: (1) cultural differences affect both formal and informal mentoring, and (2) technical competences are not improved when implementing mentoring relationships.**

**Key words:** Software development teams, human factors, cultural issues, mentoring.

## INTRODUCTION

Globalization is an unstoppable trend in almost all industries. In this new millennium, due to the advent of this phenomenon, the world is becoming increasingly interconnected (Jackson, 2008). Globalization is a business fact, expanded worldwide beyond domestic boundaries, that is, creating an interconnected world economy in which companies do their business and compete with each other anywhere in the world, regardless of national boundaries (Cullen, 1999). In fact, the world today is experiencing an unprecedented intensification of economic, cultural, political, and social interconnectedness (Jackson, 2008).

Globalization presents an important challenge for cultural differences and diversity (Kim, 2008). Although the common wisdom among economists is that the benefits from globalization are clear and significant, increasing international trade and bringing improvements in efficiency and access to goods and services (Olivier et al., 2008).

Information and communication technology (ICT) is playing a major role in the globalization phenomenon. ICT offers several important contributions: it enables managerial control over vast global supply chains, ICT itself is a product and service that can readily be offered to global markets, it is a trade platform, which joins suppliers and customers and eliminates barriers for information sharing and networking (Leidner, 2010). Apart from that, ICT has been fundamental for improving productivity and the development of knowledge-intensive products and services (Soto-Acosta et al., 2010). The instrument that is enabling such transformation is the Internet (Chuang and Hsu, 2010).

Globalization is not only affecting traditional industries but also the ICT industry. This industry is becoming more global both in ownership and in market scope (Aramo-Immonen et al., 2011). Within the ICT industry,

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globalization is causing profound changes in software development (Jaakkola, 2009; Smite et al., 2010). Nowadays, software engineering is connecting people and companies in novel and complex ways (Lu and Heng, 2009) and the industry and organizations itself are affected by social-centric paradigms (Valencia-García et al., 2010). Software development organizations that are close-knit time ago and which are typically collocated entities in this new scenario, require remote collaboration across distances and present a multinational and multicultural setting (Milewski, 2007). This new set up requires the flow of personnel over geographical borders and also major changes, which are transforming software development companies in multicultural organizations (Jaakkola, 2009). This trend towards globalization within the software industry is here to stay and proper multicultural team management is becoming essential (Mead, 2009). Thus, in an industry in which human capital is key (Colomo-Palacios et al., 2010; Liu et al., 2011; López-Fernández, et al., 2010), multicultural project management is becoming a new important issue in an already complex area. The demographic diversity of the software development workforce is growing as the mobility of professionals increases (Kankanhall et al., 2004) and, as a result, bringing cultural issues to the fore (Carmel and Agarwal, 2001). Contemporary international management literature has identified that the management of multicultural teams is an important aspect of human resource management (Ochieng and Price, 2010). The management of multicultural teams is complex and difficult, since diversity training and cultural sensitivity are often used to minimize cultural differences, creating pseudo homogeneous teams. In the new paradigm, global companies can draw more value from cultural diversity (Fallah and Lechler, 2008). Earley and Mosakowski (2000) stated that multicultural teams are used because outperform monoculture teams, especially when performance requires multiple skills and judgment. Moreover, global companies pursue to create a universal culture and integrate multi-domestic operations within the organization through individuals who hold opposing work-related values (Siakas and Balstrup, 2006),

In an industry intensive in human capital such as the software development industry, personnel development and management is crucial to guarantee a sustainable competitive advantage. Mentoring has received much attention recently as a tool for personnel development. Mentoring is increasing ethnic diversity in both the national and international workforce through the development of intercultural mentoring relationships (Osula and Irvin, 2009). In this scenario, and taking into account the intrinsic human capital intensive nature of software industry, knowing to what extent culture impacts on mentoring should be a relevant finding to help managers and software professionals in intercultural team management. Moreover, formal and informal mentoring relationships coexist in software industry. These two different kinds of mentoring interactions, according to literature, produce diverse effects that, to date, are unexplored in the software industry arena. The aim of this paper is to study the implications of multicultural interactions in the context of mentoring within the software development industry. The relevance of the work roots on the importance of human capital development in software industry and the multicultural nature of such sector in which studies of intercultural mentoring outcomes are scarce.

## MENTORING PROCESSES

Mentoring is one of the traditional ways to transfer knowledge. The concept of mentoring dates back to the earliest stages of human civilization (Kammeyer-Mueller and Judge, 2008). More specifically, it dates back to Homer's Odyssey where Odysseus, before leaving to fight in the Trojan War (traditionally dated 1193 BC-1183 BC), entrusted his older friend mentor to teach and educate his son, Telemachus (Gentry et al., 2008).

There are many definitions of mentoring in the literature, for instance, Haggard et al. (2011) identified approximately 40 different definitions used in empirical literature since 1980. For the purpose of this paper, Mentoring is defined as the matching of a novice with a more experienced person in the same role (Reiss, 2007). The People-Capability Maturity Model (P-CMM) stated that the purpose of mentoring is to transfer the lessons learned from experienced personnel in a workforce competency to other individuals or workgroups (Curtis et al., 2009). Furthermore, mentors use their experience to provide not only skills but also personal support and guidance.

Mentoring activities are organized around knowledge, skills and process to deploy competency-based competences (Curtis et al., 2009). The importance of mentoring has long been recognized in the literature. According to Zaleznik (1977) the mentor–mentee relationship is the most important relationship in an individual's professional life. Kram (1985) identified two broad functions that mentors provide to protégés: career development (that is, sponsorship, exposure and visibility, coaching, protection, challenging assignments) and psychosocial support (that is, role modeling, acceptance and confirmation, counseling, friendship). Furthermore, literature reports benefits to both parts. On the one hand, by means of mentoring, the protégé achieves success in his or her career (Allen et al., 2004; Blicke et al., 2009a; Ng. et al., 2005; O'Brien et al., 2008), higher salaries (Blicke et al., 2009b), more satisfaction and social acceptance in the working environment

(Kammeyer-Mueller and Judge, 2008) and higher job performance (Scandura and Williams, 2004). In sum, research shows that individuals who have been mentored have greater opportunities to advance in their professional career, get higher salaries and achieve better satisfaction (Knouse, 2001).

However, recent research have reported that mentoring is a good predictor of an individual's career satisfaction, but still only a very modest predictor of an individual's career ascendancy (Blicke et al., 2009b; Kammeyer-Mueller and Judge, 2008). Moreover, according to Singh et al., (2009), although mentoring matters for career success, it repre-sents only a part of a constellation of career resources embedded within the relationships. On the other hand, mentors may also benefit from the mentoring process (Gentry et al., 2008). The literature have reported benefits such as: greater performance (Allen et al., 2004; Allen et al., 2006; Ramaswami and Dreher, 2007), satisfaction and rejuvenation (Gentry et al., 2008) and promotion opportunities (Bozionelos, 2004). However, Allen (2007) gives a review of these benefits.

Mentoring is a tool widely employed for knowledge management (Abdul-Rahman and Wang, 2010). It reduces the learning curve for inexperienced human resources in software development projects (Ramaswamy, 2001; Lesser and Storck, 2010) and its introduction in education environment has been reported widely in the literature (Chen et al., 2010; Meerbaum-Salant and Hazzan, 2010). As a result, mentoring has been identified as a technique or strategy used for knowledge management in software development companies (Fehér and Gábor, 2006). Niazi et al. (2006) pointed out that mentoring is vital for the implementation of improvements in software development processes. More recently, mentoring has been identified as one of the leading success factors in adopting agile software development practices, since it expands the organizational culture (Misra et al., 2009; Shih and Huang, 2010). However, Casado-Lumbreras et al. (2009) stated that the distance between the theoretical program and its implementation decreases the efficiency of mentoring in software development companies.

## CULTURE: DIMENSIONS AND INFLUENCES

The first comprehensive definition of the 'culture' term is claimed to be provided by an anthropologist (D'Mello and Eriksen, 2010). Taylor's definition (1871), which considers culture as "that complex whole that includes knowledge, beliefs, art, morals, customs and any other capabilities and habits acquired by human beings as society members". There are researches that have thoroughly discussed cultural issues (Kluchhohn and Strodtbeck, 1961; Hofstede, 2001; Hall, 1976; Trompenaars and Hampden-Turner, 1998). Kluckhohn and Strodtbeck (1961) explained culture from the perspective of value orientations and identified five areas: human nature, person versus nature, time sense, social relations and space. MacGregor et al. (2005) extended Kluckhohn and Strodtbeck's (1961) culture statement "culture consists in patterned ways of thinking, feeling, and reacting, acquired and transmitted mainly by symbols, constituting the distinctive achievement of human groups, including their embodiments in artefacts, the essence of culture consists of traditional ideas and especially their attracted values". Hall (1976) presented a dimensional model which considers the culture from an anthropological standpoint.

Some of the dimensions considered in the model are time (polychronic versus monochronic) and communication patterns (high-context versus lowcontext). Trampenaars and Hampden-Turner's (1998) focused on the impact of intercultural variances on business and management processes. Their study was based on an empirical observation and as a result they developed a set of 7 value dimensions. Amongst all of them, Hofstede's work has gained more popularity and, therefore, for the purpose of this work, Hofstede's (2010: 6) definition is adopted "Culture is the collective programming of the human mind that distinguishes the members of one human group from those of another".

Hofstede (2001) provided strong evidence regarding how national cultural differences shape organizational behaviour at a local level and how differences in national and regional cultures affect work values. Social scientists have conducted extensive research on how cultures differ, which dimensions are more important and the clustering of similar and different countries (Olson and Olson, 2004).

Three famous models have analyzed culture dimensions in the literature, Hofstede's (1984), Hall's (1976) and Trompenaars and Hampden-Turner's (1998) model. The three present comparable features and have been used widely in the literature. Although the model developed by Hofstede (1984), which focuses on the values and culture of computer professionals (Carmel, 1999), have been widely utilized within informa-tion systems research (Myers and Tan, 2002) and, there-fore, deserves our consideration (Casey, 2010). In this sense, there are many recent and relevant reports on the use of this model for research on software development (Aramo-Immonen et al., 2011; Casey, 2010; Hahn and Bunyaratavej, 2010; Jaakola et al., 2010; Shih and Huang, 2010). Hofstede (1984) collected data from over 100,000 IBM employees from 40 different countries and identified 5 indices to describe the cultural variations exhibited by IBM employees. The five dimensions are as follows:

**Power distance (PDI)**

This dimension relates to how people react to inequality and how they accept the unequal distribution of power within their society and organizations. A culture with high power distance is characterized by an established hierarchy of power, based on status, wealth, intellectual capacity, or some other factors. Inequality is here considered a law of nature, rather than a problem. On the contrary, a culture with low power distance considers every individual as equal, despite differences in power, status or wealth.

**Individualism / collectivism (IDV)**

This index measures the extent to which the priority in a culture is given to individual or collective interests. The collectivist's preference is to be part of a closely-knit community. These people are expected to give allegiance to the groups they belong to. Unlike, in an individualistic culture, the interest of the individual prevails over that of the group. The ties between individuals are loose. Every person is considered as an independent entity capable of making his/her own decisions, and is expected to be fully responsible for the consequences.

**Masculinity / femininity (MAS)**

This dimension intends to find out whether an organization (or a society) minimizes gender role differences and gender discrimination. This dimension of culture is often referred to "quantity of life versus quality of life" by those following Hofstede's work (Benett, 1999). Men are supposed to be assertive, strong and focused on material success, while women are gentle, caring and concerned with quality of life (MacGregor et al., 2005).

**Uncertainty avoidance (UAI)**

This index is defined as the mechanism that different cultures employ to cope with life uncertainty. A culture with strong uncertainty avoidance presents little tolerance for ambiguity, prefers detailed planning and defines exhaustive societal rules and norms. On the contrary, cultures that present low uncertainty avoidance prefer less structure, fewer written rules and are more willing to take risks. Hofstede (1984) outlines that societies have devised three strategies to address this problem, namely: technology, law and religion.

**Long-term / short-term time orientation (LTO)**

This dimension shows to what degree people value the future versus the past or the present. Values associated with long term orientation are thrift and perseverance, whereas values associated with short term orientation are respect for tradition, fulfilling social obligations, and protecting one's 'face'.

Once the model followed in this study has been presented, the definition of two important terms is presented: intercultural and intercultural mentoring. Intercultural refers to "actual interaction between people of different cultures" (Stewart and Bennett, 1991: 12), while intercultural mentoring is an interactive relationship when mentor and mentee come from different cultures (Osula and Irvin, 2009).

The literature presents several works devoted to intercultural mentoring (Carraher et al., 2008; Crocitto et al., 2005; Mezias and Scandura, 2005; Osula and Irvin, 2009). Also, there are many reports on the use of mentoring in multicultural environments within the ICT industry (Casey and Richardson, 2008; Casey and Richardson, 2009; Lacity and Rottman, 2009; Oshri et al., 2007; Soto-Acosta et al., 2010; Woodward et al., 2010). However, no study has attempted to analyze the importance of national culture for mentoring within the software development industry. The study presented in this paper sheds light on mentoring relationships for managing intercultural setups within the software development industry.

## STUDY METHODOLOGY

### Research design

In order to analyze the cultural dimensions of mentoring relationships within software development industry, a questionnaire was conducted. The questionnaire con-tained 22 close questions (Likert-type scale with values ranging from 1 to 5) and was structured in 3 sections. The first section contained ten questions related to Hofstede's (1984) cultural dimensions, two per dimension. Questions in section one measured the influence of formal mentoring in concepts related to each dimension and, also, assess the influence of the group (informal mentoring) on the dimensions. Likert scale descriptors for these ten questions are as follows: 1 = very low influence, 2 = some influence, 3 = reasonable influence, 4 = sufficient influence, 5 = very high influence. Section two contained two questions related to the overall evaluation of the mentoring process. The first question evaluated the cross-cultural competence of the mentor (1 = very low level of competence, 2 = some level of competence, 3 = reasonable level of competence, 4 = sufficient level of competence, 5 = very high level of competence), while the second measured the overall evaluation of the mentoring relationship (1 = very poor, 2 = poor, 3 = average, 4 = satisfactory, 5 = very satisfactory).

Finally, the third section contains questions related to the influence of mentoring on technical competences improvements. Following SWEBOK (Abran et al., 2004), ten knowledge areas were selected as main technical competences of the discipline, namely: (1) software requirements, (2) software design, (3) software construction, (4) software testing, (5) software maintenance, (6)

**Table 1.** Descriptive statistics relative to Hofstede's cultural dimensions.

| | Mentors influence | | Workmates influence | |
|---|---|---|---|---|
| **Parameters** | **Average** | **Std. D** | **Average** | **Std. D** |
| Power distance index | 2.49 | 1.0140 | 2.51 | 0.7372 |
| Individualism | 2.58 | 0.9650 | 2.44 | 0.8675 |
| Masculinity | 2.51 | 0.7869 | 2.67 | 0.9293 |
| Uncertainty avoidance index | 2.16 | 0.7372 | 2.16 | 0.7674 |
| Long-term orientation | 2.47 | 0.8686 | 2.38 | 0.8336 |

software configuration management, (7) software quality, (8) software engineering management, (9) software engineering tools and methods (10) software engineering process. These competences have been previously used in several works related to competences and software engineering (Colomo-Palacios et al., 2010). Likert scale descriptors for these ten knowledge areas are as follows: 1 = very low improvement, 2 = some improvement, 3 = reasonable improvement, 4 = sufficient improvement, 5 = very high improvement.

The field work of the survey was conducted by the authors. All questionnaires were filled by subjects with the assistance of, at least, one researcher. Subjects filled the questionnaire in an isolated room located in their work environment. Questionnaires were carried out on printed copies and subsequently coded in the statistical analysis tool GNU R. In average, respondents took one hour and six minutes to answer the questions.

### Sample

The mentors sample consisted of 15 mentors pertaining to 3 different software development organizations, four women (27%) and eleven men (73%), with an average age of 42.9 and all of them were Spaniards. All com-panies had offices in several countries and the ownership of these companies is European, mainly French and Spanish. In sum, companies had about 80,000 employees worldwide.

Apart from mentors, 45 protégés were interviewed, three mentees per mentor. All mentoring relationships were intercultural. The mentees sample consisted of twelve women (27%) and thirty-three men (73%), with an average age of 27.2. Mentees belonged to twelve different countries: Algeria (3), Argentina (5), Brazil (7), Chile (3), Colombia (4), Ecuador (2), Mexico (6), Morocco (2), Peru (8), Poland (3), Romania (3) and Russia (3). All mentees were selected among professionals coming from traditional offshore countries (Latin-American, Maghreb and Eastern Europe).

## RESULTS

Table 1 presents average and standard deviation for Hofstede's (1984) cultural dimensions regarding mentors influence (formal mentoring) and workmates influence (informal mentoring).

As shown in Table 1, mentors and workmates influence presented similar values. However, with the aim of verifying whether the results presented statistically significant differences, the statistical *t*-test (comparison of two means) was used to analyze if differences between the two groups existed. The analysis was conducted for each cultural dimension. The level of statistical significance was set at 0.05. Results showed no statistically significant differences between groups PDI ($t(88) = 0.101$, $p>0.05$), IDV ($t(88) = -0.689$, $p>0.05$), MAS ($t(88) = 0.857$, $p>0.05$), UAI ($t(88) = 0$, $p>0.05$), LTO ($t(88) = -0.495$, $p>0.05$). Figure 1 shows the distribution of subjects' scores with respect to their country of origin. In average Morocco and Ecuador presents the higher mentors influence while Argentineans and Brazilians are less influenced by mentors. In informal mentoring, Argentina presents the lowest influence while Ecuador is the country that portrays the higher impact of informal mentoring in cultural dimensions.

To analyze whether differences among groups by country existed, the ANOVA analysis was used. In this case, taking into account that there are more than two groups we choose the statistical method analysis of variance (ANOVA). Results indicated that groups presented statistically significant differences for all cultural dimensions but for LTO. Results were as follows: PDI ($F(89) = 3.052$, $p<0.05$), IDV ($t(89) = 4.122$, $p<0.05$), MAS ($t(89) = 4.807$, $p<0.05$), UAI ($t(89) = 2.182$, $p<0.05$), ($t(89 = 1.819$, $p>0.05$)). These values were obtained analyzing both samples together. However, when analyzed separately, results changed dramatically, since for the mentors sample IDV ($F(44) = 2.707$, $p<0.05$) was the only index that presented statistically significant differences among countries, whereas statistical significant differences appeared for IDV ($F(44) = 2.519$, $p<0.05$) and MAS ($F(44) = 3.378$, $p<0.05$).

As stated previously two questions were included in the second section of the questionnaire, namely: the cross-cultural competence of the mentor and the overall evaluation of the mentoring process. The mean for the former was 2.80 with a standard deviation of 0.5878, while for the latter was 3.22 (with a standard deviation of 0.7351). None of the variables presented significant differences according to the ANOVA tests conducted, with respect to country of origin.

The questions on section three of the questionnaire assessed the influence of the mentoring process on

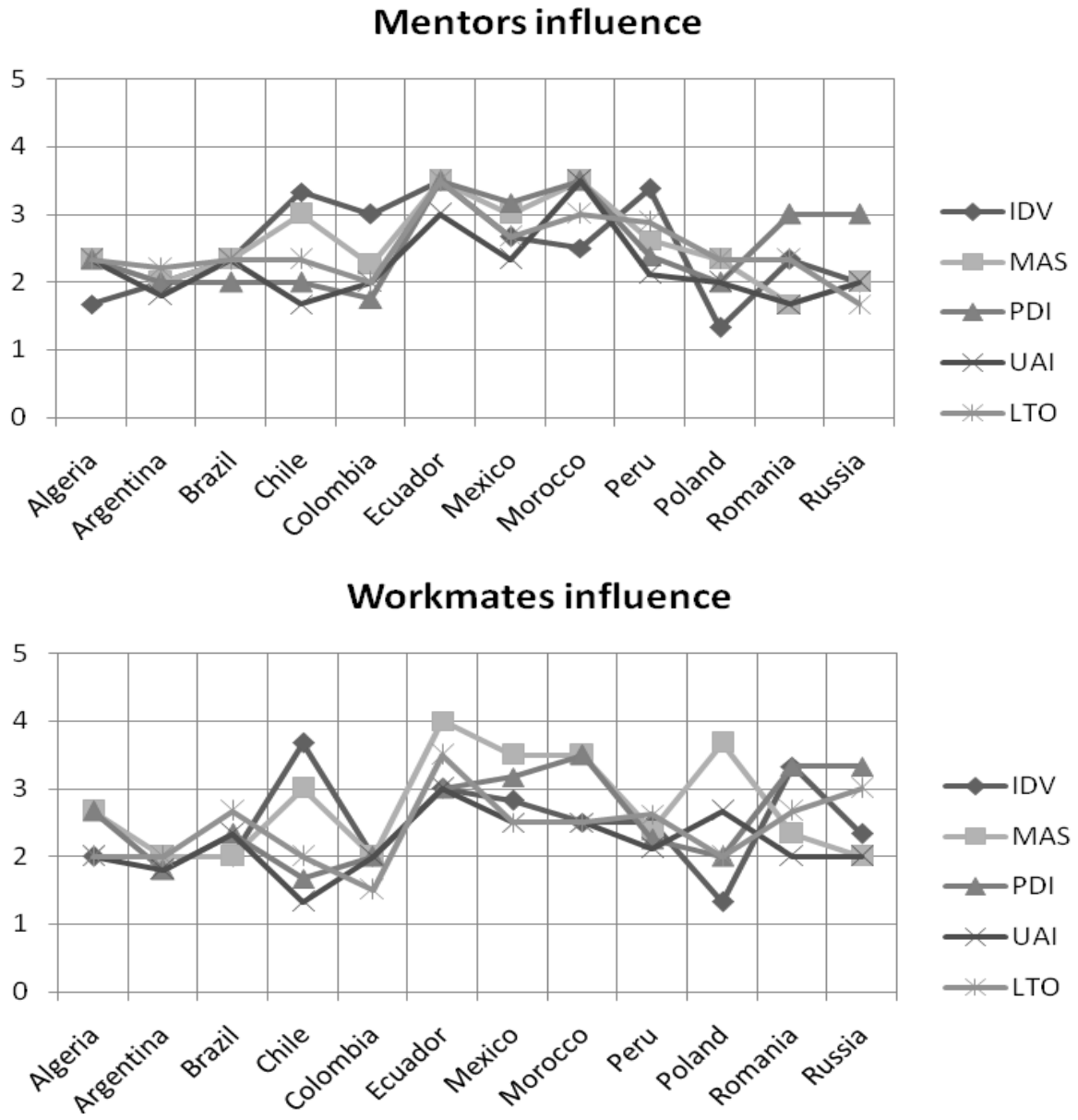


**Figure 1.** Mentors and workmates influence on cultural dimensions by country.

technical competence development. Descriptive statistics are as follows (average, standard deviation): requirements engineering (1.27; 0.4472), SW design (1.02; 0.1491), SW construction (1.02; 0.1491), SW testing (1.02; 0.1491), SW maintenance (1.02; 0.1491), SW configuration management (1.0; 0), SW engineering management (2.22; 0.8762), SW engineering process (1.24; 0.4841), SW engineering tools and methods (1.40; 0.1491) and SW quality (1.40; 0.5800). Figure 2 depicts the influence of mentoring process on technical competence improvement. All values were quite similar and low (near to 1), except for software engineering management (2.22). Moreover, five technical competences presented the same average value (1.02), while software configuration management had the lowest value (1.0).

## DISCUSSION

Results showed that no significant differences between informal and formal mentoring in the workplace with

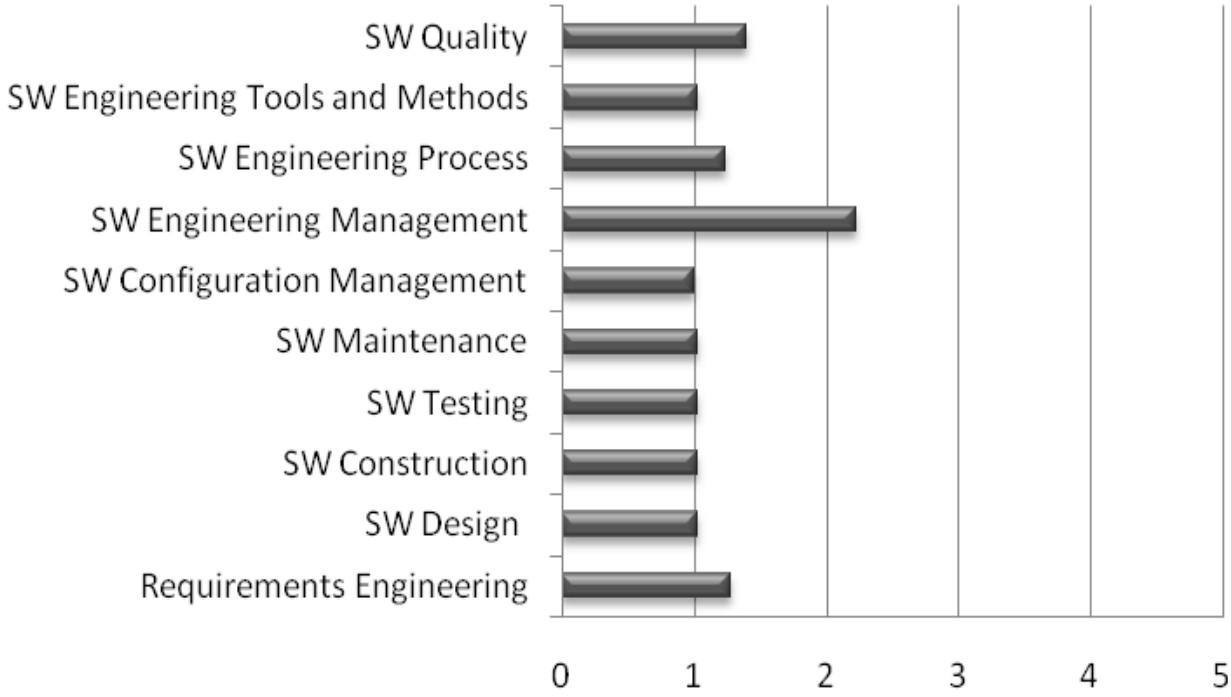


**Figure 2.** Influence of the mentoring process on software engineering technical competences.

respect to cultural values. This finding is in line with existing research (Raabe and Beehr, 2003), which suggests that informal mentoring relationships may be more valuable than formal ones. Informal mentoring relationship tends to be more natural and spontaneous, thus happening more on an ad hoc basis (Ragins, 1999) and this could help to spread corporate and national values in a proper way also. Informal mentoring has been found to be positively and significantly associated with knowledge sharing (Karkoulian et al., 2008).

Significant differences were found across countries. These differences may be explained by cultural differences among countries. For instance, differences between Chile and Spain in IDV are analyzed. According to Hofstede's data, Spain presented a value of 51, while Chile 23. In our study, Figures 1 and 2 showed high values for IDV. Using the same dimension, IDV, Poland presented low influence on mentors and workmates relationships (below 2) with similar results as that of Hofstede's (Spain = 51 and Poland = 60). To sum up, cultural differences affect both formal and informal mentoring. In this line, Bozionelos (2006) asseverates that mentoring prevalence may differ to some extent across cultural clusters.

Regarding cross-cultural competence, Osula and Irvin (2009) stated that culturally aware mentors must understand that cultural dimensions may significantly influence his or her intercultural interactions with mentees. Results showed that this competence was presented to a high extent. Findings suggest mentors take into account the cultural tendencies of the mentee and attempt to provide responses that are both faithful to the mentor's natural tendencies as well as being sensitive to the mentee's cultural expectations (Rosinski, 2003). As a result of this competence the overall process is also judged positive.

Regarding technical competence improvement, figures show very little improvement in the mentoring process. Colomo-Palacios et al. (2010) study revealed that greater levels of technical competence are presented in the first years of the software engineering career. As a result of this, very low exchange and improvement can be performed in the mentoring relationship. Moreover, Eby and Lockwood (2005) stated that the most frequently reported benefits for mentors is learning and, according to Mezias and Scandura (2005), protégés offer valuable resources to reciprocate mentors' support such as their own technical expertise. Finally, the nature of the mentoring process provides itself a justification of the low improvement levels of technical competence. Mentors are agents that transfer corporate culture, providing protégés with information on how to navigate the subtleties of the organization's informal political system, as well as appropriate behaviors (Singh et al., 2002). In sum, mentoring programmes facilitate the transfer of tacit knowledge (Dayasindhu, 2002) more than technical

knowledge. One technical competence (Software Engineering Management) presented high values. This may be because software development management is a complex task that is even more complex in multicultural scenarios where hard decisions are common (García-Crespo et al., 2010). Moreover, according to Colomo-Palacios et al. (2010), this competence presents higher levels for software engineering management than for technical roles. This could be one of the reasons for the improvement. The other can be rooted on the nature of the competence, closer to social sciences and, thus, less developed and studied in computer science or software engineering degrees.

## CONCLUSIONS AND FUTURE WORK

Today's globalization of software development has its advantages, but also its drawbacks. One of the main risks in this new scenario is cross-cultural management. Conflicts and misunderstanding may arise unless people learn how to interact in a harmonic way with persons from different cultures. Mentoring, both formal and informal, is a way to bridge the gap between people. In a scenario where many organizations present multicultural workforce even though they do not embrace (Global Software Development), mentoring may be a way to influence people's culture.

This paper presents an exploratory study of the influence of mentoring on this IT workforce. Both, formal and informal mentoring, were found to have a remarkable influence on mentee cultural dimensions, but such influence was found to be dependent on national culture distance.

This work is heading towards a three-pronged approach in terms of future work. The first consists in analyzing pair matching variables taking into account mentor and mentee cultures. The second is the study of culture in global software development (GSD) and, more precisely, the study of software engineering management practices in GSD teams adapted to cultural variables. The third is aimed to study new cultural dimensions specific to mentoring processes within the software industry.

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