

# Software Project Managers under the Team Software Process. A Study of Competences Based on Literature

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## ABSTRACT

Despite the clear relevance of the Information and Communications Technologies (ICT) market in world economics and the evident lack of success of software projects, organizations devote little effort to the development and maturity of the software project manager profession. This work analyzes the figure of project manager from the perspective of the Team Software Process (TSP), and it considers the required skills, attitudes and knowledge for a software development project. The basis for the study is the analysis of relevant references from the literature for their subsequent categorization into different competency concepts. The results of the analysis are compared with the contributions which the Guide to the SWEBOK® and the PMBOK® Guide models provide of the profiles of the project manager. The results indicate that the literature relating to the Team Software Process is focused on the definitions of skills and attitudes, and to a lesser extent on knowledge components. The lack of the definition of the components which comprise competency constitutes a challenge for software development organizations that use TSP, whose project managers should confront the task with full capacities, and without the help of established and recognized competencies. The current work attempts to establish the competencies for project managers identified in the literature, in the environment of the use of TSP for software development, using a study based on content analysis.

## KEYWORDS

*team software process; project manager; team leader; competence; software project management.*

## INTRODUCTION

The software industry has become one of the main streams of development all around the world. In Europe, the ICT market represented 5.74% of the GDP in 2007, and the expected growth for 2008 is 2.9% (EITO, 2007).

Software project management is a relatively recent discipline that emerged during the second half of the 20th century (Kwak, 2005), although most software projects are more concerned with aspects of technology rather than management (de Amescua et al., 2004). The task of managing a software project can be an extremely complex one, drawing on many personal, team and organizational resources (Rose, Pedersen, Hosbond, & Kræmmergaard, 2007). In this scenario, some authors (E.g. Turner & Müller, 2005; Munns & Bjeirmi, 1996) have indicated that the

influence of competencies on the success of projects has not been successfully explored, while other authors (E.g. Pinto & Kharbanda, 1995; Skulmoski, Hartman, & DeMaere, 2000; Jiang, 2002; Crawford, 2005) have identified the competencies of project managers applying the competency concept, that is, they have identified the competencies which fundamentally make project managers competent and successful.

In software development projects, Boehm (1981) points out that subsequent to the size of the product, personnel factors have the most important influence on the total effort necessary for the development of a software project, and that personnel characteristics and human resources related activities constitute the most relevant source of opportunities for improving software development (Boehm et al., 2000). On the same issue, some other authors state that inadequate competence verification of software engineers is one of the principal problems when it comes to carrying out any software development project (McConnell, 2003).

In the ICT field, software is a critical element. Failure rates associated with software projects are extremely high, and the personnel included in software development teams is one of the most decisive aspects for projects and their deficiencies (McConnell, 2003). The teams should be comprised of practitioners having heterogeneous education and experience (McConnell, 2003) and human resources management systems should be easily able to identify and assess the engineers' professional training, with the objective of improving the workforce's competence level (Curtis, Hefley, & Miller, 2001). This improvement is one of the key elements of profession models as stated in the 'skills development' component by Ford & Gibbs (1996) and McConnell (2003).

In software engineering, development work is a team activity, and the effectiveness of this teamwork represents a crucial factor for the quality and the success of the entire project (Humphrey, 2006a). Based on this premise, TSP (Team Software Process) originated, aligned with the principles provided by CMM (Capability Maturity Model) and PSP (Personal Software Process), TSP. The main objective of TSP is to provide the fundamental mechanisms so that a development team is able to establish a development process and a plan to define how the work is to be carried out (Humphrey, 2000b). The relevance of TSP is supported by both its integration into the quality framework provided by the SEI (Software Engineering Institute) and the benefits reported by several organizations after its adoption in terms of quality and productivity of engineering teams' improvement (Humphrey, 2000b). For example, *Teradyne* saved 228 engineering hours for every 1000 LOC (lines of code) and reduced the repair costs about 4.5 times the cost of producing the programs in the first place (Humphrey, 2000b).

Given, on the one hand, the importance of software currently in the global economy, and on the other hand, the impact of the maturity initiatives for the software process, from the point of view of the individual (PSP), as well as the development group (TSP), or the organization (CMM), the manager figure of a project in a TSP environment results to be a key element for the process. This paper proposes the current study within this scenario, aiming to elucidate whether the TSP literature adequately represents the competencies of these professionals in their distinct environments: skills, attitudes and knowledge.

The remainder of the paper is organized as follows. The next section defines the competence paradigm, as well as its components and principal implications. This is followed by the description of the role of the team leader in TSP. The literature regards this role to be similar to that of the software project manager. Subsequently, the paper provides the description of the study carried out, and its main findings. Lastly, the paper presents the principal conclusions and future work of the study.

## **THE COMPETENCE PARADIGM**

The competence approach to human resources management has a long history. The early Romans already practiced a sort of competence profiling in attempts to detail the attributes of a “good Roman soldier” (Draganidis & Mentzas, 2006). More recently, early 20th century scientific management used the concept of competence (Taylor, 1911), and is well established in the field of human resources management since the middle of the seventies, due to the works by McClelland. McClelland (1973) defined competence as those characteristics that are found to consistently distinguish outstanding from typical performance in a given job or role.

Competences and competence management has proved to be an extremely relevant area of study. There are several contributions to the field from the academia, the industry and international organizations (such as OECD, EC, and ASEM). Despite the different approaches and objectives of the mentioned initiatives, all of them remark the fact that competences are the key element for the successful development of an individual, in both professional and social environments. From this point of view, Tapio (2004) defines competence as the combination of skills, knowledge, aptitudes and attitudes that, when transferred to a certain task or professional contribution, enable the individual to perform the task efficiently.

However, the fact that the concept of competence has been used in so many areas of research (Bassellier, Horner Reich, & Benbasat, 2001) has lead to an evident confusion that has been named the ‘competence pandemonium’ (DeHaro, 2004) and furthermore, some authors point out that this misunderstanding has hindered the creation of a cumulative body of knowledge (Marcolin, Compeau, Munro, & Huff, 2000).

Competence is often used in the sense of performance, however, this is not entirely accurate (Bassellier, Horner Reich, & Benbasat, 2001). Nonetheless, competence is a factor that, coupled with motivation, effort and supporting conditions, may have a direct impact on performance (Schambach, 1994). Another approach to competence is the skills-based approach. From this point of view, competence is the fit between an individual and the task to be performed (Davern, 1996). Another component of competence is knowledge, which broadens the definition, considering that the competence is not directly linked to a specific task but is related to the ability to transfer knowledge across tasks (Bassellier, Horner Reich, & Benbasat, 2001).

The impact of the competency paradigm has also had an effect in the Project Management discipline. Diverse organizations have aimed to establish the knowledge necessary for the carrying out of the professional labor of project managers, with initiatives such as the APM Body of Knowledge (Dixon, 2000), the ICB: IPMA Competence Baseline (Caupin, Knopfel, Morris, Motzel, & Pannenbacker, 1999) and the PMBOK Guide (PMI, 2004). Additionally, multiple authors have attempted to establish the competencies of project managers from an empirical viewpoint, generally based on the application of surveys (E.g. McVeigh, 1995; Dinsmore, 1999; Skulmoski, Hartman, & DeMaere, 2000; Jiang, 2002; Crawford, 2005).

Given the range of project types, organizations and researchers can expect a wide variation in the range of project management competences and approaches that may be required (Morris, Crawford, Hodgson, Shepherd & Thomas, 2006). In the IT environment, the literature is saturated with studies concerning the competencies of the professionals of the sector. Studies can be found about the competencies necessary for analysts (Misic & Graf, 2004), chief information officers (Bassellier, Reich & Benbasat, 2001), software engineers (Turley & Bieman, 1995), entry-level IT professionals (McMurtrey, Downey, Zeltmann, & Friedman, 2008) or information systems

professionals (E.g. Lee, Trauth, & Farwell, 1995; Wu, Chen & Chan, 2007), to cite some of the most significant cases.

In the concrete environments of software development projects, initiatives concerning the definition and analysis of the competencies of project managers have also been carried out (E.g. Sukhoo, Barnard, Eloff, Van der Poll, Motah, 2005; Rose, Pedersen, Hosbond & Kræmmegaard, 2007). It is without doubt that the importance of maturity models and the characteristics of a team leader for TSP define a field of study which researchers in the field should undertake, with the objective of establishing the competencies of this role with precision.

## **THE TEAM LEADER ROLE IN TSP**

TSP (Team Software Process) was first launched in 1996 by Watts S. Humphrey, aiming at the definition of an operative process to help and support software development teams to consistently perform quality work (Humphrey, 2000b). The approach provided by TSP is aligned and extends the quality strategy developed by Deming and Juran, which also played a crucial role in the development of Capability Maturity Model (CMM) in 1987, and Personal Software Process (PSP) in 1995 (Humphrey, 2000b). PSP, TSP and CMM, as well as People CMM, are integrated into a process maturity framework devised by Humphrey at the beginning of the 1980s (Curtis, Hefley, & Miller, 2001) aimed at the adoption of best quality practices at every level of organizations.

The objective of the TSP is to create a team environment that supports disciplined individual work and builds and maintains a self-directed team (Davis & Mullaney, 2003). To achieve this goal, the TSP is structured in two primary components. The first component is the TSP launch, in which the team reaches a common understanding of the work and the approach adopted (Davis & Mullaney, 2003). By the end of the launch, the team becomes a cohesive and effective working unit, in which all the team members are committed to a plan (Humphrey, 2000b) that balances the needs of the business and customer with a feasible technical solution (Davis & Mullaney, 2003). The second component of the TSP is the team-working and management component. During this process it should be ensured that all team members follow the plan (Humphrey, 2000b) and, therefore, the figure of the team leader becomes crucial.

The team leader is responsible for guiding and motivating the team members, handling customer issues and dealing with management (Humphrey, 2000b). Management expects that the team gets the assigned job done; hence the team leader must be able to follow the schedule with the assigned resources to produce products that meet the stated requirements (Humphrey, 2000b).

The TSP literature does not describe the team leader role as a function of his competencies, but uniquely based on isolated descriptions. Research should examine the peculiarities of the figure with the objective of determining whether the team leader of TSP projects can be differentiated in any way from the descriptions of project managers in the Project Management or Software Engineering literature.

## **THE STUDY**

Taking into account that the source of information for the study was relevant literature, the study carried out is of qualitative character. The said study is centered on the analysis of two of the most relevant books from the TSP literature: (Humphrey, 2000a) and (Humphrey, 2006b). The structure of the qualitative analysis carried out stems from the schemes traditionally used in Sociology and Psychology research. The Austrian psychologists Lazarsfeld and Rosenberg

(1957) designed the classic model known as the concept indicator model. Previous authors such as Glaser (1978) contributed models for qualitative exploration, such as those entitled summing indicator concept and comparing indicator concept. Lazarsfeld and Rosember's model, as well as that of Glaser, essentially establishes a structure in which the concept which is the subject of the study, in the current case, the competences, define a series of dimensions, to each of which the researchers associate a series of indicators. The dimensions of a concept are those distinct aspects in which it can be considered, that is, those aspects which represent the components of the concept. Qualitative analysis is an established technique which has previously been used in the literature for the identification of the competencies of IT professionals (E.g. Todd, McKeen, & Gallupe, 1995; Gallivan, Tuex & Kvasny, 2004).

The focus of the content analysis was the identification of those indicators of the team leader role that are candidates to be mapped to a competence. The researchers carried out the identification of the dimensions and competency indicators by means of the analysis and classification of the occurrence of these in the quoted literature. In order to guarantee the quality of the results, an agreement indicator, Interjudge reliability was obtained, that is, the consistency of measurement obtained when different judges or examiners independently administer the same test to the same individual. In the current case, where three judges were used to verify consistency, the Kappa coefficient obtained was .86, representing statistically significant agreement ( $z=6.9$ ,  $p<.01$ ).

The results of the analysis revealed that the team leader role can be defined as the composition of 4 indicators of knowledge dimension, 13 indicators of skill dimension and 7 indicators of attitude dimension, displayed in Table 1.

<b>Dimension</b>	<b>Indicator</b>
Knowledge	Build and maintain an effective team
Knowledge	Handle funding issues
Knowledge	Lead risk evaluation and tracking
Knowledge	Participate in the configuration control board
Skill	Maintain team communication
Skill	Identify key issues
Skill	Make objective decisions
Skill	Combine forces
Skill	Work quality as a challenge
Skill	Meeting facilitator
Skill	Establish and maintain discipline
Skill	Enterprise vision
Skill	Promote initiative and creativeness
Skill	Scheduling
Skill	Lead the team effectively
Skill	Being resolute
Skill	Make the team goal oriented
Attitude	Commitment
Attitude	Personality traits

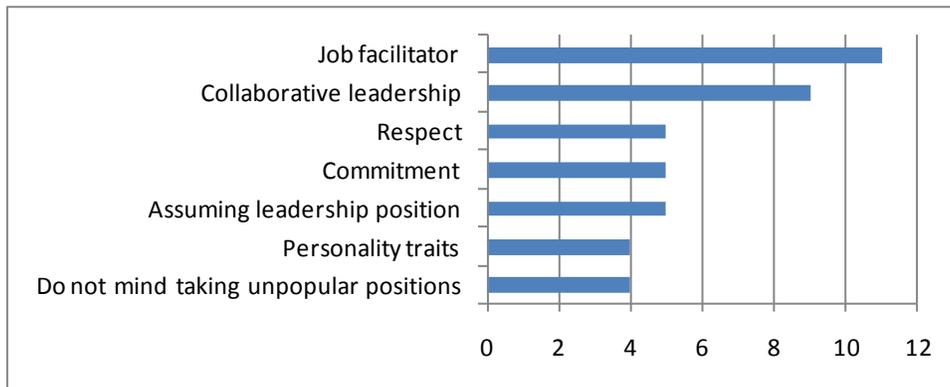
Attitude	Job facilitator
Attitude	Collaborative leadership
Attitude	Do not mind assuming unpopular positions
Attitude	Respect
Attitude	Assuming leadership position

*Table 1. Team leader role components.*

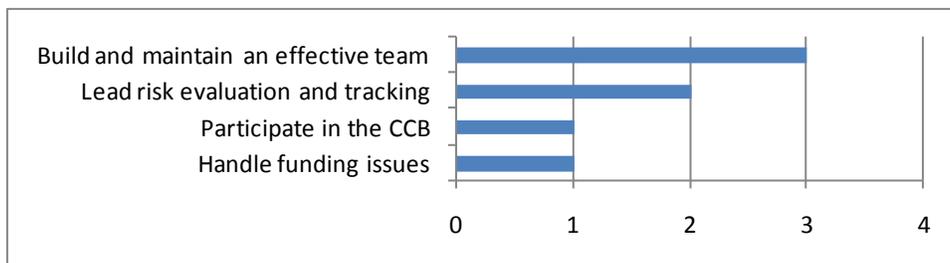
An interesting aspect for the analysis of the team leader role is to determine the relative relevance of the different components to the role. In order to do so, the authors performed a frequency analysis of the appearance of the components in the studied literature. The frequency analysis reveals that challenging the team members and using their skills to get the job done are the most relevant skills in team leaders (Figure 1). Additionally, the most demanded attitudes are the will to help the team, labeled as “Job Facilitator”, and to consider the different points of view of team members, labeled as “Collaborative leadership” (Figure 2). When considering knowledge components, although they do not present significant differences, team building and risk management have the higher incidence (Figure 3). Lastly, comparing all the components together, in Figure 4, the results of the research demonstrate higher relevance of skills and attitudes against knowledge components.



*Figure 1. Skill components.*



*Figure 2. Attitude components.*



*Figure 3. Knowledge components.*

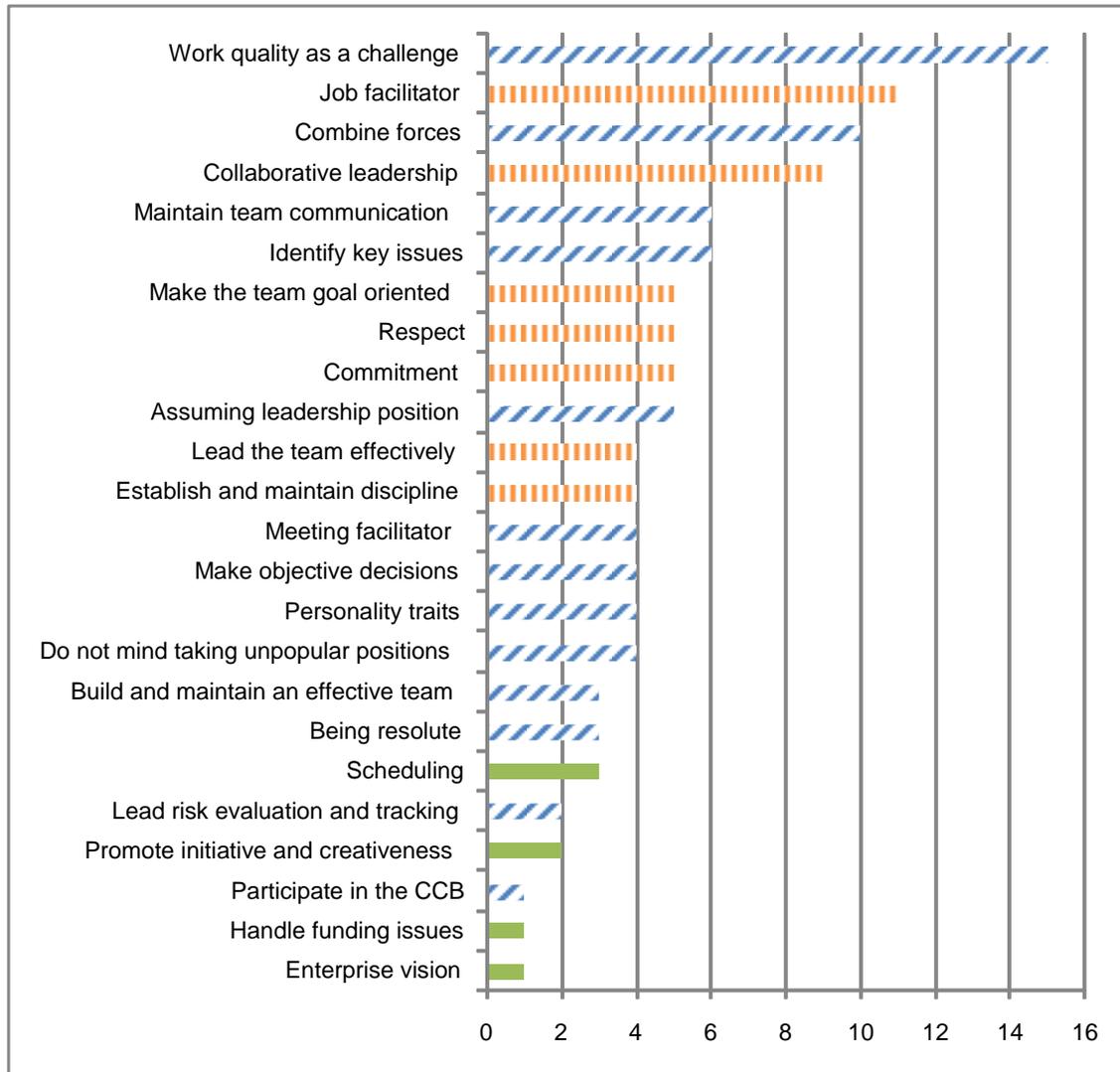


Figure 4. Team leader role components.

The authors have performed further analysis of the findings they extracted from the studied literature. The question now addressed is the relationship between TSP team leader role definition and two well-known and wide-spread bodies of knowledge such as the *Guide to the Software Engineering Body of Knowledge* (Abran, Bourque, Dupuis, & Moore, 2004) and the *Guide to the Project Management Body of Knowledge* (PMI Standards Committee, 2004). The aim of this comparison is to determine to what extent the TSP literature provides the definition of knowledge. The coverage of the team leader role components compared with the Guide to the SWEBOK® and the PMBOK® Guide is shown in Figure 5 and Figure 6, respectively. The Guide to the SWEBOK® areas are exclusively matched to knowledge components. However, when considering the PMBOK® Guide areas, matching to knowledge and skill components is found. Additionally, no matching from attitude components can be established, neither to the Guide to the SWEBOK® or the PMBOK® Guide, which is consistent with the focus and objectives of both bodies of knowledge. Nevertheless, there is a section in the introduction of the PMBOK® Guide that mentions skills classified into five areas of expertise that are required for effective

project management (PMI Standards Committee, 2004). Taking into account those skills, the matching with the PMBOK® Guide is wider, but there are interpersonal skills present in the team leader role which are not present in that section, and there are others that are less specific and are very task oriented.

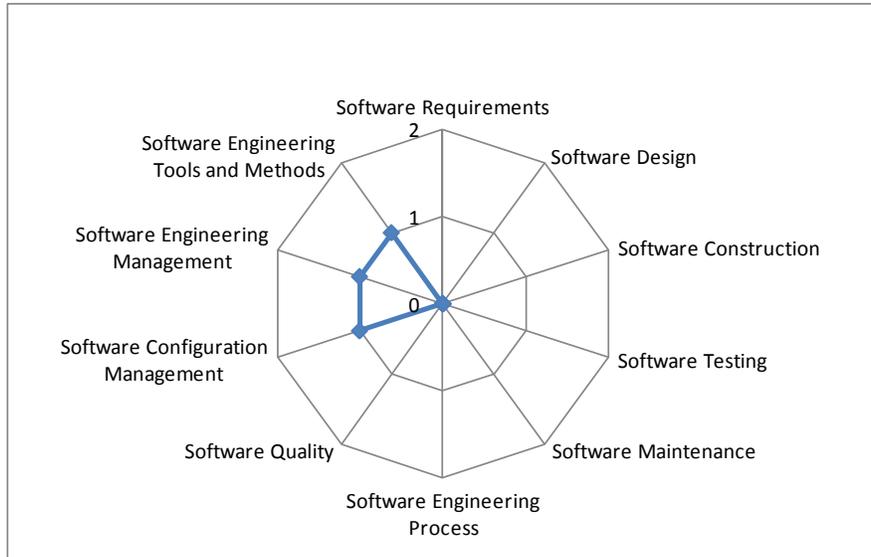


Figure 5. Matching to Guide to the SWEBOK®

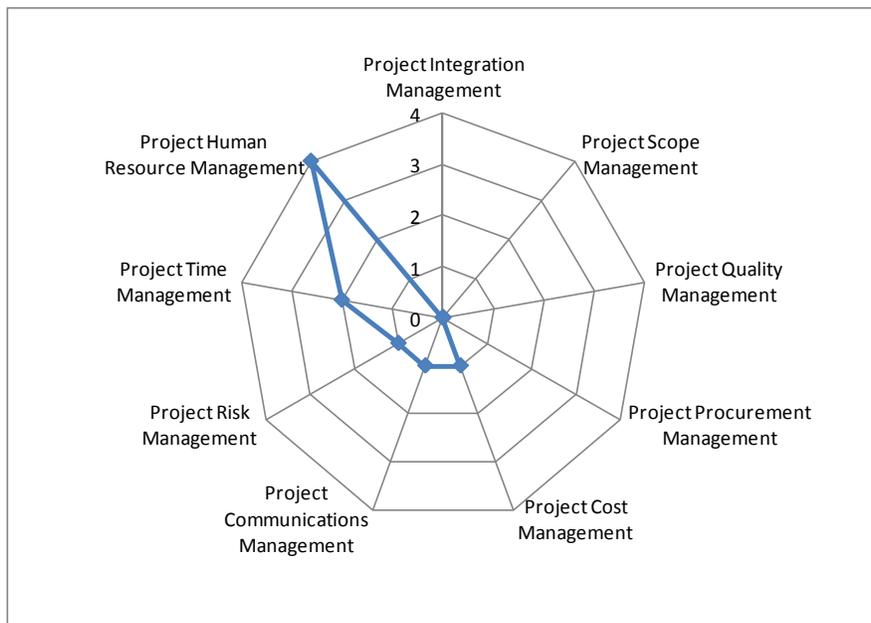


Figure 6. Matching to the PMBOK® Guide

Examining the matching performed between the competencies identified in the current study and the Guide to the SWEBOK® Knowledge Areas, this study can affirm that the outlining of more technical knowledge relative to software engineering is not sufficiently specified. Taking into account that the team leader generally does not take any other role within TSP projects (Humphrey, 2000b), this circumstance may explain the lack of the definition when referring to

this role according to technical competences. Other roles in TSP projects can be undertaken by one person or transferred to more than one during the course of a project.

However, this fact is not able to justify the necessity to know the competency levels of software development project managers in the diverse technical competencies of the discipline in detail. As a result, the authors propose to carry out an empirical study as future work which continues the works of (Acuña & Juristo, 2004) and (Colomo, 2005) in the determination and evaluation of the competencies of the participants in software projects.

Regarding the mapping of the competencies detected in the current work in relation to the areas of the PMBOK® Guide, it can be intuitively established that the principal focus can be found in the necessities of the human resource management of the project manager. Other areas of interest identified are Time Management, and to a lesser extent Risk, Communications, & Cost Management. Initially, it results paradoxical that some of the active areas of the project manager are found neglected by his role, such as in the case of Quality Management or Scope Management, for example. The answer to this paradox may be found in the intrinsic characteristics of the work groups governed by TSP, given that both areas are divided between other roles identified, for example, quality/process manager or plan manager. Thus, the current study deduces that the style of management which TSP adopts is more participative, leaving some of the competencies of the project manager in the hands of the members of the work team.

## **CONCLUSIONS AND FUTURE WORK**

This article has performed a study of the competential profile of the team leader role in TSP. The study reveals that this role is comprised mainly of skills and attitudes and to a lesser extent of knowledge components. Some of the skills and attitudes identified can be found in 'standard' bodies of knowledge such as the Guide to the SWEBOK® and the PMBOK® Guide, but others are not mentioned in the literature that supposedly defines the software engineering profession. The analysis of the work reveals two types of conclusions. In the first place, and from the technical viewpoint (Software Engineering), the competency levels of the project managers of TSP in relation to the set of competency elements are not established. In the second place, the style of management of TSP permits the team leader to concentrate on aspects such as the management of human resources, delegating some others, such as the management of quality, to team members. As part of a more extensive study, the work has the objective of presenting the analysis of the literature carried out, and in this way, use it as a base for future work.

Taking as a basis the work performed until this moment, future work may consist of identifying the sources to precisely define the unmatched team leader role components using competence as the framework. Effort could also be devoted to extend the same analysis to the other roles present in the TSP. Additionally, and adopting a more classical methodology based on the application of questionnaires, in the future, the authors of this article aim to undertake research for the establishment of the competencies of all of the members in TSP work groups. These initiatives would clearly contribute to the maturity of the software engineering profession under the paradigm presented by Ford & Gibbs (1996) and McConnell (2003).

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