Computer Standards & Interfaces 54 (2017) 162–175

Contents lists available at ScienceDirect

Computer Standards & Interfaces

journal homepage: www.elsevier.com/locate/csi

A standard-based framework to integrate software work in small settings

Mary-Luz Sanchez-Gordon[a,*], Antonio de Amescua[a], Rory V. O'Connor[b], Xabier Larrucea[c]

[a] Universidad Carlos III de Madrid, Department of Computer Science and Engineering, Leganés, Madrid, Spain
[b] Dublin City University, Dublin, Ireland
[c] Tecnalia, Bizkaia, Spain

ARTICLE INFO

Keywords:
Small companies
VSE
Small settings
Software process improvement
Human factors
Socio-technical system

ABSTRACT

Small software companies have to work hard in order to survive. They usually find it challenging to spend time and effort on improving their operations and processes. Therefore, it is important to address such needs by the introduction of a proposed framework that specifies ways of getting things done while consciously encourage them to enhance their ability to improve. Although there are many software process improvement approaches, none of them address the human factors of small companies in a comprehensive and holistic way. Samay is a proposed framework to integrate human factors in the daily work as a way to deal with that challenge. This study suggests managing human factors but pointing out the software process life cycle. The purpose is to converge toward a continuous improvement by means of alternative mechanisms that impact on people. This framework was developed based upon reviews of relevant standards (such as ISO/IEC 29110, ISO 10018, OMG Essence and ISO/IEC 33014) and previously published studies in this field. Moreover, an expert review and validation findings supported the view that Samay could support practitioners when small software companies want to start improving their ways of work.

1. Introduction

Although there is not worldwide official statistics, it is known that the vast majority of enterprises are very small or small. According to Eurostat, 98.8% of independent European enterprises have up to 9 employees (called microenterprises), and another 6,5% have from 10 to 49 employees [1]. Likewise, OECD (Organization for Economic Co-operation and Development) indicates that microenterprises account for 70 to 90% [2]. At a time when technology advances almost daily, software development companies are under increasing pressure to improve productivity while maintaining quality and keeping costs to a minimum [3] and countries need the capacity to adopt, adapt and develop relevant software [4]. Moreover, it has been observed that one of the first challenges for small companies is that their primary business objective is to survive [5,6] because their resources are scarce. They can have a low software development process priority [7], since they are focused on the product quality and delivery time rather than in the process quality [8]. Nevertheless, these companies develop and/or maintain systems and/or software that is used in larger systems [9,10]. Therefore, it is of particular importance to ensure that this sector can support the public and private sector local needs [4]. it is crucial that changes and adaptation processes be triggered only for factors that are really relevant for the company [1].

In practice, software development is beset with many challenges and constraints [11]. The implementation of controls and structures to properly manage their software development activity is necessary and constitutes a major challenge [12]. In fact, there are multiple approaches for organizing the software development process and multiple factors influencing the software development process [13]. Software is a byproduct of human activities that incorporates our problem solving capabilities, cognitive aspects, and social interaction [14]. People are fundamental in the software process and in its assessment and improvement [15]. Moreover, the software development process has been considered a *"socio-technical system"*, where organizational and human aspects have a key role and have to be supported by technology in a way that is human and organization-driven [16]. Indeed, it can be stated that the software industry is highly dependent on people [17,18]. The human factor in software development is the ingredient that ultimately gives a project team its soul [19]. As result, technical aspects are not enough to ensure the success of a human activity due to human factors impact software process and software process improvement (SPI) initiatives.

In spite of their importance, recent studies show that very small enterprises still struggle to implement software process [12,20] and SPI initiatives successfully [21–23]. Most of them usually lack the knowledge and practical experience about it and cannot afford the

* Corresponding author.
E-mail address: mary_sanchezg@hotmail.com (M.-L. Sanchez-Gordon).

http://dx.doi.org/10.1016/j.csi.2016.11.009
Received 23 September 2016; Received in revised form 21 November 2016; Accepted 24 November 2016
Available online 26 November 2016
0920-5489/

resources for, or see a net benefit in, establishing software processes as defined by current standards (e.g. ISO/IEC 12207) and maturity models such as the Capability Maturity Model Integration CMMI) [18]. Recent initiatives, such as ISO/IEC 29110, show similar challenges [21,24], but industrial experience demonstrate that small enterprise are currently not too far from satisfying those practices [25]. Taking these drawbacks into account and due to the apparent absence of any established framework for integrating human factors and lifecycle development process in small software companies, this paper presents Samay framework for improving ways of work on a daily basis in small software companies. Samay (Quechua word meaning spirit or soul) provides a core and two groups of elements: complement and support. The core includes a *software development process* along with *techniques* for dealing with human factors. First group is directly linked to the development process. Second group facilitates the adoption of the framework. In order to validate the framework an expert validation was carried out and a case study will be conducted in the future.

The rest of this paper is organized as follows. Section 2 gives an overview of the existing international standards to define Samay framework. Section 3 outlines the research approach carried out. Section 4 presents the different elements that comprise the proposed framework and Section 5 shows how the validation was done and its results. Finally, Section 6 draws some conclusions and future work.

2. Overview of International standards

The relationship between the success of a software company and the software process it utilized has been investigated [26,27] showing the need for all organizations, not just very small companies to pay attention to software process practices such as international standards [28]. It is the premise of this study that in order to support small software companies for improving their daily work, international standards can be used as a comprehensive point of reference. However, small companies require creation of a framework structured and systematic, and this paper presents an approach suited to integrate the essence of international standards into a practical framework in order to be ready or being prepared for dealing more appropriately with technical aspect of SPI initiatives.

2.1. Description of ISO/IEC 29110

ISO/IEC 29110[1] defines the minimum activities and work products that require VSEs to perform [29]. ISO/IEC 29110 provides a standard according to VSEs characteristics and needs [30] and it is considered an emerging SPI initiative [31]. Although, other initiatives are devoted to small entities such as Competisoft from Latin America and ITmark from Europe [32], ISO/IEC 29110 is becoming the widely adopted standard [18,31].

The overall objective of this standard is to assist and encourage VSEs in assessing and improving their software process. Until now, a series of pilot project for the software engineering profile standard have been completed in several countries [33]. However, there are many settings of VSEs and therefore have been proposed four profiles: entry, basic, intermediate and advanced, but only the first two have been released (2012 and 2011, respectively). The authors of this standard state that it is intended to be used by the VSE to establish processes to implement any development approach or methodology – e.g. agile, evolutionary, incremental, test driven development - based on the VSE organization or project needs. The ISO/IEC 29110 provides two main categories of processes: Project Management (PM) and Software Implementation (SI) [30]. PM process aims to establish and carry out in a systematic way the Tasks of the software implementation project, which allows complying with the objectives of the project in the expected quality, time and cost. SI process aims to systematically analyze, design, construction, integration and testing of the new or modified software products according to the specified requirements.

In summary, PM process uses the Customer's Statement of Work to elaborate the Project Plan. The PM project assessment and control tasks compare the project progress against the Project Plan and actions are taken to eliminate deviations or incorporate changes to the Project Plan. The PM project closure activity delivers the Software Configuration, produced by SI, and gets the Customer's acceptance to formalize the end of the project. A Project Repository is established to save the work products and to control its versions during the project. Therefore, the Customer provides a Statement of Work as an input to Project Management process and receives a Software Configuration as a result of Software Implementation process execution. The execution of the SI process is driven by the Project Plan. SI process starts with an initiation activity of the Project Plan revision. Project Plan will guide the execution of the software requirements analysis, software architectural and detailed design, software construction, software integration and test, and product delivery activities. In order to remove product's defects verification, validation and test Tasks are included in the activities workflow.

2.2. Description of ISO 10018

Late in 2012, the new ISO 10018 standard for quality management was published. Accordingly to ISO 10018 [34], the overall performance of a Quality Management System (QMS) and its processes ultimately depends on the involvement of competent people and whether they are properly introduced and integrated into the organization. The involvement of people is important in order for an organization's QMS to achieve outcomes which are consistent and aligned with their strategies and values. It is crucial to identify, develop and evaluate the knowledge, skills, behavior and work environment required for the effective involvement of people with the necessary competences.

The ISO 10018 standard has been released in 2012 and provides guidelines for human factors which influence people involvement and competence, and creates value that helps to achieve the organization's objectives. This standard is applicable to any organization, regardless of size, type, or activity [34]. Furthermore, the terms and definitions given in ISO 9000 and the following five apply: i) Competence mean ability to apply knowledge and skills to achieve intended results, ii) Competence acquisition means process to ensure that competence is attained by a person, a group of people, or an organization, iii) Competence development means process to increase the competence of a person, a group of people, or an organization, iv) Human factors mean physical or cognitive characteristics, or social behavior, of a person, and v) Involvement means engagement in, and contribution to, shared objectives.

The management of people involvement and competence requires both leadership involvement and strategy, and people involvement and competence acquisition process. The process is based on the four steps outlined below: i) Analysis: data are collected and analyzed in relation to the organization's short- and long-term objectives for people involvement and competence; ii) Planning: procedures are established and maintained to plan the people involvement and competence acquisition process on an organizational, group and individual level; iii) Implementation: the plans and associated actions are implemented in order to achieve the objective of people involvement and competence; iv) Evaluation: plans, actions and outcomes are reviewed and evaluated for continual improvement. There should be a review carried out at every step to ensure that the input and output data are correct [34]. These steps apply to all levels of the organization, group and individual. Furthermore, there are two annexes, human factors and self-assessment.

[1] freely available at http://standards.iso.org/ittf/PubliclyAvailableStandards/index.html.