Process Deployment: A Taxonomy of Critical Success Factors

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Abstract—**Various methods, models and standards for software process improvement have been adopted by organizations to improve their software processes. However, despite these efforts they still encounter difficulties in their process deployment throughout the organization. This is because the vast majority of these efforts focus more on the technical aspects, bypassing the human aspects. There is a set of factors that influence the successful deployment of new or modified processes. This paper presents a taxonomy of critical success factors in software process deployment to achieve the processes institutionalization.**

The development of a taxonomy related to these critical success factors is based on a systematic review of existing literature on specialized databases and industrial experiences that have deployed or implemented processes.

Index Terms— **Taxonomy of critical success factors, Process deployment, CMMI, Process definition.**

I. INTRODUCTION

VARIOUS models and standards have been created to improve processes. However the implementation of these models and standards in organizations presents difficulties that include: (1) improvement efforts are not aligned with business goals, (2) lack of leadership and visible commitment to improvement efforts, (3) the process does not respond to business needs, (4) efforts to implement technical aspects ignore strategies based on the social aspects [1].

According to Niazi [2], the problem of process improvement is not the lack of standards or models, but the lack of a strategy to implement these standards or models. Not considering the social aspects of a strategy for process deployment, threatens the institutionalization of the deployed processes.

Deploying processes based on any of the models and/or standards for process improvement requires a strategy to achieve the use and adoption of the new processes. This strategy should be based on change management and focusing primarily on the people to facilitate transition to the changes which involve the deployment of the new processes, and minimize resistance to such changes.

Although the above seems so basic, when putting into practice is neglected.

We have detected that most research are focused on improving the technology, but few mention other important factors such as culture, change management, people, communication, and training during and after the deployment process. Mc. Dermid and Bennet [3] have argued that human factors for software process improvement have been ignored and this has impacted heavily on process improvement.

According to Zahran [4], the inadequacy of proposals on the implementation of process improvement is one of the most common reasons for failure of improvement initiatives.

Identifying the factors that determine the success or failure of the process deployment is fundamental. However, it is necessary to standardize and classify these factors, which are described by different terms by different authors.

It is then necessary to have a method to classify them using common terms. To do this, two sources have been used; systematic review of the literature and the factors identified in software development organizations.

Then, to identify these factors, it is necessary not only to review the scientific evidence resulting from empirical or organizational research, but also check what is really happening in organizations that deploy their processes and identify critical success factors that influence the successful process deployment.

In order to maintain a common language in the organization, it is important to classify the factors that determine the success or failure of the process deployment.

With this objective, this paper presents a method for developing a taxonomy of factors that impact the deployment

process and should be considered in the deployment strategy.

The identification of these factors is based on a systematic review of articles and studies contained in bibliographic databases and those factors that have been identified in software development organizations during the deployment process.

This paper is organized as follows: Section 2 describes the research method for identifying the critical success factors of the deployment process, Section 3 describes the method to developing a taxonomy, Section 4 presents the critical success factors taxonomy, Section 5 presents benefits of the critical success factors taxonomy, and Section 6 presents the conclusions.

II. RESEARCH METHOD

The identification of the factors was obtained from two sources:

- Factors identified during the systematic review of articles and publications
- Factors identified through process deployment in software development organizations

A. *Factors identified during the systematic review of articles and publications*

The factors were identified during the systematic review of articles, publications, presentations and technical reports contained in specialized databases such as Science @ Direct, IEEE Computer, ACM Digital library, SpringerLink, ISI Web Knowledge, Wiley InterScience; articles and conference presentations as Software Engineering Process Group (SEPG) Conference Series Specialized and European Systems & Software Process and Innovation (EUROSPI).

In addition, articles and presentations by Software Engineering Institute (SEI), Crostalk, IT Governance and Google Scholar, were also taken into account.

All of the above are related to process improvement and deployment. To perform a systematic review the method proposed by Kitchenham [5] and Biolchini [6] has been followed. Figure 1 shows the steps and activities of the method used for the systematic review.
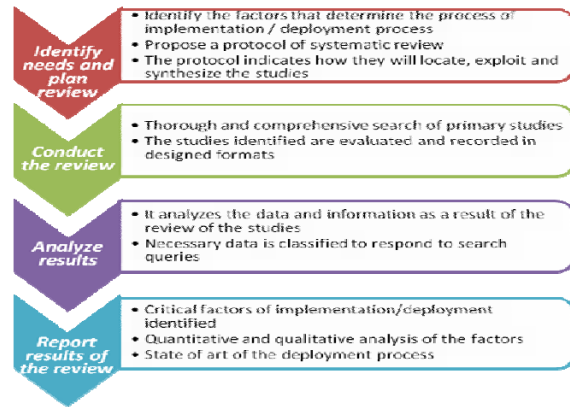

Fig. 1 Systematic review phases

B. *Factors identified through process deployment in software development organizations*

The factors were identified through process deployment in software development organizations using CMMI [7] as a reference model for the definition of their processes.

To identify the factors affecting the process deployment in organizations, a research was conducted in five organizations distributed in Latin America and Europe.

To achieve this objective, the following activities were carried out:

- Identify issues to investigate and develop the work plan.
- Identify those responsible for the deployment of processes in organizations.
- Identify the processes deployed in the organization.
- Develop a questionnaire with open and closed queries on the critical success factors identified in the deployment process.
- Conduct a survey in organizations.
- Analyze the results of the questionnaires.

III.
TAXONOMY OF CRITICAL FACTORS AND METHOD FOR ITS CONSTRUCTION

With the results of previous activities, two lists of critical success factors are obtained in order to be considered in the process deployment.

It is necessary to standardize the critical success factors in order to use a common language.

For this, a basic activity that has been performed is the development of a taxonomy to classify the critical success factors based on a systematic review, and on the industrial experience and knowledge of experts.

The purpose of taxonomy is to enable organizations to identify the factors that may affect the deployment process and include an inventory of the items identified.

Identifying critical success factors of process deployment is to classify the factors that can determine the success or failure of the deployment. The critical success factors should be taken into account when developing a deployment strategy. The result of the identification of factors is a list containing the key

success factors which have been identified.

The main objectives of establishing the taxonomy are:

- Provide support during the preparation of the process deployment method.
- Facilitate the search and grouping of relevant information.

To set this taxonomy, a method based on a systematic review of methods and models used for the development of taxonomies has been developed [8] [9], [10], [11], [12], [13], [14], [15], [16].

In this section, the method for the design of the critical success factors taxonomy for the process deployment is explained.

The method has been developed in order to serve as a guide for building the taxonomy of critical success factors of the deployment process.

The proposed method consists of 5 phases.

- Phase 1. Planning.
- Phase 2. Identification and extraction of information.
- Phase 3. Design and construction of the taxonomy.
- Phase 4. Testing and validation.
- Phase 5. Deployment of taxonomy.

These phases are described in briefly in the following sections.

A. Phase 1: Planning

The purpose of this phase is the planning of the project that will result in the design and implementation of the critical success factors taxonomy of the process deployment. The products obtained in this phase are: (1) Work Plan for the development of the taxonomy, and (2) Taskforce for the development of the taxonomy.

B. Phase 2: Identification and extraction of information

The purpose of this phase is to align the work plan with the information needs of the organization. At this stage the sources of information, the terms or variables to use, the definitions that will be part of the taxonomy will be identified.

The extraction of the necessary information for the elaboration of the taxonomy may come from internal and external sources. Internal sources are: (1) revisions which are carried out with the user's taxonomy, (2) surveys to identify needs, (3) policies to be followed for the taxonomy to have meaning and to be of usefulness to the organization, and (4) the information from representatives of all involved areas.

External sources include information from other organizations such as (1) scientific literature related to the subject under study, (2) existing business cases, similar experiences of other organizations.

The products obtained in this phase are: (1) general inventory for the construction of the taxonomy, (2) policies for using the taxonomy, (3) characteristics of the technology to use, and (4) list of representatives of all involved areas.

C. . Phase 3: Design and construction of the taxonomy

The purpose of this phase is the design and construction of the taxonomy using the inventory of terms. Identify the first level of categorization and other levels to determine the final structure of the taxonomy.

The products obtained in this phase are: (1) categorization of the first level terms, (2) general taxonomy and (3) dictionary of categories and subcategories.

D. Phase 4: Testing and validation

The purpose of this phase is to ensure that the designed taxonomy would be useful to users. The necessary tests and validation must be performed. The products obtained in this phase are: (1) validated taxonomy, (2) dictionary of categories and (3) validated subcategories.

E. Phase 5: Deployment of the taxonomy

The purpose of this phase is deploying the taxonomy throughout the organization. The products obtained in this phase are: (1) staff trained in the taxonomy and (2) taxonomy available to users.

Figure 2 shows the main activities for each stage of the method to develop the taxonomy of critical success factors.
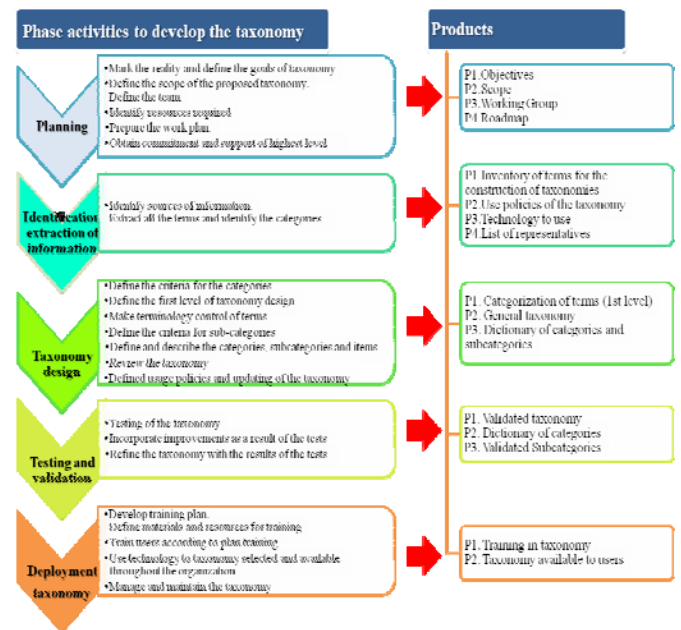

Fig. 2 Main activities to develop the critical factors taxonomy

IV. CRITICAL SUCCESS FACTORS TAXONOMY

As a result of the implementation of the taxonomy of critical success factors in the deployment process a limited number of categories are identified.

These categories were defined after a review of research literature on critical success factors taxonomy in process improvement and process deployment [17], [18], [19], [20],

[21].

This taxonomy includes five categories related to the object of study. The categories are:

- *Organization*: many factors which are not covered in the deployment process depend on the organization in which to carry out the process deployment.
- *People*: the deployment process is based on people at all levels, groups, teams and organization. etc.
- *Processes:* processes are deployment input and this process may be influenced by several factors.
- *Product:* quality product, delivered on time and on budget and required functionalities.
- *Others:* this includes other factors not found in the above categories.

Having identified the categories, the related elements are identified in the list of factors, grouped into subcategories.

Table 1 shows the list of factors according to the category and subcategories identified.

TABLE I
SUBCATEGORIES OF TAXONOMY

Category	Subcategory
1. Organization	Top management commitment
	Infrastructure
	Policies
	Corporative vision
	Organizational Culture
	Standards and procedures
	Commitment stakeholders
2. People	Leadership
	Skills
	Communication
	Knowledge
	Motivation
	Values
	Training
	Teamwork
	Participation
	Change Management
	Roles and responsibilities
3. Process	Process definition
	Process Library
	Institutionalization
	Deployment of process
4. Product	Quality Audit
5. Other	Globalization of the market

V. BENEFITS OF TAXONOMY

One benefit of the taxonomy is that having identified the critical success factors of the process deployment, it is able to propose a method for the deployment of processes, including these factors and ensure the process deployment.

The critical success factors taxonomy based factors of industrial experience and by systematic review has identified the factors related to the technical and social aspects that should be incorporated into a deployment strategy.

At this point, it is important to clarify that the method will take such factors as preconditions before starting the deployment of processes in the organization, such as:

- Obtain commitment from key stakeholders in the project.
- Have commitment of top management.
- Having the necessary resources to carry out the deployment of processes.
- Strategically aligning processes with business needs. Take the lead in carrying out the deployment process.
- Establishing clear reasons for the change, because understand why we need to change helps people to accept and work for the change.
- Establishing clear objectives and the benefits to be achieved for both the organization and the employees.
- Having defined and measured processes adapted to the needs of the organization which will be implemented (including tailoring guidelines).
- Have a library of automated processes that allows online access and use of participants in the deployment.
  Factors that have been considered in the taxonomy of factors obtained.

VI. CONCLUSIONS

Despite the existence of different methods, models and standards for software process improvement, difficulties arise during the implementation process. Because organizations when implement into their processes, most of them are focused on solving the technical aspects and leave out other factors related to social aspects. Specifically, the factors related to people who are running the activities.

Identifying the factors that determine the success or failure of the deployment process of processes is fundamental. However, it is necessary to standardize and classify these factors.

Several authors have classified the critical success factors for improving processes; however, there is no evidence of the classification of factors for the process deployment, which motivate to the interest in having a taxonomy of factors to focus on the process deployment, which incorporates factors such as process definition, deployment of processes, process library and institutionalization.

In this paper, have been presented two techniques: (1) review of the literature on critical success factors in the process improvement and process deployment and (2) the analysis of the presence of the factors contained in the taxonomy at the level of subcategories, in software development organizations.

Having a method for the preparation of taxonomy has allowed us to sort and classify the critical success factors of the

deployment process, standardize the concepts and it could be incorporated into a strategy that considers the factors focused on people.

The taxonomy of research-based factors of experience in organizations and in the systematic review has shown the need to take into account not only technical aspects, but to incorporate social aspects in order to achieve the process institutionalization, when a process deployment strategy is developed.

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