A Framework to Evaluate Software Developer's Productivity
The VALORTIA Project

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Abstract: Currently, there is a lack in companies developing software in relation to assessing their staff's productivity before executing software projects, with the aim of improving effectiveness and efficiency. QuEF (Quality Evaluation Framework) is a framework that allows defining quality management tasks based on a model. The main purpose of this framework is twofold: improve an entity's continuous quality, and given a context, decide between a set of entity's instances on the most appropriate one. Thus, the aim of this paper is to make this framework available to evaluate productivity of professionals along software development and select the most appropriate experts to implement the suggested project. For this goal, Valortia platform, capable of carrying out this task by following the QuEF framework guidelines, is designed. Valortia is a platform to certify users' knowledge on a specific area and centralize all certification management in its model by means of providing protocols and methods for a suitable management, improving efficiency and effectiveness, reducing cost and ensuring continuous quality.

1 INTRODUCTION

Currently Software Quality management is a concern in industry since a good management ensures that a project, product or service meets the expectations and interests of all placeholders. Carrying out a first-class quality management involves to steadily analyze and evaluate the present state and to define policies, goals and plans leading to improve and increase users and costumers' satisfaction. This trend motivates the existence of today's multiple lines of research centered on improving efficiency and effectiveness in different quality management processes and achieving resources, processes and products with the best quality guarantee.

An effective and efficient quality management also demands to define a Quality Model that states the required goals and objectives. A Quality Model consists of a set of features and relationships among them that constitute the basis for specifying quality and the subsequent evaluation. Thus, defining a Quality Model is not an easy, but a complicated task, if there is no clear strategy defining the main goal that interests us regarding a company's quality management.

However, selecting a Quality Model is essential, because if not clearly established and designed, no goal is reached and any project management is difficult to succeed. That is why a strategy is compulsory to analyze, evaluate and manage quality models effectively and efficiently. In conclusion, planning first a good strategy defining the design basis of a Quality Model is needed to elaborate one that meets the expectations.

Finally, continuous quality must be implemented to develop quality management, as well as to learn how to improve quality management processes through their control and the results of improving the Quality Model. Consequently, it is necessary to define a framework that may allow managing quality, ensure its continuous effective and efficient

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improvement, and implement appropriate management tools in such proposals.

The QuEF framework is found in these lines of research to analyze and evaluate quality models. It allows a study of quality models to choose the most suitable alternative for particular resources, processes and products.

Particularly, this article constitutes a resource: an IT professional. It lays the groundwork that can establish a framework to obtain a management environment for a given entity, in an efficient and effective quality framework where an entity may be any type of resources, processes or products. This work can be generalized to study and assess the quality for a particular entity from two points of view: the owner's and the interested organizations'.

The best productivity of technicians who will develop the project is listed as an important factor in software quality. Therefore, candidates who will participate in the project must be examined to determine whether they are suitable enough to perform it.

The productivity of technicians who will participate in a project will be assessed before tackling its development, in order to carry out the project's goal and improve efficiency and effectiveness. For this aim Valortia, a platform to evaluate users' skills and certify their knowledge on a particular subject is presented. It perfectly fits the QuEF framework as it takes into account Valortia's two main points of view: offer (evaluate productivity of professionals along software development) and demand (select the most appropriate experts to develop the suggested project)

Valortia has evolved into a powerful testing tool following the examples of the most used Web tools in this field, so as to identify whether the selected technicians are possible candidates to carry out the project,. In addition, Valortia uses the concept of tags allowing building their models according to ISO standards for people's accreditation, which gives this tool a very relevant value in the face of organizations concerned with the certification of their staff.

These standards are vital in organizations because with them, they increase their value in products and offers to be endorsed by recognized guidelines and standards. Similarly, ensuring the smooth running of staff evaluations constitutes the main objective of the tool presented in this article. Thanks to these rules, Valortia becomes a different test platform than the typical tools, meaning a very remarkable product for businesses.

After this introduction, this paper is structured as follows: Section 2 summarizes the work context of Valortia project and the related work. Then, Section 3 presents the QuEF framework and how it associates with Valortia. Section 4 describes the skills and attitudes that Valortia covers. Subsequently, Section 5 analyzes Valortia platform and finally, Section 6 states conclusions and future work resulting from Valortia project.

2 WORK CONTEXT AND RELATED WORK

This section introduces the real Valortia project, which is a platform to evaluate users' skills and certify their knowledge on a particular subject. Productivity is a model that consists of two parts: skills (professional knowledge and technical competences in software development) and attitudes (professional conduct or behavior in certain situations).

This tool has been developed according to the QuEF Framework guidelines, which combines phases with the idea of labels. Following this method, Valortia can carry out its goals in a simple, fast and effective way.

Valortia aims to achieve a framework to raise the discussion to the European e-Competence Framework (e-CF) (European e-Competence, 2014) that provides a clear guidance both for private and public businesses and organizations that need to make decisions on the candidates they are going to evaluate. It is also useful to promote clearer understanding of ICT organizations' skills, professions and professional perspectives needed.

Specifically, it focuses on the necessary skills to:

- Develop, maintain and manage ICT projects and processes.
- Exploit and use ICT in organizations.
- Make decisions, develop strategies and promote the use of ICT.

The recipients of this framework are:

- ICT professionals and managers.
- HR executives.
- Educational Institutions and training centers.
- Providers of certifications.
- Market analysts and policy makers.

It is divided into 4 dimensions:

- Dimension 1: 5 areas of expertise: PLAN - BUILD - RUN - ENABLE - MANAGE.
- Dimension 2: 40 ICT skills.
- Dimension 3: 5 levels of professionalism.
- Dimension 4: Examples of knowledge and

skills.

The previous framework of reference lays the foundation to develop assessment tools that enable IT professionals and businesses to have knowledge on:

- The current profile of each ICT technician.
- Plan or goals of professional development.
- Analysis of job profile target to fulfill.
- Study of current knowledge or skills.
- Examination of the gap related to the target position to fill.
- Investigation on the most valuable certifications for profile target to complete.
- Training and certification plan.

In addition, ISO/IEC 17024:2012 (ISO/IEC 17024, 2012) is crucial since the platform can create certificates for companies depending on the their projects contexts. It constitutes a specification for managing organizations and institutions that apply for accreditation and international validation in the field of people's certification.

ISO/IEC 17024 responds to the need to establish an internationally recognized scheme for the certification of individuals who operate it together with agencies. It applies to any discipline that tends to demonstrate competence of individuals under certification.

ISO / IEC 17024 requires that both the organization that operates under the management of people as well as certified individuals demonstrate proficiency. Competition implies that people have been tested and validated on defined requirements for education, knowledge, experience and skills.

This standard provides the general requirements for implementing, maintaining and certifying people's management authorization, describing the processes to certify competence and keep in secret the information obtained, considering the concerns of those affected and the organization itself as competent to carry out the validation.

A certification generally verifies the quality of a product, an organism or an individual. In the last case, it means that someone possesses a proficiency level to work properly and adequately to provide the expected services. In the field of Information and Documentation, certification represents the set of tests to obtain a certificate attesting professional qualification at a given moment in someone's career.

Certification ensures that a professional who possesses certain levels of knowledge and skills can perform a job in the best possible conditions. Apart from academic considerations, or values, above all, the degree of adaptation to the requirements of professional practice and development prospects must also be considered. Certification also offers professionals a tool for assessing levels of competition in the area, as well as clarifies and helps identify the suitable profile of candidates for a job, thereby providing greater transparency elements and saving functioning in the labor market.

Many bodies responsible for this authorization exist to support these certifications, such as:

- ENAC, which is responsible for accrediting organizations by assessing compliance with UNE-ISO / IEC 17024: 2012 requirements. It certifies professionals through their evaluation in order to assess whether they meet the requirements previously agreed.
- AENOR (Spanish Association for Standardisation and Certification), which is an organization standing for the development of standardization and certification (N + C) in industrial and service sectors..

As related work, it can stand out the different tools that today exist for conducting exams. BlackBoard, WebCT and Moodle are examples of these tools.

BlackBoard Testing tool is a kind of strategy for assessing students' performance, since it allows integrating sets of items to one or more topics. This tool scores some types of questions in a systematic way and records some others manually.

WebCT has a tool to create test, self-evaluations and surveys. The teacher first asks questions in a database of questions. Then he/she elaborates tests incorporating questions from the database. The student finishes the exams and they can know their scores and possible solutions. The teacher can view the results: grades, student responses or statistics, for example.

It also uses Quizzes/Surveys to create and handle tests and questionnaires:

- Exams are tests with assigned ratings. Both students and teachers can access grades and statistics.
- Questionnaires are anonymous tests with no grades assigned, but statistics. The answers to the questionnaires are automatically graded and the results are summarized.

Moodel platform has a wide variety of activities that can be used during the students' learning process. Some can be used to publish materials; others for students to perform work individually or in groups (wikis, databases or workshops, among others) and some others may be especially useful for assessing or review students' knowledge. The last group copes with tasks and activities, especially questionnaires.

Besides the possibility of creating exams easily with high- quality results, Valortia hides in the structure a very important factor. It is guided by the above standards, so that it ensures quality guarantees that the old tools do not provide.

Therefore, Valortia aims to consolidate as a tool to accredit professionals with different certifications offered and supported by the standards on which they are based.

3 A FRAMEWORK TO EVALUATE QUALITY

QuEF (Quality Evaluation Framework) is a framework that allows defining quality management tasks according to a model, so that all services the software used can be generated automatically or semi-automatically attending to the definition of that model. It is based on the set of good practices known as ITILv3 (Information Technology Infrastructure Library) (ITIL, 2011).

QuEF was initially developed to analyze, assess and improve quality of Model-Driven Web Engineering (Escalona, 2004; Escalona, 2008; Domínguez-Mayo, 2014; Vallecillo, 2007; Schwinger, 2008) proposals, but it has now become a generic framework for handling the quality of resources, processes and products. It aims to plan, control and improve those elements of an organization that affect customers' satisfaction and then achieve the result the organization expects.

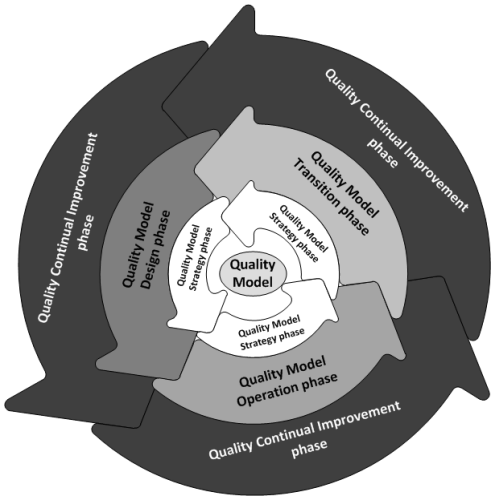

Figure 1: Schematic QuEF framework supporting the set of QuEF factory (Domínguez-Mayo, 2012).

As shown in Figure 1, QuEF Quality Model lifecycle (Domínguez-Mayo, 2012) is organized into the following phases:

- **Quality Model Strategy phase:** It is conceived as the heart of the Quality Model lifecycle concept and its main objective states that quality management should become strategically active.
- **Quality Model Design phase:** It deals with the Quality Model design, processes, and other aspects of the final design management effort. Significantly, design in QuEF is understood to encompass all relevant elements to elaborate the Quality Model.
- **Quality Model Transition phase:** It consists in changing the Quality Model, without influencing the Operation phase, which is related to the Quality Model changes management.
- **Quality Model Operation phase:** It performs the analysis, evaluation and plan of the approaches continuous quality improvements. In this phase, the Quality Model is used to manage the quality of approaches.
- **Continual Improvement phase:** It aims to align and realign the Quality Model with the properties to be covered and quality characteristics to be agreed with the approach development teams. The Quality Model can change due to identified new trends or technology changes.

As previously mentioned, the QuEF framework revolves around a Quality Model, which was composed of the following elements in the early QuEF:

- **Model:** It refers to the model to develop so as to carry out various operations that are performed in QuEF and to which all the techniques and concepts defined in the framework are applied.
- **Features:** This is a set of properties of the previous model.
- **Sub-features:** It is a branch within the above features to expand their level of detail.
- **Properties:** They should indicate the description of the characteristics and needs the Quality Model must cover.

These properties can be assigned to previously defined metrics. They indicate the type of measures that properties are undergoing, which have a range of values defined by the designer of the model who, in turn, will make some judgments of the properties according to users' needs.

Furthermore, Quality Characteristics also refer to the Quality Model. They point out the characteristics

derived from software products. Quality Characteristics have a relationship with Features. It is necessary to meet a number of requirements defined by the Features to achieve one of these characteristics.

All these concepts have been adapted according to ISO/IEC 15939, which defines a measurement process applicable to all disciplines of system and software engineering and management.

Nowadays, the model has been transformed to facilitate adaptability and flexibility in different domains. Now, the Quality Model in QuEF is represented by hand, a model of labels (tags model) and items (this will replace Properties) that are labeled through the model labels.

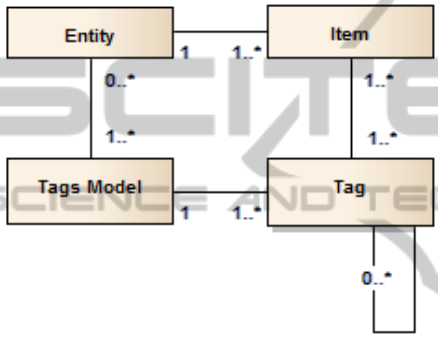

Figure 2: Tag model.

Another objective of the framework is the automation of all processes currently developed to support QuEF. It should provide tools that support each of the phases defined in QuEF in relation to quality management in order to transform the QuEF framework into a business reality.

In addition, thanks to the definition of the Quality Model, this knowledge can be shared among those responsible for quality management in the same context in order to:

- Build quality control tools, application and analysis of process control and inspection.
- Use metrology and statistical methods to diagnose and correct improper practices in quality control.
- Understand human factors and motivations.
- Working with concepts and quality costs techniques, having knowledge and ability to develop and handle information management systems.
- Audit quality systems regarding identifying and correcting deficiencies.

In addition, by changing many of the concepts, tools have also evolved. This is the case of Valortia tool; a powerful platform that adapts to the new definition of the Quality Model previously identified, allowing a quick and efficient study, reliably backed up by quality standards results. The purpose of the QuEF framework is to converge towards quality continuous improvement through tags, automated assessment and plans for monitoring and improving quality automatically, in addition to reduce effort, cost and time.

4 A MODEL TO EVALUATE PRODUCTIVITY: SKILLS AND ATTITUDES

In Valortia project, productivity has been defined as a model that consists of two parts: skills (experts' knowledge on software development together with their technical skills and competences in that area) and attitudes (conduct or behavior of technicians when facing particular situations).

As skills concerns, the European competence framework that defines the e-CF framework is taken as reference. Valortia takes into account the following different models of skills:

- **Application Development:** Interpret application design to develop an appropriate application according to the customer's requirements and tend to adapt existing solutions, by encoding, debugging testing, documenting and communicating at every stage of product development.
- **Component Integration:** Integrate hardware, software or system components into an already existing or a new system complete processes and procedures. Take into account the compatibility of already existing and new modules to ensure system integrity, system interoperability and information security.
- **Testing:** Build and execute systematic test procedures for IT systems or customer usability requirements to satisfy design specifications.
- **Documentation Production:** Elaborate documents describing products, services, components or applications that comply with relevant documentation requirements by selecting the appropriate style and presentation materials in the media.
- **Problem Management:** Identify and resolve the root cause of incidents as well as take a proactive approach to prevent and find out the root cause of ICT problems. Deploy a knowledge system based on the repetition of

common errors. Solve or escalate incidents and optimize the system or component performance.

Valortia takes into account the models of attitudes that are listed below (Optima Infinito, 2014):

- **Global Vision:** Have a complete integrated, updated and always available perspective to overview the existing commitments, and be aware of the consequences of success or failure to meet each of them.
- **Focus on results:** Identify, in a very concrete and specific way, the expected outcome of each of the actions as well as the sequences of steps leading to their achievement.
- **Analytical Thinking:** Define the meaning of "work" in a concrete way, transforming the inputs received into specific and manageable actions and results.
- **Decision Making:** Decide systematically and objectively what to do, based on the actual circumstances and needs of the moment.
- **Effective Delegation:** Systematically delegate any action that can be performed by another person and manage delegated actions effectively.
- **Commitments Management:** Keep an integrated update and effective organization system, including an updated inventory of all the existing commitments and reviews to dynamically renegotiate them, depending on the actual circumstances and needs.
- **Personal effectiveness:** Achieve results in an optimal way in terms of effectiveness, efficiency and quality. Effectiveness: get the most relevant results first. Efficiency: use resources optimally. Quality: maximize the generation of added value.
- **Effective Communication:** Communicate in a direct, concise, specific, proactive and assertive way, giving and asking for feedback, to ensure that the information provided is fully understood by all parties.

5 THE VALORTIA PROJECT PLATFORM

Valortia is a platform for evaluating users' skills and certifying their knowledge on a particular subject. It can be used from two points of view: offer (evaluate productivity of professionals along software development) and demand (select the most appropriate experts to develop the suggested project).

On the one hand, if it is aimed to design a model that could meet customers' needs and expectations, the framework will allow analyzing, evaluating, controlling and improving the model, so that these needs could be fulfilled. Valortia helps award certifications based on tags in order to know users' capabilities. They enable assessing and analyzing their knowledge on the subject.

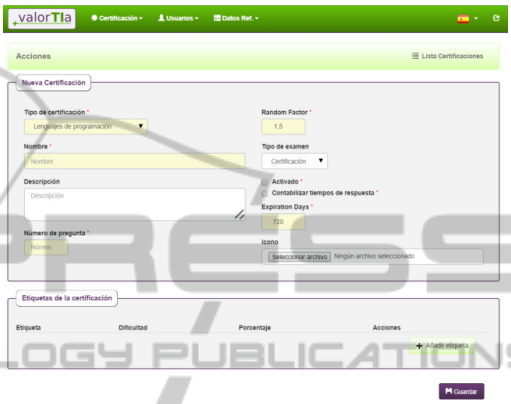

Figure 3: Certification creation form.

These certifications will be created by organizations that intend to find the best ways to handle the resources, processes and products being conducted. The creation form of these certifications is very simple and intuitive. Note that the label definition part is relevant as a distinctive feature to each of the questions (feature) in the certification (model) that can be assigned. These labels appoint a weight according to the importance given to the project and thus, they determine the best candidates for that specific project.

This process is possible thanks to the concepts and techniques the QuEF framework establishes.

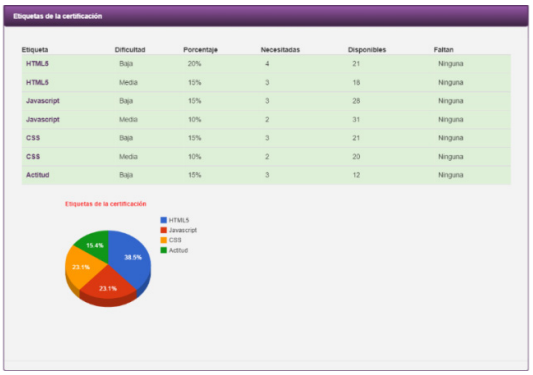

Figure 4: Labels and weight in the certification.

On the other hand, deciding on the most appropriate model in terms of personal interests means to be on the side of customers, users and recipients of model instances, thus the working framework may allow comparing model instances to achieve the key aim. As Figure 2 shows, Valortia platform offers values concerning the productivity of professionals. Customers can perform the certifications that fit the context in which they will assess productivity. Valortia offers a lot of facilities to make certifications exams improve usability of tool and respect availability of customers.

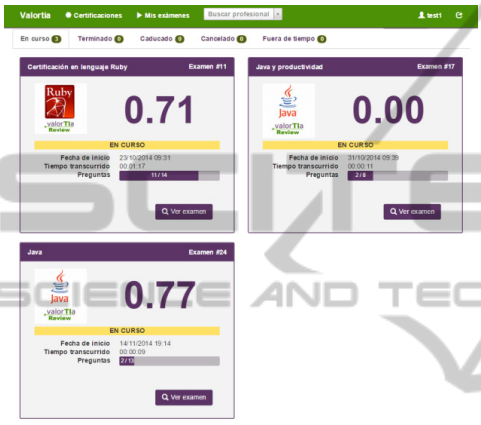

Figure 5: Evaluations made by a user.

Users may sit certification exams that are posted on the application. Besides, an organizer may invite a user to take a certification examination. In this way, companies or organizations may send this invitation to the candidates who will carry out the project.

In accordance with the exams creation models of the aforementioned applications, Valortia stores a variety of questions types to create certifications. These questions or exercises may be of the following nature:

- Free Text
- Unique Selection
- Multiple Choice

Questions may also have different levels of difficulty and an established response type (numeric or short/long text, for instance).

Finally, it is worth appreciating that different responses, in cases where there is more than a true or incomplete answer, may share scores.

Users will be doing these certifications gradually, provided that they are within the maximum set for the completion of the certification.

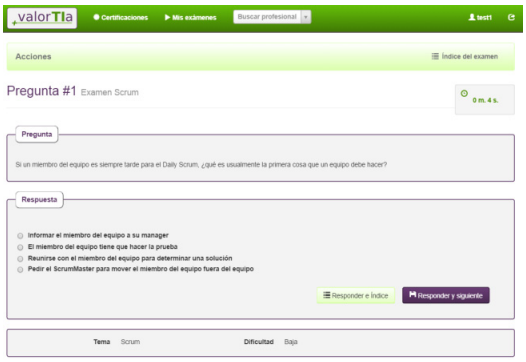

Figure 6: Multiple choice questions.

6 CONCLUSIONS

In conclusion, this paper shows that quality software can be developed thanks to the guidelines based on quality standards provided by the QuEF framework for the analysis and evaluation of models. This will allow studying and assessing them and it will be friendly for organizations to use it, keeping quality of results.

The concept of productivity has multiple meanings in literature. In the current project, it primarily focuses on all those attitudes and competences (or skills) that ICT professionals achieve. It also defines a model that includes the following features: skills and attitudes

After a detailed analysis of the literature, we can conclude that:

- Productivity can and should be measured. In the light of the success criteria of the project, it must creatively seek measures to assess progress in a systematic and regular way.
- Productivity rarely can be compared to external projects, unless the same indicators and metrics are used.
- Normally productivity can improve, but it does not mean that all factors can. These topics require not only a lot of experience to provide an overview of the circumstances that shape the project, but also a high dose of inspiration to hit effectively with appropriate and timely action.

Furthermore, it is very important to consider both the rules in UNE-EN ISO / IEC 17024 and European e-Competence Framework to certify people. These standards have been the guidelines for the development of Valortia. In consequence, this tool can ensure quality assurance of the results obtained.

Besides, Valortia has methods and templates available to create a Quality Model based on labels.

These labels are supported by the QuEF framework, which, by assigning a weight, can be used for analysis and evaluation in a quick and efficient way. It is worth pointing out that Valortia creates certifications based on the aforementioned skills and ISO 17024. Thus, it ensures good practice guidelines to evaluate customers. Finally, the QuEF framework is starting to be applied in industry: THOT, VALORTIA, ADAPT and CalipsoNEO are examples of this practice.

As future line of research, there is still work with THOT project, in order to make a decision on which documentation tool and features are better. Additionally, ERIS G3 project uses the QuEF framework to compare organizations and decide on the most suitable one to develop the project.

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