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Quality Model for Peruvian Microenterprises of a Software Product Factory

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Abstract

Microenterprises represent around 90% in the software industry in Peru and a similar percentage in Latin America and worldwide. They are characterized by the use of quality models of both the process and the product. In this descriptive research, t the proposed software quality model applied to a microenterprise is observed, which shows how the model generates an improvement in the software quality processes in the projects for its clients that support the effectiveness of the model. Expert opinions of professionals have been included. An evaluation of the impact on the improvement of software quality will be done; as a result, to use the proposed model by a Peruvian micro-company that produces software: the evaluation was carried out through the application of two international models in the assessment of software test management processes.

Keywords; *software quality, process control, microenterprises of software, software testing, product quality, ISO/IEC 29110, very small entity (VSE).*

I. INTRODUCTION

According to[1],[2],[5]the software production industry in Peru is mainly made up of micro-companies. For these micro-software companies to survive in a highly competitive market, they must produce high-quality software that guarantees a sustainable business model.

The software quality model proposed in this article provides competitive advantages at a micro-business level cited by [2].It increases the quality of the software produced, facilitates the communicative and comprehensive relationship between people in The software project team supports the sequential improvement of software testing processes and procedures, supporting the automatic execution of specific software testing tasks.

The proposed model addresses the limitations faced by software producing microenterprises in Peru, according to which they are: low budget, lack of resources, short time for deliverables, informal organizational structures, disorder, and even chaos; lack of skills and experience of its collaborators to test critical and complex software, as well as that the worldwide software testing methodologies are not focused on the needs and problems of the Peruvian software producing microenterprises.

Modeling has within itself software testing mechanisms with the objective goal of making possible necessary tasks to evaluate the functionalities of software as a product with an organized connotation, as well as and systematized, with an emphasis on those of design and testing execution. This proposed modeling was established based on the analysis of international testing methodologies in a few models for reference and different investigations.

This article critically studies the software testing processes of a microenterprise producing software in Lima. The ARWEBSYSTEMS SAC microenterprise is riddled with flawless software, often causing its customers to abandon the software provided after it was purchased and cut its business ties with ARWEBSYSTEMS SAC. In this article,

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the state of software testing, in general, was investigated, and the ARWEBSYSTEMS SAC microenterprise was provided with modeling with practical and straightforward testing processes that allow the creation of higher quality software.

Experts also confirm the specific problems for software testing processes in a micro-enterprise such as ARWEBSYSTEMS SAC that is determined with the use of questionnaires and in software quality in Peru and the world and the software engineering literature with emphasis on software testing.

II. BIBLIOGRAPHIC REVIEW

2.1 Software Quality Models

Quality is not an absolute term; it is valuable to someone. Therefore, we must keep in mind that testing cannot fully guarantee that the software application is correct. Quality functional dimensions such as Usability, Scalability, Performance, Compatibility, Reliability are highly subjective terms that have significant value for one person but maybe intolerable for the other.The stages that influence the quality of the software are divided into two main groups:

- Defects foundin software testing.
- Ease of performing maintenance on the software.

The main software quality models are:

Table 1: Quality Model Comparison (in US dollars)

Model	Year	Intitution	Pais	Business focus	Process	Cost		
						Certification	Training	Implement
CMMI-DEV	2011	SEI	USE	Medium and large	22	100 000	5 000	50 000
ISO 29110	2010	ISO	Intl	Smalland médium	43	50 000	20 000	40 000
MPS BR	2011	MPS BR	Brazil	Micro, small and médium	19	Subsidized by the government		
Competisoft	2008	Competisoft	Latinamerica	Small and médium	9	20 000	10 000	20 000
Moprosoft	2005	MASQ	Mexico	Small and médium	8	20 000	10 000	20 000
Proposal	2020	Government of Peru and Microenterprises	Peru	Micro	5	Subsidized by the government		

Source: Own, Based on Galvis (2013), Suarez and León (2019)

2.2 Software Process Quality

According to [3] Chavarría proposes an integrating model where human talent is included in the software development process along with its processes, practices, and tools based on CMMI, TSP, and PSP, and applies it in a micro-company, managing to minimize costs and defects, also improves the satisfaction of its users. A method called ACS is proposed in [4], which has three parts: Essence, to understand quality concepts, tools to control quality in software production projects, as well as metrics for measuring results and improvement of internal processes in software production projects.

Finally, according to [5],[14]highlights that: The software industry recognizes the contribution very small organizations make to the products and services they provide. Likewise, it is mentioned that the ISO / IEC standards were not aimed at very small organizations until the ISO 29110 standard was done. As the result of the creation of this model for evaluating and improving software, processes have been proposed, deployment packages, pilot projects, and implementation strategies to support the standard, considering knowledge management tools to support the adoption of the model.

2.3 Software Product Quality

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Likewise, [6],[13]highlights the model of the standard to software engineering-product quality, which aims to quantify software products based on quality attributes. The model covers the quality of the process, the quality of the product, the quality of the software, and the software quality of use distributed in the models of internal quality and external quality.This means that both process quality and product quality must be guaranteed.

The main thing in the quality models of software as a product is to detail, measure and qualify the fulfillment of characteristics, attributes, and sub-attributes of the product software, for this internal and external metrics, are used. The standards and norms of software quality at the product level define three types: internal, external, and in use, according to [7]. This perspective is oriented to validate the strict fulfillment of characteristics that allow the satisfaction of the end-user about the requirements grouped and classified in the initial stages in the process of software production by micro-companies [14].

They compare different software product quality models, establishing a series of criteria, such as purpose, structure, type of software project, quality characteristics metrics, type of software model, identifying as the most used to ISO 9126, ISO 25010, ISO 29110and among others software product quality standards [9],[13].

2.4 Software Project Management Quality

In [8], reference is made to the Chaos Report 2015, which shows the percentage of successful projects, changed and that failed, from the two software production methodologies: Agiles and Waterfall in recent years, as well as analyzes comparative with real results between projects. In all project sizes, agile approaches turned out to be more successful and of higher quality, as shown in the following table:

Table 2. Problems in software projects

SIZE	METHOD	SUCCESSFULL	CHALLENGED	FAILED
All Size Projects	Agile	39%	52%	9%
	Waterfall	11%	60%	29%
Large Size Projects	Agile	18%	59%	23%
	Waterfall	3%	55%	42%
Medium Size Projects	Agile	27%	62%	11%
	Waterfall	7%	68%	25%
Small Size Projects	Agile	58%	38%	4%
	Waterfall	44%	45%	11%

Source: Lynch (2015)

2.5 Peruvian Microenterprises of a Software Product Factory

Microenterprise is an economic unit formed by a natural or legal person, under any of the organizational and business forms that are contemplated in the current laws, which are intended to implement tasks of production, extraction, marketing, transformation, of goods or that provides services.

The INEI together with the Ministry of Production of Peru prepared the document Peru: Business Structure 2018, which revealed that 94.9% corresponds to micro-companies, thus classified by the amount of sales that do not exceed 622,500.00 soles per year, which it is equivalent to 150 Tax Units (UIT). 4.2% corresponds to the segment of small companies that sell between 150 and 1,700 UIT, while 0.6% corresponds to the large and medium-sized companies which have sales higher than 700 UIT. Finally, only the remaining 0.3% corresponds to public entities.

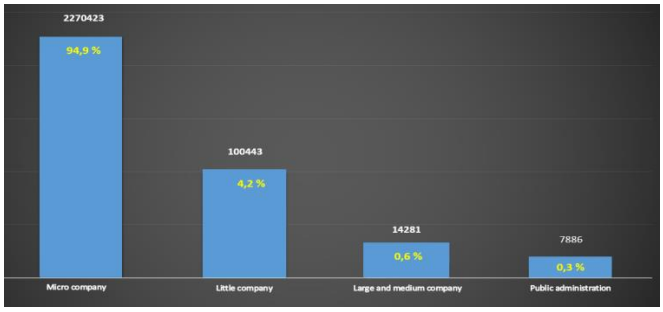

Figure 1: Peruvian companies according to business segment, 2018Source: INEI

III. METHODOLOGY

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The software producing micro-enterprises were approached using their level of quality of the process and the software product. For this, it is considered that the population is made up of a software-producing micro-company located in the city of Lima, called ARWEBSYSTEMS. Regarding the definition of the sample size, the value of 90% is considered as a confidence level, in addition to the value of the probability that micro-enterprises apply quality factors in the production of the software, which results in the amount of 0.8, based on surveys.

3.1 Measuring instrument

A questionnaire was designed for business people or general managers; the majority of the questions being closed. The questionnaire consists of 5 modules (table 3).

Table 3: Survey modules

Module	Content
1	Software Quality Models
2	Software Process Quality
3	Software Product Quality
4	Software Project Management Quality
5	Microenterprises of a Software Product Factory

IV. RESULTS

Taking as a premise that software producing companies must implement projects to improve production processes and quality, there are different efforts in Peru and Latin America that try to strengthen the software industry in each country, but at the level of small and medium-sized companies (SMEs), but no equivalent efforts have been made for the micro-business sector. This effort has been focused on improving quality software production processes, in such a way that it allows these companies (SMEs) to increase their competitiveness. The quality certification of the software production process and the products derived from it is a step that sooner or later micro-software producers must respond to two situations: the first, by image, to enter and stay in a market global; the second, of necessity, to make your projects efficient and effective administrative units of [5],[10],[12].

According to [11], most of these efforts are focused on transferring the requirements imposed by models such as CMMI and ISO to typical companies in Latin America: micro, small, and medium software companies. The most representative of these efforts isMPS.Br, Software Process Improvement in Brazil, the MoProSoft Process Model for the Software Industry in Mexico has been developed to promote the standardization of its operation through The incorporation of best practices in software management and engineering, in addition to these is COMPETISOFT. However, it is necessary to know the differences between a microenterprise and a small and medium-sized company, in addition to knowing the requirements that these models provide, efforts aimed at implementing these requirements within or outside the framework of an improvement project [15],[16],[18].

In the framework of the proposed model, SOFTMICRO.PE, an improvement strategy has been defined, which attempts to cover two efforts: that of alleviating requirements and guiding the improvement process, as well as that of generating a set of practical recommendations for the implementation of the software process requirements.

Methods, techniques, practices for software producing micro-companies	Economic sub-model partially subsidized by the state				Support tools for micro-software producers
	Sub-model of human talent provided by public universities				
	Generic sub-model for micro-business software project management	Generic sub model for quality project management of complex software	Generic sub-model for micro-business software process improvement	Generic sub model for software improvement as a product	

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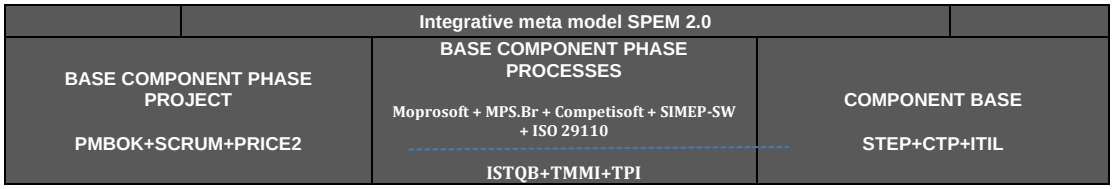

Figure2: SoftMicro.Pe 1.0 - Quality Model for Software Project Management in Micro-enterprises

Economic sub-model partially subsidized by the State

This submodel is made up of the intervention of the following state entities:Concytec and SUNAT through Law 30309, and its emergency decree that deducts taxes of up to 215% on companies that invest in science, technology, and technological innovation projects. Pronabec, state-subsidized skilled labor, required to work for the state. Ministry of Production, through its affiliated projects such as Innóvate Peru, Start-Up Perú, Inacal, and COFIDE. The Digital Government secretary to manage the projects and establish Peruvian technical standards. Congress of the Republic for bills of law. National Universities through the facilities of their Faculties of Systems Engineering, Software, Computing, and related. Contributions from Angel Companies: Private Companies, Private Universities, NGOs, International Foundations, IDB, IMF, WB.

Table 4: Benefit to the State with formal Micro-enterprises

Formal Microenterprises	The benefit to the State
• Economic support from the State provided with labor that I have already subsidized through university scholarships, and these must be paid to the nation, through the adoption of the proposed model. • Tax deduction up to 215% of investment in science, technology, and innovation projects. • The technological platform of the State at the Service of Micro-enterprises.	• Increase in the GDP of our country. • Increase in the GDP of our country. • Generation of direct and indirect employment. • Increase in per capita income. • Increase in private investment (Google would put its technological development headquarters in Lima, as well as in Belo Horizonte - Brazil). • Increase in economic activity. • Poverty reduction. Example Case of India. • Reduction of External Debt.

Sub Model of Human Talent provided by Public Universities

Public Universities give the list of Systems Engineering, Software Engineering, Computer Engineering, and related students.

With the following characteristics:

1. They belong to the ranking of Academic Excellence of their average university of all the years of study of the Third Superior, Fifth Superior, Tenth Superior, and First Positions.

2. Be studying the Penultimate or Last cycle or semester of university studies.

3. That they obtain in the national exam Software Fortune 500 (Evaluation provided jointly by Amazon, Google, Airbnb, Microsoft, Oracle), getting an equivalent score higher than 15 points in the vigesimal system.

4. They are additional points if they have technical studies related to their professional career, Pre-Professional Work Experience, level of English language proficiency, Won Contests related to

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Systems, Software, and Computer issues, First positions in their primary education and high school.

Generic Sub Model for Micro-business Software Project Management

It is based on a higher percentage of 50% by SCRUM (Agile Software Development), 25% by PMBOK (Acquisitions, Communications, Stakeholders), 25% by PRINCE2 (Acquisitions, Communications, Stakeholders).

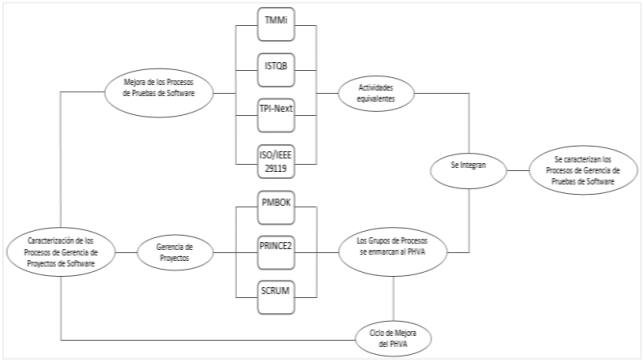

Figure3:Generic Sub Model for Micro-business Software Project Management

Generic Sub Model for Microenterprise Software Process Improvement

It is based on process improvement, MPS.BR, Moprosoft, Competisoft, ISO 29110, and SIMEP–Sw project of [17].

Quality Process for Microenterprises	Quality Process	Business management Project, process and knowledge management	Quality Process for Microenterprises	Metamodel, Tools, and Methods
MPS.Br	Moprosoft	Competisoft	ISO 29110	SIMEP–Sw

Figure 4: Generic Submodel for Microenterprise Software Process Improvement

Generic Sub Model for Software Improvement as a Product

This sub-model is based on ITIL, CPI and STEP processes, in the model shown below, ITIL processes are yellow, CPI and STEP are purple, while in green, as an additional contribution, the processes of the proposed model.

Quality Strategy	Quality Process	Quality Management	Quality Commitment	Quality Performance
Plan Strategy	Acquire Testware	Reviewer	Support Software	Measure Behavior
Strategy	Design	Transition	Operation	General Quality
Continuous improvement of the service				

Figure 5: Generic Sub Model for Software Improvement as a Product

SPEM 2.0 Integrating Metamodel

The Metamodel of Software Engineering Processes (Software Process Engineering Metamodel SPEM). This metamodel is used to describe a software development process or a family of related software development processes. The evaluation SPEM in the context of model management architecture makes it necessary to integrate the meta-perspective.In the model proposed in this paper, it is used to integrate the different components of the standards, methodologies, and methods that currently exist.

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Generic Sub Model for Quality Project Management of Complex Software

It is based on the development based on SOA Architectures, Cloud Computing, Mobile Applications, and the integration between them.

Security Quality Component	Software Container Managers	Quality Component Protocol
Application server Database Server	Quality Orchestrator	Continuous Integration Server Continuous Delivery Server Automated Test Server
Versioning Software	Quality Middleware	Change Control Software
Microservices	IDE + Framework + Software Libraries + Software Patterns	Microservices + REST
SOA	Cloud Computing	Mobile Applications

Figure 6. Generic Submodel for Complex Software Quality Project Management

V. CONCLUSIONS

More than 50 flexible, adaptable and scalable processes were designed with their respective activities and support tools at management and technical level to efficiently manage software quality micro-business projects aligned to the most modern software development methodologies today. The processes were applied in ARWEBSYSTEMS SAC projects in its clients. In this regard, 39.4% of the total number of respondents stated that they used these services.

More than 50 processes, activities, and tools were designed to allow the economical, operational, and technical feasibility for the efficient management of MPS software quality projects. 100% of the surveys indicated that the successful execution of software quality projects contributes to improving the quality of service.

Technologically modern architecture was designed that makes it possible to manage complex software quality projects under SOA, Mobile, Cloud Computing platforms, and the integration between them. The ARWEBSYSTEMS SAC microenterprise directly used the architecture in its most technological clients, such as the Financial Institution.

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