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Perception of Pymes in the Development and Quality of Software in Baja California, Mexico

Roberto Carlos Valdés Hernández[1], José Luis Arcos Vega[2], Félix Fernando González Navarro[3]

[1,3]Instituto De Ingeniería, Universidad Autónoma De Baja California, Blvd. Benito Juárez andcalle De La Normal S/N, Mexicali, Baja California, Mexico

[2,]Universidad Politécnica De Baja California, Calle De La Claridad S/N, Mexicali, Baja California, Mexico

Abstract: ***In this study, we present the results regarding the perception in the development and quality of software in small and médium companies (Pymes) dedicated to software development in the State of Baja California, with 52 companies participating; for this, a quantitative-descriptive research was made. The results obtained were studied by analyzing the frequencies and percentages of the variables used in the application tool, which was made of 32 questions answered by the managers of these companies. The data collected helped identify the affinity that exists between the categories and their contribution to the company's objectives. It is worth noting that, in the results obtained from the comparisons made between the questions applied in the evaluation tool, we analyzed the relation between such variables and their importance in the software development process in the company.***

Keywords: ISO/IEC 25010, Software, Software development and quality

1. Introduction

Nowadays, the software industry worldwide has had a big development, which has created an interest from governments, universities, and companies, since it is an area that focuses on innovation, development, and company competitiveness; some countries with growing economies have entered this industry and center their strategies in developing custom-made software, supplying, in this way, a market with very specific needs, achieving development and evolution as time goes by, becoming a competitive industry in a dynamic economic environment. In this sense, due to the high levels of innovation and development that this industry faces, the challenges regarding growth are limited, since resources destined to growth and investment strategies are limited [1]. When talking about a software system, we refer to a combination of decisions on design, seeking to satisfy the clients' needs, and such decisions are made in order to improve a system's development [2], for which the company makes decisions focused on an efficient process, which is a fundamental part in software development, generating a proposal offered by the company, where such development proposal must be supported by a model that helps the company to generate a quality software product, establishing a development process in which the quality of a developed software is guaranteed and focuses on guaranteeing use ease, portability, and efficiency, which are considered as a main part in the satisfaction of the end-user [3]; this is achieved through sustaining the quality of the software program, where the company seeks to survive through the achievement of objectives, by being productive, and generating an added value product, assuming new strategies in a dynamic industry, applying models, standards, and methodologies to their productive processes. Quality objectives can be achieved if the company guarantees to that the developed software program meets the highest quality standards asked by clients, where a quality standard is understood as the group of structured rules where software can be evaluated at the end of the process and that it achieves each objective, as well as evaluating quality regarding use and availability, along with efficiency and efficacy of the software program [4]. For this, methods and tools are a main pillar, since they are oriented to improving software quality, considering that quality software attributes are a necessity for software companies, for this allows the improvement of less efficient tasks and the acquisition of quality products, as a main part of their company strategy [5]. This means a competitive advantage for companies, since measurement helps modify those factors that provide more efficacy in the productive process and contribute to product quality [6]. Considering the aforementioned, efforts have been made trying to identify which factors affect software quality, for which it is needed to measure attributes that affect such quality, and these can be measured during the development process, which takes the company and, specifically, the process manager to a real-time closeness to the efficacy of analysis, design, and codification, as well as the quality of the software developed [7][8]. Inside the software industry, Pymes dedicated to this area recognize the importance of delivering a quality software product to their clients, since it is an important pillar in the development process in a market that demands high quality products that can satisfy their needs [9].

It is important to mention that Pymes use techniques and models in the specific process through which the activities and techniques used in the development process of a software product are defined, seeking to assure software quality [10]. For software companies, a crucial factor in development project is the methods used in such process, oriented to improve software quality, where a deficient estimate of the project's process and length can cause loss of competitiveness and incompletion of the product delivery [11]. In order to manage these types of projects, we use technological platforms that facilitate the access to information and work flow, seeking to interact in the development process among the personnel involved, as well as the roles established in order to do the activities in such process. In this sense, there have been different organizations that seek to facilitate the creation of projects

among companies, which is the case of DEMOLA, a web that was created in Santurtzi, Spain, which seeks to include companies, researchers, as well as students to work together in software projects and also in projects with goals, creating a work frame and cooperation between members [12].

In this sense, it is necessary to characterize Pymes dedicated to developing software on a low work frame, in which the needs that companies should cover can be established in order to implement a processes improvement focused in the companies' characteristics, considering he experience in improvement processes, problems they have had in such implementation, as well as identifying the development process in companies, thus contributing to the generation of information in order to characterize companies towards the implementation of an improvement in said process [13]. As a result, it is essential to keep continuous track of the execution process of the product's development, always seeking to improve the efficacy of factors during the productive process and, thus, contributing to product quality, where many countries such as Malaysia, Philippines, Thailand, and some in eastern Europe such as Poland, Czech Republic, and Hungary, as well as Ireland, are developing high quality software, determining in their processes an added value for their clients, reaching a clear global leadership in software industry [14]. The development of quality software, nowadays, is a necessity for companies, whether small, medium, or large, since there is a lot of competition with industries in other countries such as India, China, or the United States, for these countries have certifications in quality and processes improvement, where companies' competitiveness is so when improving their productive processes and providing an added value to their clients, which is why the companies that dedicate to the software industry seek to continuously improve through the implementation of a quality model or standard [15]. Companies dedicated to software development face the challenge of incorporating new requisites, which are demanded by clients, where there must be a balance between such demands, the service provided by the companies and continuous improvement, always considering the product's characteristics, which supposes the risk of facing the consequence in the decision-making process; when these decisions must be focused on improving the client's satisfaction without considering those factors that highly affect the company, since that can lead to creating a software product with less functionality, accessibility, or usefulness, which can lead the company to an image or economic detriment [16]. Companies dedicated to software development have created their own line of work regarding system quality management, meaning, they work on the software production process in order to promote quality in their products and thus satisfy their clients' needs [17]. From a national and international perspective, in Baja California, at the National Chamber of Electronic, Telecommunications, and Informatics Industries (CANIETI), between years 2000 and 2001, a group of businessmen representing companies related to software products and services made the decision of creating a formal organization or cluster, as they call it, having as main goal to compete in the markets of California, United States and Mexico, seeking to make the most out of the demand in California for software services, and their objective was to strengthen this economy area since they considered it a main area for the technological development of the productive system in the state of Baja California, Mexico [18]. Since it is an initiative from the businessmen, seeking to group together and have a better competitiveness in the market south of California, specifically to companies dedicated to software development in the area, through the tools that the state has to develop and do businesses with the state of California, making the most out of the border between both countries [19]. And so, based on this, the Software cluster was created, understanding as cluster the group of interrelated companies that work on the same industry and collaborate strategically in order to obtain common benefits. On February 20th, 2004, such efforts were fulfilled when the CANIETI and the Association of Technology Suppliers of Baja California (APTI) publicly announced the signing of an agreement for the constitution of the 'Clúster de Tecnologías de Información y Software de Baja California, A.C.', with 26 founding affiliated companies. Under this context, a research was made regarding the perception in the development and quality of software from Pymes dedicated to software development in the state of Baja California, Mexico.

2. Method

A descriptive study was carried out, analyzing Pymes in the software development in the state of Baja California, for which a 36-question survey was applied, divided into four sections: the first one consisted of 8 questions regarding the company's general data, the second one consisted of 8 questions about software development, the third one consisted of 11 questions regarding clients' satisfaction, and the last one consisted of 9 questions regarding software quality, where we used the classification scale Likert, which purpose was to characterize the development, clients' satisfaction, and quality of small and medium companies (Pymes) dedicated to offer software products and services in the cities of Ensenada, Mexicali, and Tijuana in the state of Baja California. Likewise, the results obtained correspond to 52 Pymes dedicated to software development, which allowed the identification of the relation between development, clients' satisfaction, and quality, and how these affect the results in this industry, seeking to contribute to software continuous improvement [20].

3. Results

For this study, we analyzed the perception of managers in Pymes dedicated to software development, regarding quality and development, by applying a survey to 52 companies, whose results are described as follows:

Table 1: Number of employees in the company

Classification	*N*	*Percentage*
Micro (0-10)	31	59.6
Small (11-50)	18	34.6
Medium (51-250)	2	3.8
Large (251 and more)	1	1.9
Total	52	100

Table 2: Level of agreement on whether or not the company has measures or indicators of quality with the need to be certified and the success of quality in the development processes

Scale of values To be certified on any standard	Level of agreement regarding quality of development processes as a factor for success											
	Totally agrees		Agrees		Neutral		Disagrees		Totally disagrees		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Totally agrees	6	85.7	1	14.3	0	0	0	0	0	0	7	100
Agrees	1	25	3	75	0	0	0	0	0	0	4	100
Neutral	2	100	0	0	0	0	0	0	0	0	2	100
Disagrees	1	100	0	0	0	0	0	0	0	0	1	100
Totally disagrees	0	0	0	0	0	0	0	0	0	0	0	0
Total	10	71.4	4	28.6	0	0	0	0	0	0	14	100
Totally agrees	1	16.7	4	66.7	1	16.7	0	0	0	0	6	100
Agrees	10	71.4	4	28.6	0	0	0	0	0	0	14	100
Neutral	2	66.7	1	33.3	0	0	0	0	0	0	3	100
Disagrees	0	0	0	0	0	0	0	0	0	0	0	0
Totally disagrees	0	0	0	0	0	0	0	0	0	0	0	0
Total	13	56.5	9	39.1	1	4.3	0	0	0	0	23	100
Totally agrees	1	100	0	0	0	0	0	0	0	0	1	100
Agrees	1	11.1	7	77.8	1	11.1	0	0	0	0	9	100
Neutral	1	33.3	1	33.3	1	33.3	0	0	0	0	3	100
Disagrees	1	100	0	0	0	0	0	0	0	0	1	100
Totally disagrees	0	0	0	0	0	0	0	0	0	0	0	0
Total	4	28.6	8	57.1	2	14.3	0	0	0	0	14	100
Totally agrees	0	0	0	0	0	0	0	0	0	0	0	0
Agrees	0	0	0	0	0	0	0	0	0	0	0	0
Neutral	0	0	0	0	0	0	1	100	0	0	1	100
Disagrees	0	0	0	0	0	0	0	0	0	0	0	0
Totally disagrees	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	1	100	0	0	1	100

The information presented on table 1 indicates the classification according to the number of employees on the company, and the majority of them informed they are Micro (0-10) companies, with 59.6%, followed by 34.6% that reported they are a Small (11-50) company, and with a lower percentage of 3.8% for the ones that informed they are a Medium company, and just one with 1.9% who reported it is a Large (251 and more) company. According to the results analyzed regarding whether or not the company has certifications on its development processes, the perception of the companies' managers agrees that it is necessary to be certified under a software quality standard, balanced with the level of perception regarding that this quality is considered as a factor for success. From the total (52) of managers surveyed, 37 of them think positively of these quality standards, which percentages are shown in a separate way in the scale of values for each answer. On table 2, they expressed their agreement level regarding whether the company they work for continuously introduces technological changes to software development in order to answer to the clients' new demands regarding the innovation and improvement of products and services; 85.7% answer to the needs and expectations detected in clients and totally agree, and 14.3% agree to it.

Table 3: Level of agreement regarding whether the company introduces organizational and technological changes with competitiveness in the area and the involvement of clients and suppliers

Scale of values Offering added value services	Level of agreement regarding whether the companyconsiders the analysis of the environment											
	Totally agrees		Agrees		Neutral		Disagrees		Totally disagrees		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Totally agrees	22	55	15	37.5	3	7.5	0	0	0	0	40	100
Agrees	5	41.7	6	50	1	8.3	0	0	0	0	12	100
Neutral	0	0	0	0	0	0	0	0	0	0	0	0
Disagrees	0	0	0	0	0	0	0	0	0	0	0	0
Totally disagrees	0	0	0	0	0	0	0	0	0	0	0	0
Total	27	51.9	21	40.4	4	7.7	0	0	0	0	52	100

Regarding table 3, we present the results that derived from the perceptions of the managers on whether the company introduces technological and organizational changes with competitiveness in the area, as well as the involvement of clients and suppliers; the levels were high on companies that offer added-value services to clients, which distinguishes them from the competition according to their perception in this same line of opinion when deeming important the analysis of the competitive environment to clients, suppliers, current competition, and incoming participants to the area. On a general way, an excellent percentage (92.3%) of managers surveyed reported they agree to these activities in their companies and only 7.7% have a neutral opinion.

Table 4: Level of agreement regarding the need and benefit of being certified and added-value services to clients

Agreement level Certification of software quality	Level of agreement regarding the need to offer added-value services to clients											
	Totally agrees		Agrees		Neutral		Disagrees		Totally disagrees		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Totally agrees	14	77.8	4	22.2	0	0	0	0	0	0	18	100
Agrees	20	74.1	7	25.9	0	0	0	0	0	0	27	100
Neutral	3	75	1	25	0	0	0	0	0	0	4	100
Disagrees	3	100	0	0	0	0	0	0	0	0	3	100
Totally disagrees	0	0	0	0	0	0	0	0	0	0	0	0
Total	40	76.9	12	23.1	0	0	0	0	0	0	52	100

On table 4, we present the results in the level of agreement perceived by the people surveyed regarding the need to be certified and the benefits of being certified, as well as the added-value services offered to clients: the percentages of perception from the companies' managers are highly positive since 100% agree that it is needed to be certified on a standard, that it is useful and beneficial to the company to have a software quality certification, and also, as part of the competitiveness, it is necessary to offer added-value services to clients, which makes the difference and makes them more competent with other companies of the same industry.

4. Conclusions and Recommendations

One of the biggest barriers that small companies face is the manager's attitude, who, generally, show little interest on investing resources in activities that do not suppose a short-term, noticeable economic gain; it is important to point out that small organizations receive, with pleasure, the incorporation of free tools in their processes, hence, it I important to work, research, and adapt existing tools to the ways to work in an organization. The activities carried out by companies involved in this study are focused on clients' satisfaction; these companies involve many external factors that invite them to participate in improvement and innovation activities carried out in the company; and with this, comes the importance of anticipating to the potential and future clients' needs, involving them in the company's activities, which also has as purpose to collect valuable and necessary information regarding the clients' and other participants' perceptions that request the services the company offers, achieving clients' satisfaction. Also, derived from the analysis, it was detected that it is important for companies to provide their added-value services (100%) because they are completely sure that this will allow them to be more competitive, to adequate to the requirements and needs of every client. Since added value demands to review the existing models and to think on doing different, better, more quality things, centered on the clients' needs, and, as a company, it will help them distinguish themselves from the others. As future work, we propose the adaptation and integration of existing tools or methodologies to improve software processes, preparing Pymes in the creation of strategic advantages regarding competition, from the approach that a product's quality derives from the quality of the process used in the development, so that there can be obtained indicators from which decisions can be made regarding the process and quality of the software product. Even though Pymes surveyed make a documental report and keep track of preemptive and corrective actions during the development process, it is recommended to continue analyzing in the indicators associated to software development, considering it an improvement area for the company. It is relevant to consider that, in order to be in a competitive and dynamic market, Pymes must apply controls on aspects related to software development, defining process improvement patterns, where support is provided to Pymes regarding the identification of their current scenario towards the best path of improvement of software development processes based on their own specific characteristics, so they can provide a product with the highest quality standards, where such product is perfect for the clients' needs.

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Author Profile

Received Master's Degree in Information Technology and Communication from the Autonomous University of Baja California (UABC), Mexicali, Mexico. Currently working as a teacher at UABC, teaching the subjects of Information Systems and Information Technology and studying a Doctorate in Computer Science at the UABC Engineering Research Institute based on research in Software Development.