IMPACT: International Journal of Research in Engineering & Technology
ISSN(P): 2347-4599; ISSN(E): 2321-8843
Vol. 6, Issue 6, Jun 2018, 1-8

COLLABORATION OF THE SOFTWARE INDUSTRY WITH THE EDUCATION, PRIVATE, AND GOVERNMENT AREASIN 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, Mexicali, Baja California, Mexico

[2]Universidad Politécnica de Baja California, Mexicali, Baja California, Mexico

Received: 11 May 2018 **Accepted:** 25 May 2018 **Published:** 02 Jun 2018

ABSTRACT

The knowledge society, where innovation, science, and technology play an important role, faces challenges, since universities not only are academic institutions but also generate innovation and technology in the new University-Industry-State liaison model, thus, these three main concepts play an important role in the new economy. Thus, this study has a purpose to present an experience where the education and software areas are linked, analyzing this liaison between industry and education areas, as well as the software product quality in Pymes in this area in the state of Baja California, considering the support provided by government institutions in order to integrate quality methodologies or rules in the development process of a small or medium company (PYME). The results obtained correspond to 52 Pymes dedicated to producing software in the state of Baja California, which allowed to identify the relationship between the education and software industry areas, and how the influence and contribute the continuous improvement of this industry through process innovation, being these the core of this area.

KEYWORDS: *Liaison, Software Industry, TIC's, Quality*

INTRODUCTION

Nowadays, the software industry faces many challenges to develop software where innovation, science, and technology play an important role, and also universities have a key role in the generation of technology innovation, as well as their liaison with industry and state. In this society, the 3-core model stands out, which is based on the relations between the university, the industry, and the government, considering the industry as the first core, referring to companies that form a country's company conglomerate (Etzkowitz and Leydesdorff, 2000). The education core refers to the activities carried out by the universities in a country. The third core, the government, seeks to support technological innovation in their countries in a direct way (Acuña et al., 2015). In this sense, the software industry seeks to develop software products that meet the clients' needs in terms of quality, for which they have generated diverse work methodologies, as well as models applied in software development processes, considering the complexity that this entails. According to Holguín (2015), there are a great variety of organizations dedicated to this area, as well as different clients and markets. This is why it is so important to choose appropriate methodologies and rules that are integrated into the organizational context for a better probability to improve quality and clients' satisfaction.

The software industry (Flores, Ceballos, y Bojórquez, 2016) is different from other industries due to its high quality of human resources. Some international organisms such as the United Nations Department for Trade and Development, the World Bank, and the Organization for the Economic Cooperation and Development point out the importance and role of software in economic development. In this sense, governments in countries like Ecuador help Pymes invest and develop their businesses, giving access to financial support in search of invest capital in order to keep innovating and competing, encouraging their productive development and generating a favorable business environment, granting access to technical assistance credits to introduce management and quality improvements, expansion and search for markets, internationalization and participation in commerce, training of human resources, and business development, which the National Secretary of Planning and Development (SENPLADES) considered as a facilitator of effective articulation of public policy and materialization of this transformation (Senplades, 2012). Likewise, in Chile, one of the challenges that the software industry faces is to determine a functional definition of competitiveness to a business level and to have instruments its measure, allowing for software production companies to dedicate to activities aimed for organizational objectives, seeking to provide to the country's economic development (Villalobos, Karmelic, &Néspolo, 2016).

In this sense, in Spain, a point to consider is the technology, since, through it, the government seeks to provide easiness to Pymes in order to develop new business models; a transformation that strengthens the technology innovation in the processes of Pymes dedicated to the IT area (Serna y Ramírez, 2016). In addition, according to López (2017), almost 13% of Pymes in Ecuador have financial issues, which is attributed to the high tax rates, as well as confusing and bureaucratic paperwork they have to go through in order to acquire credit; considering that software is the process of transforming social knowledge in a digital way, in such a way that it can be manipulated, disseminated, and controlled through the architecture of a binary code, in order to help automate a company's process, achieving very specific objectives, where technology plays an important role, which is why this industry has grown over the last decade (Alanís, 2005). Another case is Colombia, where Riascos, Aguilera, and Achicanoy (2016) mention there are 143 countries and Colombia is in the 64th place, considering two variables for this ranking: economic impact and social aspect, where the IT investment is generated, demonstrating an economic impact generated by the number of patent requests, including IT in the company's projects and models, as well as the development of new products.

In the case of Pymes, some of their organizational objects are supported and strengthened by IT, which is why companies need to analyze what are the risks and opportunities inherent to their business processes, and implement appropriate models in order to manage them, as well as to analyze the impact that said technologies in their performance as companies (Loeser, et al., 2012).

There are diverse studies that show IT's are included in the development program of many countries, since they help consolidate the socioeconomic aspect of Pymes, increasing income, decreasing management costs, as well as improving decision making in the company's operations, seeking strategic differentiation (Quinde, 2017). In this sense, companies can generate competitive advantages for their benefit, considering strategies aimed to the construction of innovation and competitiveness plans, generating an organizational performance, financial as well as operative (Galvez, Riascos, & Contreras, 2014). Likewise, the United Nations Conference for Trade and Development considers that, in order for the IT's access improvement to produce the wished benefits, the devices and services provided must respond to the real needs and capacities of the users, and for this, it is required to have access to technologic capacities related to the

country's economy and, particularly, to the software area (UNCTAD 2012). In this sense, in a software project, it is indispensable to control, as well as monitor the performance and progress of the software product development, considering indicators that lead to an analysis of the current state and the future project, which must be aligned to an efficient and effective decision making; nowadays, there are a series of informatics tools for project management for this, nonetheless, these tools not always cover the client's expectations, due to specific aspects related to prices, private licenses, or open software, being these some of the factors why there have been initiatives in Cuba, where contributions are made for technologic development when facing the need of personalization of the software industry, specifically in data-analyzing software, which is a development initiative of the Research Laboratory in the Informatic Science University of Cuba, known as Suite of Project Management Xedro GESPRO (Marín and Lugo, 2016).

As a mechanism to improve development, in order to provide the client with a product that meets quality standards, in Spain, the industry has developed models focused to improve the test process, nonetheless, one of the main obstacles they face is the difficulty to adapt maturity tests to models for the specific environment of an organization. As pointed out by Calvo-Manzano, Cuevas, and San Feliu (2016), Pymes face many obstacles in order to implement their software test processes, which is due to the lack of resources, as well as the difficulty of adapting maturity models to a company's specific context, for which they propose DISPROVAL, which is a tool for the definition of the validation process in small companies dedicated to software development. As established by the regulation ISO/IEC 25010, the software product quality can be interpreted by the degree at which said product satisfies the functionality, performance, security, and management requisites of its users, providing value in this way. According to García, et al. (2016), the software development process must have, as the main purpose, a quality product that meets the clients' and users' request and satisfies their needs; he proposes a methodology that was applied to an educational media software, proposing many phases or steps of the methodology with sub-products generated in each one, through a logic monitoring.

Núñez (2016) mentions there is a high competitiveness, which has made the companies incorporate technologies that help the management of resources applied to the company's diverse developmental processes. In this sense, Mexico has developed new projects in the area of information technologies; such is the case of Yucatán, which formed the first cluster of Information and Communication Technologies (ICT) in Mexico. Nonetheless, due to politics related problems, the project was not consolidated, thus, it will lead to its extinction. Recently, there has been work regarding the construction of a new center of innovation and development focused on information technologies, for which it is required by the companies' owners to integrate into this new project, achieving an economic impact in the technology area in this region (Flores, Ceballos, and Bojórquez, 2016).

OBJECTIVE OF THE STUDY

Analyzing the software development in terms of models, requirements, and quality system of Pymes dedicated to software development in the state of Baja California.

METHODOLOGY

In order to analyze data, we carried out a quantitative, descriptive study, analyzing small and medium companies (Pymes) dedicated to software development in the state of Baja California, for which an instrument was designed, which has 36 questions, applied to managers of the companies in this area, and using a Likert and Alpha of Cronbach

qualification, scale for reliability and validity of the instrument applied, which purpose was to know and analyze the liaison variables of the education are with the software industry and its product quality. Likewise, the results obtained allowed to identify the relation between the software industry and the state, seeking to the continuous improvement of this industry (Hernández et al., 2006).

RESULTS

For this research, we studied 52 Pymes dedicated to software development, applying a survey to them, which are located in three municipalities in the state of Baja California, and are distributed in the following way: Mexicali (22), Tijuana (20), and Ensenada (10), whose results are described next.

Table 1: Level of Agreement Regarding the Collaboration Agreements with the Education, Government, Research Center, Or private Sector Areas

Name of Agreement	Level of Agreement with the Capacity of Innovation											
	Totally Agrees		Agrees		Neutral		Disagrees		Totally Agrees		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Technologic centers	5	83.3	1	16.7	0	0	0	0	0	0	6	100
Federal government dependencies	2	100	0	0	0	0	0	0	0	0	2	100
Federal and local government dependencies	1	100	0	0	0	0	0	0	0	0	1	100
Local government dependencies	1	33.3	1	33.3	1	33.3	0	0	0	0	3	100
Private innitiative companies	0	0	0	0	0	0	0	0	0	0	0	0
Private sector	3	100	0	0	0	0	0	0	0	0	3	100
Universities	1	25	2	50	1	25	0	0	0	0	4	100
Universities and Technology centers	2	66.7	1	33.3	0	0	0	0	0	0	3	100
Universities and Federal government dependencies	0	0	1	100	0	0	0	0	0	0	1	100
Universities and Local government dependencies	1	50	1	50	0	0	0	0	0	0	2	100
Universities, Technology centers, Local government dependencies	1	100	0	0	0	0	0	0	0	0	1	100
Universities, Local and Federal government dependencies	1	100	0	0	0	0	0	0	0	0	1	100
No agreement	11	44	11	44	3	12	0	0	0	0	25	100
Total	**29**	**55.8**	**18**	**34.6**	**5**	**9.6**	**0**	**0**	**0**	**0**	**52**	**100**

In table 1, the results inform the percentages related to collaboration agreements that companies have with other education, government, research centers, or private sector organizations regarding the opinion level that they have in the company about the flexibility to develop new projects and services as a competitive advantage.

Table 2: Level of Agreement Regarding Whether the Company has Quality Certifications in the Development Processes as a Success Element

Value Scale Certified in Any Regulation	Level of Agreement with the Development Processes Qualityas a Success Element											
	Totallyagrees		Agrees		Neutral		Disagrees		Totallydisagrees		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Totallyagrees	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	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
Totallydisagrees	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**
Totallyagrees	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
Totallydisagrees	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**
Totallyagrees	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
Totallydisagrees	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**
Totallyagrees	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
Totallydisagrees	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**

In the twelve agreements we had good results, since the surveyed people informed that there is a positive level in all of them, since they agree with that the company has innovation capacity. With the overall results, the results are in an excellent level (90.4%) on this aspect, equal to 47 opinion surveys and only five of the surveyed people said they are in a neutral position in the face of these work connotations. In table 2, the results of the surveyed people in the companies are at highly positive levels of agreement since they think it is necessary for the companies to be certified under a software quality regulation; it was equilibrated in the perception that this quality is considered as a success element. Out of a total people surveyed (52), 37 of them think in a positive way regarding quality standards, which percentages are shown in the value scale for each answer.

Table 3: Level of Agreement with the Company Introducingtechnological and Organizational Changes with Competitiveness in the Area and the Involvement of Clients and Suppliers

Values scale To offer many added value services	Level of Agreementwhich the Company Considersin the Environment Analysis											
	Totallyagrees		Agrees		Neutral		Disagrees		Totallydisagrees		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Totallyagrees	22	55.0	15	37.5	3	7.5	0	0.0	0	0.0	40	100.0
Agrees	5	41.7	6	50.0	1	8.3	0	0.0	0	0.0	12	100.0
Neutral	0	0.0	0	0.0	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	0	0.0	0	0.0
Totallydisagrees	0	0.0	0	0.0	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	0.0	52	100.0

In table 3, the level of agreement about whether the company in which they work introduces the continuous technology and organizational changes in order to be capable of responding to the new demands of clients regarding innovation and improvement in products and services; likewise, 96.1% agreeing that it responds to the needs and expectations detected in clients and 3.8% is on a neutral opinion. Out of a total (52) surveyed, 29 clients said they had no collaboration agreements, nonetheless, (100%) agree that it is necessary to offer an added value to clients that can distinguish them from other companies, since competitiveness is high in each of the areas of society. Some of the other agreements that are in the same position where the technology centers, private sector, universities, federal and local government dependencies, of which the number of surveyed people by the company that considers customer service are shown (see table 4).

Table 4: Collaboration Agreementswith External Organization or Dependenciesagainst the Value Addedoffered to Clients

Name of Agreement	Level of Agreement about the Needto Offer Added Value Services to Clients											
	Totallyagrees		Agrees		Neutral		Disagrees		Totallydisagrees		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Technologic centers	6	100	0	0	0	0	0	0	0	0	6	100
Federal government dependencies	2	100	0	0	0	0	0	0	0	0	2	100
Federal and local government dependencies	1	100	0	0	0	0	0	0	0	0	1	100
Local government dependencies	1	33.3	2	66.7	0	0	0	0	0	0	3	100
Private innitiative companies	0	0	0	0	0	0	0	0	0	0	0	0
Private sector	3	100	0	0	0	0	0	0	0	0	3	100
Universities	4	100	0	0	0	0	0	0	0	0	4	100
Universities and Technology centers	2	66.7	1	33.3	0	0	0	0	0	0	3	100
Universities and Federal government dependencies	0	0	1	100	0	0	0	0	0	0	1	100
Universities and Local government dependencies	1	50	1	50	0	0	0	0	0	0	2	100
Universities, Technology centers, Local government dependencies	1	100	0	0	0	0	0	0	0	0	1	100
Universities, Local and Federal government dependencies	0	0	1	100	0	0	0	0	0	0	1	100
No agreement	19	76	6	24	0	0	0	0	0	0	25	100
Total	40	76.9	12	23.1	0	0	0	0	0	0	52	100

CONCLUSIONS

Of the results shown, according to the instrument applied, the quality of a software product is one of the main concerns for both the developing company and the final client. The present study shows an analysis that allowed the evaluation of software products through the liaison of the industrial sector with the education sector, in addition to considering quality as a main factor, detecting that it is highly important for the companies to provide added value services,

since they are completely sure that this will allow them to be more competitive, adequate to the requirements and needs of each of their clients. Added value demands to review existing models, and to think in doing different, better, higher quality things, more focused on the client's needs, which will help the company to distinguish itself from the others.

It is appropriate to consider that, in order to remain in a dynamic and competitive market, the companies dedicated to develop software should obtain support from the state, which will allow them to apply models or methodologies related to the software development process, in order to provide a product with the highest quality standards, where said product is in accordance with the needs and satisfaction of the client, considering that, nowadays, the software product quality has a key importance, since such needs evolve to a world value concept, where they seek to improve a position in terms of international competitiveness; thus, it is important to use appropriate models that help us has a better control in the software development process.

REFERENCES

1. *Acuña, C., Cuenca Pletsch, L., Tortosa, N., Tomaselli, G., & Pinto, N. (2015). La vinculación Universidad-Industria como instrumento de mejora para la competitividad de las empresas de desarrollo de Software del NEA.*
2. *Alanís, B. (2005). El capital humano en la industria del software. Tesis que para optar al título de Licenciado en Economía. México, DF: Universidad Nacional Autónoma de México).*
3. *Calvo-Manzano, J., Cuevas, A. y San Feliu, G. (2016).* DEPROVAL: herramienta para la definición del proceso de validación en pequeñas organizaciones de software. *En: "11ª Conferencia Ibéricas de Sistemas y Tecnologías de la Información", 15-18 Jun 2016, Gran Canaria, Islas Canarias, España. pp. 992-997.*
4. *Etzkowitz, H., &Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. Researchpolicy, 29(2), 109-123.*
5. *Flores, A.,Ceballos, S.* ***y*** *Bojórquez, A.(2016): E*l sector de las tecnologías de información en yucatán: origen, evolución y perspectivas. *In: El desarrollo regional frente al cambio ambiental global y la transición hacia la sustentabilidad. Asociación Mexicana de Ciencias para el Desarrollo Regional, A. C, México.*
6. *Galvez, E., Riascos, S., & Contreras, F. (2014). Influencia de las tecnologías de la información y comunicación en el rendimiento de las micro, pequeñas y medianas empresas colombianas. Estudios Gerenciales, 30 (133), 355-364.*
7. *García, et. al. (2016). Metodología para el desarrollo de software multimedia educativo MEDESME. CPU-e. Revista de Investigación Educativa, (23), 216-226.*
8. *Hernández, R. et al. (2006) Metodología de la investigación (cuarta edición). México: Mc Graw Hill.*
9. *Holguin, J. (2015). Definición de un proceso de desarrollo de software con control de calidad del producto en una empresa pyme de la región. Tesis de Maestría en Gestión y Desarrollo de Proyectos de Software. Manizales Colombia: Universidad Autónoma de Manizales. 185 p.*

10. *Loeser, F., Grimm, D., Erek, K. y Zarnekow, R. (2012). Information and Communica-tion Technologies for Sustainable Manufacturing: Evaluating the Capabilities ofICT with a Sustainability Balanced Scorecard. In Proceedings of the 10th lobalConference in Sustainable Manufacturing, Istanbul Turkey, (pp. 429–434).*
11. *López, X. (2017). Apoyos bancarios e incentivos tributarios en el ecuador para la creación de nueva empresa en el periodo 2012-2016, Tesis que para obtener para optar al título de Ingeniero en Ciencias Empresariales. Ecuador:Universidad De Especialidades Espíritu Santo.*
12. *Marín, J., & Lugo, J. (2016). Control de proyectos de software: actualidad y retos para la industria cubana. Ingeniare. Revista chilena de ingeniería, 24(1), 102-112.*
13. *Núñez, R. (2016). Software ERP: Análisis y Consultoría de Software Empresarial. 2ª Edición, IT Campus Academy.*
14. *K. Selvakumar & S. Panneerselvam, A Study on Strategic Financial Performance in Software Industry, International Journal of Financial Management (IJFM), Volume 3, Issue 2, June-July 2014, pp. 7-14*
15. *ISO/IEC 25010,Portugal: ISO25000.com,http://iso25000.com/. Consultado marzo de 2018.*
16. *Quinde, B. (2017). Tesis: Servicios TI para PYMES de la ciudad de Cuenca. Recuperado a partir dehttp://dspace.ucuenca.edu.ec/handle/123456789/27759*
17. *Riascos, S., Aguilera, A., &Achicanoy, H. (2016). Inversión en Tecnologías de la Información y las Comunicaciones y su relación con en el direccionamiento estratégico de las PYMES de Santiago de Cali-Colombia. RISTI-Revista Ibérica de Sistemas e Tecnologias de Informação, (18), 01-17.*
18. *Senplades, S. N. (2012). Transformación de la Matriz Productiva, Revolución productiva a través del conocimiento y el talento humano. Quito: SENPLADES/. Obtenido de www.planificacion.gob.ec/wp-ontent/uploads/.../matriz_productiva_WEBtodo.pdf*
19. *Serna, M., & Ramírez, O. (2016). Gobierno abierto y competencias digitales: Transformando la administración pública para afrontar los retos del nuevo paradigma. Cuadernos de Gobierno y Administración Pública, 3(1), 1-14.*
20. *UNCTAD, 2012. Informe sobre la economía de la información, conferencia de las naciones unidas sobre comercio y desarrollo, la industria del software y los países en desarrollo. Greenwich, Reino Unido.*
21. *Villalobos, M., Karmelic, V., &Néspolo, M. (2016). Enseñanza de los Procesos en Ingeniería SoftwarevsCompetitividad de Empresas Creadas por Ingenieros Informáticos. Formación universitaria, 9(1), 03-14.*