Article

Organizational structure of software development companies located in the city of San Francisco de Campeche

Estructura organizacional de las empresas desarrolladoras de software radicadas en la Ciudad de San Francisco de Campeche

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Abstract

This research presents the results of the diagnosis of the current situation of the software industry in the City of San Francisco de Campeche, as well as the context in which it is at a national level. In March 2022, a survey was made to 83% of the software development companies in the city, with the use of the software called "Virtual Observatory" where an instrument consisting of 65 specific, observable and measurable indicators, classified in 3 categories referring to the organizational structure: Composition of Departments, Human Resources, Research, Innovation, Development and Technology. The indicators in turn were organized in 20 questions of closed format, which allowed to know the characteristics of the personnel, as well as the technologies that request to be mastered, and the different areas with which the companies operate. In this way, we contribute to the state of the art of the software industry in the community and thus detect areas of opportunity that detonate the economic development of the community.

Organization, Human Resources, Software

Resumen

En esta investigación se presentan los resultados del diagnóstico de la situación actual de la industria de software en la Ciudad de San Francisco de Campeche, así como el contexto en el que se encuentra a nivel nacional. En mazo de 2022, se realizó una encuesta al 83% de las empresas desarrolladoras de software de la Ciudad, con el empleo del software denominado "Observatorio Virtual" donde fue vertido un instrumento que constituido de 65 indicadores específicos, observables y medibles; clasificados en 3 categorías referentes a la estructura organizacional: Composición de Departamentos, Recursos Humanos, Investigación, Innovación, Desarrollo y Tecnología. Los indicadores a su vez se organizaron en 20 preguntas de formato cerrado, que permitieron conocer las características del personal, así como las tecnologías que solicitan ser dominadas, y las diferentes áreas con las que operan las empresas. De esta manera se contribuye en el estado del arte de la industria de software de la comunidad y con ello detectar áreas de oportunidades que detonen el desarrollo económico de la misma.

Organización, Recursos Humanos, Software

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Introduction

Manufacturing industries represent the third place of economic units (UE) in Mexico according to data from the economic census 2019 (INEGI, 2020) with a total of 579,828 UE, with employed personnel of 6,493,020 employees. Campeche contributes with 3,851 which represents 0.67 % of the economic units and 17,206 employed personnel representing 0.27 %. The manufacturing industry in Campeche as an economic entity generates 945.547 million pesos in remunerations representing 0.12% compared to the national level and a value of 6,596.046 million pesos in income representing 0.05% data from the 2019 census (INEGI, 2020) hence the relevance of this sector in the economy.

Campeche is one of the largest economies in the country, occupying the seventh place and the first place in the GDP of secondary activities where the manufacturing industry is part of (Hernández, 2018). As Campeche is an economic management entity, it is a good opportunity to generate and promote activities that improve the economy, such as the software industry.

In Mexico, computer sciences and information and communication technologies have a large number of people employed, of which 68% are men and 32% are women. Regarding their specialisation in the area 43% in computer science and 57% in information and communication technologies data from the national survey of occupation and employment (ENOE) (National Institute of Statistics and Geography (INEGI), 2019).

In 2018 Mexico reflected a 2.2 % gross domestic product (GDP), where the manufacturing industry of the state of Campeche contributed 0.4 %, data obtained from the Mexican National Accounts System (Cuéntame de México, n.d.) (Hernández, 2018). The state of Campeche has approximately 928,363 inhabitants, which represents 0.7% of Mexico (Cuéntame de México, n.d.).

Hundreds of young people are currently studying and working in the different areas covered by this industry. On the other hand, innovation and technology continue to advance, giving birth to new careers that strengthen the foundations and thus prepare new young people interested in being part of this great team, contributing new ideas, building new foundations and generating an economic contribution that allows the development of Mexico as well as the states in growth of the software industry.

According to INEGI data, the type of occupation of personnel working in the software industry is that 55% work as professionals and technicians, 14% in auxiliary jobs in administrative activities; 10% in activities related to commerce, 7% as civil servants, directors or managers; industrial and handicraft jobs occupy 6% and other activities such as transport, surveillance and personal services 8%, as can be seen in Graphic 1.
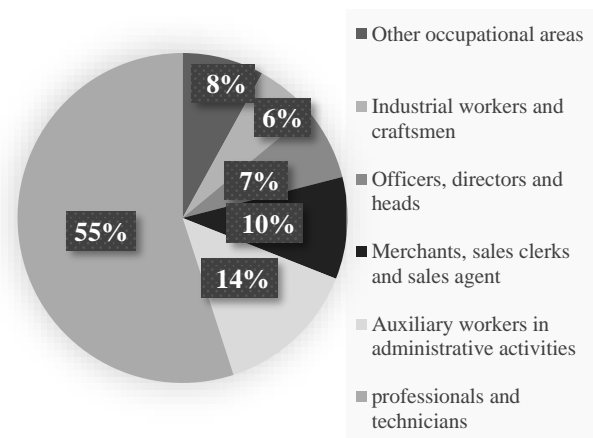
Graphic 1 Type of occupation of personnel in the software industry
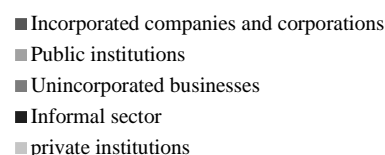*Source: INEGI. National Occupation and Employment Survey, ENOE. First quarter of 2020.*

The economic sector in which professionals in the software industry work is distributed according to the activities in which they specialise: 26% are employed in professional, financial and corporate services, 14% in commerce; manufacturing industry is one of the busiest areas with a total of 13%, social services 12%, governments and international organisations 9%, transport, communications, mail and storage 8%; miscellaneous services with 7% and construction with 4%; 3% is distributed in the restaurant activities and accommodation sectors, 2% in the extractive and electricity industries; agriculture, livestock, hunting and fishing account for 1% and non-specific sectors also account for 1% in employment Graphic 2.
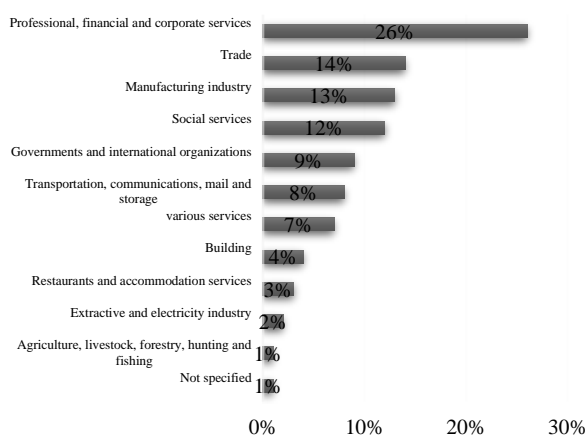
Graphic 2 Activities in which software professionals specialise
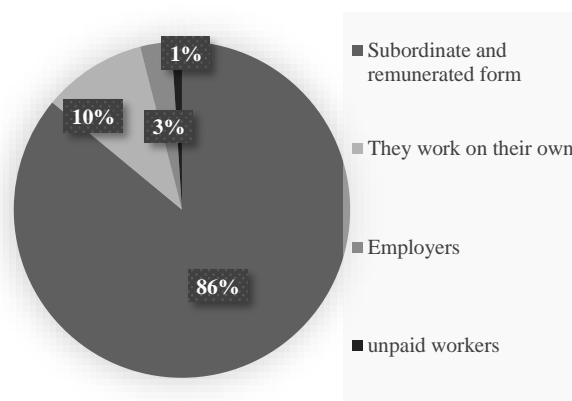*Source: INEGI. National Occupation and Employment Survey, ENOE. First quarter of 2020.*

Many of the software workers are found working in 3 main fields; 52% belong to incorporated companies and corporations, 20% to public institutions and 15% to unincorporated businesses; the rest of the workers are found working in the household sector or informally with a percentage of 10% and private institutions represent 3% Graphic 3.

Graphic 3 Main fields of work
Source: INEGI. National Occupation and Employment Survey, ENOE. First quarter of 2020

Regarding the fields in which each of the software specialists work, a percentage is found according to the type of contract of the institutions, i.e. the performance of the population is mainly reflected in a subordinate or remunerated form with a value of 26%, those who are self-employed 10%, employers correspond to 3% and 1% by unpaid workers (Graphic 4).

Graphic 4 Type of contract of the institutions
Source: INEGI. National Occupation and Employment Survey, ENOE. First quarter of 2020

The state of Campeche is part of the group that contributes in areas of science and technology or better known as the manufacturing industry, the entity has areas such as Material and intellectual infrastructure occupying the 6th position of the state at the national level, Public and private investment in science, technology and innovation occupies the 27th position; the 30th is represented by Scientific production and Information Technologies the 18th, data obtained from the Analysis Centre for Research in Innovation (CAIINNO, 2016).

Campeche is a developing state and more and more young people are interested in the various areas of the manufacturing industry contributing to improve the index of science, technology and innovation.

In the Human Development Report Mexico 2016 Inequality and Mobility (UNDP, 2016) apud by Cabrera, 2022, it is considered that innovation is no longer an exclusive task of research centres or industries, but opens the possibility for companies, businesses or non-productive sectors to intervene in the design of technological, social or educational solutions. (Cabrera, 2022).

Methods

The methodology used for this work was the creation of an instrument to help measure the software industry in the city of San Francisco de Campeche.

A.   Instrument design

For the design of the instrument to measure the software industry in the State of Campeche, indicators were generated, so that from them a complete instrument could be generated to measure the organisational composition of the software industry. The instrument was generated using the systematic review methodology, developed for the purpose of compiling and evaluating the available evidence pertaining to a topic (Biolchini, Gomes, Cruz, and Travassos, 2005).

1. Development of the protocol

a) Formulation of the question.

(1) Question focus:

To identify the set of indicators that will help to recreate an instrument to be able to evaluate the software industry in the city of San Francisco de Campeche.

(2) Breadth and quality of the question.

(a) Problem:

Currently there are no recent studies that indicate or detail the condition in which the software industry is currently in San Francisco de Campeche, which is why it is of utmost importance to propose a set of indicators that will help recreate an instrument to be able to measure the performance of the software industry in the state.

(b) Question:

What are the most relevant indicators to evaluate the software industry in the city of San Francisco de Campeche?

Is it possible to classify the indicators that help to evaluate the software industry in the city of San Francisco de Campeche?

(c) Keywords and synonyms:

The definitions used to solve the research question were Software, software industry, technology, growth, boom, economy, investments, ICTS, Software Clusters, 2004, 2005, 2007, 2008, 2009, 2012, 2014, 2018.

(d) Intervention:

Indicators to assess the Software industry of the city of San Francisco de Campeche.

(e) Outcome:

Studies to identify the strengths, weaknesses, opportunities and threats of the software industry sector in the city of San Francisco de Campeche.

(f) Field of research:

Publications related to the quality area of the software industry from countries around the world.

B.   Construction of the Indicators Instrument

The instrument was created based on a methodology presented in the work "Propuesta de indicadores para evaluar la industria de software de una región", (Mex et al, 2021).

In this work, 3 categories are presented referring to the organisational structure that includes: departmental composition, human resources and research, innovation, development and technology.

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The number of indicators that were established per category are shown in Graphic 5.

Graphic 5 Number of indicators by category
Source: Own elaboration

In order to be able to collect the indicators, the required questions were designed to include several indicators, distributed into 3 questions on Organisation, 5 on Human Resources and 12 on Research, Innovation, Development and Technology (Graph 6) (Graphic 6).


Graphic 6 Number of questions per category
Source: Own elaboration

C. Target population

The target population of the instrument is constituted by all the software development companies that have their fiscal domicile in the city of San Francisco de Campeche, being a total of 6, of which 3 belong to the AhKinTech cluster and 3 do not belong to any association.

D. Application of the SME Instrument

The application of this instrument was carried out during the month of March 2022, where a total of five developer companies participated, two from the Ah Kim Tech cluster and three that are not affiliated, as shown in Figure 1.
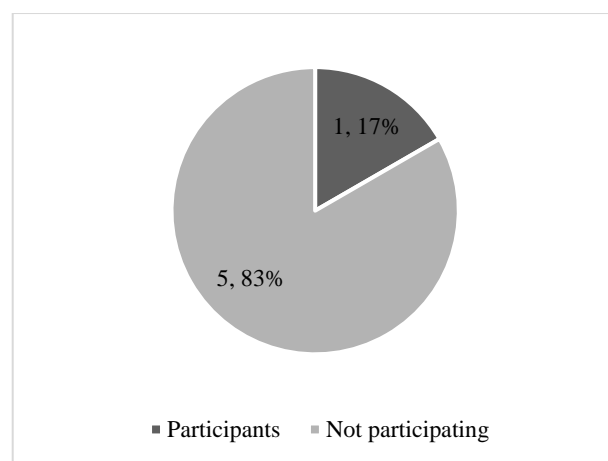
Figure 1 Participation of software development SMEs
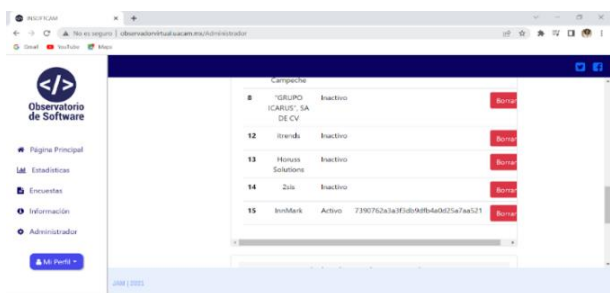*Source: Own elaboration*

The software developed, called "Virtual Observatory", automatically performs the statistical analysis of the data thanks to the definitions of variables and formulas that were established in the construction of the instrument, therefore, it offers us the option of visualising the results from different perspectives.

In order for the surveyed companies to be identified by the system, accessing as System Administrator, the entities must be registered with their name, contact telephone number and e-mail address. Figure 2 shows the registration window.

**Figure 2** Registration window
Source: Own elaboration

Once the entity is registered, a TOKEN is generated which will be active until the survey is completed. Figure 3 shows the window where tokens are administered.

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Figure 3 Token administration
Source: Own elaboration

Registered companies will be able to access the questionnaire by entering the URL: http://observadorvirtual.uacam.mx/

Subsequently, they must enter the token, which was previously sent by e-mail. Figure 4 shows the access window.
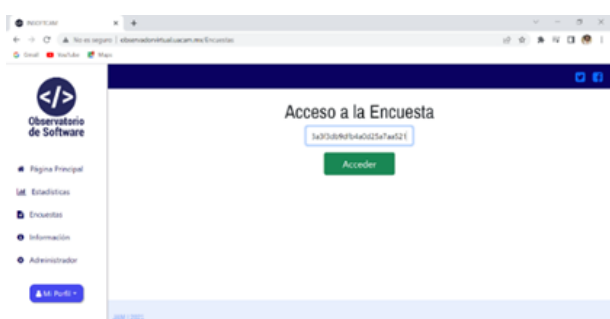
Figure 4 Access window
Source: Own elaboration

Once the TOKEN has been validated, you can start filling in the corresponding answers, as shown in (Figure 5)
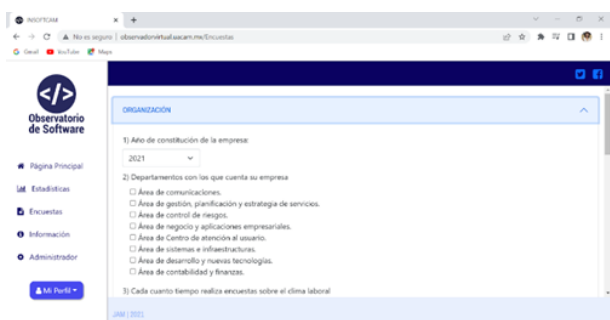
Figure 5 Filling out the survey
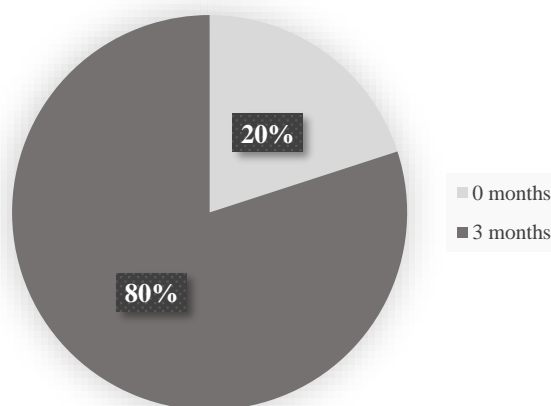*Source: Own elaboration*

Results

The average age of the SMEs in Campeche was found to be 10.5 years.

Graphic 7 shows the organisation of the areas within the companies, so that the risk control area is not included in any of them, as a priority is the area of management, planning and service strategies which will be responsible for setting the direction of the company as well as coordinate, manage and organise major tasks that promote their development; On the other hand, they also have areas such as the user service control area and the business and business applications area. The accounting and finance area represents a smaller percentage compared to the areas of communication, infrastructure systems and the area of development and new technologies.
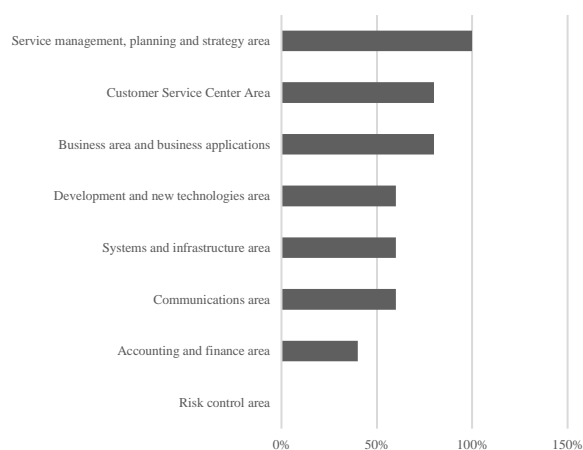
Graphic 7 Company departments
Source: Own elaboration

Graphic 8 shows that 20% of the SMEs, i.e. one of them does not carry out any kind of work climate survey and the remaining 80% carry it out regularly within a maximum period of 3 months.

Graphic 8 Time taken to carry out surveys
Source: Own elaboration: Own elaboration

With regard to recruitment criteria, Graphic 9 shows that for SMEs, teamwork skills and willingness to learn are fundamental and of great importance. SMEs consider that these criteria complement different areas and generate quality work by obtaining new knowledge. On the other hand, problem-solving skills are also relevant according to 60% of the SMEs and 40% consider innovation important, not only the creative mind but also the construction and development of new ideas that generate software infrastructure. 20% of SMEs consider time management and responsibility to be important among the skills of their employees. Experience, certifications and being responsive were not chosen among the main criteria, because they are characteristics that are obtained in a certain time frame and that with the main criteria are possible to achieve.


Graphic 9 Main recruitment criteria
Source: Own elaboration: Own elaboration

The SMEs handle different types of contracting, the most used with 63% being a dependent who follows the orders of a boss, receives a salary determined by the hours or months that he/she has been working in the company, contributing to the company's performance, and is paid by the number of hours or months that he/she has been working in the company. The independent contracts or outsourcing consist of a contract with the company.

Independent contracts or outsourcing consist of delegating an activity of a company to a specialised professional in order to obtain better performance indicators. 25% of the employees of software development SMEs in the city of San Francisco de Campeche work under this scheme.

Temporary employees are those who are under a governmental programme scheme that at the end of it will no longer be part of the company and represent 6%. Apprentices and/or trainees are students of various degrees who provide their services or professional internships and represent 6% as can be seen in Graphic 10.
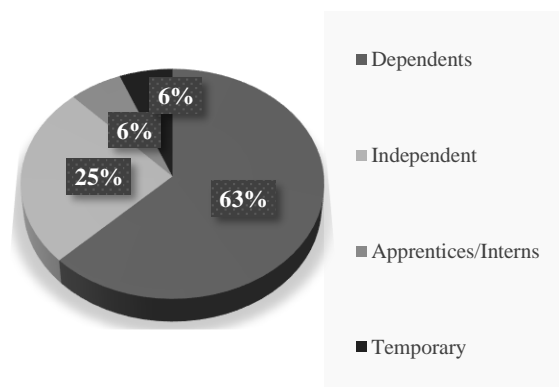
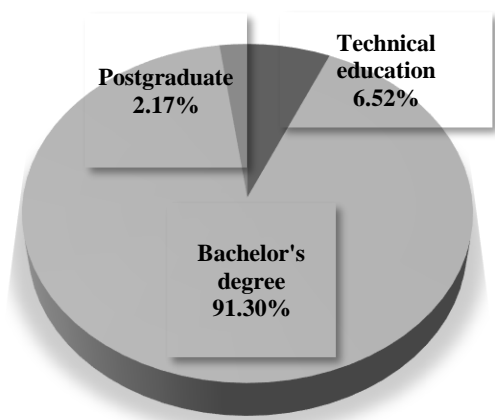**Graphic 10** Type of recruitment
Source: Own elaboration

86% of the personnel hired have a bachelor's degree, 8% have a technical education and 6% have postgraduate studies, as can be seen in (Graphic 11).
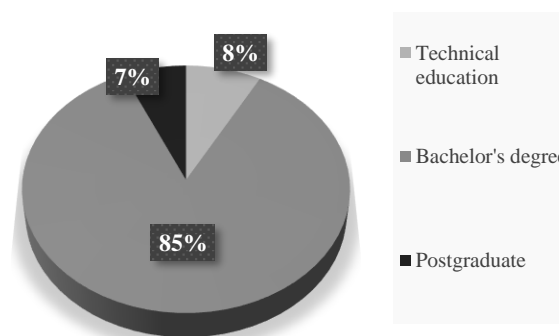
Graphic 11 Level of studies
Source: Own elaboration

With regard to the number of programmers by level of studies according to the type of contract, the majority of programmers are at undergraduate level with a percentage of 91.30%, followed by 6.52% with technical education and 2.17% with postgraduate studies (Graphic 12).

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Graphic 12 Programmers by level of education
Source: Own elaboration

Staff rotation is a practice rarely employed within the software industry in the city of San Francisco de Campeche, as can be seen in Figure 17.

In (Graphic 13) we can observe the programming languages most used by the SMEs, where Java and PHP are the most required, leaving in second place the languages like C# and Swift, Python occupies the third place, each one of them are a fundamental base for the complete development of the software industry.
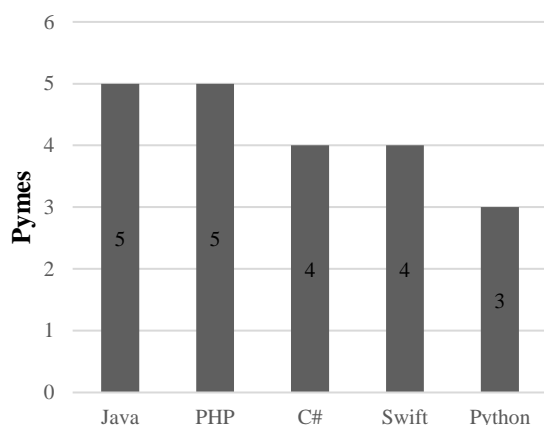
Graphic 13 Programming languages
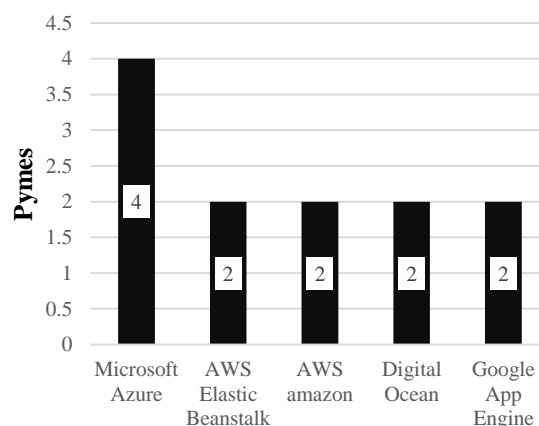*Source: Own elaboration*

Databases allow to store, organise, maintain privacy, as well as to avoid redundancy of large amounts of information or data which can be consulted anywhere. Graphic 14 shows the databases most used by SMEs, firstly MySQL, followed by Amazon RDS, Firebase, MariaDB and PostgreSQL.
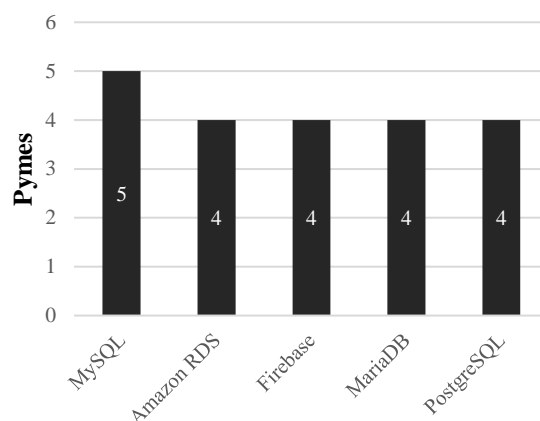
Graphic 14 Database
Source: Own elaboration

Graphic 15 shows the technologies implemented for development in the cloud, where Microsoft Azure is requested by 4 companies, followed by AWS Elastic Beanstalk, AWS Amazon, Digital Ocean and Google App Engine, requested by 2 SMEs each.

Graphic 15 Technologies for development in the cloud
Source: Own elaboration

Acknowledgement

Funding

Conclusions

SMEs have several areas that allow each of the employees to perform adequately, most of them consider the work climate surveys and give more weight to soft skills with willingness to learn, responsibility and teamwork, as high hiring criteria, leaving experience and certifications in second place, as over time these criteria can be obtained. The phenomenon described above makes them hotbeds of talent.

Most of the companies are under the regime of dependent employees with a salary and legal benefits, while a smaller percentage is occupied by independent contracts, highlighting that this type of regime benefits the fiscal interests of subordinates.

On the other hand, the level of hiring of employees with programming skills is more specified, i.e. they prefer people with technical education rather than postgraduate studies, due to the level of salaries they can offer.

Carrying out the application of the "Virtual Observatory" and being able to visualise the results from different perspectives allows us to know the economics and development of the different companies in the software industry; the advancement and empowerment of the various areas.

It is noteworthy that none of the companies consider an area of risk control or specialised personnel to ensure better development and growth. Therefore, this becomes an area of opportunity to prevent and cope with the risks they may face that could lead them to failure.

It is suggested that in future research, a qualitative evaluation should be carried out to complement the data provided by the instrument with the companies' appreciation of the different reasons that influence their organisational structure.

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