MicroErp, a computer solution for small and medium-sized enterprises: Case study of collaboration between university and industry

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Abstract

Over the years, one of the most important problems in engineering university education is the lack of student attention. The great majority of this problem is that the student feels that the knowledge transmitted in class has nothing to do with the real world. Besides that, the industry needs creative and innovative solutions and universities are best suited to meet the challenge through attractive and relevant curricula integrating innovation topics. For this reason, there is a phenomenon has emerged, known as collaboration between the university and industry (CUI), which becomes very beneficial for both agents. This article aims to show a case study of a collaboration project between small and medium-sized enterprises (SME's) and the entrepreneurship of a team of teachers and students. The project, called MicroErp, is being developed through end-of-course projects of the computing faculty and consists of the creation of a computer tool for medium and small business resource management.

Keywords

Case study, Collaboration Industry – University, Enterprise Resource Planning, Small – Medium Enterprise, engineering curricula.

1. Introduction

The university offers knowledge that can be used to solve some need of society. According to the curriculum guide presented by ACM (Association for Computing Machinery) for undergraduate software engineering programs (ACM: Software engineering, 2015), a graduate of this career should have the ability to design and implement complex software components by applying recognized and proven principles of engineering and must have the ability to develop software under the concepts of the software construction process (Jacobson, 1999).

In the Pontifical Catholic University of Peru (PUCP) located in Lima - Peru, for a student can graduate, must present a thesis work. The work must to relate the knowledge learned during the previous 4 years and must have the advice of a teacher. Usually the topics are related to development of solutions or research in the field of software (Alari, 2016). There are two mandatory courses that are taught in the ninth and tenth cycle of Software Engineering career that support the thesis work: In the ninth cycle the student has the thesis project course 1, where he will receive support to define the problem, objectives and state of the art of his dissertation work and in the tenth cycle the student has the thesis project course 2, Where he will receive support to complete his thesis document and the product. Once the courses are finished and the document and the product are ready to present, the student must present the work before a jury in order to demonstrate that the thesis work contains concepts studied in his career and can be useful for society. However, thesis work, for the most part, is not implemented in society because thesis work does not meet the necessary scope of use. It is also worth noting that the motivation of the student to continue developing his project is very low.

On the other hand, the implementation of software in companies for management and decision making of their resources is fundamental. For approximately 10 years, technology companies have offered integrated computer solutions that can handle resources in companies (LAUDON & LAUDON, 2004). Enterprise Resource Planning (ERP) is the trade name for software that seeks to provide a computer support in the management of sales, purchasing, and logistics, among other main processes of a large company (ORACLE, 2016). ERP is a very useful solution for large companies but not for medium companies neither small companies especially.

The project proposal was oriented to develop software, named MicroERP, which solves the lack of computer tools that support the management and decision making of small and medium enterprises. To reach the objective of the project it was proposed to divide the scope by means of the work of 4 thesis projects. Each thesis work aimed to develop a functional module of some area of the companies. The functional modules are: sales, purchasing, inventory and accounting. Each thesis project had as objective to define the scope of its module, to achieve this; it was made interviews with four companies that served as income in the definition of the business model to be considered in the software. The software was developed for web platform and communication between modules was used web services. With respect to the methodology of the software development process, the stages presented by RUP were considered: business model, requirements acquisition, analysis, design, construction, testing and implementation. It was also necessary to define a framework and to use several principles presented by SCRUM.

In this study, we described a case of the collaboration between university and industry and analyzed the results obtained in the collaboration through the stages of the construction of MicroERP software. It should be noted that this project involves the courses of the last semesters undergraduate computing.

2. Conceptual framework

2.1 University-Industry Collaboration

With the motivation that universities can bring their knowledge to society, University-Industry Collaboration (UIC) is created. Collaboration is defined as any activity that allows the industry to obtain new knowledge. The university can also obtain benefits such as real situations for research and funds for new research. The UIC is part of the university-industry-state link (Etzkowitz, 2000, Sábato & Botana, 1968). The links generated between the three agents aims to generate innovation in a region. Sábato (Sábato & Botana, 1968) defines that the university, industry and state must not only perform their role in isolation, it must generate links between the other agents. The CIU is not new, it can be seen that, in the United States in order to contribute to innovation in industry and take advantage of university research, created the aforementioned Bayh-Dole Act. The Bayh-Dole Act helps the university in the process of transferring technology to the industry through intellectual property. The Bayh-Dole law obtained positive results (Dai, Popp & Bretschneider, 2005) and helped the university patent its research and transfer

technology effectively (Scott 2004). A clear example was the spin-off increase with technology base created in the university (Mowery, 2011). The Bayh-dole Act is very beneficial but care must be taken in the incentives to researchers. Researchers can seek to patent only by getting beneficial and losing the university's goals (Scott, 2004). China has policies that encourage UIC also. For example, there are programs that provide internships for students in order to become experts in some technology. Students become technology experts and serve local businesses (Wu, 2010).

The UIC can be done in different ways. The obtaining of the university resources is achieved by means of the transfer of technology and knowledge that is realized from the university to the industry. Arenas (Arenas, 2017) describes that the mode of transfer can be given in the formal way, where there is some kind of formal agreement between the university and the industry; and informal way, where there is no formal agreement. The formal way has the following means of transfer: patents, prototypes, research results. The informal way has the following means of transfer: Conference (can also apply for teaching), publications of scientific articles, informal discussions.

The MicroERP project is an example of UIC with the informal modality. The teaching of thesis project courses 1 and 2 made it possible for students and teachers to present a project linked to the need of small and medium-sized enterprises

2.2 Definition of the software construction process

Another necessary concept for the article is the software building process. The process consists of the following phases: business modeling, requirements, analysis and design, implementation and testing (Aalst & Stahl, 2011). Next, we explain each phase used, also called disciplines, with which we worked on the project (Reyes-Delgado, 2016).

a) Business Modeling: The purpose of this phase is to know the operation of the company activities. This phase aims to understand the activities of the company and to be able to obtain the necessary requirements for the elaboration of the system. It analyzes and describes the business processes involved in the different activities of the company.
b) Requirements Management: The purpose of this phase is to define the requirements that the software needs and to make a coherent specification of the requirements. The main activities are: to collect, organize and document the necessary requirements to develop the software.
c) Analysis and design: The purpose of this phase is to define the software architecture; it should include the database architecture and the component architecture to be programmed. This model must capture the functionality of the information system to be developed. In addition, the purpose of this phase is to develop a functional software model that serves to be validated by the user and serves as a guide for the software development team.
d) Implementation: The purpose of this phase is to build software. This entails writing and debugging source code, unit testing and software building management.
e) Testing: The purpose of this phase is to perform the verification of the built, this implies defined functionalities and technical specifications.

3. Case study: UIC collaboration experience

Thesis Project 1 and 2 courses aim to help students develop their thesis project. It should be emphasized that the thesis is a fundamental requirement to achieve the degree of engineer. Also it is necessary that the student has approved all the courses corresponding to the computer science curriculum. The thesis project must have the advice of a teacher (advisor). The consultant should guide the student in developing a project according to a thesis, that is, have an adequate degree of complexity and have a social impact. As described, the thesis project can be validated as an informal mode of UIC, whose means of transfer is the presentation of the paper and the university collaborates with the industry through a finished product.

The MicroERP project aims to provide a digital tool to micro and small companies in Peru, so they can manage their resources. For this is being created software composed of four modules: accounting, purchasing, inventory and sales. Each module was developed by a student and presented as a thesis project. All the thesis projects have been advised

by a group of teachers, who helped the students to align the needs of the industry with the knowledge obtained in the university.

Each phase of the software building process was an UIC experience, because students were required to obtain information from companies and construct their corresponding module. It means that the knowledge obtained was very valuable on the part of the student and the companies involved.

3.1 Software Building Process

As a first step to the software building process, you should check whether there are defined business processes. The objective is identifying the activities to be considered in the software. For the project there were four small Peruvian marketing companies, which have in common not having defined processes. The four companies belong to different categories but similar activities were identified. For this reason, it was decided to establish a model, where business processes can be adapted. Interviews were conducted with the help of a common questionnaire, with the purpose of obtaining information about the sales, purchasing, finance and inventory processes, to then diagram the business model, identifying the activities and interactions between the processes. Figure 1 shows the business model for the purchasing module.

Also, in this first step it is necessary to review the software situation that could help small businesses through a state-of-the-art review. There is a variety of software for managing a company's resources. Management software, such as an ERP, would be the best option as a tool for support in your business processes but has the disadvantage of being very expensive for small businesses. It is also noted that small companies decide to use applications developed as they support some management processes but their difficult support does not provide continuity of service availability. Finally, it will be appreciated that some small businesses rely on office tools like Microsoft Office but may be limited because their purpose tools are not supportive to business management specifically. The following are some technological solutions that have objectives similar to this project: Odoo (Odoo, 2016), Microsoft Excel (Microsoft, 2016), SAP Business One (SAP, 2015), Microsoft Dynamics NAV (Microsoft, 2015) y Suite de Negocio de Openbravo (Openbravo, 2015a; Openbravo, 2015b).

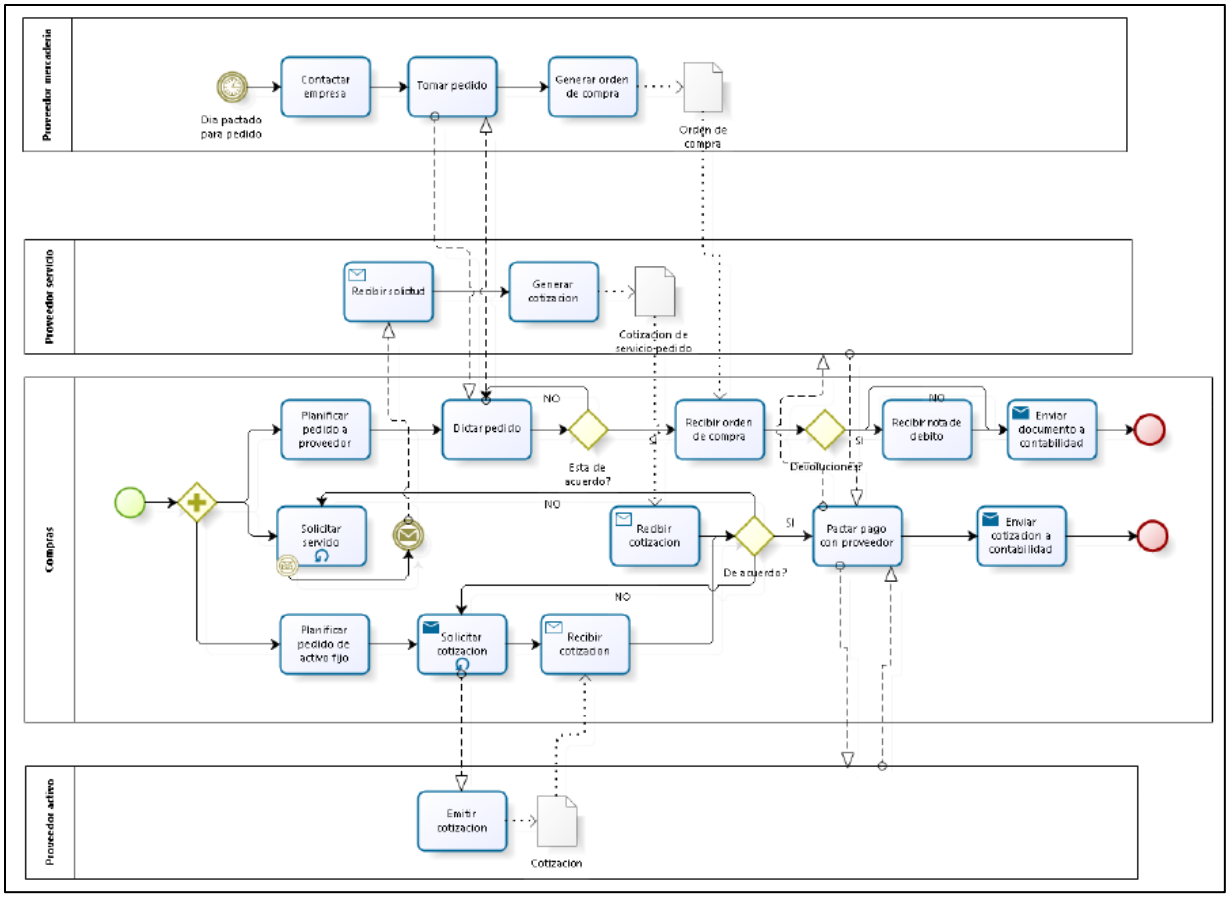

Figure 1: Business model for purchases

After diagramming the common business activities and determining that there is no IT solution suitable for small business, proceed to continue the construction process. In order to do this, we defined an interactive work between the students and the four companies, where weekly meetings were defined, which helped define software with greater clarity. To achieve this we used principles raised by the SCRUM framework (Schwaber, K., & Sutherland, J. 2013).

The second stage in the software construction process is the elaboration of system requirements. In the case of the project, interviews and additional consultations were carried out with the operators of the companies. It obtained about 120 requirements, which include functions and technical aspects such as: the management of the system on different platforms, these being web and mobile. Figure 2 shows a section of the requirements defined for the inventory module.

From this list, the analysis stage was carried out and the "use cases" and "user stories" techniques were used, considering the latter to complement the understanding of the functionalities described in the cases of uses for the Users. At this stage there is a transfer of knowledge on both sides. On the one hand, students learned how to show the functionalities of the software and on the other hand, companies learned to analyze their requirements from a technical point of view. Figure 3 shows a use-case diagram for the accounting module, Figure 4 shows an example of the user history and Figure 5 shows the user history for product management.

Código	Requisito	Subproceso
LOG.RF.001	El sistema permitirá registrar y consultar Notas de Ingreso	Ingreso de productos
LOG.RF.002	El sistema permitirá reservar productos para Despachos Pendientes	Ingreso de productos
LOG.RF.003	El sistema permitirá modificar Notas de Ingreso	Ingreso de productos
LOG.RF.004	El sistema permitirá consultar Órdenes de compra	Ingreso de productos
LOG.RF.005	El sistema permitirá consultar Documentos de Venta	Ingreso de productos
LOG.RF.006	El sistema permitirá consultar proveedores	Ingreso de productos
LOG.RF.007	El sistema permitirá registrar y consultar Notas de Devolución	Ingreso de productos
LOG.RF.008	El sistema permitirá modificar Notas de Devolución	Ingreso de productos
LOG.RF.009	El sistema permitirá registrar y consultar lotes de productos	Ingreso de productos
LOG.RF.010	El sistema permitirá modificar lotes de productos	Ingreso de productos
LOG.RF.011	El sistema permitirá registrar y consultar los ingresos de productos a almacén	Ingreso de productos
LOG.RF.012	El sistema permitirá registrar y consultar productos	Inventario
LOG.RF.013	El sistema permitirá modificar productos	Inventario
LOG.RF.014	El sistema permitirá registrar y consultar categorías de productos	Inventario
LOG.RF.015	El sistema permitirá modificar categorías de productos	Inventario
LOG.RF.016	El sistema permitirá registrar y consultar almacenes	Inventario
LOG.RF.017	El sistema permitirá modificar almacenes	Inventario
LOG.RF.018	El sistema permitirá registrar y consultar secciones de almacén	Inventario
LOG.RF.019	El sistema permitirá modificar secciones de almacén	Inventario

Figure 2: List of requirements obtained for the inventory module

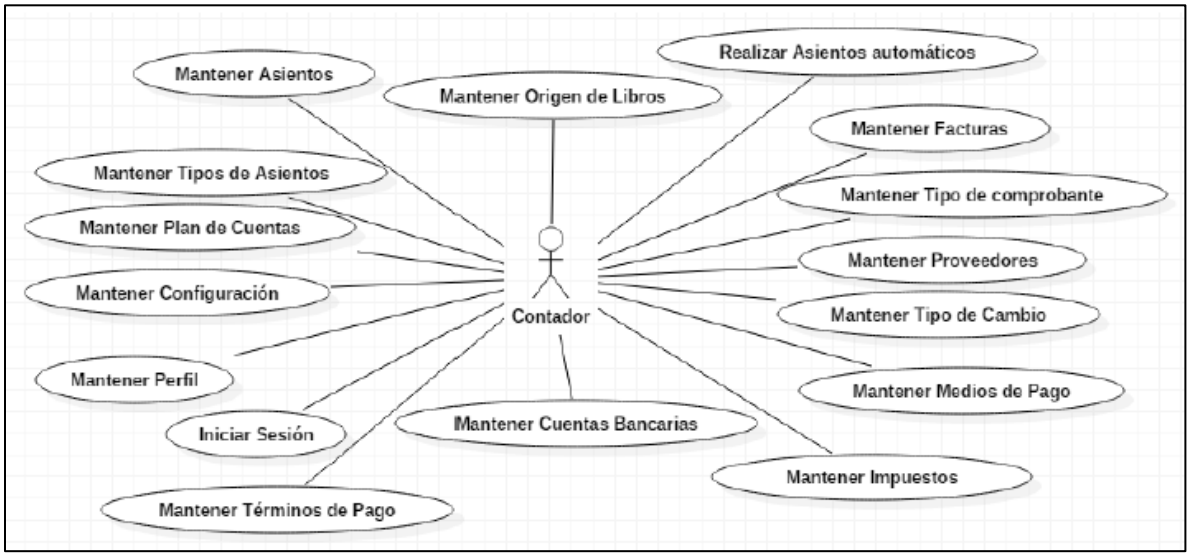

Figure 3: Use case diagram for the accounting module

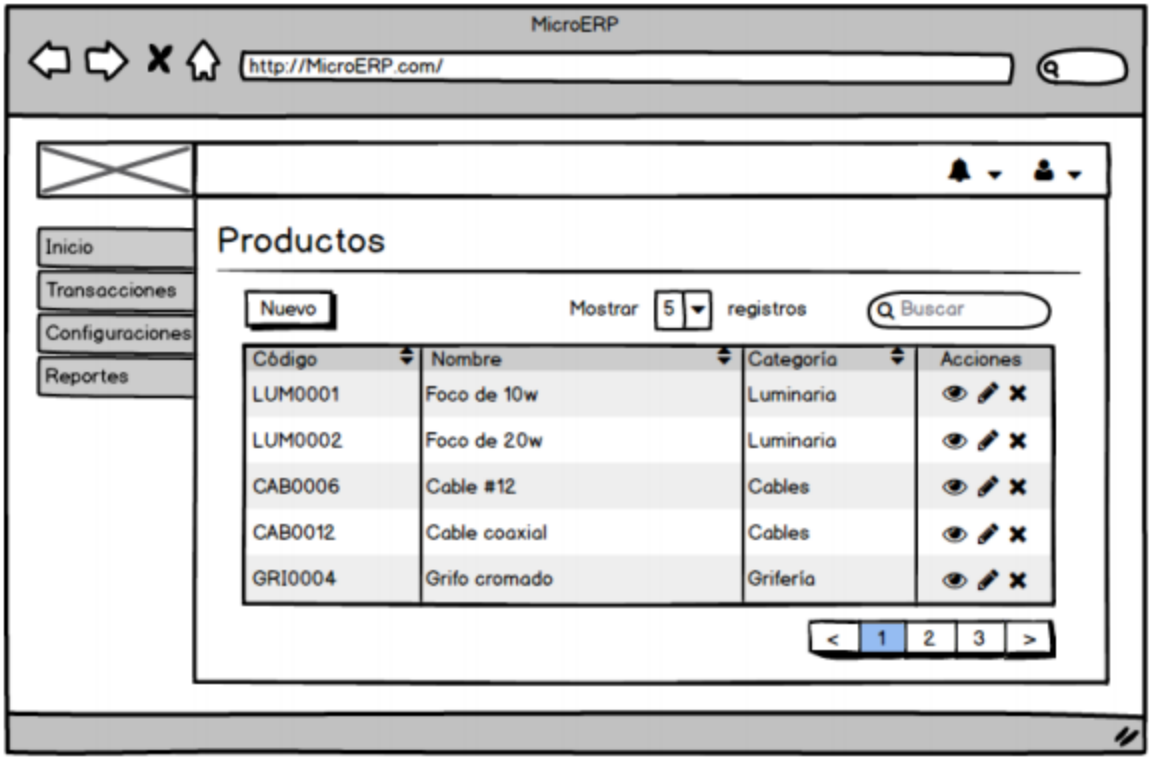

Figure 4: User history for product management

As a third step, the software architecture and the database were designed. The choice of a "multi-layer architecture" was chosen and the use of a single database was established, that is to say that although ERP systems offered in the market handle databases for each module they contain (Kroenke, 2006), for this project it was determined To use a simple and inexpensive solution that allows micro-enterprises to obtain a fast information backup if required at a low cost. Figure 5 shows the architecture of software components.

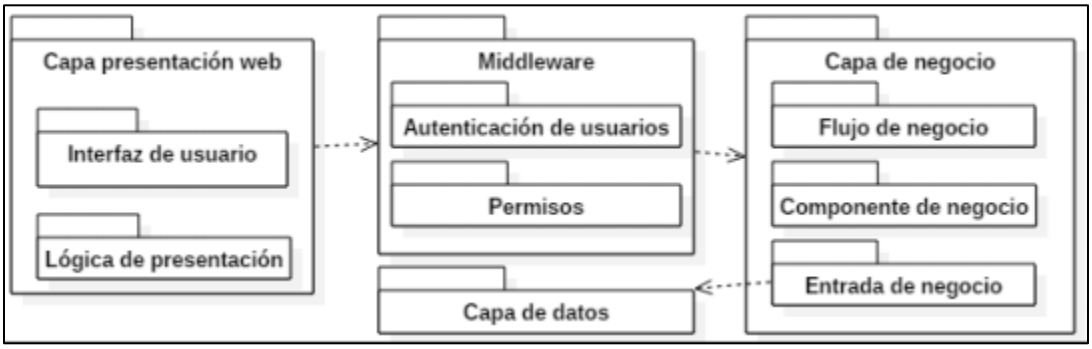

Figure 5: Architecture of software components

As a fourth step, the software modules were developed. To do this, each student put together a list of tasks, which were executed with the programming techniques learned during the undergraduate program. For the execution, they used the good practices of SCRUM, taking control of the progress of the implementation of each module.

As the fifth and final stage for the project, tests were carried out to verify the correct elaboration of the functionalities by module. Different test design techniques will be used. For example classes of equivalence and limit value. The validation of the correct software operation with respect to the previously defined business model by the user is also performed. In this last stage some activities with respect to the transfer of technology were observed. The companies obtained the final software for validation and future use.

4. Analysis of results

The MicroERP Project is a clear example of University-Industry collaboration, where knowledge and technology transfer can be appreciated. On the one hand the industry has obtained a management support tool that will allow a better management of resources of small companies. The software presents functionalities suitable for small businesses. Figure 6 shows an example of the product promotion screen. The industry is also getting a digital platform without worrying about implementation and maintenance of the infrastructure, currently the hardware of the digital platform is housed in the servers of the university.

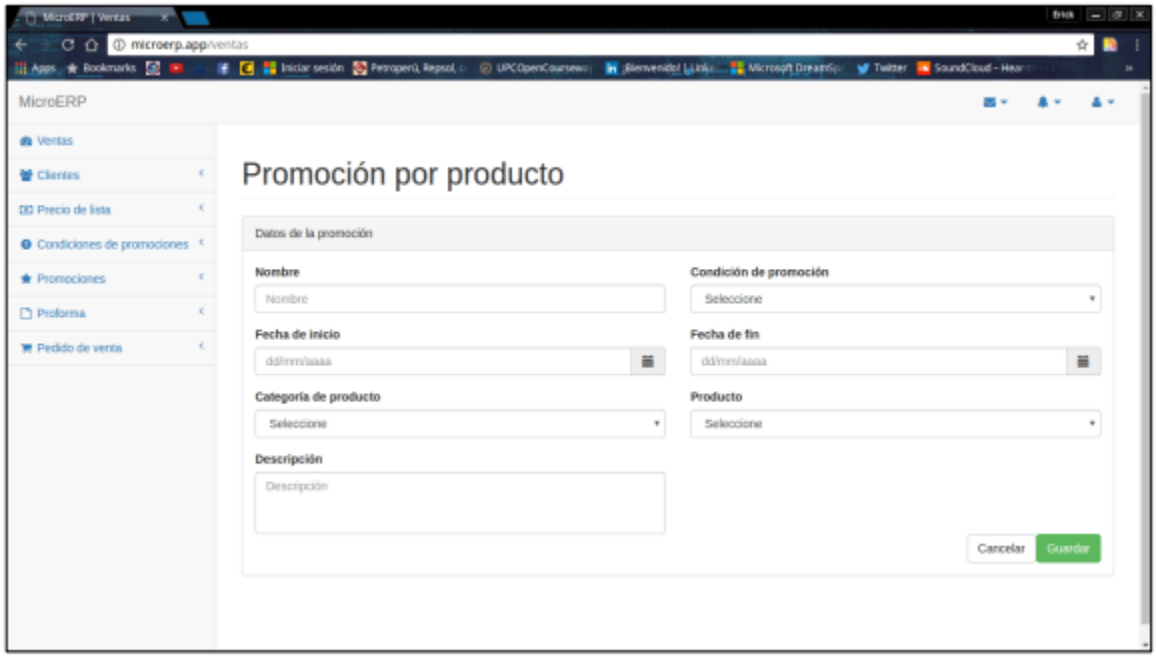

Figure 6: Product promotion web page

On the other hand, the university has also obtained very interesting benefits. The students gained new knowledge about communication techniques with companies, had to learn to translate their technical knowledge into an understandable language for small businesses were also able to validate their knowledge gained during their university life in a real project. The students were also able to apply their technical knowledge, developing a Web application in PHP with a database engine in MySQL. Additionally, communication between the modules was achieved through web services, where each module had web services that can be consumed by the other modules.

5. Conclusions and Future Works

Collaboration between the University and industry not only happens through written agreements. It is possible to conduct informal collaboration, linking students' projects with industry needs without the need for a signing agreement. This type of collaboration helps to make communication and the transfer of knowledge and technology more fluid. It should be noted that in the future this collaboration must be of a formal type, with some written agreement to help limit the responsibilities and benefits or create a university spin-off.

The role of the teachers involved in the project was fundamental in the collaboration. The experience in subjects related to communication with company helped the students to know how to interact with the companies. Teachers also help motivate students during the course of the entire project development. Knowledge of the business environment helped a lot to know a need and served as a starting point for the MicroERP project

Finally, knowledge and technology gained was invaluable collaboration. On the one hand the company obtained software that will allow you to manage your resources efficiently. The companies also gained knowledge about

software development projects, which will be used for future projects. On the side of the university, the students were able to validate their knowledge obtained in the university.

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Biography

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