

# ‘ICT in the Engineering and Management’

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**Abstract** – The linkage between the University/Industry/Government, is not a new idea, but it is a question that is in a priority line for Latin-American Universities, as one of the basic functions of Higher Education, similar to teaching and research. It is in this new stage of world development where linking commits a dynamic agent role, in collaboration with the innovation and the update of the production systems. The technology revolution especially that of information systems has modified the understanding of space and time and at the same time starts a world economic network, the expansion of markets and the tertiary economy. Considering that these transformations have been able to characterize the economy in three details: It is to inform, it is global, and it functions as a network. The e-Production Chain, is based on a novel University/Industry/Government outline, with special attention to the enterprise clusters, by introduction of computer solutions as they are called Enterprise Resource Planning, Customer Relationship Management, and Supply Chain Management, useful for manufacturing management, marketing and providing, which have the potential to enhance competitiveness and cost reduction. The project background is presented and its advances under the hypothesis that in the same way, the production capacities according the state of the art of the knowledge and technique; it is that generate competitive advantages for the users, such as outsourcing so as to encourage the modernization of the industrial sector.

*Index Terms* - Customer Relationship Management, Enterprise Resource Planning, Information and Communication Technologies and Supply Chain Management.

## INTRODUCTION

Undoubtedly an issue that defines XXI century is the changes that affect the society in all its dimensions, and create economical and technological transformations.

Castells [1], considers that the economy nowadays can be identified by three main points: it is global, it informs and it is a network. Global because the actions have their effect on spaces of all over the world, informs because the use of the new business manufacturing and management practices through Information and Communication Technologies

(ICTs) have registered a significant growth, and networks because it puts together different elements, different persons, different pieces of an enterprise or several enterprises to do something together – it has the flexibility advantage, it adapts quickly to the demand when this is strong it organizes in a network, when there is none, then it disappears and uses new resources. All of this has generated the opinion that the enterprises in XXI century should be able to respond to an environment of high competitiveness [2].

The development of ICTs has been stronger in the last decades, and is one of the main subjects that has favoured the strengthening of the globalization process and the international economic integration. The Massachusetts Institute of Technology (MIT) initiative “Invent the XXI Organizations” it has identified eight key elements, or urgent challenges for the actual entrepreneurial leaders. From among the impact of Information and Communication Technologies and the question of what’s going to happen to the industrial structures when the electronic markets and the information highways change the traditional commerce and business models. This phenomenon is of such an importance that the electronic or digital markets have the potential to generate the biggest expansion of the free-market system since the invention of currency.

In this sense ICT’s is an important factor for enterprise competitiveness as they allow the development of intensive processes in common knowledge and services of a modern economy. For the industries, the appropriate ICT’s use of solutions and services improves the efficiency of the value chain with better and faster communications among the commercial customers, integrating the transactions with logistic functions, reducing the mediator costs, facilitating the search of new markets, and allowing the improvement of prices policies [3].

These new technologies are just starting and we do not know yet the impact that they will have on the economy and in the society in the next years, that’s why it is important to give special attention to this new phenomenon. These forms show entrepreneurial innovation processes that favour a reduction in transaction costs and commercial restrictions, that have empowered new opportunities to generate value inside any economical activity and have revolutionized the way of doing business. ICT’s offer great opportunities to the enterprises to increase their productivity, have access to new markets, and facilitate innovation. But, as any tool, the efficiency depends upon the users capacities.

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The effective use of these technologies and especially the ones of multiple functions and Internet applications have accomplished the reduction of time barriers and geographic space, so, the enterprises can have access to new technological solutions, software, learning media (e-learning, e-consulting, self diagnostic), virtual commerce windows (e-commerce) that contribute to achieve high levels of competitiveness.

With the Internet, new forms electronic commerce have emerged (e-business), the same that can reorganize the enterprise as to have the capacity of exchanging goods, services, money, and knowledge in a digital form using ICT's based on Software as a Service (SaaS) as: Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) and the Supply Chain Management (SCM). These systems allow the enterprise organizations to be efficient and to integrate all their business operations, this reorganization drives to the capacity of exchanging goods, services, money and knowledge [4].

ERP systems are a fundamental tool to unify business functions such as: manufacture, finance, distribution/logistics and human resources, it is also the main backbone for e-business [5]. In general terms ICT's that are analysed in this research can be defined as powerful information systems that integrate all the departments and functions of an enterprise, and can respond and serve the particular necessities of different departments [6]. Further from the enterprises these systems contribute to generate new solutions through the relationships with customers and suppliers through the chain of the global product and through [7].

Historically, companies have created information islands, which means, several systems that operate or manage different parts of a business. Some times these systems are strongly linked and other times they do not have any connection or its integration is poor. Almost all of those systems that are independent require maintenance; the operation and management cost to integrate them is higher than to buy and install a new system. The majority of enterprises fail when they introduce ERP, CRM and SCM systems because they expect different benefits from those that the package offers, in other cases even though it seems very innovative they do not do all of what is needed.

Even though the ICT's have made these technologies more accessible for any user, it is still not yet as accessible for our small to mid-size enterprises (SMEs), so it is necessary to develop innovative schemes that allow the quality, security and economy for the users of these kind of technologies.

Facing these challenges, the Universities as well as the governmental entities and international enterprises have nowadays a strong ICT's infrastructure, for their own management, teaching and researching necessities solutions. This is not the case for Mexican SMEs, the limited introduction for these Technologies in the era of globalization of the economies and markets has had as a consequence reduced viability and the closing of thousands of enterprises and the risk that many more may no longer be viable in the future [8].

This document presents the production e-Chain, describes the case of a group of participant enterprises, called

De Anda Grupo Industrial, showing that ICT's are an important part for improving productivity and it helps in their integration to the value chain. Finally conclusions are presented.

## E-PRODUCTION CHAIN PROJECT

The University of Guadalajara through the Project Engineering Department (DIP) as part of its commitment to society in the linkage University-Enterprise has in operation the projects: "e-Production Chain" with the support of the Inter-American Development Bank (IDB) and the "Production Connection Centre (CAP)" with the support of the "SME Fund", for the introduction of ICT's in the production chain development.

The general project is supported by a novel linking university-enterprise scheme, having special attention on the SME, through the introduction of highly competitive informatics solutions in their capacities and costs, as the so called: ERP, CRM and SCM for the manufacturing, marketing and supplying management.

This project gives ICT's solutions that allow the participant enterprises to improve their individual productivity and help in their integration to the value chain (www.ecadena.com.mx).

### Objective of the Project

To strengthen and integrate the SMEs vertically, introducing the production and management Technologies as to make them competitive and linking them horizontally to give them competitiveness along the value chain in the Auto parts-Foundry, Furniture, sectors; the sub-sector for capital goods for the agricultural and cattle-raising sector, electronic and plastics sectors, through a physical centre and a virtual demonstration and Information Technology transfer (IT).

### Project Components

To achieve the Project purposes, the following components and activities have been developed as shown in figure 1.

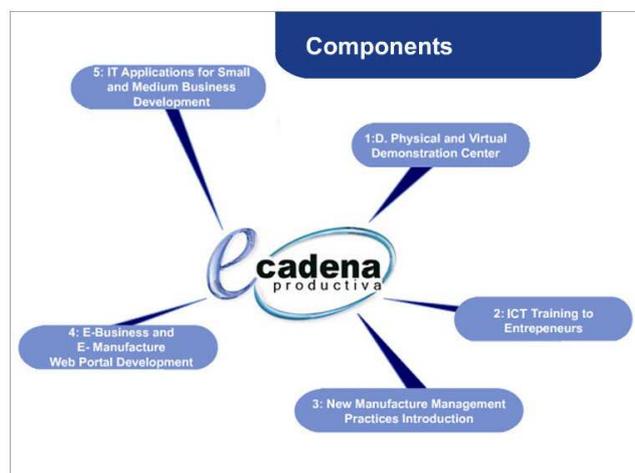


FIGURE 1  
PROJECT COMPONENTS.

**Physical Centre and virtual demonstration of Information Technologies**

To develop the Project, it was necessary to create an Information Technologies Physical and Virtual Centre, taking advantage of the physical and human capacities that the University already has through its High Performance Computing Centre (CENCAR), with its facilities, Telecommunications infrastructure, Security Systems and highly qualified personnel to offer to the SMEs and through the e-Production chain an economical and secure method to access technologies through a model of Applications Service Providers option (ASP)<sup>3</sup> providing Software as a Service (SaaS) figure 2.

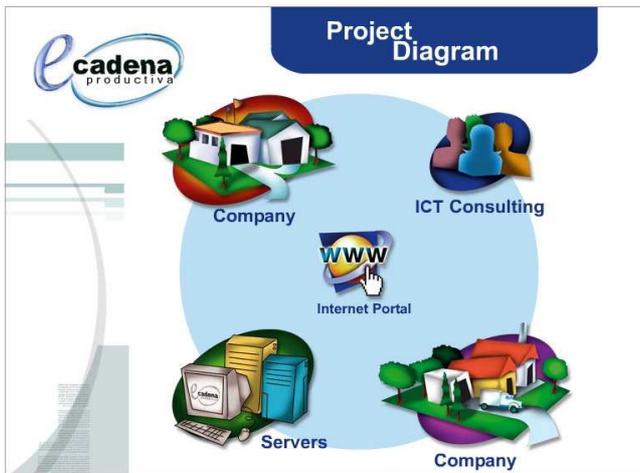


FIGURE 2  
PROJECT DIAGRAM

This center offers capacities for manufacturing design, business and e-business management, so as to guarantee security, economy, and quality. Information networks and a platforms based on the Internet will be established, where different software solutions could be accessed, and at the same time promote the products of the different production chains.

e-Production Chain adopts the ASP model, which allows the participant enterprises to use applications of first level without paying the high cost for adequate hardware, the software license, and the specialized human resources for their management. The lowering of investment in this kind of ICT's means an increase in money and a reduction of invested capital.

Among those services:

- Access to ERP solutions and e-business via the Internet.
- Access to servers for system Management via the Internet.

<sup>3</sup> The model ASP (Application Service Provider), represents a method where applications are accessed on-line through a network connection, with no local servers which requires a minimal investment. This model is referred to as Software as a Service (Saas).

- Counselling in the implementation (training) in ERP solutions and e-business.
- Production process re-engineering development.
- Design and development of web pages.
- Access to a commercial portal.

The selection an internationally prestigious ERP package with the desired characteristics for the Project, can be justified according to the following criteria: 1) kind of industry, 2) annual income, 3) number of concurrent users, 4) number of employees, 5) budget, 6) language support, 7) localization, 8) manufacturing environment, 9) performance, 10) structure, 11) server platform, 12) DBMS platforms, 13) integration, 14) standard in the industry, 15) adaptation to the customer, access to clients in small volume and standards, aspects that are shown in the Diagrams 1 and 2; additional to this, the costs and experiences reported in the entrepreneurial environment.

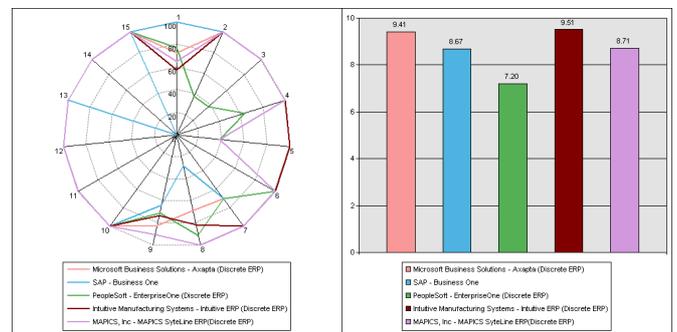


FIGURE 3  
SELECTION DIAGRAMS FOR ERP SYSTEMS

Once tools to be used have been defined we will describe our case study.

**CASE STUDY**

De Anda Grupo Industrial, 100% Mexican enterprise with 50 years in the market, located in Tepatlán, Jalisco. 75 Km north-east of Guadalajara with an area of 60,000 m<sup>2</sup> and with 25,000 m<sup>2</sup> of construction, it has 380 employees, dedicated to satisfy the demands of the cattle producers, being the national leader through the manufacturing and marketing of poultry and cattle production equipment, buildings, and structure. Its main products are buildings, cages, corrals, feeding systems, drinking systems, solid waste collection systems, egg collection systems, and various accessories for this industry for the production of beef, chicken, and pork.

**Analysis of Present Situation**

De Anda Grupo Industrial has seven different business units: Structures, Mechanization, Wire, Plastics, plated and laminated structures, which causes the organization to have more operational problems. To understand the situation of the enterprise before the ICT's introduction an initial diagnosis was done evaluating five strategic areas inside each enterprise: management, operations, supplies and

control, human resources, technology and environment, and marketing and strategy.

In each sector different aspects were evaluated according to efficiency percentage, each one receives a grade that goes from one to five, being five the best. In each sector that was evaluated there were certain quantity of issues that had to be graded. As an example in the management, twelve issues were evaluated; the most efficient in the different issues evaluated is obtained when all of the issues register a value of five, in the case of management, when an enterprise registers a value of sixty, that means that its management area has a high efficiency level. Below the results are shown:

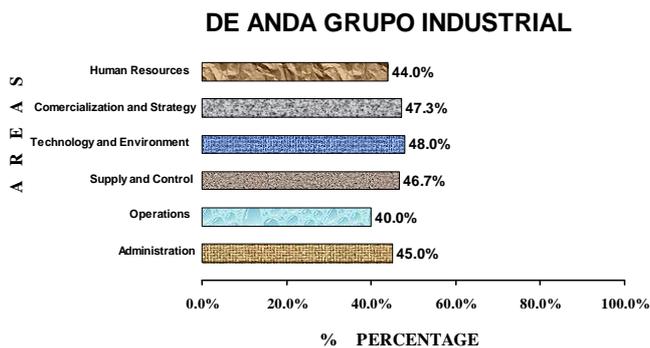


FIGURE 6  
INITIAL PERFORMANCE DIAGRAM.

As it can be seen the enterprise had several improvised processes that did not function very well, resulting in low marks as shown.

### The Project

Taking into account this processes started with orientation of the managers, showing them the actual situation of the business and the proposals for improvements that should priorities for implementation before the ICT's introduction.

*The first Project to be improved was:*

**Changing the structure of functions and responsibilities.** The enterprise's problem was that some functions were not well defined, specifically those of the persons in charge of the different business units, as they had the responsibility for raw materials, product manufacturing and the control of the finished products, and this was causing considerable waste of materials. In order to solve the problem the following actions were taken:

1. Create a warehouse for raw materials and finished products.
2. Develop the Materials Logistics and Shipping Department.
3. Define the plant Layout.

Together with these actions, the control and protection of all the material that are moved in the plant was implemented.

*Second Project:*

As the enterprise did not have product nor process engineering, they did not have the real cost of the products

that they manufactured, so the following project was developed.

**Creation and development of the Engineering Department and New Products.** The majority of the Mexican enterprises have people that know perfectly the products that they manufacture, and the only thing they need is to relate to innovative methods and techniques, so the following actions were taken:

1. Organizing the department.
2. Hiring professional personnel in this area
3. Look for personnel that already worked in the company to assign them to a position in this new department.

The result was the development of all of the product and process engineering and getting real manufacturing costs as the basis to start with the innovation.

Nowadays this department has the following personnel:

- 1 An Industrial Engineer.
- 1 An Industrial Designer.
- 1 A Control Engineer.
- 2 Persons who have more than 30 years working in the enterprise and know in detail the products.

These two projects were done so the conditions to start introducing the ICT's through an ERP system were ready.

**Phase 1. - Knowing the business.** The objective of this phase was to completely understand the initial situation and functioning of the business through a compilation of information.

**Phase 2. - Model Design.** In this phase the design of the future business situation is done, defining the business performance and the process of the ERP system. Based in the generated design, an analysis of the gaps is done through which the actions and adjustments are defined in case that a natural performance with the ERP system is not achieved with certain processes or requirements critical for the client.

**Phase 3. - Construction.** Based in the model design, in this phase the configuration of the general system, modules and users is done, as in the gap adjustments analysis done in the above phase. In the same way, the reports, formats and plant layout (process) will start being generated, as well as the conversion to an connected integrated automatic accounting system across all of the business units, according to the defined design.

**Phase 4. -Definition and tests.** During this stage the required test for the model are designed, to guaranty the correct performance of the solution (based in the criteria of acceptance of the product) after the test there is a following up of the critical points, the model is corrected and it is validated with the customer.

**Phase 5. - Training and Deployment.** Once the model is defined, corrected and validated, the users are trained in the installation, configuration and use of the system according to their profile, functions and responsibilities based in the design done in phase 4. The training is based in the final users or in a scheme of Train the Trainers, everything will be well defined and documented. As soon as the users are trained the application start is prepare to liberate the product. In this final stage the catalog is complemented according to the revision control, the check list is done to start and the pilot production system is deployed.

**Phase 6. – Stabilization and support.** This stage allows stabilization of the system helping the end users to take control of the system. For this stage, activity reports are generated, with reports and analysis of failures, and the solutions for each one.

### CONCLUSIONS

Some of the lessons learned are that SMEs can adopt IT, the point being, that they must take a series of courses starting with basic information sciences (Administration of PC's, operating systems, networks, among others). From the Internet, and its applications, these actions must proceed in parallel, with a restructuring of the production processes, and administration processes.

As a result of the introduction of the ICT's the participant enterprises have the opportunity to do other innovation projects and technological improvements to improve their production processes as the process of re-engineering, redistribution in the plant and optimization of the process using part of the projects already done.

- Users' confidence in transactions and shopping on line increases.
- An important percentage of entrepreneurs spend over the average of the ICT's.

The enterprises that have increased their sales have also increased their market positions; this can be related to the modernization strategies and the development of new products. In the majority of the cases they maintain their actual market share.

Doing the analysis that the chain gave us, we could find that the relations among clients-suppliers are very superficial, in the sense that they are not considered as belonging to a production chain, we consider that programs to help the entrepreneurs to be conscience of the necessity of working in a production chain to be able to be competitive are needed.

The success of an ERP system is found basically in the veracity and accuracy of the information with which it is feed. At the same time we can see that a software tool to help businesses to concentrate and organize the information from different variables of marketing is needed at a national and international level allowing the discovery of new market niches.

It is important to mention that since we know that smaller enterprises do not have a good organization, the introduction of the ICT's can be resolve this problem, and the implementation can even be done more rapidly, due to the lesser amount of information that they manage.

### ACKNOWLEDGMENT

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### REFERENCES

- [1] Castells Manuel (2004). La era de la información. Volumen 1: La sociedad Red, Editorial Siglo XXI Editores, S.A. de C.V.
- [2] D'Aveni, Richard A. 1994. Hypercompetiton: Managing the Dynamics of Strategic Maneuvering. New York: The Free Press.
- [3] Porter Michael E. y Millar Víctor E. (1999). "Cómo obtener ventaja competitiva por medio de la información", en Ser competitivo, capítulo 7, editorial DEUSTO, España, Pág. 81-104.
- [4] Kalakota Ravi y Robinson Marcia (2001). Del e-Commerce al e-Business, editorial Pearson Educación, México, Pág. 109-135 y 197-228.
- [5] Kowalkowski F., and Dillon C., 1998. Increasing The Value of ERP Through Knowledge Management, Article APICS Magazine, July.
- [6] Koch N., Kraus A. y Hennicker R. 2001. The Authoring Process of the UML-based Web Engineering Approach, In First International Workshop on Web-Oriented Software Technology IWWOST'2001, Valencia, to appear.
- [7] Proenca, Adriano et al (2000), «Enterprise Resource Planning Systems from a Strategic Perspective: its evolving scope and related technical issues», en Alfonso Fleury et al (2000), Building Competencies for International Manufacturing, Sao Paulo, FEENG.
- [8] Villalvazo Naranjo Juan, Limón Núñez David, Quintero Hernández Luis H. (2004). "Aplicación de las tecnologías de información y las comunicaciones a las empresas", Revista Economía Informa Número 330, Octubre 2004, Pag. 40-53.