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ERP SYSTEMS - PAST, PRESENT AND FUTURE

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Abstract *In this article I studied the evolution of ERP systems. In the first part I studied the evolution of IT systems in enterprises focusing on CIM, CRP, MRP and MRP-II. In the second part we studied today's ERP systems focusing on key features, and in the third part we studied ERP systems and Supply Chain management.*

Key words:
ERP system, information system, software, technology
JEL Codes:
M2, M3

1. THE EVOLUTION OF INFORMATION SYSTEMS IN ENTERPRISES

Traditional IT systems in enterprises have been developed through successive aggregations of differently functional, functionally functional components for which interconnection is attempted through interfaces that allow communication between different parts. These components form various operative subsystems (for example, order receipt, purchase or billing procedures, production programming or warehouse management systems, general accounting, customers, analytics suppliers, and so on). Each subsystem is a stand-alone element, part of an "archipelago" where links are provided by interfaces that provide for the regulation of communication and the flow of data and information between components (Beretta, 2001). This approach is undoubtedly limited and imperfect because a data architecture of this type constrains multiple inputs of the same data and makes information of the same nature and destination appear dispersed across the various components. We find ourselves in the situation where we have to bear unnecessary costs, redundant data and information and high operational risks due to the simultaneous updating of various information (Carignani, 2003).

Secondly, increasing the number of subsystems impose physical limits on connection and interface capabilities, making the system rigid and incapable of adapting to the evolution of operative practices and organizational relationships.

In addition, such a structured system involves inadequate updating times to the response requirements demanded by higher coordination levels, which together with the need to address specialists for the integration of subsystems

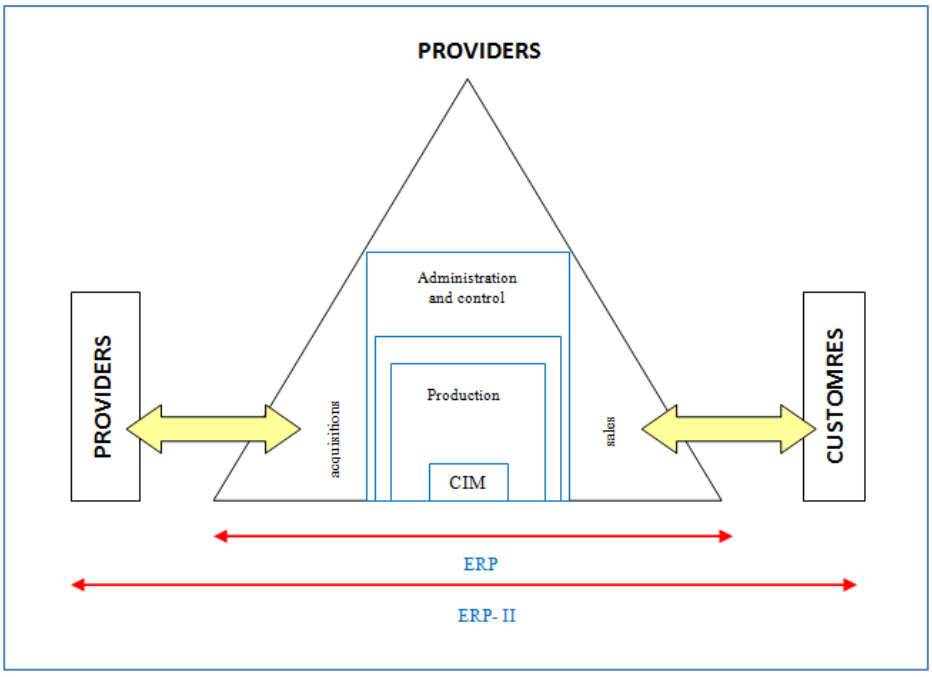
contribute to slowing the response times of the whole system.

In order to solve these problems and eliminate such inefficiency, in the '70s and' 80s, what was defined as "cycle integration systems" (Beretta, 2001) was developed for production, which in particular suffered from regarding the promptness and the speed of the reaction. In this context were born the first versions of:

- CIM (Computer Integrated Manufacturing), a tool for integrating productive activities based on the use of information technology.

  The related applicative solutions that have progressively developed are:
- CRP (Capacity Requirement Planning) systems, where integration is sought even in the production cycle;
- MRP (Material Requirement Planning) systems, where the integration environment is extended to defining the resource requirement for supplying production programs;
- MRP II (Manufacturing Resource Planning) systems, in which the integration perimeter extends to all the main operating cycles that cross the functional supply, production, and sales areas. In this view, the vertical evolution of MRP systems is shown in the diagramin Figure 1.

The common feature of all these applicative solutions is the realization of an integration concept that goes beyond the simple notion of co-ordination between distinct parts, typical of the software packages that were in use at the time (Carignani, 2003).



- With Enterprise Resource Planning (ERP) systems, the integration of the IT system into the enterprise becomes evident, in the sense that the system is already being

integrated both as an IT architecture and as a logical design: the archive is unique, the update criteria are univocal, the procedures are strictly related between them and coherent in terms of how to encode data and information; the operating rules of the entire system are common and managed in a centralized logic (Beretta, 2001). Innovation in these applicative solutions is manifested in horizontal coverage, ie in cross-logic (see Figure 1), the need to manage and treat information from all the main functions of the enterprise. Additionally, the integration of ERP systems extends beyond enterprise boundaries until it encompasses the enterprise itself with supplier companies on the one hand and client firms on the other, with application software called the Supply Chain Management (SCM) and Customer Relationship Management (CRM). This is achieved until the last level of IT systems evolution, which works under the name of ERP II.

2. ERP TODAY SYSTEMS

Current ERP systems are by their very nature:

- Integrated, in the sense that the different departments of the firm and the company are connected
- Penetrating, tend to involve the whole business in their operation.

Going the way to enterprise-wide IT integration means using a common field of definitions and codes between different departments of the organization means establishing common rules and language to facilitate communication between different units, a prerequisite for ensuring coordination. Informational integration therefore means standardizing the modalities of data definition and the harmonization of their structure and content, obtained through a common conceptual, transversal schema and accepted by all data sources. The structure of an ERP system is designed from the outset so that the data have the same meaning and the same implication over time between different users and the data stored in different databases and involved in different applications are coherent and logically compatible . On the basis of this, we have a unitary interpretive scheme that specifies the definition of common computer fields, defines the limit to which uniformity of significance must reach, and where each unit can differentiate, taking into account local specifications, indicating the structure, the rules for updating and the treatment of the data. By formalizing data and sharing common language, ERP systems provide a unitary cognitive schema of event interpretation that increases the responsiveness and response capacity of the organization and its units.

Secondly, by ensuring a uniform entrepreneurial IT base, a better flow of information and dissemination of information between the functions and units of the organization is ensured.

In fact, ERP systems increase IT development capability, operating indirectly, as follows: providing a structured, structured, articulate, structured information base from which application data and generation tools of computer syntheses, often external to the integrated system.

Due to the high level of IT integration, using the new IT technologies, ERP systems allow richer communication at the organization level by providing an integrated enterprise-wide network that circulates information that is comprehensive and easily adaptable to specific needs, easy to use for subjects and units that share the same language, and can be dispersed spatially and temporally.

The adoption of the classification standard, the valid enterprise-wide production and communications, typical of integrated systems, therefore allow for a rich and scattered communication with practically nil marginal cost (Beretta, 2001).

From the point of view of architecture subject to ERP applications, we emphasize abandoning centralized mainframe architectures in favor of client-server technology.

The feature of a mainframe platform is the strong centralization (both of data and of development logic) needed to ensure data coherence and to concentrate computing power. Mainframe platforms, however, have some limits:

- High management and maintenance costs;
- the impossibility of fully exploiting the capacity of personal computer development;
- the rigidity of the report with the different external users;
- The ever lesser availability of programs that requires development of the versions, specific to each enterprise.

These are some of the main reasons that have pushed many businesses to switch to more flexible and less costly technologies; Among these, client-server technology has been imposed, which many are considered to be the most appropriate to support higher demands as a level of user service, with lower costs, customization requirements, and faster response speeds (Beretta, 2001).

This type of technological infrastructure, which is the basis of all ERP systems, manages the processes of information development in a distributed manner, dividing, for example, a certain workload for the different operations developed by the system in its entire complex between the server and one or more customers.

This makes it possible to centrally manage the data used by different functions, but allowing decentralized studies and a more coherent use of information, with the specific requirements of different users. In this way, computing power can be optimized by devoting itself to the execution of extremely heavy operations, while clients can perform local tasks and manage the graphical interface for the end user who is free to operate completely autonomously with all the materials which are provided to him: technical documents, decision support, analysis, communication, training and management tools. These are the flexibility features that have affirmed the superiority of client-server technology, leading to the gradual

abandonment of computer architecture that has already been overcome.

"The flexibility characteristics of ERP systems are largely attributed to the presence of workflow functionality in the various operating modules. Thanks to this functionality, the system, when linked to an archive, is capable of sequencing the documentation to be scrutinized, based on assigned priorities or waiting times, and when the document is being prepared or a report, is able to specify, after certain established routines, successive authorizations and steps, indicating possible anomalies. In this way, the enterprise can work with procedures that, although within the bounds of fixed degrees of autonomy and technically manageable levels of flexibility, can help identify and intervene in emergency or abnormal situations "(Cerruti, 1999).

This is the approach of Amigoni and Beretta, after which ERP packages have four key characteristics (Amigoni e Beretta, 1998):

1. the application is modular;
2. the presence of a business model;
3. the existence of a single database;
4. system configurability.

1. Based on the first characteristic, the ERP system consists of several applicative modules, which can also function separately, each of which is in the direction of specific functional and operative areas, as shown in Figure 2.

Complex software governs a unique database that gathers and distributes data from and to a variety of applications and systems (powered independently by the function or unit that uses them) and develops them using modular applications that support the various functions of the enterprise . The database, which is common to all applications, performs the cross-linking function between the various functions of the enterprise, and thus, the possibility of dialogue can occur. (Beretta, 2001).

The modularity of the application allows a firm that does not want the simultaneous renewal of the entire IT system, to selectively and progressively replace the applications of the different departments within the enterprise; in addition, this feature allows the firm to plan the gradual introduction of the ERP system, starting from departments where the operation or coverage of the computer system in use is deficient without touching those programs that are still considered useful and valid (Cerruti, 1999). If, on the one hand, each module is autonomous in terms of managed functionality, on the other hand, in some cases, the potential offered by a module is subordinated to the activation of other modules related to it and then, consequently, the lack of modules may limit the extension of the system in question. Of course, in the case of a limited introduction of fewer modules, the enterprise loses some of the benefits of the full integration of the enterprise information system, but it is able to reduce the costs and risks of broad spectrum change interventions.

2. "The operation of different ERP system modules refers to a unitary business model, that is, a scheme that encompasses and writes all the operational processes implemented in the software. The

business model is inspired by the leader's best-practice models and, in the case of more advanced ERP packages, may differ depending on the business sector in which the enterprise operates. The presence of a business model that covers all management areas is an important reference for a software house because it confers unity on the development of the various modules and explains the interconnections between the different subprograms that make up the package. The business model is also an important guide for those users who intend to exploit ERP as a reengineering leverage, as it stimulates redesign "(Cerruti, 1999).

3. A single database is the key element that is the basic feature for integrating ERP packages. The central database defines different entities (the "product" or "customer") uniquely and homogeneously for all modules. All applications call this unique database, for which they work simultaneously, for data call, compilation and archiving without multiplication or non-alignment. It is very structured and articulated, because it has to define various managed entities (from "client" to "raw material") in their totality. This is why ERP applications require an initial, broad and articulated data input. But then the need to reintroduce the same data into other subsystems, as well as the batch realignment interventions of different databases, with advantages in terms of processing time and costs, quality, reliability and development, is reduced. Each department in the company, using this unique database, will always be aligned with the flow of the process. For example, if conflicts arise such as: the purchase of an order that is greater than the customer's credit or a planned need higher than the available production capacity, the system signals to the officers, attracting their attention and requesting an intervention in this sense. If the enterprise has also installed the workflow application, the system advises via email to the interested services by sending all the available information on the situation as attachments, making it easier to make decisions. The common database therefore allows all operating units to dispose in real time of univocal and common data based on both standard and ad-hoc analyzes.

4. "The attribute that contributes most to the flexibility of the ERP system is that of the configurability, which enables the end user to define the functional characteristics of the activated modules according to the structure of the enterprise's operational processes" (Beretta, 2001).

The ERP system is sold by the software house as a basic application that the enterprise will need to configure according to its own specifications for IT architecture, organizational structure, operational procedures, and business objectives. For this purpose, configuration tables are provided, which allow the definition of the operative parameters, thus succeeding in many cases in reducing the programming activities. The configuration concerns both the technical aspects of the system and the structure of the enterprise with regard to the company's own coding system, production units and distribution channels. Once these general references are defined, programmers begin to fine-tune work processes, identifying the sequence of activity, and specifying the

characteristics of transactions, documents, and reporting (Cerruti, 1999). "Configuring an ERP system means seeking a compromise between the operating logic that is to be achieved on the one hand and the possibilities offered by the system on the other hand; possibilities that are generally ample enough to allow the user a certain "discretion" in society, so as not to hinder the specificity requirements imposed on the enterprise "(Beretta, 2001).

I. when the options fail to meet the company's operational requirements, the designer can: Make a customization that allows the system to be modified by re-engineering segments of the original code, directly from the development environment. In this way, however, the means of communication between the parties to the system and the possibilities of acquiring technological innovations, which the provider of the applicative solution offers, are compromised;

II. to appeal to distinct application systems to support specific specifications and functionalities, and to build interfaces capable of communicating with the rest of the ERP system. But there is also the risk of compromising the degree of IT integration of the original system.

After Cerrutti, the potential of ERP systems can be highlighted by the following two apparent paradoxes that characterize their introduction into the firm:

- ERPs are sophisticated and technically complex IT systems that make it possible to simplify the organizational structure of the firm;
- ERPs are complete and integrated information systems inside, which is convenient because there is more openness to the company for collaborations with customers and suppliers.

ERP systems, even if they are very complex programs themselves, favor simplification of activity in the organization. Thanks to their integrated architecture and linkage to a common business model, they redesign processes in a linear and effective sequence, remove functional barriers, reduce hierarchical levels, and delete many entity entities. The simplification of the organization also contributes to the transparency of complete online availability of managed information.

Due to the fact that there are programs that make the developed processes faster and more efficient, ERP systems favor the outsourcing of operational activities. Their configuration facilitates openness to information sharing with customers and operative integration with suppliers through computerized reports "(Cerruti, 1999).

Resuming the discussion of the effects of the systems in question on the organization of the firm, which we have just discussed above, we must point out that given the relevant impact that the information treatment capacity has on the organizational structure, the introduction of an ERP system, radically how it works, but also the costs that the enterprise collects, develops and distributes information. It has to be evaluated not only as a technical transfer project of the old software on a

new platform, but also as an organizational change intervention.

The ease of accessing the data allowed by telematic network infrastructures and the availability of advanced data-processing systems allow for overcoming organizational barriers and encourages the creation of inter-working groups (bringing together different professions and competencies in the organization) and widening of service tasks Beretta, 2001; Cerruti, 1999) attributed to each post, with the resulting requirement, ie a greater professionalism of the operators.

New technologies favor rethinking the company's configuration with regard to:

- Reducing the number of hierarchical levels and
- Reduction of staff.

The efficiency and speed with which the IT system is able to gather, develop, and disperse information in the organization largely replace the work of preparing the reports, the work of intermediary managers and staff. The tendency to flatten the hierarchical structure is also favored by the lowering of the specialization of these tasks, which we quoted above (formalisation of tasks). In fact, at the same time as the working groups with full responsibility for the inter-functional processes, the necessary positions for coordination and supervision are reduced.

This advanced availability of the IT system to produce different reports - we can exemplify the Manufacturing Resource Planning tools - then enable the reduction of indirect staff, specialized in programming and control. Some of these staff may therefore be used to carry out operative activities, thus becoming more involved in achieving the desired outcome and more responsibly for the actual needs of the process.

"ERP systems also enable redesign of support processes with increased information intensity (from staff management to IT management) to improve functionality and reduce costs, automating the work that previously worked manually and integrating them directly into primary processes . Some activities, which have traditionally been attributed to staff, are absorbed by automated operations performed by the system, often with a higher degree of accuracy and regularity over previous manual edits. This is the case for the reporting and staffing activity analysis, which is scheduled as a periodic elaboration of the system. An analogous speech is valid for other activities in the computing center, among which we are exemplifying the activation of batch data streaming between different systems and the realignment of archives that are completely erased from ERP due to the uniqueness of the data bank and real-time operation "(Cerruti, 1999). Turning now to the second aspect we have discussed above about outsourcing some business activities by connecting with customers and suppliers, we highlight the role of ERP systems in opening new collaborative spaces, expanding the opportunities for enterprise networking process reengineering. The use of communication protocols and the availability of enabled / consultable modules via an Internet connection enables the company to develop new market reports without making any special

investment for that. The same application, which allows you to conduct business in the company's internal transactions (Intranet), can become the business portal for access to the Extranet or the Internet. ERP systems in fact present modules for integrated supply chain management and support e-commerce initiatives. Because of these possibilities, ERP systems are not just ERP systems, but ERP II or ERP II. It is now clear the transformation that has taken place over the years to ERP systems: "When it went from the client-server architecture to the center, they had to transform to follow the evolution of technology. Today, in front of web-based technology, ERP systems have to face a new evolution".

3. ERP II systems and SUPPLY CHAIN MANAGEMENT

Large companies adopt ERP II systems because:

- The IT system is a platform where redundancies can be redesigned, and more open relationships can be developed, collaborating with their own suppliers and customers, increasing transparency and speeding up decision-making.
- The interface between organizations' IT systems allows participants to rethink tasks and responsibilities in supply and delivery chain management at customer service, improving the efficiency and effectiveness of the network.
- Facilitating administrative procedures and faster and more accurate communication between channel participants, allows for cost savings.
- Greater clarity in production specifications, made possible by creating a common production list, and tracing batching by identifying the path that has been tracked, identifies where the main defects have been generated and supports the qualitative improvement of products and processes.
- A faster flow of communication (based on information on purchase orders) and integrated production programming will help reduce response times.

"Today's businesses are almost without borders, in that internal functional barriers are abolished in favor of horizontal process management, while external separation between sellers, distributors, consumers and businesses is gradually diminishing. This is the concept of extended enterprise that transforms our world, our way of thinking, into a competition between organizations, and then to reconfigure the value chains. It is the use of common information that allows for such horizontal inter-functional management "(Christopher, 1998). The expanded company comprises the downstream and downstream phases of the production activity, as illustrated in the following figure.

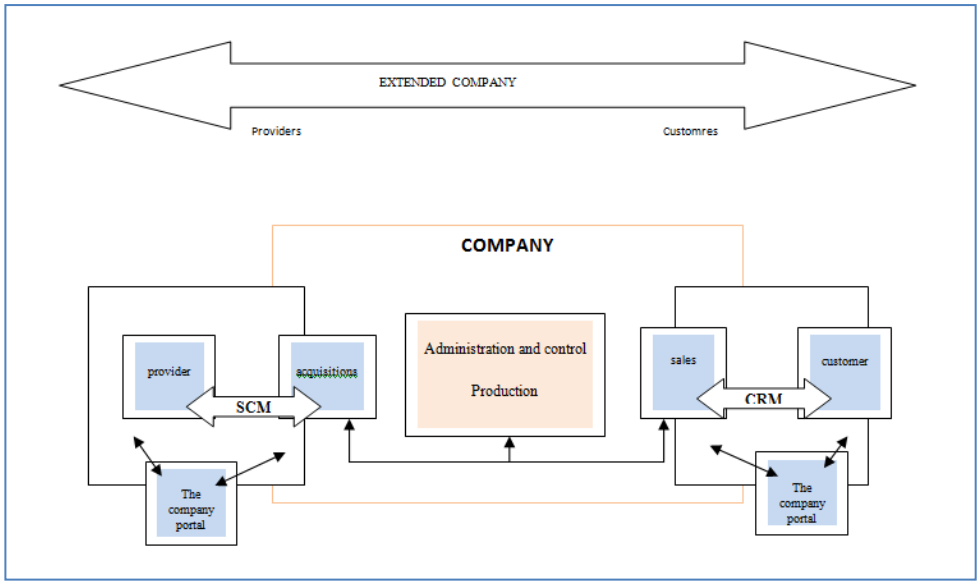


Figure 3: Extended enterprise.

The ERP-based integrated management support logic has been extensively structured into inter-organizational relationships with vendors using Supply Chain Management (SCM) applied software (Cerruti, 1999). It is obvious that SCM is a significant change compared to traditional distance relationships, even if we refer to conflicting ones, which have often characterized the buyer-supplier relationship in the past. The SCM is focused on cooperation, confidence and the conviction that if it is well managed, "the whole may be greater than the sum of the parties".

The EQS should be considered in the context of a global e-business structure as shown in Figure 5. The term e-business, but can also be used in a specific sense when using the Internet to achieve supply chain integration; in a similar context, this term includes "planning and executing front-end and back-end operations in the supply chain using the Internet" (Møller, 2003).

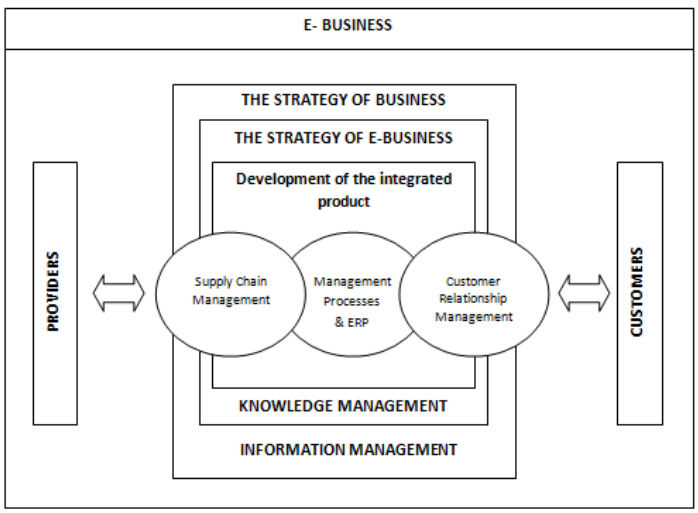


Figure 5 - Supply Chain Management and e-business

The Internet is a perfect means of delivering the virtual supply chain. The advantage is that it not only makes possible access to the global market at a minimal cost, it not only allows consumers to drastically reduce research time and transaction costs, as highlighted above, but also allows various organizations in the supply chain to divide and exchange information in a cost-effective manner with the help of Extranets. Organizations with so different IT systems can now access customer data about sales or use of the product, and can use this information to manage the supply and advising their own suppliers for immediate needs.

The term "chain" should be substituted by the term "network", as many suppliers, vendor suppliers, as well as many customers and customers are usually included in the system.

4. CONCLUSIONS:

Following analysis of ERP systems, we found that traditional IT systems in an enterprise have developed through successive aggregations of differently functional, functionally functional components for which interconnection is attempted through interfaces that allow communication between different parts . As far as the road to IT is concerned, it means using a common field of definitions and codes between different departments of the organization means establishing common rules and language to facilitate communication between different units, a prerequisite for ensuring coordination. By formalizing data and sharing common language, ERP systems provide a unitary cognitive schema of event interpretation that increases the responsiveness and response capacity of the organization and its units. At the same time, the integrated management support logic characterizing ERP systems has been extensively structured into inter-organizational relationships with vendors through application software called Supply Chain Management

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