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ERP integration in a healthcare environment: a case study

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Abstract

Purpose – Aims at providing a classification of the ERP integration concept in a healthcare organization and at presenting a real world example of process integration using SAP R/3.

Design/methodology/approach – Research is based on a case study involving in-depth semi-structured interviews with key stakeholders and action research conducted in the hospital during the ERP implementation period.

Findings – Findings suggest that an apparently simple software implementation of an ordering process can have a considerable impact on stakeholders in a complex environment operating ERP software. Organizational change issues, implementation and integration issues of SAP R/3 with other non-SAP systems and SCM considerations are discussed.

Originality/value – Analyzes enterprise integration concept specifically in a healthcare environment and describes a real world process integration solution (missing from the literature) achieved by using SAP R/3 software.

Keywords Distribution and inventory management, Manufacturing resource planning, Health services, Medical informatics, Procurement, Greece

Paper type Case study

1. Introduction

Healthcare institutions are complex, multi-functional, information intensive organizations that require sophisticated integrated clinical and business management information systems. This integration was hardly achieved by the information systems used by hospitals throughout the 1980s and in most of the 1990s. However, the emergence of the enterprise resource planning (ERP) software radically transformed the computing platform of most organizations, including hospitals (for a discussion of ERP systems, see Rosemann, 1999; Klaus *et al.*, 2000). One of the ERP systems characteristics is the ability to automate and integrate organizations' business processes (Fui-Hoon Nah and Lau, 2001). However, despite the fact that ERP systems were introduced as integrated suites, they have not achieved many of their anticipated benefits while they still co-exist with autonomous and heterogeneous applications (Themistocleous *et al.*, 2001). This fact indicates the importance and the need for applications integration and justifies the recently large number of publications examining integration technologies.

Although integration success in ERP implementations is questionable (Themistocleous *et al.*, 2001), ERP systems functionality and integration greatly improved over the last decade by incorporating specific industry solutions. For example, the Hospital Industry Solution developed by SAP (IS-H), designed to integrate the clinical, financial and administrative functions, provided an incentive for hospitals worldwide so as to implement SAP's R/3 ERP software. In Canada, for example, about 15 percent of Quebec hospitals had implemented ERP systems until 2001 (Pare and Sicotte, 2001). In addition, integration capabilities with third party non-ERP systems increase system functionality, flexibility and integration, supporting streamlined

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business processes. This is currently highly required as competitive and public policy pressures to improve the quality of health services and minimize costs are increasing (Grimson *et al.*, 2000).

This paper reports on a case study aiming at describing and evaluating the integrated Computerized Order Entry (COE) system implemented in Papageorgiou Regional General Hospital ("PH" thereafter) utilizing SAP R/3 software. It also aims at identifying any organizational change that resulted by implementing and using the COE process. The importance of this particular case study is grounded to the fact that COE process represents a fundamental application of the Clinical Information System (Davidson and Chismar, 1999). More specifically, the paper examines whether R/3 improved the efficiency and effectiveness of the process involving reordering from the clinical departments to the pharmacy and to the medical materials warehouse. It should be noted that the implementation of SAP R/3 software in PH was the first ever implementation of ERP software in a hospital in Greece. SAP Hellas, a subsidiary of Germany's SAP AG, considered this project to be a significant first pilot, a case that could be replicated in other hospitals in Greece and as of this provided full support to it. It is also worth mentioning at this point, that the Regional Health System, a government organization, is expected to finance about 100 hospitals in the near future for the acquisition and implementation of ERP systems. It is questionable, however, whether these organizations, as well as other enterprises worldwide, are fully aware of the capabilities, advantages, risks and costs of implementing and operating ERP software. The objective of the paper is to increase managers' and stakeholders' awareness of the issues involved in process and application integration in healthcare organizations adopting ERP software.

The paper is structured as follows: first, integration and EAI issues in relation to the health care environment are presented. Then, the methodology section and a general description of the research site are provided. Next, the status of the ordering process, both before and after the implementation of the software, is described. Finally, findings from the interviews with hospitals ERP main users, problems arising from the implementation of the software and conclusions are presented.

2. ERP and EAI in healthcare environments

Application software integration was always a requisite for organizations running stand alone applications and systems in diverse computing platforms. The increasing acquisition of enterprise packaged software and the need to integrate this software with already existing systems created a whole new market, that is, the EAI market, providing a variety of integration services, products, methods and techniques (Lee *et al.*, 2003). This market encompasses, for example, wrapping, message queuing services and middleware solutions, such as component ware, agent technologies, virtual reality networks and workflow management (Loos, 2002). It has been argued, however, that whereas many of these technologies perform better in relatively small volume transactions, they might not be so effective for information intensive organizations processing huge volumes of data, such as hospitals (Chu and Cesnik, 2000). On the other hand, it should be noted that integration solutions requiring extensive programming are very costly. Recent EAI technologies do not require point-to-point integration between applications. Instead, applications communicate with each other through a common interface layer, thus reducing considerably programming costs, time and company resources (Lee *et al.*, 2003). The horizontal integration, however, of ERP and other non-ERP systems is far from trivial (Grimson *et al.*, 2000). Nevertheless,

it has been reported, that by adopting EAI solutions to integrate diverse information systems into a seamless whole, a cost reduction of around 50 percent can be achieved compared with other integration solutions (Themistocleous *et al.*, 2000). This is a considerable benefit, taking into account the fact that organizations spend at least 40 percent of their IT budget for system integration (Puschmann and Alt, 2001).

Other benefits for a health care organization influencing the adoption of EAI include, among others, efficient data sharing, increasing collaboration between partners, reliable data transfer, system security, data integrity, decision-making improvement, both security and access to patients' data (Khoumbati *et al.*, 2003). In addition, it should be noted that EAI enables the integration of business processes and, in many cases, even forces reengineering, a concept that has become more evident and important with the emergence of ERP systems. Integrated process modelling has justifiably received the attention of researchers (e.g. Green and Rosemann, 2000) because of its impact on enterprise operation and performance.

It could be argued that ERP software acquisition forced organizations to homogenize considerably their computing platforms by adopting the client/server paradigm and establishing common interface architectures. However, it is still true that ERP did not resolve integration problems since many organizations require specialised applications, developed by various vendors, which need to communicate with each other. This is especially evident in hospitals processing large volumes of data generated by diverse systems in clinics, laboratories, pharmacy, material warehouses, and administration (Khoumbati *et al.*, 2003). The following list depicts the variety of information (sub)systems operating in healthcare organizations. In addition, a considerable number of organizations adopted the "best-of-breed" approach in selecting both core and extended ERP applications, which need to integrate with built-in-house legacy applications and other off-the-shelf packaged software. Therefore, practically, an absolutely homogeneous information systems platform is not really an option for today's complex and dynamic business environment. Healthcare information systems consist of:

- order entry system;
- patient flow systems;
- patient records systems;
- administrative information system;
- pharmacy and materials management information systems;
- human resources management information system;
- personnel presence card system;
- financial and cost accounting information systems;
- patient relationship management system;
- picture archiving and communication system (PACS);
- laboratory information system (LIS);
- operation theatre systems;
- e-procurement system of medical supplies;
- telemedicine system;
- e-learning system; and
- web-based SCM information systems.

The need to satisfy requirements in different environments urged ERP vendors to facilitate integration and encourage third parties to develop add-on applications that could communicate with the core ERP product. Most ERP vendors finally developed themselves components and application systems that extended considerably ERP functionality and facilitated integration. However, customers were rushing into ERP implementation without seriously considering integration problems, an attitude contributed significantly to excessive costs and prolonged time schedules (Sprott, 2000).

To make the discussion more practical, we examine below integration issues in a health care environment characterised by a variety of applications and systems demanding seamless integration. Themistocleous *et al.* (2004) have classified the system types that are often integrated. These types are the following: custom-to-custom integration, custom-to-packaged integration, custom-to-e-business integration, packaged-to-packaged integration, packaged-to-e-business integration, e-business-to-e-business integration and custom-to-packaged-to-e-business integration.

Below, we provide a classification specifically of ERP systems integration in a health care environment. In a hospital operating ERP software, system integration refers to the following (see Table I for a summary):

- Integration between the sub-systems of ERP software or between best-of-breed ERP systems supporting critical clinical, administrative, and financial functions and daily processes, such as patient flow, reorders from clinics to various storage locations and billing. In most cases, the implementation of the software results in the re-engineering of the processes as well as in considerable organizational change. This is especially true when clinical information systems interfere with traditional practice routines followed by physicians or other personnel reluctant to accept changes (Anderson, 1997). The misalignment between ERP features and organizational requirements observed in many instances and specifically in hospitals (Sia and Soh, 2002) has been blamed for costly projects and even

Type of integration	Healthcare specific examples
ERP integration (business process integration – BPI – and/or integration of best-of breed ERP systems)	Computerized order entry system Patient flow Administrative, financial and clinical functions, procedures and processes integration (such as billing)
ERP – non-ERP applications integration	ERP integration with: Patient relationship management systems Picture archiving and communication system Laboratory information system Operation theatre systems Clinical decision support systems
ERP – web applications/systems integration	E-procurement of medical supplies Information integration among hospitals, physicians, pharmaceutical industries, medical suppliers, insurance companies, patients and other stakeholders Telemedicine E-learning
ERP – mobile devices integration	Mobile health care systems Telemedicine

Table I.
ERP integration in healthcare

failures in ERP implementations. It has been also argued that the application reference model of ERP systems are often designed for a particular context (Soh *et al.*, 2000) and may be not appropriate for a different environment, such as a hospital. Therefore, business process integration (BPI) fully supported by ERP software is not at all evident; it remains an issue in many ERP implementations. Process change management related to ERP (Al-Mashari, 2000) could provide a framework for analysing ERP implementation and integration issues in this context. To the extent change management is effective, competitive advantage and financial returns on investment are expected (Stefanou, 2001a)

- Integration between ERP software, e.g. SAP R/3, and other non-ERP third-party specialized hospital applications, such as the picture archiving and communication system (PACS) and the laboratory information system (LIS). This integration results in complete computer-based patient records (CPRs) or electronic health care records (ECHRs) which play a major role in supporting clinical decision making and in improving health care quality. Integrated patient records contain real-time patient information captured in points of care, such as intensive care units, laboratories, and operation theatres and it can support different views for users, such as nurses and doctors (Anderson, 1997; Grimson *et al.*, 2000).
- Web-based interaction with vendors of materials and drugs, insurance companies, government agencies and customers, that is, e-health care and SCM integration. Application development using the web is not yet fully functional but is promising and was fast spreading even some years ago (Cimino *et al.*, 1995). Web-based ERP software integrated with decision support applications could provide the basis for forming a supply chain with vendors of medical materials over the web or facilitate the patient flow in a district health care system. In the UK, for example, the National Health Service (NHS) proposed the Integrated Care Records Service, which includes electronic prescribing in hospitals, workflow capacities to manage patients care pathways though the NHS and integrated health records across different regions (Gandecha *et al.*, 2003). A web-based information system could also facilitate patients wishing to communicate with their physicians from home or people asking any kind of medical information and interacting in various ways with the hospital services or the physicians, thus adding value to the system. Other web applications include appointment scheduling, insurance claim forms verification and billing data validation (Murray, 2003). This integration requires a certain degree of information sharing between organizations and partners and across systems, a key success factor for implementing ERP/SCM systems in any organization (Stefanou, 2001b). It has been argued, however, that currently, the inability to share information across systems affects seriously the efficiency and cost-effectiveness of healthcare organizations (Grimson *et al.*, 2000).
- ERP integration with mobile communication devices, such as cellular phones and PDAs. Mobile healthcare systems based on wireless internet is the future technology that will have an impact on telemedicine success (Siau, 2003). Physicians will have immediately real-time information stored in enterprise systems in their hand-held communication devices, a fact crucial for decision making and delivery of quality healthcare. Major ERP vendors, such as SAP and Oracle, have already released software supporting this function (Siau, 2003).

3. Case methodology and findings

The methodology adopted in conducting this research is a mixture of the case study and the action research method. The case study method is, among others, a qualitative research method highly effective when a small sample of participants in a single organization is involved. The objective of the method is to offer insights based on the meaning of the research variables as seen by those participating in the research and as interpreted by the researcher. It should be noted that knowledge acquired by case studies is certainly contextual and care should be taken in generalising the results. However, the case study method suites the objectives and the research parameters of this study, which involves a single hospital and a novel phenomenon to be researched. In addition, it should be noted, that the second author, acting as an ERP consultant during the implementation period of the software in this particular hospital, offered recommendations in interpreting the findings of the interviews based on his first-hand experience. He also provided his own comments and suggestions, based on his experience and knowledge, in formulating the final conclusions. Although a certain extent of bias can not be logically ruled out, it should be noted that the first author, who was not involved in the project in any way, acted as moderator, in an effort to reduce any bias as much as possible.

Data collection was based on on-site personal interviews with 20 individuals from various clinical departments of the hospital (nurses), the pharmacy and the medical materials warehouse (administrative employees). These individuals were singled out because they were the primary users and they had the heaviest interaction with the software. Interviews were not conducted with doctors, because they were not using extensively the system at the time, especially with regard to the order fulfilment process.

The sample is not large; however, this is not unusual for this kind of qualitative research, as argued above. The semi-structured interviews were based on a questionnaire developed by the authors. The interview protocol for the clinical departments was slightly different from the one addressed to the pharmacy and the medical materials warehouse personnel. Both protocols included questions referring to:

- demographic variables and computer literacy of the respondents;
- the training period on the system and to which extent this was considered sufficient;
- the degree of the integration of the ordering process supported by the software;
- the extent to which the use of SAP R/3 changed the way of doing the everyday work;
- the general evaluation (speed, errors, integration, communication, etc) of the implemented new order process; and
- the overall performance of the SAP R/3 system as perceived by its users and the extent of their satisfaction with it.

The above questions, excluding the first two, were stated in a five-point Likert-type scale. In addition, the questionnaire addressed to the warehouse and pharmacy employees included a section with questions on the evaluation of the purchase order process with regard to the hospital's vendors.

The open-ended questions addressed the following:

- which were the most serious problems users faced regarding the use of the system and the quality of information/reports they are receiving from the system; and

- which were the most serious problems regarding the procurement process before and after the implementation of the software's ordering process.

3.1 The site of the research: Papageorgiou Regional General Hospital

The Papageorgiou Regional General Hospital, located in Thessaloniki, Northern Greece, is a non-for-profit organization belonging to the Greek National Health System, and therefore, it operates under the control of the Greek Ministry of Health. The hospital's healthcare services include prevention, diagnosis, treatment and rehabilitation. PH is managed by a seven-member Administrative Council. The General Director of the PH coordinates its activities and chairs in the council of directors.

The hospital's total capacity is 750 beds, 367 of which are currently operating. It is a modern hospital that began its operation in August 1999. During its construction period, special care had been taken to exploit the natural lighting, to apply a bioclimatic architecture and to install structured wiring of voice and data. Its technological infrastructure includes, among others, the following:

- system of central control of buildings and its electrical circuits;
- picture Archiving and Communication System (PACS);
- laboratory Information System (LIS);
- telemedicine and videoconferencing system; and
- closed TV circuit in operation theatres with picture and sound available in the conference rooms and the amphitheatre.

Today, the PH occupies roughly 1000 employees of all specialties out of a total of 1,400 job places available according to the internal regulation of operation. There are about 30 departments functioning on a regular basis (clinics, external surgeries, department of urgent incidents) and all of them are covered by the SAP R/3 system. The system consists of various subsystems communicating by exchanging real time information. Currently, the subsystems in operation are the following: Hospital Information System, Financials (general ledger, receivable accounts, payable accounts), Controlling (cost accounting), Materials Management, and Human Resource Management. R/3 is also interlinked with other non-SAP systems such as the payroll application, the personnel presence card system, the PACS, and the LIS, thus providing the backbone of the integrated information platform of the hospital. However, up until recently, all processes (e.g. administrative or financial) were not fully implemented or integrated. This is at least inefficient, as resources are wasted. The case study reported in this paper analyses the implementation of the integrated ordering process using SAP R/3 software.

3.2 Implementing an integrated ordering process

Recently, PH decided to discard the manual ordering system involving clinics, pharmacy and the medical material warehouse and implement an integrated ordering process using its SAP R/3 software instead. The integration involves mainly the following SAP R/3 modules:

- materials management, used for medical materials warehouses and pharmacy administration;
- financials, used for the billing of patients and the costing of healthcare provision function; and

- hospital, a specifically designed industry solution for hospitals, used for clinical and patient data administration.

The design and operation of ERP systems in the healthcare sector are bound to be influenced by existing national legislation (Grimson *et al.*, 2000). According to current legislation in Greece, hospital clinics are required to give each patient the required daily drug dose (patient dose record). Clinics are not generally allowed to retain drug inventories themselves except for a certain quantity of medical materials. This material is ordered on a weekly basis and covers the needs of the clinic or the department. It should be noted that the ordering of drugs and materials is not only an administrative function but it can also have consequences to the physicians' decision-making (Davidson and Chismar, 1999). It has been also reported (Aydin, 1994b) that nurses' roles are expanding to interpret physicians' intent when nurses are allowed or instructed to enter into the computer system physicians' handwritten drug orders, a fact emphasizing the importance of the order entry system.

3.3 Description of the pre-existing situation

Before the software implementation of the reordering process, personnel of each clinic had to complete manually a form of each patient's personal drug dose, which was sent to pharmacy. Pharmacy's personnel prepared and executed the orders, sending the materials to each clinic while entering relevant data into the system.

This process resulted in the accumulation of all orders in the pharmacy at around the same time and created a big volume of transactions, which in turn resulted in delays in the execution of orders. Loss of handwritten orders and mistakes were bound to happen. At the end of each month, lists of drugs outside the pre-fixed drug costing formulas (used by insurance organizations and government agencies) should be prepared and sent to patients' insurance companies, a time-consuming and complicated activity.

Each patient record had also to be updated manually by the billing department with the quantities and value of all drugs and materials consumed. This had to be done after calculating the cost of drugs – in cooperation with the financial department – in order for the billing process to be completed. As it can be seen, this manual process was not always straightforward and many problems did occur as far as the accuracy and the speed of the completion of the billing process were concerned.

In conclusion, the manual system exhibited the following problematic areas:

- poor communication between nurses and the storage locations personnel;
- different data definitions and procedures between departments;
- incomplete billing procedures and high risk for inaccurate billing; and
- informal approach resulting in information misuse.

3.4 Description of the new solution

Top management of the PH has a very clear vision about what should be achieved in the hospital by using efficiently and effectively its information system and technology. The objective of acquiring and implementing SAP R/3 in the first place was to integrate all processes and subsystems into a technological platform, supporting effectively and completely all activities (clinical and administrative) and facilitating the provision of quality health services. One step towards that goal was the re-engineering of the reordering process. This meant that the personnel of the clinics had to discard

the manual order system and to use the computer and consequently the R/3 menus in order to enter each patient's daily drug list and place the orders. Now, some time following the completion of the project, the process seems to be much more friendly, accurate and fast. The users, i.e. the nursing personnel, select the required drugs per patient (individual daily drug dose) from a relatively small list of the most commonly used drugs in a particular clinic. Nurses enter the orders into the system but do not have the authorization to dispatch the orders to the pharmacy. Each order is approved by the head of each clinic on a daily basis and all orders are sent through the application to the pharmacy and to the medical materials warehouse (Figure 1).

It should be noted that certain departments, such as the departments of urgent incidents and surgery, manage their own stock required for urgent needs in order to save time which can be critical for patients. In these cases, an agreed stock of drugs and medical supplies are reserved in each clinic, which if granted to patients, is replaced upon request by the pharmacy or the medical materials warehouse, which in turn orders the required materials from vendors.

3.5 Order fulfilment

All orders are checked per clinic centrally by the pharmacy or by the medical materials warehouse for the availability of requested drugs and materials. The pharmacy has the authority to change the orders in case of shortage of stock or because of hospital policy regarding consumption of certain drugs. All physician orders and any changes made by the pharmacy's personnel are permanently recorded by the application. The ID of all users who use the application is always recorded. Therefore, the system provides complete real time information regarding any changes that might have been entered in the system at any time by any user.

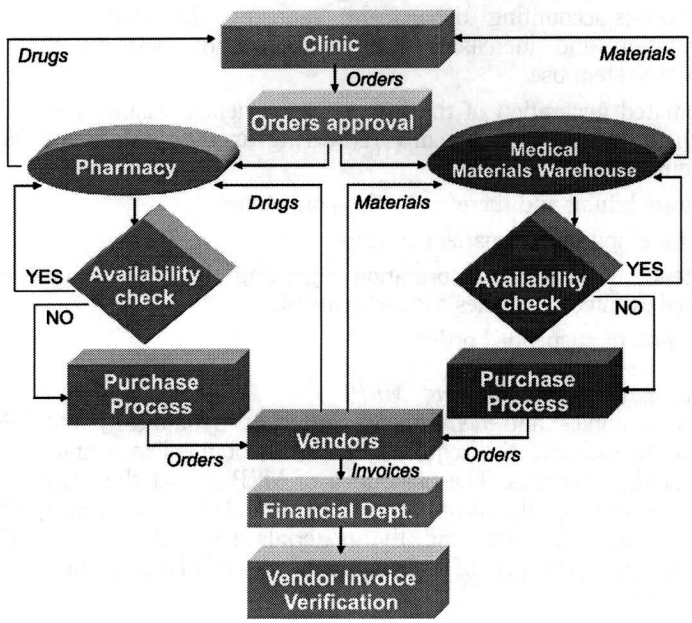

Figure 1.
Integrated order process

After the completion of the stock availability control (internal check by the software) the ordered materials are sent to each clinic. The orders are always executed through the use of the smaller unit of measurement (i.e. pill), an issue the implementation team had to take into account during the implementation of the process, considering that the purchase orders made to vendors use the measurement unit adopted by the vendors (e.g. box of pills/boite). This unit of measurement issue was easily accommodated by the software.

Although the process described above sounds straightforward, quite a number of problems, mainly people oriented, were observed during its implementation. These problems and the improvements, resulting from the use of the new process, are presented below:

3.6 Solution implementation problems

Some of the problems encountered were:

- initial negative reaction of nursing personnel;
- existence of points of friction between clinics and pharmacy with regard to the final choice of medicine; and
- the existence of autonomous drug stocks in certain clinics.

3.7 Advantages of the new solution

Some of the advantages were:

- Improvement in information quality: real-time information about the availability of the stock and the status of each order. Visibility and improved quality and timeliness of information, which can lead to better decision making and improvements in health care.
- Common data and practice sharing in the departments (clinics-pharmacy-warehouses-accounting department) reducing the ambiguity about order information and increasing the communication between departments to support system use.
- Automated generation of the list of requirements, arising from clinic orders, which influence the system's reordering module (Materials Requirement Planning-MRP).
- Accurate billing and therefore no loss of income.
- Real-time updating of patient records.
- Existence of available information regarding the type and the quantity of ordered-granted medicines for each patient.
- Follow-up of suspended orders.

3.8 Material requirements planning (MRP)

The orders of clinics and departments influence dynamically the MRP system that is used to estimate the required quantities of medicines and materials that will be ordered to vendors. The basic idea of MRP is that the essential quantities of goods required by the hospital can be calculated considering the existing stock, the demand forecast, and the materials reservation stock. The system functions on the principle of consumption based planning using a two-way process:

(1) reorder point level; and
(2) forecast based planning.

Because of the short time the hospital has been in operation, the lack of historical drugs consumption data and the continuously increasing level of activity (which cannot be forecast as it is influenced by government policies on healthcare spending), the MRP system is based on the reordering level of each drug. Under this method, the system compares the available reserves to the reordering point. If the available stock is under the reordering point, an order form is created automatically taking into account the stock safety level, the orders, and the deadline for order execution. With the adoption of the MRP system the hospital achieved:

- essential reduction of reserves in both drugs and medical materials;
- increased productivity in the planning process; and
- improved service quality for the departments, i.e. in-time and more reliable stock delivery.

3.9 Findings from the interviews

The implementation of new technology usually results in some form of organizational change (Davidson and Chismar, 1999). However, the impact of the implementation of ERP software on the organization is usually huge (Davenport, 1996). This is attributed to the fact that, generally, ERP software is not easily customized and the organizational processes have to adapt to software's embedded best practices. In addition, ERP implementation is also seen as an opportunity to re-engineer and streamline business processes. New technologies also require new knowledge, skills and capabilities and usually users have to be trained extensively (Aydin, 1994a). Consequently, users have to learn, acquire new knowledge and adapt to new methods of doing their jobs. It is only natural, then, that the introduction of a new system or an application can result in major organizational change, where, besides technical problems regarding the information systems architecture of the organization, important people issues have to be managed carefully and effectively, as well (Bancroft *et al.*, 1998).

During the period just after the implementation of the process, nurses were quite reluctant to use the system. Clearly, there was initially a negative reaction of nursing personnel to accept the system. This can be attributed mainly to the fact that most of them were not literate with computers and especially with ERP software and to the limited period of training they had received. However, some weeks after the implementation of the process, as the users started to realize the benefits of the new way of performing their work, resistance had been reduced to a minimum and everyday transactions were executed smoothly. Now, it could be said that nurses, after a relatively short period of time, became supporters of the new process. It is even possible that the process might not have been implemented had the support of the administration been weak. We should point out, however, that the well-known finding from previous research of the importance of top management support in ERP implementation success has been fully proved in this particular case. In fact, top management were pioneering the whole project, from the initiation of the selection process of the ERP package to ERP integration.

The main problem nursing personnel were facing, before the implementation of the process, was to advance the hand-written orders to drugs and materials storage locations (62.5 percent). The remaining percentage of the respondents mentioned the loss of

handwritten orders and the lack of information regarding the availability of drugs in stock. Most of the respondents (87.5 percent) agreed that the implementation of new processes using SAP R/3 changed considerably their way of doing their jobs (50 percent much, 37.5 percent very much). Some of the respondents stated that they needed more on-line help from the information system. One other problem many nurses are still facing is the searching of the names of drugs in the application files because the names of the drugs used now by the system are different from those that were used before. As one nurse said: "We had a problem of getting right the names of drugs and materials as asked by the system – we could search them by their codes but there were hundreds of them and no one knew what they really meant". And another one: "We were used to writing the prescriptions on a piece of paper using the name of the drugs as we knew them but all has now changed – We have to learn all the new names or codes of the drugs..."

Half of the respondents (50 percent) have also pointed out the need for additional training regarding the use of the system. In a question asking for an overall assessment of the system, 25 percent answered they were satisfied "enough" and 75 percent "much" in a five-point scale ranging from "not at all" to "very much" although the majority of them considered that the system was often "slow". A considerable percentage of the sample states that one of the main problematic areas of the software is that it requires "many steps to complete simple data entries". This fact reveals that many users may not have fully understood the philosophy of the ERP system perhaps due to the limited training period they had received (on average, two weeks).

In addition, nursing personnel thinks that R/3 facilitated communications with individuals of other departments (75 percent), a question targeting to identify the integration achieved between departments, but it did not eliminate hand-written documents (25 percent totally or little agree and 37.5 percent neither agree or disagree).

The findings are quite similar as far as the pharmacy and the medical materials warehouse personnel are concerned. However, they exhibited a larger percentage of satisfaction concerning the overall assessment of the system compared to nursing personnel; 91.6 percent of them responded they were overall "much" satisfied with R/3. For the ordering fulfillment process, they think that the implementation of the new solution considerably shortened the time for the completion of the orders (60 percent of them "much" agree), but not the errors in order fulfillment (50 percent of them are neutral) and the drug consumption, a fact which is in any case very difficult to be assessed and attributed to the information system being used.

It should be finally noted that there is still a conflict between clinics and pharmacy regarding the final choice of the specific drugs ordered by the clinics. This happens because it is at the pharmacy's discretion to serve clinics with drugs of its choice in case of shortage of those particular drugs requested by the clinics. This does not generally occur in other hospitals in the area, where doctors mostly dictate their preferences towards particular brands. This procedure can be a matter of friction between pharmacy's personnel and clinics' physicians, who may get other drugs (brand names) for their patients from those they had requested. However, this is a policy matter and not a software implementation issue. One other problem, which was finally resolved, was that the pharmacy personnel executed the orders placed by the clinics without knowing the name of the patients as the only information they were initially receiving was a numbered order form. However, in many cases, nurses contacted the pharmacy personnel regarding a patient's drug order using the patient's name and not the order number. At the time of the interviews this had been cited as one of the main problems encountered by the pharmacy personnel.

4. Conclusions

ERP operation in an organization, especially in a complex one, such as a hospital, does not automatically imply the existence of fully integrated processes, procedures, applications, and daily administrative functions. Various specialized clinical and hospital information systems, such as the PACS and the LIS operating in a healthcare environment, require seamless integration between ERP and all the remaining non-ERP systems. EAI technologies may be adopted by those organizations aiming at minimizing costs, improving operations, and establishing a flexible computing platform so that they can adapt faster to changing conditions. This is crucial not only for increasing the quality of execution of the transactional procedures but also for the delivery of quality healthcare and the improvement in decision making, which can be crucial for patients' condition (Khoumbati *et al.*, 2003).

The enterprise integration certainly involves behavioral integration as well, in addition to applications integration (Lee *et al.*, 2003). To illustrate this point, the paper focuses on a paradigm of the implementation of the integrated reordering process, which is a specialized and significant area for a healthcare organization (Davidson and Chismar, 1999). This is even more evident for organizations operating ERP because it involves, by its nature, a large number of stakeholders both inside and outside the organization and it integrates the specialized Hospital Industry Solution with the materials management/logistics and the financial/controlling subsystems of the ERP software. Therefore, an always up-to-date, complete and error-free electronic patient record can be achieved. The study identifies the critical implementation areas and the benefits achieved, as well as the organizational issues involved.

Starting with the benefits, the implementation of the above-mentioned process through the R/3 software resulted in a number of considerable improvements. These include the following: improvements in information quality, data integrity and procedures, visibility and timeliness of information, increasing quality of communication between nurses and the storage locations' personnel, common data definitions and procedures among departments, automated generation of the list of requirements resulting from clinic orders, decreasing transaction costs and complete and accurate billing procedures.

However, the computerization of an order entry system in a hospital is not a straightforward activity and care should be taken regarding both technical and organizational issues. In our case, technically speaking, the two main sources of difficulty in implementing the process were the following: first, the existence of small warehouses of medical materials in some departments, which operated in addition to the main warehouse of the hospital. Secondly, the existence of different units of measurements of drug doses among ERP system's stakeholders (e.g. pharmacy and clinics). Although it is not very difficult to handle technically both issues, which had been implemented rather easily after all, the mere mention of them implies that some technical issues during requirements analysis may have been overlooked. This can be explained by the fact that this was the first ever installation of an ERP package in a healthcare environment in this particular country and the top priorities were to get the system ready to run, leaving minor points to be dealt with later. It is also true that the implementation team were focusing intensively in adapting the software to conform to the Greek legislation which was, and still is, very complicated with regard to the healthcare sector.

On the organizational level, it should be noted, that old habits and practices may threaten the smooth daily operation of internal transactions. Changes must be managed carefully, as they may lead to disorganization and user resistance, which is not always

evident in complex environments such as hospitals (Lowe and Doolin, 1999). There is always a need to consider the organizational context when implementing new processes supported by information systems. In the early stages of the introduction of a technological solution, benefits are not so obvious, personnel is used to working while relying on past habits and traditional practice routines and resistance to new system is quite high. Acceptance of a technological solution, such as integration, is more widespread after a certain period of time, when it becomes evident that this could bring benefits, minimize costs and help individuals to perform their tasks better. In our particular case, for example, physician acceptance of the system was not immediate and the new solution initially led to misunderstandings between themselves and the nursing, the pharmacy and the warehouse personnel. This is alarming, as it can potentially have serious effects on the quality of health care provision. It should be reminded at this point, that physician IT acceptance remains a barrier to new clinical information systems (Patel and Kaufman, 1998) and it is a critical success factor for medical assessment system implementations (Tulu *et al.*, 2003). Therefore, social and organizational issues have to be resolved as those are the critical factors for information system implementation success (Anderson, 1997) and not solely the technical issues, which the organization, most of the times, finally overcomes.

The final conclusion arising from the case study is the following: the software implementation of the COE process may seem simple or even trivial, but it has a profound effect when implemented in a complex environment, such as a healthcare organization, operating ERP software, such as SAP R/3. First, it requires the integration and smooth operation of the Hospital Industry Solution with other core R/3 subsystems as described above. In general, this represents only a part of the full integration required between SAP and other non-SAP applications operating in a hospital. Secondly, it has a considerable impact upon patients, nurses, and doctors, warehouse and pharmacy operation/personnel, financial and costing functions/personnel and even upon third parties, such as insurance companies and healthcare authorities. ERP integration, as defined in the paper, of any magnitude and extent, triggers rippled effects and it certainly requires a new organizational culture of vision that encourages people to work closely together following new ways of performing their tasks while sharing common objectives and goals.

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