Lessons Learned from the Introduction of a Laboratory Information System in a State Hospital of Athens, Greece

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Abstract

The integration of the Information Systems in a Hospital is accomplished by the introduction of a number of specialised and interconnected Information Systems. At the General Hospital of Athens "G. Gennimatas", a Clinical Information System (CIS) is installed and running. Shortly after the operation of the Clinical Information System, it became apparent the need to couple the CIS with a Laboratory Information System (LIS). The LIS had to be interconnected with the existing Clinical Information System and the Information System for the Hospital's Administration.
The difficulties encountered along the progress of this project and the decisions taken in order to obtain the determined goals are presented in this paper. The project's management team designed a master plan for the entire duration of the works. Along the course of the project's development, many decisions had to be reconsidered, altered or postponed and many arguments had to be discussed leading to a number of compromises.

1. Introduction

Implementing an Information System (IS) in an analytical laboratory it is rather a trivial task in our days [1, 4]. Such a statement is proved to be quite misleading when it refers to the implementation of an integrated Laboratory Information System for one of the largest Greek hospitals as in the case of the "G. Gennimatas" General State Hospital of Athens[1], Greece. The project of development and installation of such an integrated LIS was planned and scheduled according to international literature, standards and experience. Certain factors were underestimated and overlooked while others were overestimated resulting to the unexpected extension of the project's duration of five more months than the initial estimation. The project concluded and it is characterized acceptably successful since the system is used widely and productively. The earned experiences and practices will be used as valuable guidelines for future and analogous projects in other hospitals in a definitely controllable manner and qualitatively more successful.

This paper describes in brief the deployment of the project in the hospital and it emphasizes on the major lessons learned from the entire implementation in order to provide a set of documented instructions for analogous cases.

2. Hospital's IT infrastructure

Information Technology applications were introduced at the hospital in the early 90s. The Ministry of Health and Welfare invested in the development of an *Integrated Information System for Administration* of a Hospital, known as IIASH, and assigned this project to KHYKY, one of the state's computer serving organisations.

The first applications started to launch in 1993. The administration of the hospital's Pharmacy Department was the first installed application. A year later, the Patients' Admissions Office and the External Patients' Appointment Office were installed. Then, the Billing Department's application was installed. In 1996 the software applications for the Warehouse and Supply Departments were used productively. A year later, the software application for the Dietary Department was

[1] General state Hospital of Athens "G. Gennimatas" with 750 beds and more than 2,500 employees, is one of the largest hospitals in Greece.

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installed. In 1998, the last software application was installed concerning the Accounting Department that is interconnected with all the rest of the applications.

The IIASH system was developed under the close supervision of the users of the system. Hence, this Information System is widely accepted by the users and in the short period of time of few weeks each application was productive to the benefit of the patients and the Hospital.

In the fall of 1998 a Clinical Information System was introduced in the hospital [7]. This system is in its roll out phase now by being introduced in more than half of the clinical departments. So far, there have been activated specific and discrete functions of the Clinical Information System such as sending drug orders to Pharmacy, keeping records on patients' follow up, issuing discharge documents, etc. The need and the related service to book patients' laboratory examinations (clinical orders) and receiving the results electronically became apparent during the first few weeks of operation.

3. Goals to be obtained

Among the participating laboratories, only the biochemistry lab had some experience since a rather primitive computerised system was already in use connecting the analysers with stand alone computers. The haematology and the microbiology labs had never been exposed to laboratory computerised systems.

Three goals had to be obtained. First, the system had to be interconnected with the existing Information Systems exchanging information in an acceptable manner. Second, the developed system had to enjoy the personnel's appreciation and acceptance, both in the laboratories and the clinical departments, sending clinical order, performing tests and calibrations, and receiving diagnostic results using the installed IS. Last, the bureaucratic procedures that caused delays and errors, satisfying the local legislation frame, had to be automated.

4. Implementation phases

The project was planned and distinguished into discrete phases with the common objective to deliver a fully functioning LIS. Each phase was overviewed by a steering committee consisted of representative personnel from the laboratories, the Hospital's IT department, and the Computer Technology Institute (CTI). The project scheduled according to the following phases, which were included, in details, in the agreement with the vendor of the system.

4.1. Phase 1: Analysis of the laboratories' needs regarding the LIS (duration: 1 month)

Besides the analysis performed by the project's steering committee, the vendor performed a detailed analysis too on the needs of the Labs which acted as a correcting feedback factor to the final design. The final report on the design included, among others, the following:

- a detailed analysis of the current workflow followed by the Labs, and a proposed S/W customisation,
- a design of the exact places in the Labs where the computers and the peripherals should be positioned relatively to analytic devices and laboratory equipment,
- a set of tasks to be performed by the various specialities of the Labs staff regarding the LIS,
- the complete migration procedure for those of the Labs that used to employ computers,
- a proposed method for the interconnection to the HIS system and IIASH,
- a proposed security policy,
- a compliance statement with the scientific methods, protocols and standards followed by each the laboratory speciality.

4.2. Phase 2: Installation of the computer H/W (duration: 1 month)

The computer hardware, main servers, workstations, printers, and peripherals were installed at the laboratories facilities connected thought the local network to the Hospital's wide area IT network. The computers were coupled with the laboratories' instruments, devices and equipment deploying the proper communication interfaces taking under consideration factors such as ergonomic installation, human factors, safety and scientific laboratory policies with respect to quality and measurements.

4.3. Phase 3: Installation, customisation and fine-tuning of the S/W (duration: 2 months)

The designed software installed and customised in such a way to cover and implement, using computers and software, the procedures followed by the laboratories including the employed methods, protocols, standards and peculiarities demanded. The collected data to older installed computer systems transferred to the under development system maintaining and preserving their initial meaning. Also, the installed LIS interconnected to the rest of the Hospital's Information Systems.

The customisation included the design of a user-

friendly interface demanded by the users corresponding to the laboratories personnel's level of maturity with respect to technology and computers, and the individuals' conception about the computerisation of the related work place.

The users' habits carried on the installed system including the particular vocabulary used in the labs in order to allow them to visualise the workflow as it is performed by the computer software. The system loaded with data, trial clinical orders were issued and tests carried out in such a way that the users accepted its correctness and completeness performing the directed lab tasks, in compliance with the existing legislation.

4.4. Phase 4: Users' training (duration: 3 months)

The laboratories' personnel trained in the use of the system while they were performing their usual duties. Formal classroom training was a small portion of the total duration of the offered seminars since the practical parts of the training had to be covered in the laboratories and at the same time the laboratories had to provide results to clinical orders.

4.5. Phase 5: Trial period / System Acceptance (duration: 2 months)

The last two months of the project dedicated on system's trials, performing minor changes, improvements and fixing problems as well as continuous on the job training. Satisfying the predefined operational characteristics of the system, the project's committee accepted and approved it.

5. Discussion - lessons learned

The implementation of the project, from design to productive use, provided the valuable experience to distinguish certain influential parameters that adjust and control the users' acceptance and the success of the entire project [9]. The experience earned expressed in terms of parameters may have beneficial impact in the development of analogous projects even without the detailed definition of their quantitative and qualitative aspects. Such parameters may be set up and adjusted to serve each application case separately in a way that they may absorb the extreme fluctuating factors of each implementation.

5.1. Scheduling reasonably

Optimistic scheduling may not appear to be a major pitfall in planning. Taking into account that the majority of the computer projects are rarely completed on time, careful planning and anticipation of unplanned events is essential. Vacations, Christmas and other holidays, all have to be factored in. A good rule of thump is adding one or two weeks in the timetable and the related costs as cushion at several points of the schedule.

The initial project's plan designed to last six months having in mind that the project should start on January. Due to various reasons (negotiations with the vendor, relocation of one of the labs, etc.) it started on March (with 2 months of delay) thus included the months July and August in the development of the project. In particular, August is the month for vacation for most of the people in Greece (July is a more or less vacations' month too). Hence, the project had no progress during these months and started again on September. As a result the overall delay was more than 5 months!

5.2. Be prepared for hiring more personnel

When a new Information System is introduced in an organisation the consequences include the installation of a new computer server, possibly a new operating system and a database, tens of personal computers as well as various peripherals. All this equipment must somehow be supported and maintained especially after the completion of the project, when the vendor’s people are leaving from the site. As it applies to most of the cases [10], the MIS Department is understaffed and at the same time overloaded, the only effective solution is to hire additional personnel.

Although the problems arising from personnel shortage were anticipated, the current legislation for personnel hiring at state hospitals demands a rather time-consuming procedure and as a result no additional personnel employed. The MIS Department had excessive load providing fewer services both quantitatively and qualitatively.

5.3. Do not change the Labs’ procedures

Computerizing the internal laboratories procedures does not imply that the content of the procedures' workflow has to be altered. The application of an information system in each laboratory is based on the existing procedures adopting certain parts of them to be used on a different technological level and environment. The introduced LIS is customized to each of the laboratories requirements regarding measurements, accuracy, employed methods to perform tests and calibrations. In other words, the use of a LIS causes the evolution of the performed procedures and processes to be

mostly carried out, controlled and recorded by computers in a standard and uniform format, in an IS. The LIS accepted by the medical, scientific and technical laboratories' personnel as the automation tool to advance the quality of their work reducing the corresponding workload keeping the same procedures' infrastructure customized in such a way to be followed through the use of the installed system. The LIS is evolving along with the lab where it is installed following the progess achieved by the laboratory. As a first stage, it is acceptable to have satisfied users performing the laboratories' tasks using the LIS. When the users will be more comfortable with the LIS and perceive the benefits that may return from the use of the system, they are going to ask for them, at this stage, though, they are just introduced to the computerisation of their work.

5.4. Write a good contract

Whenever a conflict appears to be brought up, between the vendor and the Hospital, everyone refers to the terms of the signed agreement. As a consequence, the contract's details, holding terms and conditions, must not be let fulfilled by lawyers since it is not possible to be aware of certain aspects of the implementation and operational procedures of a LIS and computer systems, in general. The terms of the agreement with the vendor must be fulfilled with the assistance and co-operation of the MIS and the Lab's staff as well as with the advice of the procurement Department.

5.5. Make the right people participate in the deployment of the project

In order to have a LIS widely accepted by its users, they have to be involved in the selection process and thus to be responsible for the outcome. On the other hand, since the MIS Department's staff will support the system afterwards, they must participate in all phases of the development too. Later on, both of the above mentioned departments should co-operate throughout the deployment of the project by supervising and guiding the vendor. In this project, two representatives from the labs and an employee from the MIS Department formed the project's committee. The directors of all three labs were taking part in weekly meetings along with the project's committee, the CTI and the head of the MIS Department. In those meetings the progress of the project was discussed as well as the problems that happen to occur.

5.6. Use of standards

Carrying out an extensive research on the available standards that exist in the world regarding LIS and generally in the field of Medical Informatics, it was found that many standards' organisations and committees are working towards the development of various nomenclatures and vocabularies [2, 4]. Some of them are mature enough and have a wide acceptance: e.g. HL7 is the standard for message formatting and is widely used in Australia, Canada, Germany, Israel, Japan, The Netherlands, UK and USA. ICD-10 (International Classification for Diseases) is accepted worldwide. LOINC seems to be the vocabulary of choice for test nomenclature in USA.

Last year the GMHW produced a version of ICD-10 in the Greek language and it seems to be adopted by most of the vendors. Nowadays, most of the S/W vendors start to support HL7 and LOINC. All of these standards considered as a requisite for the LIS, the outcome of the project proved that the LIS succeed to a) be accepted in the Labs and started to work productively and b) be interconnected to the HIS and IASH. The last point was a vital prerequisite for the success of the whole project and it was achieved due to the crucial factor: the developer of the two component systems, HIS and LIS, it happened to be the same vendor, one vendor was responsible for the interconnection of both systems.

Therefore, the lesson we took is: try to use all the existing mature standards but this is not a "panacea"!

5.7. See the vendor as a partner

Since the vendor of the LIS is going to support the Labs for a decade (e.g. through the maintenance contract, new versions of the system, inclusion of new laboratory methodologies, etc.), it is better to establish a different type of relationship similar to that of a partner. At the same time, the vendor must have analogous intentions and perception about the future co-operation. Hence, the vendor must be prepared and show adequate arrangements for a long-term business plan regarding the support of the Labs. This is very important and it may be one of the major factors choosing a vendor. In this project, the vendor developed HIS and LIS and hence, this above reasoning holds too.

5.8. Carefully design the migration process

Change is costly and this is true for the Labs too. The migration of a complete system entails significant complexity. In particular, when the change involves switching from one vendor's system to another, the cost is often unquantifiable. The most important operation is the adequate transfer of the data from one system to another

while keeping the data having the same sense. In most of the times, it tends to be a difficult and tedious task. In "G. Gennimatas" hospital, only one of the three Labs happened to have a local computer system.

5.9. Technical decisions

The client/server architecture was adopted due to the nature of both the flow and the volume of data. The installed computers connected to the labs' analysers and the rest of the analytical instruments in order to control them and to automate certain laboratory procedures. It was taken under consideration the fact that later on three more labs will be added in the near future towards the integration of the LIS of the hospital. A dedicated main server (both data and application) was chosen apart from the hospital's main server that is currently supporting both the Administration and the Clinical Information Systems. For consistency and maintainability reasons, all three systems (Administration, Clinical and LIS) use the same network type and architecture and the same RDBMS vendor. The data transfer from system to system is achieved by a peer-to-peer call between database servers using the mailbox method on the databases. Actually, the operational speed of the terminals is indifferent due to the nature of the running application and its architectural design. Any personal computer above 100 MHz is considered to be adequate since there is no medical device in the labs that can provide analytical results in the time interval of one instruction cycle of an ordinary personal computer, which in turn makes the system quite affordable.

6. Conclusion

The Laboratory Information Systems may be designed, developed and evolved independently and apart from the rest of the Hospital's Information System. The interconnecting interface of the Laboratory Information Systems must serve the purposes and principles of integrating control, information passing, user transparency, reliability and scalability.

Planning for the development of a Laboratory Information System, discrete phases with associated specific objectives, time limits, the necessary resources and a well - organised contract is required. Also, it must be taken under consideration the fact that under no circumstances the laboratories' productive operation can not be disturbed or stopped, even for the installation of a laboratory computer system otherwise the Hospital must stop admitting patients.

In order to achieve both the on-time completion of the LIS project and the preservation of laboratory's productive work, the procedures followed by the laboratory must be altered at a minimal level, if not changed at all. Besides that, the right people must be involved in the project's deployment, and in most of the cases new informaticians must be hired for proper support.

The roles of all involved parties in the project have to be specifically stated in a mutually signed agreement, both by the Hospital and the vendor. The selection of standards and the used coding must be explicitly stated and matched with the coding used in the rest of the Hospital's Information Systems.

The contract must contain all the necessary terms, conditions and the specific controlling terms that will assist the laboratories' personnel towards both the qualitative and quantitative acceptance of the developed Information System.

The vendor developing the laboratories' software must be faced as a business partner. Since the laboratory environment is a dynamic one, the vendor will be frequently asked to perform alterations on the installed software by changing existing or adding new scientific or administrative methodologies.

Finally, it is not possible to predict and predetermine all hypothetical problems and provide in advance in the agreement the appropriate corresponding solutions, the contract will just provide the framework of the project. Writing the contract, its terms and conditions have to be seen through the prism of receiving services, not a rigid product.

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