MEDICAL TUTORIAL: PORTING OF A CLINICAL PORTAL BETWEEN HEALTHCARE ORGANIZATIONS
Reuse of an Application in Health Informatics

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Abstract: The aim of the paper is to discuss the application of a methodology for the structured evaluation of the porting of an eHealth solution. In particular a web Information System in the area of Medical and Nursing Informatics, the portal developed by an Healthcare Organization for supporting clinical management processes, is taken as practical example of such a process. A procedure used for the evaluation of reuse in public administration is brought forward and, through the example, it is shown how it could be applied to Healthcare Management Systems.

1 INTRODUCTION

The main objective of this paper is that of finding a way to define a path to be followed in order to choose to reuse (i.e. the porting of an ICT application in a different organization) a solution in health informatics. Nowadays, some guidelines to define reuse of information solutions have been released in many sectors of public administration, but none of them refers to health. The concept of reuse implies some steps to be followed in order to evaluate advantages and disadvantages of an alternative, by jointly considering technical and functional features. These steps should be evaluated in health sector as well as done for other environments (CNIPA, 2006).

It is worth considering the reuse of an application only if the impact on procedures does not imply excessive efforts to change the way people are used to work. This and other aspects are analysed in the following sections, through a method which considers: requirements definition and selection of an application, adequacy and convenience verification, feasibility study. By analysing the real case of porting of a clinical portal from one hospital to another, this paper aims to show the aspects which can position this solution as an example of reuse of an application. By doing this, an empirical demonstration of the possibility to extend this concept to health informatics will be given, placing the basis for the creation of a structured method to evaluate it.

2 A REAL CASE OF REUSE IN HEALTH INFORMATICS

The hospital "Azienda Ospedaliera Niguarda Ca' Granda" is the leading public hospital in Milan since 1939. It is national reference hospital for emergency events and the only regional point of care qualified to perform any kind of tissue and organ transplant. The Hospital employs 1.540 doctors and 740 nurses and counts 54.000 yearly admissions (both ordinary and Day Hospital) and 3 millions First Aid Station treatments. The hospital has begun developing its own portal as an internal application since 1991, in order to fulfil the needing of digitalizing patients' clinical dossiers, by updating in real time their health history after their first access in the hospital, tracking processes and supporting clinical activities (Shepherd, 2000). From that year since now the

portal has spread enormously, thus becoming an instrument by which sanitary operators can feed patients' virtual clinical history, by visualizing and inserting data required by their cure processes. Today the portal, together with its various vertical specifications, is widely used by physicians and nurses in different units, with successful results and great appreciation expressed by the users. The excellent results gained in Niguarda have soon become recognised as best practice in the regional health environment and other hospitals are beginning to consider Niguarda's portal as a possible solution for their own realities. That's how a solution originally developed with a simple digital storage aim has come to compete with clinical market packages and has placed the basis for the definition of successful reuse experiences in health informatics. What makes the solution really different from traditional Health Information Systems is the brand new approach followed by Niguarda of rethinking the traditional concept of patient record, conceiving it as a core instrument for supporting extensively clinical management processes (Pollak, 2001). The main idea is to develop a web intranet portal conceived as a virtually unique access point to the HIS, networking the other vertical subsystems and thus linking clinical processes that did not communicate before, allowing new information flows sharing patient data. Being based on a centralized patient reference registry and on an open network architecture, the portal is able to retrieve and link both clinical and administrative patient-specific data regarding its relationship with the hospital, gathering them into a common and friendly interface, standardizing communication and process interaction between different hospital departments.

The lack of competences in analysing other realities and spreading the solution is filled by Niguarda with the continuous collaboration with Fondazione Politecnico di Milano, which makes its managerial competences available for managing the transfer of the solution, taking care of all the aspects concerning relationship with clients and engineering additional features to satisfy their requirements.

Being known among the regional health environment, Niguarda's portal has been pointed out as one of the possible alternatives for its clinical information system by "Fondazione IRCCS Istituto Neurologico Carlo Besta", a centre of excellence for care and scientific research of neurological diseases, well known at national and international level. Transferring the solution requires a deep organizational change as well as a porting, which, by definition, is "the process of adapting software so

that an executable program can be created for a computing environment that is different from the one for which it was originally designed" , but it is a term more widely used to refer to "the changing of software/hardware to make them usable in different environments"(Mooney, 1997. Garey, 2007).

2.1 Requirements Definition and Application Selection

The decision of making a change in the clinical information system, has to be linked to requirements emerging for different reasons, ranging from difficulties in properly using current systems to legal aspects. Requirements definition phase involves the evaluation of procedures and definition of functionalities, distinguishing them by priority. This separation is useful in a reuse process when evaluating the impact of personalization of the original solution: the more fundamental features are covered by the application, the less is the cost of realization of new functions. Technological aspects should be evaluated, in order to make a comparison with those of the original solution; flexibility and adaptability to changes of current technologies has to be considered as well. (Magnis, 2000) Another fundamental requirement is management's commitment, together with a cost-benefit analysis and an evaluation of the level of protection which has to be given to data. All this features have been taken in consideration by Besta's management, as a first filter to alternatives which can be considered as possible solutions.

A benchmark analysis is fundamental in order to identify, among solutions already available on the market, those compliant to the requirements previously defined. In this way a cluster of solutions is built, in which commercial solutions, such as clinical market packages, are distinguished from "ad hoc" solutions. Even if market packages have great probability to cover a great part of requirements, since they have been developed with the aim of standardizing optimized clinical procedures, this feature has to be evaluated since they lack flexibility, so they require a change in the way people work. On the contrary, "ad hoc" solutions could be more appreciated, especially if they are already successfully used in other structures. These and other points are subject to further analysis, in order to determine which solution is the one that best fit functional, procedural and economic requirements.

2.2 Adequacy Verification

The analysis of a possible reusable solution starts with a verification about its adaptability to requirements. Selecting Niguarda's application, Besta needed to evaluate similarity of the organizational context, features of functional and technological factors as well as quality level of the chosen alternative. For this activity the role played by Fondazione Politecnico di Milano has revealed fundamental, thanks to its ability in analysing processes and quickly identifying required evolutions and the more adequate technologies to adapt a solution to different realities (Davenport, 1993).

2.2.1 Organizational Context

Organizations can find opportunities in reusing applications already developed and tested by other enterprises working in the same context. This is Niguarda and Besta's case, both working in health area, with similar procedures and operating processes, since subject to the same laws and rules at national and local level. Being Niguarda the biggest regional hospital and having developed portal's functionalities for many units, its application already covers most of the features required by a specialized clinical structure as Besta: starting from this point, only few functions need to be fully developed. Another important organizational feature is managerial commitment towards the change in procedures; since users are mainly physicians, information systems are supposed to simplify their procedures, not to introduce criticalities: reusing a solution remarkably reduces this impact. The real situation has shown adequacy on the organizational side, proving Niguarda's solution can be easily integrated into other clinical organizations.

2.2.2 Functional and Technological Features

A detailed analysis over functionalities is indispensable to determine whether key requirements are satisfied or not by the target application (Duplaga, 2004). The result Besta's management aims to reach is that of creating a portal which not only allows digital handling of patients' clinical data, but also gives the possibility to use them into scientific research (Lehmann, 2006). This aspect lacks in Niguarda's solution, so it is necessary an ad-hoc development, interoperable with the portal; the stability of this kind of requirement, assured by inner features of client's structure, guarantees that all the future maintenance will be

aligned to this aim, so, with the vendor continuously supporting the solution, the impact of this feature will be very low on the basic structure of the developed system. Flow analysis and collaborative approach towards integration with other existent information systems are useful tools to prove that Niguarda's portal can be considered functionally adequate to Besta's reality.

A great effort for adequacy verification should be dedicated to technological analysis. This activity requires the evaluation of software, hardware and network infrastructure, as well as the interoperability with already existent solutions, especially those required by law for regional and national data interchange. Laws concerning health require the possibility for physicians to digitally sign outpatient reports they produce and to make them available for other hospitals in the region to access them when visiting patients already passed from other structures; that is what the local government of the region of Lombardy is making with SISS (the Regional Social-Sanitary Information System) platform. Besta's current applications were developed with a configuration suitable to this platform, then, before installing a new one, it is necessary to adapt the functioning environment and to verify interoperability. In a case of reuse such as ours, this checks are facilitated since the involved structures belong to the same context and are compliant to the same rules.

As far as hardware is concerned, a server farm working in outsourcing will be used. An important advantage for both client and vendor is represented by the possibility to make some activities converging, as in the case of test environment's optimization, first performed for Niguarda's solution and then replied for Besta. Contribution from technological partners in this field would provide the experience required to find the best way to lead this activity.

On software side, analysis have been made to evaluate possible incompatibilities with DBMS or Application servers, revealing adequacy under this aspect. The whole application has been developed with open source technologies, assuring continuous maintainability at low costs. The project will use the DBMS technology of Oracle (compliant with the technology of the Regional System – SISS) but the data access, application and presentation technologies will be completely open source based to create a J2EE architecture: Java Server Faces (JSF) and Java controllers in the web presentation layer; Enterprise Java Bean in the application layer;

Java Data Access Object (DAO) Services and Persistence Manager for the data layer.

Finally, support for daily activity is an important feature: Niguarda will be part of Besta's help desk. Technical resources will be contacted directly from Besta for higher level help desk, while maintenance on the system will be enabled by remote network access.

All these features contribute to judge the solution adequate from technological point of view.

2.2.3 Quality Level

In order to complete the adequacy verification, a further analysis should be conducted, evaluating the compliance to some quality levels: compliance to standards, maintainability, reliability, usability, support's quality, portability.

As far as standards are concerned, it has already been said that Niguarda's application has been developed with standard open source languages. Moreover, standard technologies have been used also for application servers and communication protocols. Interoperability is assured by the use of HL7; using this language reduces the amount of problems which has to be faced while configuring the right communication between the parts of the Health Information System (Aspden, 2004). Compliance to standards is an important aspect also in assuring maintainability of the application.

Concerning reliability, a reuse experience must refer to success of previous uses. Wide appreciation manifested by users in Niguarda is a symptom of reliability; moreover, reliability is assured by the fact that people who already follows development and functioning of the original application and who knows problems related to it are the same who will follow the application reinstalled, so they are supposed to be able to anticipate the more common troubles they have already faced.

Usability is guaranteed by a structured training program that Niguarda will hold to Besta's users and by the functionality of eLearning provided inside the portal. Moreover, usability is improved by constant monitoring of functionalities, based on users' feedback, together with a perceptual interface, developed to allow users to easily navigate through patients' clinical data and among different patients with the lowest number of intermediate masks.

Portability is assured by definition, since the whole project of reuse is based on the concept of porting the application. Adaptability to operating environments, ease of installation and compliance to porting standards are therefore assured.

Niguarda's solution appears strong under all these points of view. It appears reasonable to say that the level of quality held by this solution makes the adequacy verification completed.

2.3 Convenience Verification

Selection of an application can't be made without considering the costs it will imply (Wager, 2005).

Realization costs could be evaluated on two sides: those related to usability and those concerning covering of functional factors.

Costs related to usability are those linked to time spent by people on learning how to use the new system. Since the impact of Niguarda's solution on Besta's procedures will be low, users will have to learn just where old functions are positioned in the new system and how to use the new features. Other costs related to usability are those involving the analysis phase and the production of technical documentation. Documents already available for the original application make easier the flow analysis, due to the similarity in the organizational context. This documentation could be followed by users to better learn how to become familiar to the new system, requiring lower times and lower costs.

Covering of functional factors is strictly linked to the costs of development, since the more new functions have to be added the more costs will have to be faced. The adequacy previously verified, as regards new functions and low investment in technologies, contribute to keep costs moderated. The excellence of this project will also allow a funding contribution of Italian Ministry of Health.

After the solution will be installed, it will be subject to different maintenance activities. Evolutionary maintenance concerns the development of new features. Costs regarding this aspect are reduced in Besta's case, since requirements' stability assures that future interventions will be limited to just few functionalities, generally made as specifications of already developed functions.

Updating maintenance is related to adapting the application to new software releases or to modifies on the hardware platform. Corrective maintenance is related to the correction of bugs in the developed functionalities. Being used on two sides, actions concerning these aspects could be optimized: costs can be reduced since updating is made just once and used for both the original and the reused application.

2.4 Feasibility Study

All the previous analysis have to be summarized inside a feasibility study, conducted in order to understand whether a solution, selected after adequacy and convenience verify, could really be implemented and with which modality (Tan, 2001).

First of all, it should be evaluated if process analysis could really be reused. As already assessed, Besta's flows are very close to Niguarda's and to all the other healthcare realities; it is important to notice how modalities followed by Niguarda to fill in the gaps from the "as is" to the "to be" situation could be replied on Besta's situation. This activity has been conducted by Fondazione Politecnico in Besta's situation through empirical analysis of the flows, evaluation of the procedures enabled by the dismissed information systems, analysis of the real requirements and evaluation of their adaptability to original application's functions, validation of the proposed flows. Beside these activities, the alignment with management has been kept through periodical communication and an applicative demo. This solution has been thought together with the management of the client organization, in order to directly involve users in suggesting new functionalities and in expressing their opinion about future criticalities.

The modality through which the reuse could be implemented are linked to available resources, both human and financial. According to Besta's reality, the better solution appear to be a reuse in facility management, where Besta will have the operating responsibility over the service supply, by providing an adequate hardware structure for the environment installation. On the other side, Niguarda assures evolutionary maintenance and support for training and help desk activities, as well as its support for the functioning of the application. Both Besta and Niguarda will cooperate in finding solutions for enabling interoperability with already existent solutions.

The reuse impacts on risk analysis: Niguarda's strong involvement in the application, which will remain its property, contributes to keep a low effect of risk factors on the application, since they have been already evaluated on the original application.

2.5 Benefits Related to Reuse

The choice of an application provided as a reuse solution is always subject to an evaluation of benefits provided, in comparison to those reachable through other tools, such as clinical market packages (Sommerville, 2007; Chauldry, 2006). In this section benefits are analysed in the form of financial savings and intangible advantages.

As regards savings, some remarkable points have to be analysed. First of all, project realization costs are reduced, since the development is made through open source technologies and some typical costs of a best of breed solution bought on the market, such as licences, are avoided.

Other costs remarkably reduced are those related to maintenance and management of the application. All the evolutionary maintenance realized for Besta will be also part of updating in the original application. In this way the costs of development are shared between two companies and produce results for two applications, even if they require the effort for maintaining just one.

Human resources involved in this kind of projects are far less than those involved by the introduction of a "best of breed" system. Users will go on working with a different application but similar enabled procedures. Costs linked to training are less than those implied by market packages, since required hours are less and documentation has to be subject to few modifies in comparison to that already used for the training of Niguarda's staff.

Intangibles advantages are related to organizational procedures, since "ad hoc" solutions are realized to fit real requirements, instead of giving parameters towards which addressing procedures. The implemented solution allows to collect clinical data in a structured way, making them useful for scientific treatments with research aim; in addition, structured data allow an automated traceability of people registered into the system, whose complete clinical histories are visible 24 hours long. Completeness is assured by a new structure given to data, which links them to the clinical event and associates each event to the patient involved in it. Moreover, also administration systems can gain benefits from structured data, since they are constantly updated and create a precise clinical path which allows the accurate identification of the cost centres.

If Besta's benefits appear quite clear, it is worth underlining the advantage for Niguarda: the reuse of its application is a way to share development costs for widening the range of functionalities provided by the portal. Proposing its solution as a "best way" for healthcare applications will open the possibility to spread it among other hospitals, bringing benefits, savings and also prestige to the development unit and the hospital in general.

3 CONCLUSIONS

In Italian reality there is no mention to clinical information systems as example of successful reuses. Besta's project provides a practical demonstration of how to follow the steps required by a structured method to evaluate the possibility of reusing an information system in health environment. Other projects involving the reuse of health information systems could point it out as a best practice and reply its successful experience to gain similar results.

After the first roll-out of the system in the new reality (go live: 22 October), benefits that were just potential began to turn out to be authentic: the use of a standard language to make possible the communication with other applications revealed efficient, providing the physicians with an updated working list of patients to be visited each day. The continuous monitoring of the process, held by Fondazione Politecnico di Milano, assured an uninterrupted flow of feedbacks from the users to the developers, in order to quickly analyse and solve "infancy problems" of the solution and also to capitalize on flexibility provided by open source technologies, beginning to work in order to improve the solution with current users' requirements.

These results will be the basis for further development in the field of health information management. An already planned evolution for extending Besta's current project has been financed by the Italian Ministry of Health, by which a Web Integrated Information System for the management of clinical and research activities in the field of the neuroscience will be created as a specialization of the already existent clinical portal. New specific features will be added to the portal in order to implement an individual Electronic Health Record, by connecting the local systems with the regional (CRS-SISS) health system and with specific networks of pathologies. The strategy followed in developing the current solution will ensure the possibility to adapt the portal to become a single-entry point to the neurological area, in order to support and assist healthcare professionals not only in their day-by-day activities, but also for research, and decision-support functions. Impacts of the project will be felt in the areas of clinical processes and data modelling, where information and results will be transferred from research area to patient care. The experience already made and the compliance to users' requirements will be exploited to challenge the development of clinical pathways on patients, for which a deep understanding of the system by the physicians is required, in order to feed it with data as much complete as possible. Usability of the system and support's quality will facilitate success in this challenge.

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