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The Evolution of Hospital Information Systems and the Role of Electronic Patient Records: From the Italian Scenario to a Real Case

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Abstract

Health care organizations can gain great value from Information and Communication Technologies (ICT), yet, although there is growing awareness of the potential benefits associated with their use, results often fall far short of expectations. Each year, the "ICT in Health Care" Observatory – part of the Politecnico di Milano School of Management – outlines a profile of the role of ICT in the Italian health care industry, investigating current projects in terms of their impact on processes and organizations, implementation state of the art, governance models, and prospective pathways. The 2009 collaborative research process outlines the need for a change in the way health care CIOs approach technological and organizational evolutions. ICT departments lack vision, governance mechanisms, skilled resources, and top management commitment. This has led to a series of distortions in the innovation of Hospital Information Systems (HISs) and ICT departments themselves. Currently they are too concerned with day-to-day operations and delay comprehensive initiatives capable of leading to effective ICT-driven innovations. The paper points out the problems that health care organizations are tackling and how they are trying to solve them. The case of the Italian National Cancer Institute in Milan provides a valuable example of how a health care organization is developing its HIS.

Keywords:

ICT-driven innovation, Italian health care industry, Hospital information systems, ICT governance, Electronic patient record, Mobile & Wireless.

Introduction

Information and Communication Technologies (ICTs) have become necessary for Italian health care organizations – not only due to their increasing pervasiveness, but also to their ability to respond to the main innovation challenges currently facing the sector: the rationalization of health care costs [10], and the increase in the quality of health care processes [3].

The enormous volume and the intricate complexity of clinical and administrative information to be managed, make ICT essential for both running and innovating health care organizations. To understand this, it is sufficient to think of all the potential benefits that Hospital Information Systems (HISs) could achieve with a digitally-integrated management of clinical information flows, done with Electronic Patient Records (EPRs). Unfortunately, this kind of strategic role has yet to be achieved. Actually, most health care organizations:

- Continue to barely give them a second thought as a source of innovation [5], and
- Don't adequately analyze the organizational changes required to make all the benefits associated with ICT projects become a reality [1].

Thus, instead of being considered strategic resources, ICTs are often simply confused with other health technologies, and generalized as one of the drivers in the rising cost of the health care sector. Helping companies analyze and improve their information streams, EPRs, HISs and – more generally – ICTs, can be seen as a fundamental set of resources able to generate corporate benefits – with the coordination of other medical technologies and health care practitioners. In order to do this, health care organizations need more models, tools and skills on which to base the management of ICT.

Materials and Methods

This study is based on a broader and continuative research initiative promoted since 2007 by the Politecnico di Milano School of Management, i.e. the "ICT in Health Care" Observatory (IHCO), which focuses specifically on the analysis of ICT-driven innovation in the Italian health care industry[1].

Every year, the Observatory follows a stream of collaborative research [11] led by IHCO researchers, and is enriched with the involvement of practitioners in the gathering and analysis of the data pertaining to the research problem. The research stream, outlined in Figure 1, is a combination of a quantitative panel of electronic surveys, several qualitative in-depth case studies, and a series of focus groups called *Advisory Boards* (AB).

[1] The IHCO is one of the 30 Observatories specifically focused on the study of ICT and Management that the Politecnico di Milano School of Management started in 1998.

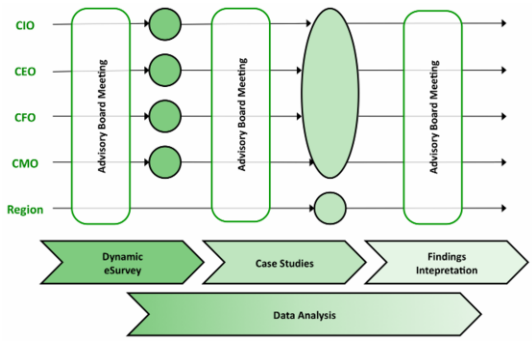

Figure 1 - The collaborative research process used by the IHCO

Every year, an electronic survey is created and delivered to a sample of more than 500 Italian health care CIOs – from representative organizations of varying types and sizes in different geographical areas. In 2009 [8], a 24% response rate was achieved thanks to: (i) a specific survey design[2], (ii) a series of comprehensibility and completeness tests from pilot respondents, and (iii) a set of improvements established with the AB. Every year, a second set of surveys is delivered to the Strategic Board – Chief Executive Officer (CEO), Chief Financial Officer (CFO) and Chief Medical Officer (CMO) – of the same health care organizations of responding CIOs, in order to cross-validate responses given.

A comparative analysis of more than 50 in-depth retrospective case studies is performed every year. The selection of target organizations is based on: (i) dimension of ICT department[3], (ii) ICT strategic importance[4], (iii) ICT projects, and (iv) AB suggestions. Data is gathered through a series of semi-structured interviews given to the CIO, CEO, CFO and CMO. The interviews are based on a common protocol constructed according to survey responses and an *a priori* analysis of the health care organization. Other information came from organizational charts, HIS architectural schemes and other materials shared with the research group (data triangulation).

The AB is a multidisciplinary focus group that advises and helps in directing the focus of the research, in interpreting data, in anticipating future research issues and confirming results. The group counts more than 50 representatives among which: (i) CIOs of the principal Italian health care organizations, (ii) National and International health technology suppliers, (iii) experienced professionals from Italian national health care associations, and (iv) other research partners. The annual AB contribution to research counts three key meetings (see Figure 1). The first one deals with informal discussion about annual research objectives and priorities in the data gathering process. In the second meeting, preliminary results are discussed, and the AB suggests potential best practices on which to perform annual case studies. In the last meeting, overall results and explanations are discussed in order to test, review and confirm them.

Results

The Strategic Value of ICT and HIS Governance

A constant piece of evidence emerging every year is the extreme heterogeneity in the ways in which Italian health care organizations give ICT a strategic value [8]. Interviews pointed out that ICT maturity is strongly related to: (i) the strong regional connotation of the Italian health care industry (including providers and vendors as well) and (ii) the historical socio-technical context in which health care organizations operate.

Thus, in order to clearly understand the real level of diffusion of ICT tools among Italian health care providers, surveys analyzed the main areas whose processes are supported by ICT. These areas are classified in: (i) primary activities of health care delivery, (ii) support activities, and (iii) network processes. The matrix in Figure 2 shows past (from 2007 to 2009) and expected (from 2010 to 2012) investment levels in these areas.

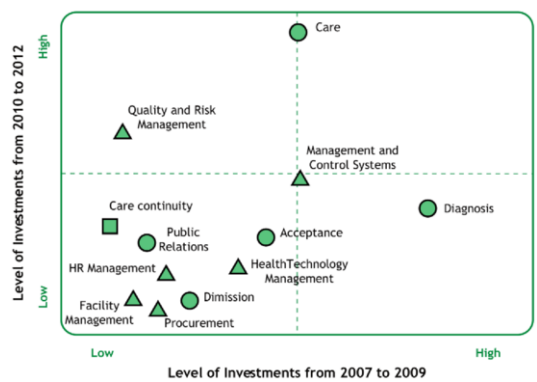

Figure 2 - Past and future ICT investment priorities areas of Italian health care CIOs (Circles = Primary activities areas; Triangles = Support activities areas; Squares = Network processes areas)

The majority of primary processes were evaluated as currently positively/highly supported (e.g. the diagnostic area), apart from core care activities (e.g. bedside, EPR, and so on). ICTs also play a relevant role in clinical support activities, but with the exception of core areas like quality assurance and risk management.

Interviews emphasized that almost all health care organizations implemented ICT solutions with the main aim of increasing resource efficiency. For example it's interesting to consider the contribution that ICT has given in the last few years to time-consuming activities like Admissions, or to costly "material-consuming" activities like those performed in radiology [4]. On the other hand, difficulty in introducing ICT in core care processes can be only partially explained by a low maturity level of market solutions: the implementation of these pervasive tools requires the agreement of all the actors participating in health care service delivery, and a high level

[2] The survey is designed with semi-closed questions (to balance usability and speed) with the possibility of expounding on each question.
[3] Measured with the rate of ICT FTE to overall organization employees.
[4] Measured in budget terms.

ing in health care service delivery, and a high level of structural integration within health department processes. ICT can play this "linking" role, as confirmed by 80% of organizations, but the level of integration of HIS remains low. Drawing on evidence from the case studies performed, approximately three out of four Italian health care organizations either aren't structurally integrated, or don't realize a level of integration able to lead to future ICT-driven innovation.

Low financial support – often pointed out as the main problem – is mainly a reflection of the low strategic commitment on the part of the strategic board, which doesn't have a clear idea about how ICT can have an impact that goes beyond mere efficiency. Reasons are multiple and range from a lack of a technological perspective on the part of CEOs, CFOs and CMOs, and the inability of CIOs to clearly propose all the advantages tied to ICT solutions, to the need for high investments to reach concrete organizational results[5].

Without a critical mass, ICT employees are forced to play help-desk or hardware manager roles. Very few learning processes are initiated to enhance their technical skills. Leadership programs are practically inexistent. Turnover rate is very low, and many difficulties are found in attracting professionals from other sectors. CIOs tend to ascribe all these criticalities to exogenous causes, rather than internal inadequacy, and to blame operational workload instead of their own incapability to face it. We found [8] that the CIO himself often has a narrow strategic view hindering an approach to innovation. This is due to: (i) a low level of managerial capabilities, (ii) difficult alignment with corporate strategies and (iii) overuse of technical language in strategic board interactions, not abstracting from ordinary operations. Hence, most of the problems can be referred to governance – not to technological matters.

The Role of Electronic Patient Records

According to Figure 2, clinical care is one of the main areas that received, receives and will receive most of ICT investments in health care. This area is highly representative of the necessity of integrated ICT-based solutions, in order to achieve affordable and effective ICT-driven innovations in health care [7]. Clinical care increasingly requires clinicians to access patient record information that: (i) may be distributed across multiple systems, and (ii) is represented as a mix of narrative, structured, coded and multimedia entries. EPR is the ICT-based solution that many health care CIOs are adopting and evolving to tackle these strategic clinical issues, and that have the highest potential to provide advanced integration capabilities to the other HIS components[6]. The importance of EPR in the evolution of HIS's integration led IHCO to include a vertical analysis on this topic in the research process [8].

A comparison between budgets allocated to EPR shows a significant increase in the number of EPR investments than will exceed 500,000 €[7]. These efforts potentially could justify the adoption of effective integrated solutions. However, surveys and case studies outlined a still fragmented situation. Literature analysis [9] allows the identification of five functional areas that characterize EPR:

- *ADT Area*: often integrated with the ADT system, this area manages patient admissions, discharges and transfers within the hospital, as well as vital statistics and administrative documentation (e.g. informed consent).
- *Diagnostic Area*: the features in this area allow exam requests and report delivery from/to wards.
- *Clinical Dossier*: this area embraces the management of all medical and nursing sheets, including initial assessment, vital signs automated monitoring, anesthesiology documents, OR reports, etc.
- *Therapy management*: this area includes support to prescription and administration of drugs, transfusions, nutrition, etc.
- *Out-patient management*: this area manages admission and medical reporting in case of out-patients, and feeds the patient's EPR with information like preliminary report or follow-up examinations.

Figure 3 shows the current and the expected percentage of diffusion of these functional areas in the research sample. Clinical Dossier (e.g. nursing sheets, vital signs monitoring) and Therapy Management are the functional areas with lower diffusion and on which CIOs recognize that they have to work in the future. Unfortunately these areas not only have a key impact on clinical activities, but also are the ones that need higher levels of integration in order to allow EPR to really become a useful clinical tool[8]. Case studies confirmed that the lack of integration with the rest of HIS and the absence of an enterprise-wide approach to solutions are the main limit of current EPR projects.

Case studies and AB meetings showed that the main hinders are, again, not related to technology, but to the extremely complex socio-technical nature of clinical processes (even more if we consider Public providers). Apart from the lack of support often occurring after implementation, the real criticalities are (i) the singling out of actual medical necessities and (ii) processes mapping – mainly because head physicians tend to act almost autonomously, without the real involvement of ICT department. External ICT supplier involvement is almost always operational or consultancy-oriented and in the few cases in which the relation is continuative, CIOs don't delegate much, and work alongside them – even in highly outsourced operations.

[5] The research reveals a generalized distance between the CIO and the top management: only 57% of surveyed CIOs are accountable to the CEO, while many ICT Units belong to Administrative or Technical Departments. Few CIOs act as true C-Levels, and often the ICT Department is not seen as a relevant actor in strategic planning activities – especially in comparison with CMO and CFO.

[6] E.g. Clinical data repository, ADT System, Diagnostic Area Systems, Order Management Application, middleware, etc.

[7] If from 2007 to 2009 the % of investments higher than 500,000 € was 6%. This percentage will increase to 24% by the end of 2012.

[8] Case studies pointed out that the investments in Clinical Dossier and Therapy Management areas will be driven by mobile hardware acquisitions. Surveys revealed that nowadays there is a clean prevalence of desktop PCs (89% of cases), while the use of fully mobile devices is still not widespread. This is a strong barrier against the implementation of really paperless health care organizations, because key clinical features must be delivered bedside with a proper device in order to support daily routine (e.g. PDAs for nurses administering drugs or transfusions, MCAs to support doctors filling daily records).

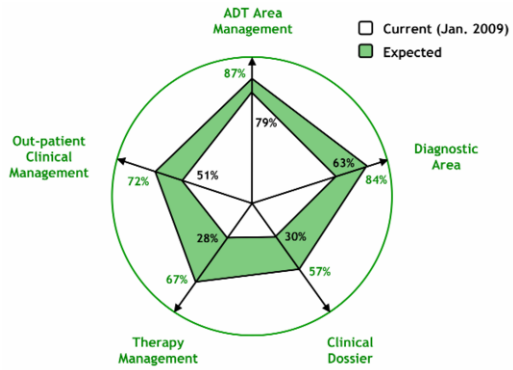

Figure 3: The January 2009 and expected diffusions of EPR functional areas

The AB meeting proposed a few guidelines to change this situation, which were also applied in the best case studies. First, to effectively sustain the change required in health care, CIOs need to work on their capabilities, as already done in other sectors [6]. In 65% of surveyed health care organizations, CIOs play a merely operative role. Obviously, this isn't sufficient: possessing more CIO capabilities doesn't necessarily constitute an ICT strategic role. The ICT department won't generate ICT-driven innovation until it has knowledge of clinical processes, relational capabilities and the ability to exploit external knowledge, working alongside Medical Offices. Thus, ICT governance models have to direct their attention to core health care businesses; to designate the ICT department as the main interface between the supply and the demand of the health care organization, and to develop strong absorptive capabilities to catch external innovation enablers[9].

A Case Study

Founded in 1925, the National Cancer Institute (NCI) in Milan (in Italian *Fondazione IRCCS Istituto Nazionale dei Tumori*) is a top-tier Scientific Research and Treatment Institution which has achieved renowned excellence in the field of preclinical and clinical oncology research and care. About 2,200 patients pass through the institute every day – with an annual average of 900,000 out-patient treatments, and more than 15,000 surgical treatments (including many liver transplants).

The NCI has consolidated expertise in: (i) exploiting ICTs to rapidly switch from experimentation to clinical practice, and (ii) developing ICT solutions able to increase processes quality in day-to-day critical areas. The interviews with the CIO and the Strategic Board outlined that the reasons behind these results are both internal and external to the ICT department[10]. The CIO has externally recognized leadership and acts as a true C-Level director. Her style of management continually strives toward the achievement of coherence within ICT and organizational strategies; and Strategic Board recognizes her key role in the definition of NCI strategies. This greater interaction with internal and external organizational actors could potentially create a loss of focus, trying to adapt to very different business needs: robust methodologies were implemented to prioritize tasks and let all ICT-driven synergies emerge.

All these targets could be met thanks to (i) a comprehensive socio-technical perspective associated with ICT-based solutions, and (ii) a homogeneous development all along the different evolutional paths of ICT-driven innovations. Taking a closer look at the five functional areas of EPR described above (see also Figure 3), we find the following:

- *ADT Area*: this is the first area that was digitalized – mainly for historical reasons. Recently NCI replaced the old central mainframe with modern systems, compliant to up-to-date requirements and international interoperability standards to feed EPR.
- *Diagnostic Area*: all core diagnostic departments are supported by state-of-the-art solutions. Only smaller labs (e.g. genetics) are supported by local applications, not integrated within the HIS.
- *Clinical Dossier*: NCI is supporting Lombardy in the test of a new clinical repository of (i) digitally signed medical reports, (ii) structured data, (iii) events (e.g. transfusions, surgery) and (iv) many others, from clinical placement to exam requests. Physicians will be able to browse through a patient's clinical history and retrieve more and more clinical information. Moreover, this clinical repository will feed patients' Regional Health Records (Italian FSE) as well as Pathology Networks.
- *Therapy management*: NCI is also leading a research program on clinical risk management in chemotherapy (funded by the Italian Ministry of Health). The program aims to develop clinical and organizational guidelines, as well as tools based on mobile & wireless technologies, in order to better integrate the therapy management system with the rest of HIS.
- *Out-patient management*: the NCI outpatient solution is fed by the Central Booking System and supports physicians for the digital signing of visit reports.

The use of mobile devices is also spreading within wards. NCI of Milan can be considered a forerunner amongst European health care organizations in its application of RFId technologies [12][11]. All the benefits associated to these last ones [2] are

[9] It is interesting to remark that the Lombardy region has recently established a set of mandatory guidelines for the development and the implementation of EHRs. Guidelines emphasize the relevance of integrated hospital-wide solutions, as well as the importance of specific functional areas like Clinical Dossier and Therapy Management. In Italy these kinds of Regional initiatives have a strong impact on the priorities that health care organizations set in order to develop their HISs. Surveys and case studies showed these changes from Region to Region.

[10] To evaluate them as homogeneously as possible, the external reasons were identified with the help of CIOs and then compared with the opinions of the CEO, CFO and CMP; the determination of internal reasons followed the inverse emergence and ratification process.

[11] Current key projects address: (i) general patient and staff identification, (ii) safety and traceability of transfusions, (iii) tissue bank

also associated with a major operational flexibility which is core, not only to clinical daily support but also to long time ICT-driven innovation.

Conclusion

The 2009 annual research done by IHCO outlines a complex scenario for ICT-driven innovations in the Italian health care industry:

- In order to be effective, research on EPR, HIS and ICT-driven innovation in health care will have to progressively involve practitioners in cyclical research processes of collecting, providing feed back, and reflecting on data;
- Geographical and historical contexts strongly affect ICT use in health care organizations;
- The major hinders to an organic and effective HIS development are related to governance, not to technology;
- The lack of effectiveness of EPR, HIS and – more generally – of ICT-driven solutions is mainly related to: (i) an organizational culture that still does not perceive ICT as a process support lever and (ii) an ICT department without the competences and poise required to play a real strategic role;
- To solve these problems health care organizations must work on the profile of CIOs and on the ICT department organization and governance mechanisms, with the objectives of bridging the gap between technological opportunities and clinicians' needs;
- In order to be effective and affordable, the development of EPR and/or HIS has to follow a clear evolution strategy managed by the ICT department in close coordination with the strategic board, medical departments and health care technology suppliers;
- The ICT-driven innovation in clinical core processes requires high levels of integration among specific ICT solutions. HISs and EPRs suggest that a lack of interoperability standards could become a barrier to integration and, thus, to ICT-driven innovation.

The analysis of the case of the Italian National Cancer Institute in Milan seems to confirm these points.

Acknowledgments

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operations, (iv) chemotherapy dilution and administration (v), quality assurance in bedside radiology activities, (v) radiotherapy machines.

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