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Contents

The Impact of the Implementation of the Electronic Medical Record in an Italian University Hospital

Alessandro Zardini, Cecilia Rossignoli and Bettina Campedelli

Abstract In the last years the use of the information communication technology (ICT) has become a leading driver of managerial reform in the public sector [1] and in particular in the healthcare system [2]. In particular, the Electronic Medical Record (EMR) is one of the most studied ICT systems in the healthcare management literature. Using the Zaharia et al. model [3], in this study we investigate the implementation of a core element of the EMR, in an university hospital, the deployment of which is expected to spur internal efficiency and pave the way for the development of the principles in other departments and/or hospitals. It then analyses the organizational impacts of EMRs on the healthcare provider's structure.

Keywords Electronic medical records · Case study · Electronic health records · EMR impact · EHR impact

1 Introduction

In the last years the use of the information communication technology has become a leading driver of managerial reform in the public sector [1] and in particular in the healthcare system [2]. In particular, in the last three years, the Electronic Medical Record (EMR) is one of the most studied ICT systems in the healthcare management literature. However, there is not a unique definition of EMR, because it is depend on the healthcare system, so it is quite different from country to country. In particular, there are a lot of researchers [4–7] that highlight the negative impact of the EMR in the American healthcare system. Sinsky et al. [8, pp. 728] emphasized

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these concerns when they wrote that: "after a decade of growth in the use of EHRs (Electric Health Record) that has been both promising and painful, we believe it is time to step back and develop principles for their design, implementation, and regulation that support higher value primary care". Unfortunately, the authors identified only general principles that they are not so useful, because the US hospitals are competitors and they do not want to share patient information. Hence, in USA it is not easy to develop a shared EMR.

In Italy, the situation is completely different because there is a public healthcare system. Hence, the hospitals are public and they are not in competitions, but there are other issues. Nowadays, every regions define the EMR principles, so (in theory) there are 21 different EMR systems. Moreover, only few hospitals had implement or are implementing the Electronic Medical Record.

In order to understand what are the main principles, in this paper we used the Zaharia et al. [3] model, re-elaborated by Buntin et al. [2], and we identified and categorized the positive impact and the critical factors generated by the implementation of the Electronic Medical Record in a general medicine department in an Italian university hospital.

Hence, the paper aims to respond to the following research questions: *What are the positive impacts and the critical factors of introducing EMR in a general medice department? What factors influence the implementation process?*

In the first part, we proceed with the literature review, after we illustrated the research methodology and approach. It then analysed the introduction of EMRs to an Italian university hospital and evaluated its impact on the hospital's organisation. The paper closes with the authors' conclusions.

2 The Theoretical Background

Over the past few years, Information Technology (IT) has become a leading driver of managerial reform in the public sector [1] and in particular in the healthcare system [2]. Technology is reshaping organizations by blending their Information Systems with rapidly advancing information and communication technology [9, 10], and it is becoming the catalyst factor for economic growth [2].

Hence, private-sector companies deploy ICT solutions to optimise organisational performance precisely because of its potential to reduce transaction and agency costs (principal–agent issues), but also to rationalise their business processes [11, 12]. The introduction of ICT to the public sector is expected to produce similar results [10]. These are highlighted by Smith et al. [13, pp. 491], who write that "the impact of Electronic Medical Records sophistication on financial performance indicate that EMR sophistication is associated with improved revenue cycle management, and increased 'Days Cash on Hand' (DCOH)".

On the other hand, some academics [1, 4] identified that for the majority of practices, the return on investment of the EMR was negative, particularly for smaller practices. Dey et al. [6, pp. 90] reinforce the previous thesis, saying that:

"Simply incentivising health care service providers to move up the stages of EMR capability may not lead to the realization of the potential benefits of the higher stages of EMR capability. The practical implication of this finding is that health care service providers need to assess whether their choice of a stage of EMR capability is commensurate with their idiosyncratic technological, organizational, and environmental contexts characteristics before committing to a stage of EMR capability". Hyman [7] emphasizes these concerns in a paper titled: "The Day the EHR Died".

Unlike the previous authors, Bardhan and Thouin [14, p. 442] argue that 'spending on health IT does matter … and it is important to measure quality outcomes at the process level, and not only at an aggregate institutional level'. The authors conclude by saying that the adoption of EMR within US hospitals generates benefits for both patients and clinics.

As underscored by Hannan [15], the medical record should be the main 'repository' of the patient's medical information, as it not only supports clinical decisions, but is also a useful tool for other healthcare-related services (administrative, insurance, quality, epidemiology and so forth). As a result of the close relationship between medical decisional processes, data accumulation, healthcare costs and the quality of the health service [16], the quality of clinical treatment, the efficiency of the health service and the health of citizens call for a medical record that is an effective decisional-support tool [15, 17]. The EMR is such a tool [18] because it enables immediate access to encoded and standardised patient information and 'more active decision support' [19, p. 3] through the alerting, interpretation, assisting, critiquing, diagnosing and management functions [15, 18].

All these benefits are summarized by Shaw [16, p. 200] that re-elaborated the Schoen et al. [20] model, and he defines the EMR core features as: "the electronic ordering of tests, electronic access to patients' test results, electronic prescribing of medication, electronic alerts for drug interaction, and the electronic entry of clinical notes. Beyond these core capabilities, physicians may extend features by performing searches on their patient population, creating templates to speed their entry of notes, set reminders for medical tests, and ensure that non-electronic data are scanned and linked electronically to the patient record".

An other important point is that in the literature, there is not an unique definition of Electronic Medical Records, but it depends on the national healthcare systems model. Hence, sometimes there is an other issue because the EMR and the EHR are considered interchangeable terms [21] and comprise all the previous conceptualizations [22]; in fact "other similar interpretations exist, albeit with a sometimes slightly restricted focus" [23, p. 1]. Otherwise in this paper, we cannot interchange these two terms, because in the Italian Healthcare System they are different.

In this way, we can define EMR as 'computerized medical information systems that collect, store and display patient information [24]. They are a means to create legible and organized recordings and to access clinical information about individual patients' [21, pp. 129]. They provide an effective, active decisional-support system, whether the decisions regard healthcare or management, [15, 18, 19, 25]. A hospital organisation can expect EMRs to generate key benefits, including enhanced quality

of healthcare, reduction in clinical errors and gains in organisational efficiency, thanks to lower management costs [15, 19, 25]. Hunt et al.'s [26, p. 1339] review of the main studies on the information systems that support clinical decisions indicates that EMRs have increased the clinical performance of 'drug dosing, preventive care, and other aspects of medical care'. Further, in their study of the cost/benefits of EMR for primary healthcare providers, Wang et al. [24, p. 397] note that EMR adoption has 'a positive financial return on investment to the health care organization'.

McDonald [18] reports many cases in which the EMR has enabled healthcare organisations to reap significant rewards as a result of to its positive impact on both physician behaviour and healthcare processes. The two main effects of the EMR identified by the literature review carried out by Hayrinen et al. [22] are, first, personal—that is, changes in clinical procedures and document management, improved decisional processes (although the timing remains the same) and the potential access of patients to their personal records—and, second, organisational—that is, the effects of an IT system on the communication and cooperation of the various stakeholders, in particular, document accessibility and the possibility to re-examine clinical information [27]. The enhanced quality of patient healthcare is a further important organisational effect.

According to Zakaria et al. [3] and Buntin et al. [2] success or failure of the projects that introduce the EMR and decisional-support systems depends on many factors [28]. These key factors can be divided into three categories: organizational challenge, human/people challenge, and technical/technological challenge. In the first category, the authours consider organizational costs associated with planning, specifying requirements, customizing and re-customizing systems, training providers, and reengineering the delivery of healthcare systems to accommodate hospitals. Moreover, they define also the concept of organizational culture, and resistance towards usage of ICT. In the second one, they insert the skills and expertise of the employee to use new technology, because organizations that fail to manage their present staff stand little chance of obtaining and retaining outstanding individuals [3]. In the last category, the ICT and in particular the EMR can enhance healthcare services electronically where barriers like time, distance and space no longer matters [3]. Moreover, it helps psysician community to share patient information and supports them to make the right decision.

3 Case Study

The Alfa university hospital is one of the largest healthcare providers and is composed of two facilities. The two facilities combined treat an average of 60,000 inpatients per year, 10,000 of whom come from other Italian regions. Daily admittances total 1,300 for ordinary stays and approximately 400 for day hospitals. The goal is to automate and computerise the most important organisational

processes, the number and complexity of which are far higher than most other healthcare providers [5].

The EMR is one of the projects currently being developed and implemented by Alfa. One of the main components of the Electronic Health Record (EHR) is the EMR, the repository for all the internal information generated by the hospital's individual organisational units. Thanks to Gekos system, hospital physicians are able to view al lot of data, such as: laboratory test values, RX picture, TAC picture, old documents, and other patients' data.

However, they are not able to insert, modify or delete data.

4 Methodology and Method

The study uses a qualitative approach to respond to the research question. In particular, the case study method [29, 30] enables the object of analysis to be investigated in its natural state by taking into account multiple dimensions that are difficult to analyse using a quantitative approach [31]. According to Darke et al. [32, p. 274] 'case study in research is useful in newer less well-developed research areas particularly where examination of the context and the dynamics of a situation are important'.

The case addressed in this paper began with an analysis of the Alfa hospital during the EMR analysis and implementation phase. Two main reasons led the authors to select Alfa as their case study. First, this hospital case is particularly insightful for research into EMR adoption and use because it involves an e-government tool used by highly complex public healthcare providers [33]. Further, the Alfa hospital has two different, highly structured organisational (university and healthcare) identities (spirits) that, while integrated, have specific, composite natures. Second, the authors were given direct access to the data.

The case study was conducted according to the methods and instructions suggested by Yin [31]. This entailed gathering data through semi-structured interviews, direct observance and document research. The interviews and the internal documentation were used as the testing sources. Privileged access to the relevant information enabled the authors to collect data from several sources, increasing the quality of the information obtained [34].

The case was analysed using the results of the 11 semi-structured interviews (each of approximately 40 min duration) held with the hospital staff and designed to enable the respondents to answer freely, in their own words. Each interview was attended by two researchers, used the protocol presented by Arksey and Knight [35, pp. 74–75] and was tape-recorded. The respondents consisted of two managers from the Alfa healthcare management, five medical physicians, one practicing doctor, two ward nurses, and one nurse coordinator, all of whom work in the two hospitals facilities.

The data and results obtained were presented to the main organisational actors and the board of directors of Alfa hospital through the interview transcriptions and

the interim results of the data-collection phase. The authors used Atlas.ti Computer Assisted Qualitative Data Analysis Software (CAQDAS) to analyse the data because it enables organisation and summarisation by concept (for example, improved collaboration, system adequacy and error reduction). Data collection commenced in November 2013 and continued for approximately four months. The analysis and integration of the existing data began in April 2014.

5 Data Analysis and Discussion

As mentioned earlier, in this paper we analysed the impact of the EMR using the model presented by Zaharia et al. [3], that it was re-elaborated and improved by Buntin et al. [2]. In the Table 1, we summarized the main factors (nine codes) that we found during the data analysis and we categorized them in the three categories, or challenge types, proposed by previous authors [2, 3]. Some of these codes are reported in the literature, and they influence the impact of the introduction of a new Electronic Medical Record system.

In particular, in the organizational challenge category, there are five codes, where two of them the had a positive impact on the organization (reduction of errors, and knowledge sharing), whereas the others had a negative impact on it.

An important aspect identified by the analysis is the perception of the respondents (10 on 11) of a significant reduction in errors compared with the past. The interviewed recounted how the former paper-based procedure was more prone to errors (imprecise requests, imprecise/unreadable medical report, potential misunderstandings and the illegibility of handwritten notes). Today, the higher level of

Table 1 The main codes categorized with Zaharia et al. model

Challenge type	Code	Code frequency	Number of respondents
Organizational	Reduction of errors	25	10
	Increase of low value-added work	19	9
	Increasing size of bureaucracy	16	10
	Limited capacity to manage processes	15	8
	Knowledge sharing	12	7
Technical/Technological	System inadequacy (ineffectiveness)	34	11
	System slowness	23	9
People	Better cooperation and coordination	19	9
	Lack of leadership	13	8

uniformity and integration of procedures enabled by the standardisation introduced by the computerised routines has resulted in efficiency gains and reduced organisational errors and redundancies. This was attested to the physician no. 3 (internist medical doctor): "These systems are useful, because reduce a lot of the main potential errors, such as: prescribing faults, prescription errors, misinterpretation of handwriting… and they can better manage the medicines procurement process, because we can buy medicine that we actually use".

Moreover, according to Bardhan and Thouin [14], thanks to EMR the knowledge sharing is improved. In fact, the informant no. 1 (internist) explained: "The system is certainly efficient and useful. It allows us [psysichians] to do much of our work at the bedside, in real time, and to share information/data with nurses (diagnosis and therapy)… We can also request the advice of others medical specialists (i.e. diabetologists, gastroenterologist, etc.) and we can see all patients data anywhere and anytime". Otherwise, the other three codes are in contrast with the literature [15, 16, 18, 24]. In fact, the introduction of the EMR in the internal medicine had a negative impact on the organization because increased the low value added-work, and the size of bureaucracy. These concepts can be summarize in the following quotes:

"Nowadays the EMR is a really waste of time, but as usual, it is a period of adjustment to fine-tune the processes. There is a phase where users waste time to find data (about patients data) and to properly use the system, but I hope the in few mounts we should have some benefits" (practicing doctor). "I noticed that increase the size of bureaucracy, because I surely waste more time to put in the system the diagnosis and the appropriate therapy, and in many cases with patients in emergency, I do not have enough time to do (insert and save) all the operations required by the system" (two internist medical doctors). "The programs (some soft wares present in the EMR) that we use are not interfaced. Often when we switch from one program to the other the documents (inserted) are not visible, indeed, very often are canceled by the systems, so we have to repeat the input. We know that it is a temporary situation and it should be resolved shortly, but in the daily situations, especially in large departments like ours, it is a huge limit" (ward nurse and nurse coordinator).

In the second category (technical challenge), according to Moore et al. [5] and Dey et al. [6], we identified two codes (system inadequacy, and system slowness) that they had a negative impact on the EMR acceptance. It is normal to encounter a certain amount of 'diffidence' in the use and/or evaluation of a system during its start-up or initial phase, given its complexity and the mixed bag of actors involved [36]. EMR came on stream only a few months ago and that a period of settling in and comprehension of the potential and criticalities of the new artefact is required [37]. However, all respondents mentioned the lack of an adequate planning in order to define which are the technological infrastructure requirements for the EMR operation. Informant no. 5 (internist) explained: "the 80/90 % of our laptops are too old (more than eight years), in same areas the Wi-Fi internet access are not available, and the LAN is undersized, so in some hours of day, it is too slow".

How well highlighted by Zaharia et al. [3] and Buntin et al. [2], the use of inappropriate technologies can decrease the quality and the reach of both information and communication and it can cause the failure of the projects that introduce the EMR in this hospital [38, 39].

At the end, in the challenge people, we found the last two codes. Eight of the eleven informants made specific mention of the leadership adequacy aspect, underscoring the lack of a clear and established organisational leadership in the implementation process adopted by this hospital. According to informant no. 4 (physician): "there was no leadership, everything was left to the initiative of a few people. Nobody asked us, what are our needs, and how we can customize the EMR in order to be useful, and so on. Moreover, we do not have a trained project manager, someone who has goals to pursue.

However, the new system has also generated a benefit: the enhanced collaboration between the various organisational actors involved in the process. The computerisation and standardisation of the procedures have improved the level of interaction and collaboration, which translates into an activity of comparison and discussion that can optimise the organisational and work practices of the various units. The interviewed 3 (physician) explained that: "I think that thanks to the EMR, I can better collaborate with my colleagues and I can share more data with them (other specialists). Moreover, the team works are better, because we can better define what are our tasks, thereby improving the coordination process. Now we have to implement an EHR, in order to share data/information with the other hospitals".

6 Conclusions

In this paper, we analysed the impact and critical factors in implementing a new Electronic Medical Record in the general medice department of an Italian university hospital, which represents a particularly complex healthcare structure. In particular, in order to highlight positive and negative factors, we used the model of Zaharia et al. [3], that it was re-elaborated by Buntin et al. [2]. According to the previews model, we subdivided the main codes in three categories (organizational, technological, and people).

The following codes are the positive impact that we noted:

- a reduction in the number of flaws and errors (imprecise requests, imprecise/unreadable medical report, potential mis-understandings and the illegibility of handwritten notes).
- Faster access to clearer and more specific information, enabling physicians to diagnose patients more promptly.
- Knowledge sharing helps physician, nurse and medical specialist to better analyse patient information and to find the most appropriate treatment.

- Cooperation and coordination process thanks to EMR is developed, because the system improves the collaboration inter- and intra-team and helps physicians and nurses to schedule medical examination, prescriptions, and treatment.

However, we identified also some negative impacts that they are quite normal in the first phase of the EMR implementation. In fact, according to Kucukyazici et al. [36], during the start-up or initial phase is normal to encounter a certain amount of 'diffidence' in the use and/or evaluation of a system, given its complexity and the mixed bag of actors involved. The main critical factors identified by this paper were:

- a lot of the interviewed (eight employees) underscored the lack of a clear and established organisational leadership in the implementation process adopted by the EMR adoption.
- Almost all interviewed identified that the EMR increased low value added-works, and the size of bureaucracy. Ten of them told that they waste a lot of time to find data patients and to properly use all the systems of the EMR.
- The most critical factors that they explained were the slowness and inadequacy of the network (LAN, and Wi-Fi) and the peripheral devices (laptop, desktop, and so on) because the personal computer are dated (average more than eight years) and the network is undersized.

The decision to analyse the EMR and, specifically, the general medice area, has generated system-specific results; however, these can be extended, with due caution, to the other IT models and systems of this hospital various operating units, as well as to those of similar organisations. In fact, the critical factors of the case need to be taken into account each time a similar project is addressed [36, 40] as useful references to both improve the systems already in use and progressively develop and adopt projects to create an effective EMR.

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