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Armando Suppa[a], Ludovico Bullini Orlandi[b], Alessandro Zardini[c] and Paul Pierce[d]

[a] armando.suppa@univr.it, [b]ludovico.bulliniorlandi@univr.it, [c]alessandro.zardini@univr.it, [d]paul.pierce@ics.lu

[a,b,c]Department of Business Administration, University of Verona, via Cantarane, 24, 37129, Verona, Italy

[d]Department of Informatics, School of Economics and Management, Lund University, 221 00 Lund, Sweden

Abstract. In the last years the use of information communication technologies (ICTs) has become a leading driver of OECD national health systems to improve healthcare quality and reduce healthcare costs (Oecd, 2010). In fact, the use of ICTs are a primary lever of OECD countries to enhance the efficiency and the effectiveness of health services delivered to the citizens. This has led the Italian government to assign priority to electronic healthcare and specifically to the creation and adoption of electronic health record (EHR) (Bergamaschi, Laura, & Elianna, 2006). We analysed the experience of developing and implementing an electronic medical record, core element of a EHR, by the Azienda Ospedaliera Universitaria Integrata (Integrated NHS-University Hospital) of Verona. We identified the critical factors in the system implementation, its organizational impact, and the effects on clinical practice as perceived by the system's users.

Keywords: information communication technology, electronic medical records, e-government, electronic health

1. Introduction

The past two decades have seen the more developed countries launch major public-sector reforms to increase the efficiency and effectiveness of their public administrations (PAs) (OECD, 2005). The use of information communication technologies has become a leading driver of managerial reform in the public sector to produce and deliver citizen services (Shareef, Kumar, Kumar, & Dwivedi, 2011), in particular in the healthcare organizations (Zakaria, Affendi, & Yusof, 2010). ICTs are pivotal in health

systems thanks to the multiplicity of uses they can be employed. In fact, ICTs, that enable the timely and accurate collection, transfer and retrieval of health data, are likely to foster better care and the more efficient use of resources. However, in many OECD countries, healthcare organizations have been slow to embrace ICTs, and " *most physicians are still using their computers mainly for billing or other administrative tasks*" (Oecd, 2010, p. 27). Of all the information technology presently used in the health field, the electronic medical record (EMR) has the most wide-ranging capabilities and thus the greatest potential for improving quality (Miller & Sim, 2004). In the last years, the Electronic Medical Record (EMR) is one of the most studied ICT systems in the healthcare management literature (Berner, Detmer, & Simborg, 2005). However, in the literature, it is still a controversial topic, for example in the study of Lau et al. (2012) the major (51.2%) of the EMR project had a positive results on the organizations, while a third (30.2%) had almost no impact. Otherwise, Sanders et al. (2013) underpin that almost 29% of all EMR projects had a negative impact on workflow, clinical volume and patient care.

The majority of researchers on the impacts and critical factors of EMR were conduct in United States and Canada (Ajami & Bagheri-Tadi, 2013; Berner et al., 2005; Boonstra & Broekhuis, 2010; Jha et al., 2006; Lau et al., 2012), where the healthcare systems are private and a lot of concern is about cost reduction and efficiency (Hillestad et al., 2005; Wang et al., 2003). In Europe the situation is different, because there is a public healthcare system. Usually the hospitals are public and they are not in competitions. In 2004, the European Union launched the European eHealth Action Plan, where one main objective is to standardize health information system. Studies and development projects are ongoing in several countries to elaborate and implement a national health information system (e.g. Canada , Australia, England, the United States, Finland etc.) (Häyrinen, Saranto, & Nykänen, 2008). Moreover, there is no unique definition of EMR, because it is dependent on the healthcare characteristics and activities (Ajami & Bagheri-Tadi, 2013; Garets & Davis, 2006). In fact, ICTs implementation may have multidimensional and uncertain effects in their reach and scope, and difficult to control. In addition, the positive effects of ICTs adoption strongly depends on contextual conditions (Oecd, 2010), specially in the public sector (Pollitt & Bouckaert, 2011). In fact, develop and implement an EMR in its complete form, starting form a paper base database, is not just a technical innovation; it is a cultural transformation (McDonald, 1997; Oecd, 2010; OECD, 2005).

In England, they implemented a national Electronic Health Record[1], that is part of a national healthcare reform (National Programme for Information Technology) lunched by the Ministry of Health Care, and they have achieved extensive implementation of individual eHealth applications (Deutsch, Duftschmid, & Dorda, 2010). In Germany, the Government has introduced, as part of initiatives to implement nationwide EHRs, an electronic health card for all German citizens by 2006 (Hoerbst, Kohl, Knaup, & Ammenwerth, 2010) . The France Government has introduced the Dossier Medical Personnel (DMP) and the Dossier Pharmaceutic, accessible to patients through Web services and under the responsibility of the regional health agencies (Bourret, 2010). In Italy, the Government has promoted a program to develop and adopt an electronic health record (EHR), a single database accessible by all healthcare providers. The electronic health record is the Italian National Health System main electronic record-keeping tool, used to collect, store and display citizens' health and socio-health data. The EHR is expected to generate not only economic benefits but healthcare quality improvement as well (Zardini, Rossignoli, Suppa, Ricciardi, & Benetollo, 2014). The Italian local governments (region) have the responsibility to direct and coordinate the implementation of regional EHR so there are different EHR and not a harmonized one. Furthermore, Only a few healthcare organizations have implemented a EMR, a type of EHR generally focused on medical care and contains information entered by a single hospital (Häyrinen et al., 2008). One of this is the 'Integrated NHS-University Hospital (INUH) of Verona that is developing and introducing an electronic medical record (EMR) system, a key factor in spurring the efficiency and efficacy of hospital management and a primary building block of the future EHR. So given the current rate of the EMR deployment in Italy, due to mandatory requirements and budget cuts, there is a urgent need to understand what factors are critical for a successful implementation of EMR and which impacts a EMR can have in the Italian national health context.

We analysed the ongoing experience of implementing an EMR in the INUH. We present, in this paper, the results of our qualitative study, based

[1] In this paper we Defined EHR, using the definition of ISO 20514, as a repository of patient data in digital form, stored and exchanged securely, and accessible by multiple authorized users. It contains retrospective, concur- rent, and prospective information and its primary purpose is to support continuing, efficient and quality integrated healthcare (Häyrinen et al., 2008).

on semistructured interviews, on the critical factors of the system implementation, its organizational impacts and the effects on healthcare processes, as perceived by the internal users.

2. Background

Healthcare involves a process of continual accumulation of patient medical data and information; therefore, the medical record is a pre-birth to post-death record-keeping system that provides medical and clinical intelligence to the diverse healthcare providers, from primary to intensive care (Hannan, 1996). The importance of medical records in providing healthcare services was recognised in the late nineteenth century. Hospitals first began to use computers in the early 1960s, mostly for administrative and management functions, but started to computerise healthcare procedures as the benefits of the new electronic systems became clear: quick access to the information contained in patients' medical records to improve clinical decisions, reduce errors and, through 'reminders' and 'alerts', support clinical decisions (McDonald, 1997).

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 for other healthcare-related services (administrative, insurance, quality, epidemiology and so forth). This is the result of the close relationship between medical decisional processes, data accumulation, healthcare costs and the quality of the health service (James, 1989; Shaw, 2014). 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 (Hannan, 1996; Lakshminarayan, Rostambeigi, Fuller, Peacock, & Tsai, 2012; McDonald, 1997). The EMR is such a tool (Oecd, 2010), because it enables immediate access to encoded and standardised patient information and 'more active decision support' (Berner et al., 2005, p. 3) through several functions (viewing, ordering, messaging, analysis and reporting etc.) (Miller & Sim, 2004).

In the literature, there is not a unique definition of EMR, the definition and the specifications of EMR are "unstable" and depends on functions and different data collected (Häyrinen et al., 2008). The two principal terms to indicate health records management systems are Electronic Medical Records and Electronic Health Records (El-Yafouri & Klieb, 2014). The EMR and the EHR are considered interchangeable terms by vendors,

government and some academics (Ajami & Bagheri-Tadi, 2013; Boonstra & Broekhuis, 2010). However, in this paper, these "label" are not interchangeable and we are only focused on the EMR. In fact, for EMR we mean a comprehensive computerized medical database that enables several functions (clinical decision support, order entry, computerized provider order entry, pharmacy, clinical documentation applications etc.) owned by one healthcare organization (El-Yafouri & Klieb, 2014). So EMR are computerized medical information systems that collect, store, display and re-use patient information (Wang et al., 2003). They are a means to create legible and organized recordings and to access clinical information about individual patients (Häyrinen et al., 2008). Otherwise, EHR is a computer-based clinical data, a subset of healthcare organization EMR, that include data about patient form different interoperable EMRs and permits the input and the interchange of data among healthcare organizations across multiple locations (regions, states and even countries) (Protti, 2007). EHR needs EMRs being in place, and a full effective EMR reliant on an interoperable EHR being in place (Garets & Davis, 2006).

A hospital organization 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 (Berner et al., 2005; Chaudhry et al., 2006; Wang et al., 2003). Cost benefits are obtained by a widespread adoption of the functionalities of EMR that enable the reduction of outpatient (lab test, radiology, drug usage chart pulls etc.) and inpatients (nursing time, length-of-stay, medical record etc.) health activities (Hillestad et al., 2005). Further, in their study of the cost/benefits of EMR for primary healthcare providers, Wang et al. (2003, p. 397) note that EMR adoption has a positive financial return on investment to the health care organization. The EMR can increase the the quality of clinical performance thanks to improvement of drug dosing, preventive care, health information exchange, access to patient data and other aspects of medical care, the most important of which is the decrease medial errors (Felt-Lisk, Johnson, Fleming, Shapiro, & Natzke, 2010; Hunt, Haynes, Hanna, & Smith, 1998; Yoon-Flannery et al., 2008). The health performance improvement and the cost benefits are interconnected, two slides of the same coin. In fact, as noted by El-Yafouri and Klieb (2014, p. 507), "*Some of the quality enhancements procedures can lead to increased efficiencies, reduced time, material, and ultimately reduced cost*".

McDonald (1997) 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. (2008) are, first, individual—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. The enhanced quality of patient healthcare is a further important organisational effect.

The success or failure of a project that introduce ICT and decisional-support systems (the EMR) depends on many factors (Miller and Sim, 2004; Castillo et al., 2010; Ajami and Bagheri-Tadi, 2013). Some of these factors are related to technical and technological dimension, such as the use of the same standards to encode medical information (McDonald, 1997; Dolin et al., 2006), the interoperability of different clinical data systems (Berner et al., 2005), user perception and satisfaction (Chang et al., 2012), the simplicity, flexibility and interactive features of the systems (Miller and Masarie, 1990; Miller and Sim, 2004) and the 'inefficiency in physicians' computer input techniques' (Berner et al., 2005, p. 6). Other factors include the strict legal requirements on data security and patient privacy (Miller and Sim, 2004; Berner et al., 2005). Another potential hurdle to the introduction of the EMR is the cost of implementation and management, as well as, the cost of teaching the medical staff to use the systems (Miller, 2005; Scott et al., 2005; Boonstra and Broekhuis, 2010). Moreover, a significant negative influence on physicians' perceptions of IT as a useful tool, and hence their intention to use it, is the perceived threat to professional autonomy (Walter and Lopez, 2008). Physicians' perceptions and considerations of the introduction and usefulness of the EMR are other critical factors for system implementation (Meinert, 2005).

A systematic literature review carried out by Boonstra and Broekhuis (2010) identified the following determining factors in EHR adoption: financial (installation and management costs, uncertain return on investment, lack of funds); technological (no IT skills, no training, system complexity, system limitations and low levels of customisation, interconnectivity and standards); timing (the time required to select and implement the system, train staff and input the relevant data); psychological (lack of trust in the system, need to retain control); social (uncertainty of the system suppliers, lack of support from external organisations (especially

public institutions), doctor–patient interference; legal (privacy and information security issues); organisational (size and type of healthcare provider); and the change process (lack of support from the organisational culture, lack of incentives, lack of participation). Furthermore, the literature cites other factors that need to be taken into account and managed appropriately during the implementation process: the adequacy of the project leadership; the type and influence of the organisational culture (participatory and cooperative or authoritarian and hierarchical); and the adequacy of the system implemented and the training provided (Scott et al., 2005; Heeks, 2006; Pagliari, 2007). These factors are critical and can lead to the total failure of a project, causing the healthcare provider to suffer economic and structural damage (Heek, 2006).

It is important to note, as emphasized by Hyman (2014) EMR capability is commensurate with their idiosyncratic technological, organizational, and environmental contexts characteristics. This is more valid in public administration field where the context matter (Pollitt & Bouckaert, 2011), in fact, as underlies by Ongaro (2013, p. 193), "*features of the political-administrative context interact with the unfolding of administrative change over time*". So it is crucial to analysis what are the impacts of electronic medical systems and which factor are critical for a successful adoption, in the Italian context, where their "massive" introduction is in the early phase and a few studies have been carried out.

3. Methodology and methods

We used a qualitative approach to conduct the present study and respond the research question. Qualitative research methodologies can contribute to health care studies give a rich information about different aspects, medical decision making, patient preferences , health behaviour etc. (Bradley, Curry, & Devers, 2007). A quantitative approach need to conduct a study well defined and limited theoretical constructions for data reduction, in order to have acceptable response rate for statistical inference (Shaw, 2014). Otherwise a qualitative methodology is a process to analysis non standard data in order to deal with the complexities of a phenomena, not considered in variance models (Creswell, 2003). In particular, the case study method enables the object of analysis to be investigated in its natural state by taking into account multiple dimensions (Miles & Huberman, 1994). In fact, case study can generate useful and rich information in newer research areas,

specially where examination of the context and the dynamics of a situation are fundamental to understand the phenomena be analysing (Darke, Shanks, & Broadbent, 1998).

The case addressed in this paper began with an analysis of Verona INUH during the EMR development and implementation phase. Two main reasons led the authors to select AOUI as their case study. First, the AOUI case is particularly insightful for research into EMR adoption and use, because it involves a e-government tool "new" in the Italian public administration field, used by highly complex healthcare provider. Further, the Verona INUH is the result of the merger of a general hospital and an academic hospital, that has generated an highly structured organisation, while integrated, have specific, composite nature. Second, the authors were given direct access to the data (Eisenhardt and Graebner, 2007).

The case study was conducted according to the methods and instructions suggested by Yin (2009). This entailed gathering data through semi-structured interviews, direct observations and internal documents. In fact the privileged access to the relevant information enabled the authors to collect data from several sources, increasing the quality of the information obtained (Benbasat, 1984). The interviews and the internal documentation were used as the testing sources.

The case was analysed using the results of the 34 semi-structured interviews (each of approximately 50 minutes duration) and one focus group (3 participants) held with the AOUI 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 (1999, pp. 74–5) and was tape-recorded. The participants included two leaders from the AOUI healthcare management, one clinical manager, ten medical physicians, two surgeons, two ward nurses, four nurses, two laboratory technicians, three radiologist, one neurologist and two laboratory physicians, all of whom work in the two Verona AOUI facilities.

Data collection commenced in 2013 until 2015 and continued for approximately three months. The analysis and integration of the existing data began in December 2015.

We analyzed interviews inductively and thematically. 30 responses were coded and collated to create themes. Unclear responses were clarified with interviewees. We held regular discussions to review themes and clarify factual aspects raised by data. This paper reports only themes that were mentioned by at least four respondents (of a total of 29).

4. Case Study Analysis: use of EMR in the Verona AOUI

4.1 Scenario

The Verona AOUI is one of the Veneto region's largest healthcare providers and is composed of two facilities, one located at Borgo Roma (the former university hospital) and the other at Borgo Trento (a former NHS hospital). 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.

AOUI has been undergoing development and re-organisation since 2008, according to a strategy that calls for the main hospital departments to progressively adopt information systems. 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 (Bergamaschi et al., 2006).

The EHR is one of the projects currently being developed and implemented by AOUI. One of the main components of the EHR is the EMR, the repository for all the internal information generated by the hospital's individual organisational units. The EMR is split into different information fields, the most significant and numerous of which is laboratory tests. For this reason, the laboratory tests unit was chosen as the pilot project for AOUI's development and introduction of the EMR. In order to manage all information in this area, the hospital's board decided to implement a specialised system called a laboratory information system (LIS). Along with the order-entry system, LIS helps administrators to manage a part of the information contained in the EMR. LIS is used to manage the laboratory test request-results process and to store all information about laboratory tests (for example, cholesterol, glucose and bilirubin levels). It is used only in the test laboratory unit. Hence, other physicians cannot directly access LIS, but if they want to see (some or all) laboratory information, they need to access a system called 'Gekos', which is the EMR of the Verona AOUI, that is mix system partially supplied by a vendor and and home –grown EMR, developed by internal It staff. Via Gekos, hospital physicians are able to view all laboratory test values and radiology images (x ray; computed tomography; MRI, CAT etc.). Physicians and nurses also use Gekos for recording patient entry;

prescription and to report temperature they are not able to insert, modify or delete data.

LIS operates in modules, taking a step-by-step approach to computerising single units and using specially developed software to coordinate with the information needs of the users and the units involved. The laboratory tests unit is now fully computerised and integrated with the order-entry system, which is also a future component of Gekos. Order entry is another system that facilitates the management of patients' personal information (name, surname, age, address and so forth) and previous hospitalisations (past illnesses, treatments performed, analysis and so forth). The authors chose the laboratory tests department, radiology department, department of general internal medicine as the units of analysis for this study because LIS system and order entry are up and running, and can provide a clear and faithful view of the organisational impacts of the information system implemented to manage the hospital units' records.

4.2 Data Collection

The main testing sources for the case study analysed in the paper were the semi-structured interviews conducted with the AOUI staff, as previous reported, which primarily concerned the introduction of the EMR, and the documents furnished by the AOUI management. The anonymous, semi-structured interviews consisted of 14 questions on two main research themes: 1) the functioning methods and the critical factors (strengths and weaknesses) of the new IT-enabled laboratory test request-results process; and 2) the future organisational impacts (potential advantages/benefits) of the computerised laboratory test request-results system, a core element of the EMR currently under development.

The material gathered was examined using hermeneutical analysis (Bryman and Bell, 2011) supported by qualitative research software, CAQDAS (Miles and Huberman, 1994), run in parallel by two researchers (Morse et al., 2002). The independent results were discussed and screened in meetings held by the researchers involved in the analysis procedures in order to refine and improve the coding process (open, axial and selective code) and memoing (Strauss and Corbin, 1990), but also to ensure the rigour of the research by removing any potential interpretive bias (Miles and Huberman, 1994; Morse et al., 2002).

A work of aggregation, refining and revision (axial and selective coding) was used to identify and denominate the codes according to whether the new system had a positive or negative impact on the work routines, as reported by the principle case informants. A total of 35 open codes were initially identified; these were pared back to 18 axial codes after discussion in internal research team meetings and considering the outcomes of the focus groups. Some of the open codes were aggregated because they were explicative of the same construct, while others—deemed insignificant and not endorsed by the key informants—were eliminated. To better illustrate the aspects most relevant to this study, the authors chose to add a positive (+) or negative (–) sign to the codes to indicate the relative effect on the core concept. Table 1 shows the selective code identified, the frequency with which the code came up in the interviews, the effect it had on the lab test request-results process (positive or negative on the concept indicated) and the number of interviewees that reported it. It is important to note that when using a qualitative approach, the number of codes has no statistical relevance but underscores the potential importance and value of that aspect for the individual case informants.

Table 1. Code Analysis

Code	Frequency	Number
Project leadership adequacy (–)	8	4
System adequacy (–)	7	4
System adequacy (+)	27	10
Enhanced collaboration (+)	18	11
Enhanced process control (+)	19	5
Enhanced process control (–)	7	6
Enhanced service (+)	24	9
Cost reduction (+)	11	7
Bureaucracy reduction (+)	6	6
Error reduction (+)	9	8
Low added-value labour reduction (+)	21	9
Decision support (+)	7	5
Knowledge sharing (+)	7	2
Facilitates research (+)	14	10
Inefficiency (–)	40	11
Error reduction (+)	34	11
EMR usefulness (+)	8	8
Speed of access (+)	23	8

4.3 Data Analysis

As mentioned earlier, the object of investigation of this study is the new computerisation process of the laboratory test request-results (LIS), an order-entry system used after patients are admitted to hospital. More generally, the project is part of the study of the initial EMR model used by the healthcare provider.

The previews factors (Tab. 1), some of which are reported in the literature, influence the introduction of a new EMR system. In particular, a leadership that is either too authoritarian or too participatory could trigger inter-organisational conflicts or the boycotting of the system (Scott et al., 2005). Further, the system could be overly complicated and not suited to the needs of the organisational actors for which it is intended and, as a consequence, could create a climate of dissatisfaction, tension and resistance to the imposed change. That resistance and dissatisfaction could thwart the return of positive or negative feedback and thus make the job of those charged with managing the change even more difficult. Matters could be further complicated by the organisation's culture; therefore, the culture must also be evaluated carefully during both the design and the implementation phase (Pagliari, 2007; Ludwick and Doucette, 2009; Boonstra and Broekhuis, 2010).

Four of the 11 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 Verona AOUI. According to informant no. 10 (physician):

> there was no leadership, everything was left to the initiative of a few people. Two people were identified, me and another doctor... we conducted an experimental phase and then the information was transferred to the young trainee doctors, who keyed in the data. The head nurse was supposed to take care of another aspect but is already overwhelmed with other duties, so, really, there is no leadership. We don't have a trained project manager, someone who has goals to pursue.

Another important aspect identified by the analysis is the perception of all the informants of a significant reduction in inefficiencies compared with the past. All of those interviewed—both the departmental physicians (the recipients of outputs exclusively) and the directly interested parties that use the management software to work, operate and interface—noted efficiency gains and error reductions as positive factors. The informants recounted

how the former paper-based procedure was more prone to errors (imprecise requests, potential misunderstandings and the illegibility of handwritten notes). Today, the higher level of 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 by informant no. 6 (laboratory technician): 'the system has made everything more useable, it's cut admission times and errors, so it is a huge benefit for us also in managing errors. Having readymade labels, for example, has accelerated everything and for us speed is often vital'. On the same subject, informant no. 3 (nurse) said that: 'the system has certainly reduced conflict and possibly a bit of laziness. Now, there are very few inconsistencies …. So [the system] has reduced conflicts, standardised behaviour and curbed inefficiencies'.

This reduction in inefficiencies and errors was considered the most significant effect of the new system by all the informants. However, although the new system has considerably reduced the risk of error, it has not eliminated it completely. In fact, some of the responses revealed that some of the flaws of the previous paper-based system still existed, albeit at a much lower rate of seriousness and frequency. On this point, informant no. 8 (physician) claimed that: 'errors in identification (of the patient or the sample) continue in part … they still happen and we never know when we make a mistake because we never get any feedback, there is no return'. Informant no. 7 (nurse) commented that: 'there were a huge number of inconsistencies before but now they've fallen significantly, although they've not been fully eliminated'.

These informant observations can be correlated to another factor, that of the perception of the inadequacy of some of the software application's operations. As emphasised by the literature (Pagliari, 2007; Kucukyazici et al., 2008), 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. We remind readers that the 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 (Heeks, 2006). Almost all the informants were clearly aware that this new technological solution would require improvements in the immediate future.

Returning to our examination of the impacts of EMR adoption, the informants transmitted an overall positive perception of the new system's implementation process. The standardisation and uniformity of the work

procedures have improved the quality of the service significantly and have led to a reduction in errors, while the time saved in retrieving reports/results and the speed of access to information has spurred organisational efficiency gains. Further, the system has provided physicians with an important decisional-support tool via which they can obtain clear and accurate information for diagnosing patients.

Compared with the previous paper-based procedures, which required a high expenditure of resources in terms of time and effort, the reduction in the need for low added-value labour has enabled the healthcare provider to re-assign staff to other, more responsible positions (empowerment). This, in turn, has raised the satisfaction levels of the staff in question, who now feel more involved in the production and decisional processes. This dovetails with another important result: the knowledge sharing promoted by the new system. The model has enabled the various units to learn about what they do and why because the software has increased their understanding of the established activities and, therefore, has broadened their professional learning horizons. The organisation of processes demanded by the new information system, which guides the individual user through routines and procedures, enables them to better understand the reasons that led the medical staff to issue a specific request for tests. Informant no. 5 (laboratory technician) explained:

> [people in] the department [have] learned to manage and better understand the various and numerous tests that need to be done. Whereas before they didn't know how to properly accept or where to take the sample, now, all the information we need is on the order entry, which gives them more responsibility and the ability to manage.

Neither is it a coincidence that the new system has generated an additional 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. Informant no. 4 (head nurse) confirmed this, saying:

> before, the paper system meant that the lab had no indication of how many samples would come in the day after as the paper request wouldn't arrive till the day after. Today, on the other hand, the electronic procedure means that at 4 o'clock in the afternoon we already know about 70–80 per cent of the samples due in the

> next morning. Planning the things of tomorrow on the computer today means that we in the lab already have an idea of the workload, which enables one to plan the day's work better and more efficiently in the event of peaks of work or other matters.

A further significant effect is the enhanced ability and capacity to control the laboratory test request-results process, a critical factor in reducing systemic flaws and errors. Prior to the launch of the new system, samples would go missing, and requests were received in error or not at all, and/or were redundant, which wasted resources in terms of both extra costs and workload. However, today, the new management system makes it easy to check whether a request has been expedited or not, or whether the results are currently being prepared. In addition, the system's 'alert' function informs the physician making the request when certain tests that cannot be repeated for a set period have already been conducted. Prior to implementation of the new system, some errors were the result of misunderstandings between the various actors involved, as some physicians were not informed of the work of the patient's previous physicians; this led to redundant requests for the same test. Now, it is possible to learn where the flaw or hitch lies in the process, and thus to pinpoint and remedy the errors. In addition, the installation of 'pneumatic tube mail' (a system of pneumatic sample dispatch between the various departments and laboratories) has further reduced the probability of errors. Informant no. 2 (physician), explained:

> … the order-entry request phase is certainly a stride forward because we can see the entire prescription chain up to receipt of the test results, where, in theory, we can check at which point the test is and so avoid requesting further tests because we have no idea what happened to the request or anything.

The new system was rated favourably by all the professionals that informed the case, who considered it an excellent work tool with the capacity to enhance both service quality and diagnostic timing and quality, as well as reduce time and labour costs. Moreover, all the informants were firmly convinced that the LIS, despite its recent implementation, will become an integral and vital part of the EMR, and that this will generate important benefits for both the hospital and the patients.

5. Discussion

This study has identified not only the organisational impacts of the new LIS described above, but also the critical factors affecting its implementation process. The first criticality is the partial inadequacy of the system, which is unable to complete all the functions and activities required by the various professionals who use it. Some of the informants reported system flaws and failures in certain laboratory operations that need to be revisited and revised, taking into account the individual organisational actors and their primary needs.

Further potential criticalities of the LIS implementation process include, as indicated by the case informants, the lack of a project manager to supervise, control and coordinate the system's development and implementation. The informants indicated that AOUI had no internal staff member to act as project manager, nor any trained personnel assigned solely to developing the new system. In other words, they highlighted the clear need for professionals trained to gather and analyse feedback (positive and negative) and thus to monitor the adequacy of the system with the aim of making it more efficient and integrated with the healthcare provider's other functions. Such professionals, assigned solely to the development and improvement of the LIS, are believed to determine not only the success of the LIS, but also of all the hospital's other EMR-related projects, including, ultimately, the EHR.

Another criticality identified was the impossibility of having a system that can monitor the processes in real time. This is because the supply chain is not entirely controllable from start to finish, leaving gaps in the process-checking procedures. These gaps sometimes prevent the correction of particular flaws. The problem is attributable to the lack of end-to-end control, which prevents identification of both the cause and the location of responsibility for the error, missing results and/or discrepancies in results.

Other critical factors perceived as relevant to the introduction of the LIS can be summarised as:

- specific and adequate training (courses and updates) in the use of the system for the personnel involved in the project
- full support in the event of management needs and/or problems
- the adoption of user-friendly software that does not require intensive training.

Neither should we forget that the new system development and implementation plan is still in its early stages. Therefore, as observed by

Pagliari (2007), the criticalities revealed by the informants in the project's first phase are completely normal and, in fact, provide valuable insights for senior management and the managers directly in charge of the project.

6. Conclusion

This work of research has highlighted the main organisational impacts and critical factors in implementing a new computerised management system in Verona AOUI, which represents a particularly complex healthcare structure. Specifically, the following positive impacts were observed:

1. a reduction in the number of flaws and errors (redundant or illegible requests, patient mix-ups and so forth) in the laboratory test request-results process
2. organisational efficiency gains as a result of faster laboratory test results and less waste of resources (human and materials)
3. faster access access to clearer and more specific information, enabling physicians to diagnose patients more promptly.

The main critical factors identified by the study were:

1. the importance of assigning a project manager (that is, a key professional who understands, develops and manages the system in an integrated and coordinated way with the other hospital functions). An adequate project leadership with a holistic view of the entire project, as opposed to the more fragmented view of individual users, can recognise and better understand the problems that arise when it comes to the integration required by the various AOUI systems. Smith et al. (2013) suggest that the project manager should be the CIO (chief information officer). His/her role is important because he/she improves the EMR performance.
2. the need to take into account and understand the needs of all the different organisational actors involved when designing and developing a management application like LIS. This factor is fundamental to ensuring that the system responds to the real needs of its users as well as the need to improve the cost–benefit ratio and the expected quality of the service.
3. the need to provide adequate staff training in the use of the new system to engage and make staff more responsible, thus creating a greater sense of ownership and trust. This is an area in which the

communication and engagement processes adopted by management play an especially important role.

4. the possibility of having simple and direct control over the entire process supply chain in order to modify or improve and thus optimise the return of the new system and the healthcare provider's activities as a whole. Further development of the process control system could, in turn, engage the personnel involved and increase their sense of responsibility.

The research conducted at Verona AOUI has identified the organisational impacts and the critical factors of the computerisation and digitisation of medical records. More generally, it has underscored the strategic role played by ICT (Zardini et al., 2010) and, as a consequence, by e-government to improve both the quality (reduction of errors and flaws) and the efficiency of Italy's NHS. The decision to analyse the EMR and, specifically, the LIS, has generated system-specific results; however, these can be extended, with due caution, to the other IT models and systems of Verona AOUI's various operating units, as well as to those of similar organisations (Pagliari, 2007). In fact, the critical factors of the case need to be taken into account each time a similar project is addressed (Scott et al., 2005; Kucukyazici et al., 2008) 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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