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Perceptions of an Electronic Medical Record (EMR): lessons from a French longitudinal survey

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Abstract

The goal of this longitudinal study is to examine the evolution of the perceptions, namely anxiety, ease of use, usefulness, misfit (not customization), trust and usefulness, related to an Electronic Medical Record (EMR) for the clinical staff in a French Teaching hospital. Two surveys were conducted first in September 2013 and second in December 2015, based on a questionnaire consisting of items on the Likert scale. As results, the correlation of all the variables between the two surveys is very significant (except for usefulness, for which the relationship is significant). This is not surprising, given previous studies focused on habits and learning related to technology adoption. Nevertheless, the increase is not spectacular and it makes necessary to evaluate EMR satisfaction and perceptions in order to elaborate a measure standard enabling comparisons and benchmarking among hospitals.

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Keywords: Hospital; Clinical Information Systems; Electronic Medical Records; Ease of Use.

1. Introduction

Electronic Medical Records (EMR) are electronic records of patient health information that include progress notes, problems, medication, vital signs, past medical history, immunizations, laboratory data and radiology reports (Xiao, Sharman et al. 2012). In hospitals, EMR are intended to facilitate the sharing and storage of medical information across departments. EMR were implemented in most health organizations in several countries in order to improve quality of health, enhance patients' safety and improve efficiency (Bates, Cohen et al. 2001). Fulfilling these promises needs proactive uses and EMR adoption for clinical staff. Nevertheless, physicians' and nurses' perceptions regarding ease of use and usability of EMR is generally very low (Gadd and Penrod 2001, Rahimi, Timpka et al. 2009). Several studies highlighted usability and ease of use problems related to EMR satisfaction (Gadd and Penrod 2001, Khajouei, Wierenga et al. 2011). This issue may be related to innovation process and time needed for improving experience and creating new habits (Ammenwerth, Gräber et al. 2003). Nevertheless, this is a postulate and not proven evidence about if and how the satisfaction levels reflect the newness of the technology and the learning effects associated with mastering the new technology (Vishwanath, Singh et al. 2010). Poissant et al. found that almost all longitudinal studies since 1984 focused on evaluations at only one point in time after implementation (Poissant, Pereira et al. 2005). Hence, little research was provided about EMR evolutions of physicians' satisfaction over time. Moreover, these longitudinal studies use broad thumb rules of 3 months–1 year as arbitrary limits (Vishwanath, Singh et al. 2010). Vishwanath et al. (Vishwanath, Singh et al. 2010) provided a recent longitudinal studies on EMR effects over time. The aim was to track physician satisfaction levels 3 months and 20 months after the stage of the EMR implementation. As a result, authors stated a significant difference between pre-implementation expectations and satisfaction levels 3 months after this stage. In all cases, satisfactions levels

decreased and did not meet expectations. Moreover, the contrasts comparing satisfaction levels 3 months and 20 months after implementation showed a slight but not statistically significant increase in satisfaction levels.

The goal of our study is to compare perceptions of an EMR by clinical staff in a French hospital during the post-implementation stage.

In the first section we will present the theoretical framework used for the study. In the second section we will describe the methodology design. The third section will present main findings, which will be discussed in the last section.

2. Theoretical framework

Literature on implementation of information technologies has highlighted the importance of users' attitudes and satisfaction related to these technologies. The technology acceptance model (TAM) is a theoretical model commonly used for predicting and explaining user behavior and IT usage (Davis 1989, Holden and Karsh 2010). Nevertheless, several criticisms have been made to the TAM, such as follows:

- Parsimony concerning categories and their too generic definitions (Bagozzi 2007) and fuzzy extensions of TAM concepts that impede comparisons (Benbasat and Barki 2007).
- TAM is based on binary variables and it was studied especially in connection with simple technologies. More generally, adoption is envisaged as a binary mode: an individual uses or uses not the technology. However, complex information systems, including Enterprise Resource Planning (ERP), give rise to more or less advanced uses. Some functionalities may be used, while others not.
- TAM was designed and principally used to evaluate the intention to use in voluntary contexts, but the ERP uses are mandatory in organizations.

For these reasons, we believe that TAM is not suitable for understanding the HIS acceptance specifically in a context where its use is mandatory.

Nevertheless, we do believe that the key concepts of the model are relevant to assess users' perceptions and we propose to gather quantitative measures of these items. Previous research pointed out main factors adoption decision or users' satisfaction: ease of use, usefulness (Venkatesh and Bala 2008), anxiety, perceived behavioral control., which is defined as "one's belief in his or her ability to execute a particular task/job using a computer the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" (Venkatesh and Bala 2008), system quality, information quality, service quality (Petter, DeLone et al. 2008) and trust (Cho 2006). Furthermore, customization or fit to clinical workflows is considered a key issue for adoption of EMR in healthcare (Vishwanath, Singh et al. 2010, Cresswell and Sheikh 2013).

Nevertheless, little research was made on the influence of time on perceptions and attitudes evolution. Venkatesh & Davis (Venkatesh and Davis 2000) provided an analysis focused on the cross-temporal correlations of intention of use and its direct determinants. They found that individuals relied less on social information in forming perceived usefulness and intention but continued to assess a system's usefulness on the basis of potential benefits resulting from use (job relevance, performance benefits). It seems that a consensus has emerged regarding the key issue of time for shaping new habits and adoption of innovation including EMRs (Ammenwerth, Gräber et al. 2003).

Given this background, it may be expected that EMR assessments will increase over time. Consequently, we will measure correlations between EMR perceptions in the post-implementation stage.

3. Research method and design

3.1. Context

The study was conducted in a French Teaching Hospital that has more than 2500 beds and covers all the clinical specialties and an Emergency department. The EMR was implemented in 2012 according to a "big bang" strategy, in order to support all the departments and specialties in 9 months. This EMR incorporates computerized physicians order entry, medical and nursing observation, laboratory tests results, medical prescription, operating room process management, planning and billing management. It is a fully integrated system consisting of different modules as admission, discharge and transfer, computerized provider order entry, treatment planning (nursing and medication administration), resources and appointment scheduling system, clinical data warehouse (CDW). Results from

ancillary subsystems (e.g., laboratories, imaging, and pharmacy) are automatically integrated into the EMR as pdf. files.

The aim of the study was to measure clinical staff perceptions related to EMR, namely information and system quality (security and liability), ease of use, not customization (to the clinical process and needs), self-efficacy, anxiety and usefulness. We made the choice to investigate perceptions for all the clinical staff (including physicians, surgeons, anesthesiologists, nurses, nurse managers, medical secretaries) because they are all implied in the clinical process (medication prescription and administration, treatment sheet, vital signs). We have to mention that the intensity of use of the EMR is not an important issue because all the medical examinations and medical histories of patients, prescriptions, planning schedule for patients and administrative documents has to be documented in the EMR. Thus, all clinical staff has to notify or to use information notified by others in their daily workflow. Nevertheless, this process may be more or less optimized, according to the workflow, EMR knowledge and habits of every clinical team or individual. For example, some physicians document the information related to their patients on papers sheets before entering this information on the EMR. Some physicians dictate the conclusions of the medical examinations directly in EMR by using a speech-to-text software while the records of other physicians are taped by medical secretaries.

3.2. Method

A survey was administrated to clinical staff first in December 2013 and second September 2015, consisting in an online questionnaire. The level of 21 months was not decided at the beginning of the assessment process but was empirically decided in relation with the hospital top management agenda, which considered that the second survey might be administrated several months after a change of EMR version and exclude summer holydays.

We collected 1942 answers for the first questionnaire and 1292 for the second one, for a population of 6443 clinical employees. The final representative sample was composed of 290 answers for each questionnaire. Each variable is measured using a question derived from a review of previous studies, adapted from different scales (Morris and Venkatesh 2000, Chau and Hu 2002, Wixom and Todd 2005, Petter, DeLone et al. 2008, Holden and Karsh 2010, Chen and Hsiao 2012) and each question was answered using a seven-point Likert scale, with one indicating “strongly disagree” and seven indicating “strongly agree.”

We decided to use a representative sample that was shaped after responses, by stratification, in order to adequately replicate the larger group according to characteristics (occupations stratus) of the hospital population (table 1).

For a better understanding of the EMR context and local setting, we conducted four interviews (in 2013 and in 2015) with the two physicians involved in the EMR evolution and customization and additional data were collected by internal reports.

Table 1. Population, Answers to questionnaires and representative sample.

| Professional categories | Population | Answers Q1 | Answers Q2 | Rate Q1 | Rate Q2 | Stratus |
|-------------------------|------------|------------|------------|---------|---------|---------|
| Caregivers | 1740 | 103 | 78 | 5,92% | 4,48% | 78 |
| Anesthesiologists | 131 | 73 | 28 | 55,73% | 21,37% | 6 |
| Social assistants | 59 | 32 | 45 | 54,24% | 76,27% | 3 |
| Care managers | 250 | 79 | 56 | 31,60% | 22,40% | 11 |
| Surgeons | 172 | 56 | 35 | 32,56% | 20,35% | 8 |
| Dentists | 71 | 9 | 5 | 12,68% | 7,04% | 3 |
| Nurses | 2014 | 656 | 426 | 32,57% | 21,15% | 90 |

| | | | | | | |
|------------------------------------|-----|-----|-----|---------|--------|----|
| Résidents (physiciens or surgeons) | 280 | 117 | 52 | 41,79% | 18,57% | 13 |
| Résidents (pharmacy) | 20 | 20 | 4 | 100,00% | 20,00% | 1 |
| Kinesitherapists | 145 | 38 | 30 | 26,21% | 20,69% | 7 |
| Physicians | 844 | 328 | 171 | 38,86% | 20,26% | 38 |
| Pharmacists | 71 | 35 | 20 | 49,30% | 28,17% | 3 |
| Midwives | 99 | 26 | 18 | 26,26% | 18,18% | 4 |
| Medical secretaries | 547 | 169 | 151 | 30,90% | 27,61% | 25 |

4. Results

To evaluate how clinical staff perceptions expectations changed overtime, a correlation analyze was conducted for the first and the second questionnaire. We found that age has an impact on perceived anxiety, self-efficacy, ease of use, trust, not customization, trust and usefulness. The relationship is very significant for the first five variables and significant for the sixth one.

The results are summarized in the table 2

Table 2. Variables results.

| Variable | Significance level | Quest1 Mean | Quest2 Mean | Quest1 SD | Quest2 SD | Total Average | Total SD |
|----------------------------|--------------------|-------------|-------------|-----------|-----------|---------------|----------|
| Anxiety | <0.001 | 3,57 | 3,44 | 2,158 | 1,866 | 3,51 | 2,017 |
| Not Customization (Misfit) | <0.001 | 4,29 | 3,9 | 2,27 | 1,983 | 4,09 | 2,138 |
| Self-efficacy | <0.001 | 3,37 | 3,66 | 2,267 | 1,953 | 3,52 | 2,12 |
| Usefulness | <0.01 | 4,09 | 4,49 | 1,902 | 1,637 | 4,29 | 1,785 |
| Ease of use | <0.001 | 2,88 | 3,66 | 1,922 | 1,76 | 3,27 | 1,883 |
| Trust | <0.001 | 3,5 | 4,31 | 2,035 | 1,663 | 3,91 | 1,901 |

5. Discussion

A rapid view of these results shows time has an impact of perceptions. Anxiety, self-efficacy, ease of use and trust increase overtime for all clinicians, while non customization perception of EMR to clinical workflow decreases. Thus, it is possible to consider an experience and learning effect (Vishwanath, Singh et al. 2010) on EMR perceptions. We have to mention that between 2013 and 2015 several actions were made in the hospital specifically training programs for all the clinical staff and customization of EMR forms for medical departments and occupations.

First of these actions is a new version of the EMR, which was implemented in July 2014. The second action is related to the development of an e-learning platform for prescribing, since September 2014, which is mandatory for residents. The third action consists on the continuous customization of EMR. More precisely, two physicians were mandated by the top management of the hospital to customize and adapt the EMR (for different medical departments and specialties) and they have trained several physicians in order to enable them to configure templates for their departments. This customization was made in collaboration with the Information Systems Department. The total work of technical customization by physicians and computer specialists was assessed as 2260 hours in 2013, 2812 hours in 2014 and 2083 in 2015, not including time spent by the mandated physicians to explain possibilities of configuration and to provide help to define and refine specific needs for medical specialists, what is the technical process used to customize specific EMR views or favorites and to automate outpatients referral letters and requests.

The physicians of the hospital are very interested in automating requests, as requests related to patients, which enable physicians to discuss particular and complex cases during multidisciplinary team meetings, or requests related to health issues to drive outcomes for epidemiology supervision and research. Both physicians involved in the customization of EMR are also mediators that help every physician, which ask for, to explain his/her needs and objectives, allowing them to suggest specific forms. Once they have agreed about the form design with the applicant, they transfer the request to computer specialists of the Information Systems Department for technical configuration and to request access to administrator modules, to allow the applicant to set up and modify the specific form he or she has asked for.

The forth action has focused on the indexation of folders and files in EMR. Since 2013, a specific committee, including physicians, medical secretaries, information systems engineer or technicians and medical informatics specialists, has organized regular meetings to simplify and facilitate readability of the EMR architecture. This action was is direct response to the lack of readability that was main issue of the first survey (Ologeanu-Taddei, Morquin et al. 2015).

Besides, all changes between 2013 and 2015 are not linear and positive. In September 2014, a complete EMR breakdown (without backup) has occurred for 7 hours during the day.

We consider that the evolution of the results is not spectacular. Every variable is better assessed but, generally, EMR is not considered easy of use and clinicians do not state great self-efficacy. This assumption raises the question of the EMR assessment and barometer: how and when could we consider that EMR is a success for clinicians? Ease of use and self-efficacy do they have to be evaluated at 4, 5 or 6 on the Likert scale? For example, Hadji, Martin et al. (2016) considered that the assessment of 4.9 of global satisfaction means a success for a clinical information system. This is a subjective interpretation and more studies are needed in order to have comparisons and benchmarking.

Our results have to be related also to differences of perceptions among clinical occupations in the same hospital. In a previous paper we showed a very significant correlation of perceived ease of use, usefulness and self-efficacy with occupations. Anesthesiologists, physicians and surgeons report the lower rate of ease of use and usefulness (Ologeanu-Taddei, Morquin et al. 2015). We suggested that this finding could be explained by the medical responsibility related to prescribing.

We think that more efforts have to be done by hospitals managers on these issues. This means that change management, organizational support and training programs have to be continuous even in post-implementation stage. EMR have to be consider as a work tool, and efforts must be done by hospitals in order to make the technology more workable (Markus 2004). Use of EMR is not intuitive (Ologeanu-Taddei, Morquin et al. 2015) and requires learning and developing skills related to particular clinical process of medical specialties.

6. Conclusion

Research has recently started to assess clinical information systems as EMR taking into account users' perceptions, acceptance and satisfaction. While this studies are generally conducted at a specific time, our study provides evidence related to a longitudinal survey (on 21 months) in order to assess a significant increase of clinicians' self-efficacy, anxiety, trust, ease of use, usefulness and misfit (not customization) perception. Contrary to previous studies, we assess our results on a representative sample.

The level of 21 months can be discussed because it was not decided on scientific arguments but related to the top management agenda.

Nevertheless, the EMR evolution (e.g. changes of versions), training programs and organizational support in order to customize EMR forms do not allow us to conclude if the results are related to (only) an experience curve. Furthermore, we highlight the importance of defining objective for EMR assessment and users' satisfaction.

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