Antecedents to the user adoption of electronic medical record

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Abstract

One of the main applications of information and communication technologies in healthcare sector is Electronic Medical Record (EMR). EMR systems are expected to make benefits for healthcare providers, professionals and the health population as a whole. Actually, the EMR benefits cannot be achieved without the adoption of the system by users in the healthcare. There has been much research suggested that EMR has not been adopted as expected. To the best of our knowledge, there is a lack in research which provides a comprehensive taxonomy of the factors affecting EMR user adoption. The aim of the present study was to conduct a systematic literature review to extract factors impacting EMR user adoption and to clarify them into meaningful categories. We searched in nine scientific databases and 9684 papers found as initial screening. We excluded papers based on their title, abstract and full text and finally we had 89 relevant papers which focus on factors impacting EMR adoption. We extracted factors and identified 8 main categories: individual, psychological, behavioural, environmental, organizational, financial, legal, and technical. Our results have important implications for researchers and practitioners, including policy makers, marketers, information technology (IT) professionals, and EMR system developers.

Keywords: Electronic Medical Record, Electronic Health Record, EMR, EHR, Systematic Literature Review.
1 INTRODUCTION

EMR is a computerized system that provides methods of collecting, storing, and displaying health information. The perceived benefits of EMR can be summarized as reduction in human errors, improving the security of medical data, making easier access to medical information, diminishing duplication of efforts and documents, optimizing the documentation of health data, reducing costs of information and communication technology, supporting decision making activities, improving the quality of care, forming data repository, and reduction of papers (Ventura et al. 2011).

Although some research demonstrates the positive roles of EMR systems in healthcare, other studies suggest that EMR has not been adopted as originally expected. For example, the American Hospital Association reported that almost 11% of health institutions had fully applied electronic record, and these institutions were likely to be large and teaching hospitals and located in the urban areas (Vishwanath and Scamurra 2007). Furthermore, only 2% of hospitals in the USA have used comprehensive health record systems and almost 8% used the basic systems in at least one healthcare department (Jha et al. 2010). If users are to benefit from the use of EMR systems, it is crucial to understand the factors affecting EMR adoption. Although there are many research papers on factors affecting EMR adoption, there are only two systematic reviews, none of which provides a complete model of the factors that affect EMR adoption (Boonstra and Broekhuis 2010; Castillo et al. 2010).

In response, this paper aims to provide a comprehensive taxonomy of factors affecting EMR adoption. This systematic method can help us to establish the trends in the literature with regard to EMR adoption, as well as the major research gaps. In most health informatics research, the Electronic Health Record (EHR) and EMR are interchangeable. In our study, these terms had the same meaning and EMR is used as the more common term. We extracted factors and identified 8 main categories: individual, psychological, behavioural, environmental, organizational, financial, legal, and technical. Technical and organizational factors were most. We also highlighted some implications for researchers and practitioners working on EMR systems.

The remainder of this paper is organised as follows: Section II provides an overview of previous literature reviews on factors affecting EMR adoption. Section III explains our research methodology and describes our criteria for including or excluding different articles. The section IV clarifies the results of our study and proposes a taxonomy of factors affecting EMR user adoption. Section V provides recommendations and implications for researchers and practitioners to improve EMR systems, and in Section VI we make some conclusions based on our results.

2 REVIEWS ON FACTORS AFFECTING EMR ADOPTION

Although there are many research papers on EMR adoption (Najaftorkaman et al. 2013), there are only two systematic reviews of factors affecting EMR adoption (Table 1). For instance, Castillo and colleagues (2010) in their paper identified critical adoption factors for EHR by physicians, from 68 papers between 1985 and 2009. These included: user attitude toward information systems, workflow impact, interoperability, technical support, communication among users, and expert support.

Furthermore, Boonstra and his colleague (2010) conducted a systematic review of 22 papers from 1998 to 2009, identifying barriers to the acceptance of EMR systems by physicians, which were divided into eight categories. The first category is financial and comprises four factors: high start-up costs; high ongoing costs; uncertainty about return on investment (ROI); lack of financial resources. Technical factors comprise the second category, which is divided into eight factors: lack computer skills of physicians and/or the staff; lack of technical training and support; system complexity; system limitations; lack of customizability; lack of reliability; interconnectivity/standardization; and lack of computers/hardware.
Table 1. Previous systematic literature reviews on factors impacting on EMR

<table>
<thead>
<tr>
<th>Paper</th>
<th>Period of included papers</th>
<th>Final number of included papers</th>
<th>Number of main categories</th>
<th>Number of factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Castillo et al. 2010)</td>
<td>1985 - 2009</td>
<td>68</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>(Boonstra and Broekhuis 2010)</td>
<td>1998-2009</td>
<td>22</td>
<td>8</td>
<td>31</td>
</tr>
</tbody>
</table>

The third category is time, which is composed of five factors: time required to select, purchase, and implement the system; time to learn the system; time required to enter data; more time required per patient; and time to convert patient records. The fourth category is psychological, which is divided into two main factors: lack of belief in EMR, and the need for control. The fifth category relates to social factors, which include uncertainty about the vendor; lack of support from external parties; interference with doctor-patient relationship; lack of support from colleagues; and lack of support from management. The sixth category is legal and focuses on privacy and security concerns. The seventh category is related to the size and type of the organization concerned. The eighth category is change processes, which pertains to a lack of support from the organizational culture; lack of incentives; lack of participation; and lack of leadership.

3 RESEARCH METHODOLOGY

We carried out a systematic literature review to identify factors affecting the adoption of EMR systems, using the following approach. A systematic literature review is a kind of research methodology that works on a topic or research question, and tries to identify, assess and interpret available empirical studies (Kitchenham and Charters 2007). Kitchenham (Kitchenham 2004; Kitchenham and Charters 2007) identified three main steps for conduction systematic literature reviews: planning the review, conducting the review, and reporting on the review. The same approach is followed in this study, and we applied Ghapanchi’s research methodology (Ghapanchi and Aurum 2011) as follows: (1) finding research resources; (2) study selection; (3) data synthesis; and (4) presenting the results (Amrollahi et al. 2013; Ghapanchi et al. 2013; Ghanbarzadeh et al. 2014).

3.1 Resource Searched

Nine databases were used to search keywords related to EMR adoption. They are Science Direct, Scopus, ProQuest, PubMed, IEEE Xplore, ACM Digital Library, Association for Information Systems electronic library, SpringerLink, and ISI web of science.

3.2 Search Terms

There are three main categories of search terms. First category focuses on EMR concepts ("Electronic medical record" OR "EHR" OR "EMR"). Second category focuses on adoption terms and definitions:("adoption" OR "acceptance" OR "use" OR "behavioural intention" OR "behavioral intention" OR "user attitude" OR "attitude" OR "believe" OR "belief" OR "user satisfaction" OR "user perception" OR "usefulness" OR "diffusion" OR "user needs" OR "usage" OR "assimilation" OR "penetration" OR "user resistance" OR "user expectation" OR "user interest" OR "user participation" OR "user involvement" OR "embracement" OR "utilization" OR "utilisation"). Finally, last category concentrates on impact terms ("impact" OR "influence" OR "effect" OR "affect" OR "impress" OR "determine" OR "relationship" OR "positivist" OR "cause" OR "causal" OR "drive" OR "antecedent" OR "hypothesis" OR "hypotheses" OR "research model" OR "conceptual model"). Therefore, we were looking for relevant articles evaluated different factors impacting on EMR adoption.
3.3 Inclusion/Exclusion Criteria

The following selection criteria were used (1) English-language articles; (2) papers focus on EMR or EHR, and not other computerized systems in healthcare such as Personal Health Record (PHR); and (3) papers focus on factors that affect adoption of EMR/EHR systems.

3.4 Study Selection Process

Figure 1 shows the stages of the study selection process applied in this research. The first stage contained searching keyword terms (see the search terms section) on nine scientific databases (see the resources searched section). As a result, 9684 primary articles were identified for initial screening. Subsequently, we excluded articles on the basis of their titles (8537 papers excluded; n=1147). For example, in the Scopus database, we used the Advanced Search Section of the website and inserted keywords and hit the search button. After that we read all titles and downloaded the papers that are relevant to our study. Stage 3 involved exclusion of articles on the basis of their abstract (776 papers excluded; n=371). In this stage, we read all the abstracts of the downloaded papers and kept all the relevant articles. At the final stage, we deleted duplicated articles and read the full text (282 articles excluded; n=89). As a result of these steps, we had 89 relevant papers that focus on factors impacting on EMR adoption.

Figure 1. Stages of the study selection process

Table 2 shows the number of papers at each stage of the selection process. There were 9684 papers initially, and after title, abstract and full paper exclusion, 89 papers remained.

3.5 Data Analysis

Figure 2 depicts the process undertaken to achieve the research objective of this study. According to definitions and terminologies of the factors in literature, a list of 78 factors affecting EMR adoption was identified. In this process, some factors were merged based on the meaning and explanation of the factors in different articles. For instance, “system complexity” was one of the significant factors impacting on EMR adoption in Boonstra and his colleague’s work (2010).
According to the definition they proposed for system complexity, “The complexity and usability problem associated with EMRs results in physicians having to allocate time and effort if they are to master them” ((Boonstra & Broekhuis, 2010, p. 8), this factor was merged with “ease of use”, which has been used in EMR adoption studies. This analysing process decreased the list from 88 to 78 conceptually different factors.

In the next step, we aimed to categorize the 78 factors into meaningful clusters in order to make a more comprehensive taxonomy. To do this, we went through the source of reviews in the EMR research and also different research areas in the EMR literature such as EMR system development, policy and standards, and medical research. We assigned an appropriate label to each factor based on its terminologies in the papers with high citation rate. We applied Publish or Perish software to find out average citations per paper, citations per author, papers per author, and citations per year (citation analysis). Therefore, we have identified labels from articles with higher citation to bolster our categories. For example, psychological, organizational, financial, legal, and technical labels are based on Boonstra and his colleague work’ (2010) with the citation of 176, while the individual label is based on Liu and her colleagues’ work (2012) with the citation number 136. Finally, the idea of the environmental label is based on Ash and Bates’ article (2005) with the citation number 317 and the behavioural label is adopted from Morton and her colleagues (2010) with the citation of 58. We had four rounds to achieve a better classification of factors affecting EMR adoption. Some labels were revised with better terminology or merged in the third and fourth rounds to get the final classification. Finally, we identified the eight labels: individual; psychological; behavioural; environmental; organizational; financial; legal; and technical.

After that, a description of the 78 factors and sets of the eight labels were presented to three researchers in health informatics as a validation process. The judges were given an instruction sheet including a description of extracted factors as well as an answer sheet onto which they were asked to map the 78 factors against the eight categories identified by the authors. We have achieved 234 (78×3) possibilities from the three researchers.

Table 2. Number of papers in different stages of study selection process

<table>
<thead>
<tr>
<th>Database</th>
<th>Initial number of papers</th>
<th>Remaining papers (title exclusion)</th>
<th>Remaining papers (abstract exclusion)</th>
<th>Remaining papers (full-paper exclusion and removing duplicated papers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Direct</td>
<td>353</td>
<td>52</td>
<td>21</td>
<td>3</td>
</tr>
<tr>
<td>Scopus</td>
<td>3050</td>
<td>213</td>
<td>75</td>
<td>12</td>
</tr>
<tr>
<td>ProQuest</td>
<td>2281</td>
<td>238</td>
<td>64</td>
<td>11</td>
</tr>
<tr>
<td>PubMed</td>
<td>1382</td>
<td>297</td>
<td>92</td>
<td>28</td>
</tr>
<tr>
<td>IEEE Xplore</td>
<td>284</td>
<td>53</td>
<td>24</td>
<td>6</td>
</tr>
<tr>
<td>ACM Digital Library</td>
<td>57</td>
<td>10</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Association for Information Systems electronic library</td>
<td>78</td>
<td>22</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>SpringerLink</td>
<td>297</td>
<td>35</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>ISI Web of Science</td>
<td>1902</td>
<td>227</td>
<td>62</td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td>9684</td>
<td>1147</td>
<td>371</td>
<td>89</td>
</tr>
</tbody>
</table>


Table 3 presents the way factors were assigned by the judges to the main categories and how the proportion of inter-judge agreement was clarified for each main category. Finally, the authors finalized all possibilities and made the final taxonomy of factors affecting EMR adoption.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Judges</th>
<th>Consensus</th>
<th>1&amp;2 agree?</th>
<th>1&amp;3 agree?</th>
<th>2&amp;3 agree?</th>
<th>Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>I</td>
<td>I I I</td>
<td>I</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td>I I I</td>
<td>I I I</td>
<td>I</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Computer Literacy</td>
<td>I I I</td>
<td>I I I</td>
<td>I</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Personal Norms</td>
<td>I E I</td>
<td>I I I</td>
<td>I</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Users Autonomy</td>
<td>P I I</td>
<td>I I I</td>
<td>I</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Individual Experience</td>
<td>I I I</td>
<td>I I I</td>
<td>I</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Management Supports</td>
<td>E O O</td>
<td>O O O</td>
<td>O</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Behavioural Changes</td>
<td>B B B</td>
<td>B B B</td>
<td>B</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>


Table 3. Inter-judge agreement for the main-categories

Figure 2. Number of papers in different stages of study selection process
4 RESULTS

This section provides readers with the trend of literature on EMR adoption and also categories of factors affecting EMR adoption. Figure 3 presents the distribution of the selected articles per year, which shows an increasing trend with time. In particular, the number of articles significantly increased after 2008, peaking in 2011 and 2012. This suggests that the adoption of EMR systems has caught the attention of researchers and practitioners as a major concern in healthcare. There were only three papers in 2013, but our study was only conducted in June of that year, and the data are therefore incomplete.

Figure 3. Frequency of the papers per year

Figure 4 provides a breakdown of the frequency of the research papers authored in different continents. It shows that according to geographic region, North America was the most prolific, with 82% of the papers affiliated with North American universities. This was followed by Asia (9%), Europe (7%), and South America and Oceania (both 1%). Although affiliation with a university does not necessarily imply that the study was carried out in the country concerned, it does afford good information about EMR systems in different countries. For instance, EMR systems seem to be implemented in the USA more than in other countries.

Figure 4. Frequency of the papers per continent

Our systematic review categorised factors impacting EMR adoption. Eight categories identified: individual factors; psychological factors; behavioural factors; environmental factors; organizational factors; financial factors; legal factors; and technical factors (Najaftorkaman et al. 2014). The result of our research is depicted in Figure 5.
4.1 Individual Factors

Individual factors clarify individual attributes that consist of seven factors: age, race/ethnicity, computer literacy, personal norms, users autonomy, social norms, and individual experience (Abdolrasulnia et al. 2008; Cotea 2010; Gagnon et al. 2010; Jialin Liu 2012; Kemper et al. 2006; Vishwanath and Scamurra 2007; Wright and Marvel 2012). For example, using computers and related technologies are a completely new experience for some EMR providers in their workplace. The level of individual’s computer literacy is very important for EMR users to adopt the system. Some EMR users are not confident to use the software and hardware of a computer (Simon et al. 2007; Terry et al. 2009). In addition, user autonomy is one of the key individual factors that impact on EMR adoption. For instance, physicians like to freedom to make appropriate treatments for the patients based on their best judgment. Unfortunately, there is a strong negative relationship between physicians’ autonomy and EMR behavioural use and physicians’ autonomy is one of the biggest concerns to adopt EMR systems in the healthcare environment (Morton and Wiedenbeck 2009).

4.2 Psychological Factors

The second category, psychological factors, is composed of various factors: resistancy, user attitude toward information system, affect, self-identity, technology readiness, inability to capture the individual work of users, feeling of imposition, satisfaction, emotions, stakeholders’ skepticism, understanding of EMR concepts (users’ perceptions), system uncertainty, users’ expectation and interest, perceived ease of use, and perceived usefulness (Abdolrasulnia et al. 2008; Castillo et al. 2010; Gagnon et al. 2010; Kemper et al. 2006; Rao et al. 2011; Sassen 2009). It focuses factors impacting of emotional feeling of EMR users.

For example, perceived ease of use and perceived usefulness are the two significant indicators which impact on individual use of EMR system. Perceived ease of use or the level of complexity of the systems is defined as an individual belief about using particular system without great effort. Vathanophas and Pacharapha (2010) showed that healthcare providers' perceived ease of use positively affects EMR intention to use. In addition, perceived usefulness is defined as individual belief about using particular system can help him or her to improve the performance. A perceived
usefulness or perceived benefit is found as key psychological factor influencing EMR adoption (Morton and Wiedenbeck 2010; Nov and Schechter 2012; Vathanophas and Pacharapha 2010).

4.3 Behavioural Factors

As the name proposed, behavioural factors impacting EMR users’ behaviours to accept or reject EMR systems. It contains 5 factors: behavioural changes, perceived consequences, confirmation, automatic behaviour, and continuance intention (Gagnon et al. 2010; Mettler 2012; Tang et al. 2006). For instance, Mettler (2012) revealed that automatic behaviour or habit can facilitate EMR adoption. There are some factors, including computer literacy, task fit and facilitating conditions, impact on automatic behaviour. However task-fit and facilitating conditions are positively influence the development of automatic behaviour, computer literacy has negative impact on individual’s continuance behaviour.

4.4 Environmental Factors

Environmental category is composed of various factors: change in rate of unemployment, geographic location(rich/poor countries), environment uncertainty network effects, health maintenance organization (HMO) penetration rate, competition, optional usage of EMR, vendor efforts, geographic location (urban/rural areas), celebrity of practice, social proximity to prior adopted hospital (Ford 2009; Holden 2011; Kazley and Ozcan 2007; Linder et al. 2006; Menachemi et al. 2007; Rahman and Ko 2012; Scholl et al. 2011; Teufel II et al. 2013).

For instance, membership or social proximity in a health system as a same social group is very important factor to facilitate EMR adoption. Information exchanges during formal and informal communication in the same social system impact on individual’s behaviours. If the hospitals are members of the same health system, they can rapidly adopt a new technology. Therefore, a hospital with in focal health system is more eager to adopt EMR system compare to a hospital outside the focal health system (Angst et al. 2010). Furthermore, the rural hospitals face some difficulties such as lower rate of occupancy and supports, more financial and social pressures. In general, the rural hospitals may be the only option for local people, so they do not try to compete with the other hospital to adopt new technology. Consequently, the urban hospitals are more likely to adopt EMR system compare to the rural hospitals (Kazley and Ozcan 2007). Finally, network externalities or network effects have significant role in EMR adoption. Network effects are defined as “increased utility for users of a technology that occurs when adoption increases among other users” ((Ayers et al. 2009, p. 127). The current level of EMR acceptance among the physicians can impact on new physicians to adopt the EMR systems.

4.5 Organizational Factors

Organizational factors describe healthcare practice characteristics, which are divided into various factors: size of practice, age of practice, practice type (single/multi-specialty), practice type (independent hospital/ hospital owned by a centralized system), ownership, higher education level of hospital, type of practice (general/specialized), level of user involvement (role and responsibility), communication mechanisms, making computing more natural for users, experience, interactions between health practitioners and patients, management supports, observability, cultural changes, incentives (motivational factors), penalties, task fit, ownership stake by physicians, and workflow issues (Abdolrasulnia et al. 2008; Angst et al. 2010; Ash and Bates 2005; Avgar et al. 2010; Binti Ismail and Binti Abdullah 2011; Bramble et al. 2010; Ginn et al. 2011; Kazley and Ozcan 2007; Marques et al. 2011; Nambisan et al. 2013; Rahman and Ko 2012; Rao et al. 2011).

For instance, Health Information Managers (HIM) have vital roles in EMR implementation and adoption. HIM involvement in EMR system implementation can be participating in document improvement program, testing legal admissibility of records, participating in development of EMR functionality, and managing access control in EMR system. If the health managers support EMR system by providing workshop and training session within the health organization, they can promote EMR dissemination (Fenton et al. 2006; Wilkins 2009). Furthermore, communication between the
EMR users is very important to disseminate EMR certainty and co-workers can share their experience using the EMR system. For example, more experienced EMR users can provide support to less experienced user to apply EMR system (Castillo et al. 2010).

4.6 Financial Factors

The next category, financial factors, is composed of 5 factors: start-up costs, ongoing costs, financial resources, return of investment (ROI), and type of insurance (Abdolrasulnia et al. 2008; Boonstra and Broekhuis 2010; Gans et al. 2005; Ginn et al. 2011; Kazley and Ozcan 2007; Kemper et al. 2006). For example, Menachemi and his colleagues (Menachemi et al. 2007) evaluated the role of payer mix on physicians’ decisions to adopt EHR systems. Their findings show that if the percentage of people covered by Medicaid raises, the likelihood of EHR acceptance decrease. Furthermore, patients in the high-volume payers group such as managed-care payers and traditional indemnity insurers are more likely to adopt HER system compare to the low-volume group. In addition, Simon and his colleagues (2007) revealed that a majority of health providers pointed to financial factors, including start-up costs, on-going costs, or other financial issues such as financial constraints, and concern about return of investment, as important barriers to EMR adoption.

4.7 Legal Factors

For EMR store medical information of healthcare systems, and it can be vulnerable in terms of confidentiality, integrity and availability issues. This category is composed of some legal concept such as security and privacy concerns, legal liability concerns, and policy and standards (Archer and Cocosila 2011; Boonstra and Broekhuis 2010; Holden 2011; Marques et al. 2011; Sittig and Singh 2011; Tang et al. 2006). Security issues, including confidentiality, integrity and availability, are the major concerns in EMR adoption. Health providers should have access to the patients’ information, which is stored in healthcare record. Some health providers are doubtful about storing patients’ data in the EMR systems. They are worried that information in the EMR may be accessible to unauthorized people. Therefore, the consequences of EMR security beaches might lead to legal problems and it is very important as one of the biggest challenges in EMR adoption (Boonstra and Broekhuis 2010; Tang et al. 2006; Yoon et al. 2012).

4.8 Technical Factors

EMR systems consist of complex software and hardware. Suppliers and final users should have certain skills to apply EMR in their workplaces. Technical factors consist of 12 factors: technical training, technical supports, compatibility/interoperability, technical system features, customizability, system reliability, communication tools, initial data entry, input historic medical data into EMR, time, stepwise implementation, and system usability (Ash and Bates 2005; Boonstra and Broekhuis 2010; Castillo et al. 2010; Marques et al. 2011; Rao et al. 2011; Rose et al. 2005; Yoon et al. 2012).

For example, one of the most important barriers to EMR adoption is lack of computer proficiency. Some health providers are interested in paper-based documents instead of using computer. If these providers can not embrace computer technology in their workplaces, the adoption of EMR systems can rapidly decrease in the healthcare. Therefore, training in computer proficiency among health providers can be a key role to increase the adoption of EMR systems (Pinaire 2009). Moreover, customizability is an important factor to enhance EMR adoption. It is defined as the ability of the system to conform to specific needs of the end user. Physicians are reluctant to adopt static EMR systems which do not support their personal styles and workflow. For example, the doctors like to have their own letter format and adjust it based on their needs (Randeree 2007). Moreover, Complexity and usability difficulties are great barriers in EMR adoption (Boonstra and Broekhuis 2010). Many EMR systems have ergonomic problems. For example, some health providers use CRT monitors which are really dark making the interface hard to read. EMR systems should adjust in terms of brightness and contrast to be accessible in different lighting conditions in the healthcare. Finally, some healthcare environments need portable devices, but in some cases EMR systems cannot run properly on these devices. Therefore, some subjects such as touch screen, memory and processor
issues, navigation system impact on EMR adoption in healthcare environments which use portable devices (Rose et al. 2005).

5 DISCUSSION

We carried out a systematic literature review to categorise the factors impacting adoption of EMR systems. From a total of 89 research papers we identified eight categories. Figure 6 demonstrates the distribution of the frequency of the factors impacting EMR adoption based on their categories. The percentage of papers dealing with each category was as follows: technical factors (most often factors), 57%; organizational factors, 55%; psychological factors, 45%; financial factors, 40%; legal factors, 35%; environmental factors, 33%; individual factors, 29%; and behavioural factors (the least often factors), 3%.

![Figure 6. Percentage of the publications based on categories of factors impacting EMR adoption](image)

5.1 Implications for Researchers

The proposed taxonomy makes a good starting point for researchers who are interested in one or more of the identified factors affecting adoption of EMR systems. There are four important research gaps in the literature.

First, although there are various papers on factors impacting EMR adoption, only a few systematic reviews have been conducted, and they do not provide a comprehensive analysis. For example, Castillo and colleagues (2010) provided a knowledge-based taxonomy of critical factors for adopting EHR systems by physicians. They described only six factors that affect adoption: user attitude toward information systems; workflow impact; interoperability; technical support; communication among users; and expert support. Unfortunately, they did not provide a comprehensive summary of the factors affecting the adoption of EMR systems.

Moreover, the current literature on EMR adoption suffers from a lack of research on the impact of behavioural factors. Boonstra and Broekhuis (2010) carried out a systematic literature review of 22 papers, and identified 31 factors in eight main categories. The problems with that review were that they included papers published before 2009, and missed some important factors impacting EMR adoption, such as behavioural changes, perceived consequences, confirmation, automatic behaviour, and continuance intention. Furthermore, Castillo and colleagues (2010) provided a knowledge-based taxonomy of critical factors for adopting EHR systems by physicians. They described only six factors that affect adoption: user attitude toward information systems; workflow impact; interoperability; technical support; communication among users; and expert support. Unfortunately, they did not provide a comprehensive summary of the factors affecting the adoption of EMR systems.

Finally, there is a lack of sufficient research on EMR adoption in some countries. Scholl and colleagues (2011), for example, conducted a case study of EMR systems at a hospital in India. This
was the only study to investigate the challenges related to EMR adoption in that country. They found that notable challenges were user scepticism and lack of computer literacy. Therefore, we conclude that future research should focus on EMR adoption in countries other than North America (82% of papers), and compare systems among different countries.

5.2 Implications for Practice

From practical standpoint, there are various implications for policy makers, marketers, IT professionals, and EMR system developers.

Some health organizations are more likely than others to adopt EMR systems based on environmental and organizational characteristics. According to previous studies on EMR adoption, geographic location, and social proximity to hospitals that have already adopted EMR (membership of social network) are important factors in EMR adoption. Small and independent health organizations located in rural areas are less likely to adopt EMR systems because they do not have sufficient financial and human resources. If that is the case, policy makers should encourage small and independent health organizations in rural areas to join a health system to use the experience of other hospitals in terms of software, hardware, human resources, and training. Additionally, implementing EMR systems incurs start-up and on-going costs, so policy makers could opt to provide greater financial reimbursement for health organizations that adopt EMR systems.

Moreover, some papers have identified the role of a network effect in adoption of EMR. Marketers and policy makers should focus earlier attempts on those who have more influence among the network. If they were to use better selective targeting of important adopters, EMR adoption rate would increase in a network because they would find a larger number of potential adopters. Furthermore, policy makers should not ignore the evidence that competition has a positive influence on EMR adoption. They should focus on markets, especially in rural areas where competition may be less prevalent among users.

For IT professionals, EMR adoption studies raise awareness of improvements in technical support and training, which users of EMR require to increase their use of the system; they may optimize their usage of key functions by attending training sessions. Furthermore, studies show that IT professionals can promote initial and sustained EMR adoption if they collaborate with physicians in planning initial and on-going training.

The EMR literature has implications for those involved in developing EMR systems. First, they should have a stronger focus on customization. Users require personalized features in their EMR systems. For instance, physicians have no interest in predefined letter templates, preferring to use their own format in which forms of letters can be adjusted. Second, ergonomic considerations have a significant role in EMR adoption. For example, lighting conditions and quality of monitors in offices and exams rooms vary, user interfaces can be difficult to read. Finally, portable devices are useful in clinical workflows. Some of the devices currently available have usability problems to run EMR application such as touch screens that do not work properly, and memory and processor issues, and are in need of improvement.

6 CONCLUSION

Despite the fact there are various studies proved EMR system has positive roles in healthcare, some arguments suggest that EMR has not been adopted as originally expected. In this research study, according to a systematic literature review of 89 papers, 8 categories of factors affecting EMR user adoption identified: individual, psychological, behavioural, environmental, organizational, financial, legal, and technical. This study has contributed to a better understanding of EMR research in different continents. For instance, we found that North America is the most dominant continent of the researchers working on EMR systems. Finally, the proposed taxonomy can be used as a guideline for researchers and practitioners such as policy makers, marketers, IT professionals, and EMR system developers.
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