Acceptance Model of Electronic Medical Record

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Abstract. This paper discusses acceptance issues of Electronic Medical Record System (EMR), particularly in Malaysia. A detailed overview of EMR and its benefits are firstly discussed. A number of acceptance models are scrutinized. Then factors affecting EMR acceptance are put forward. Finally, before proposing an EMR acceptance model, an instrument formed by adapting and then finding its factors loading is presented.

Keywords: Telehealth, Total Hospital Information System, User Interface Acceptance, Electronic Medical Record.

1. Introduction

Healthcare quality has been an important issue to the Ministry of Health (MOH) Malaysia for many years. One of the many actions taken by MOH to increase the quality of healthcare in Malaysia is through Telehealth project. Telehealth model consists of four pilot projects: (1) Customised/Personalised Health Information and Education, (2) Continuing Medical Education (CME), (3) Teleconsultation, and (4) Lifetime Health Plan (LHP) (Abidi et.al. (1998)). Within these four pilot projects, Electronic Medical Record System (EMR) plays an important role in providing patients medical histories. To date, some components in the Telehealth projects are already accessible on the web but yet to be implemented.

In Telehealth, the used of information technology (IT) in health sector strives to attain the concept of patient accessing the care needed at one point of contact rather than having the patient referred to various levels of care (Manaf, 1996). For instance, Total Hospital Information System (THIS) was implemented in Selayang Hospital in year 1999 followed by Putrajaya Hospital in year 2000 (Hadis & Hashim, 2004). There are two other THIS hospitals that are still in the implementation stages: Pandan Hospital and Serdang Hospital (Hassan, 2004). Subsequent of THIS hospital, there are two other types

of Hospital Information System (HIS) introduced: Intermediate Hospital Information System (IHIS) and Basic Hospital Information System (BHIS) (Hassan, 2004). According to Hassan (2004), hospitals in telehealth project fall into three categories that will be based on bed size of the hospital. The hospitals that have more than 400 beds will be classified as THIS hospital, less than 400 beds to more than 200 beds will be categorized as IHIS and less than 200 beds will be fall into BSIC type hospital. Hassan added, in the telehealth project plan each hospital in Telehealth project has one IT planning group called as Core Team which consisted of the director of the hospital as the Head of Core Team and a group of nurses.

There are many problems and challenges in implementing THIS. As shown in Figure 1, EMR is the core system to THIS. The most significant problems are: no single software package to support the hospital needs, THIS is using multiple software packages from different vendors, not all systems are in full operation, human resistance to change and insufficient training program to train the staffs to use the application because of time constraint (Hussaini, 2000). However, recent study by Mohd and Syed Mohamed (2005) found that the integration problem has been solved. But some of the problems related to the software provided from different vendors are still unsolved because every vendor has its own expertise. As for the problem related to staff training of IT application, even though the solution is given by providing help desk and training workshop, but the implementation procedure can still be enhanced in order to provide IT skill especially in operating EMR system to the doctors.

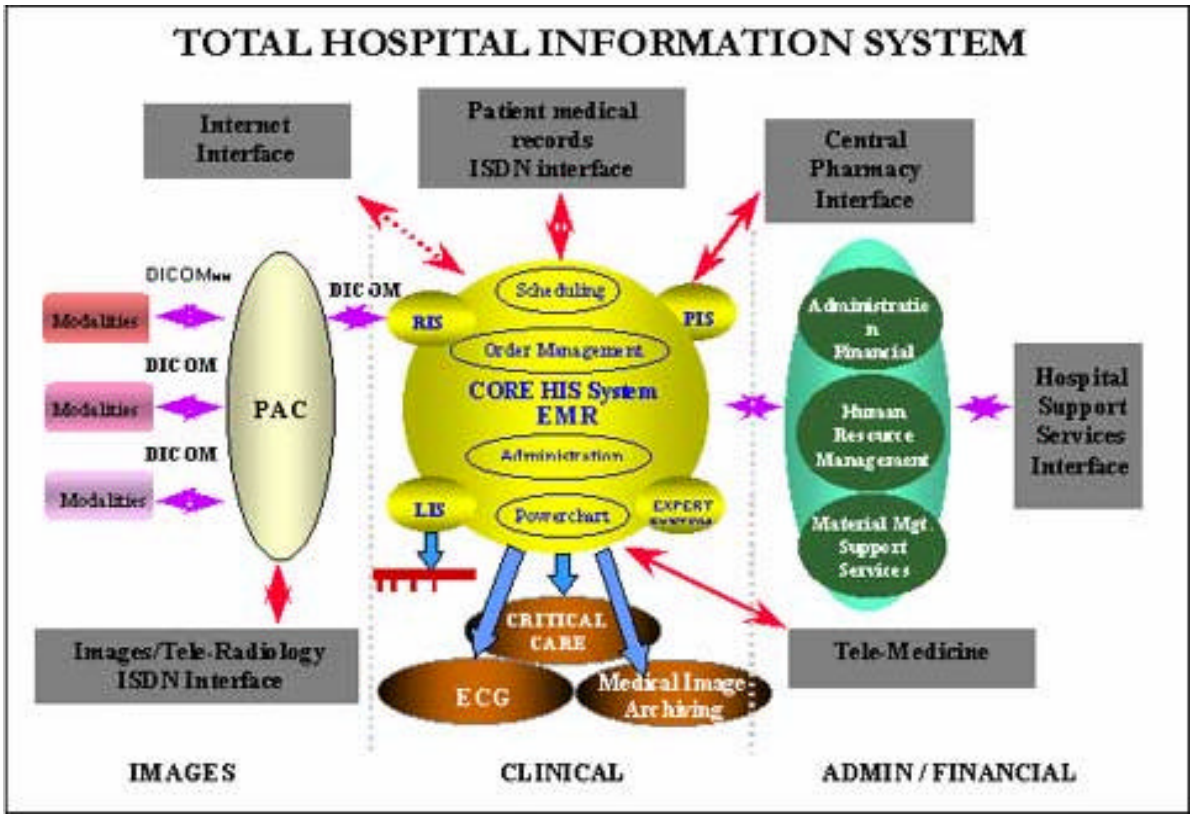

Figure 1: Total Hospital Information System (adapted from Hussaini (2000))

User resistance to change as highlighted by Hussaini (2000) is related to the user acceptance of IT application by doctors and nurses in THIS hospitals. User acceptance of IT application especially EMR system still needs proper strategies in order to enhance the acceptance level of EMR system. Mohd and Syed Mohamed (2005) found that the acceptance level of EMR system in THIS hospitals are moderately accepted. Although the existing EMR system can be implemented in other THIS hospitals with proper study for each component of EMR systems, a generic design of EMR system within THIS hospitals is required.

The focus of this paper is on EMR system specifically on the user interface acceptance factors in Malaysia THIS hospitals. The first section of this paper gives an overview of EMR, and the second section discusses the benefits of EMR. Then, the next section presents the identified user interface acceptance factors and the questionnaire design of user interface acceptance. This is followed by proposal of an acceptance model.

2. Overview of Electronic Medical Record System

The terminology for EMR is evolving, beginning with the term "computer stored medical records" followed by computerized patient record (CPR), computerized medical record (CMR), computer-based patient record system (CBPR), electronic health record (EHR), and automated medical record (AMR) (Fisher,1999). Basically, EMR is a computerized medical record that can be accessed with concerned of patient privacy, confidential and security from multiple integrated systems at any point of care within the health care enterprise. There are many definitions of EMR, thus the Institute of Medicine (IOM) and Health Level 7 (HL7), are working on a standard definition(Wagner, 2004).

One of the health care experts, Jerome (1999) defines EMR as a computer-based information system that integrates patients-specific information from diverse sources and tracks that information over time to facilitate clinical management and information retrieval, analysis and reporting. Morgan (2002) defines EMR as a confined medical record offering little integration with other system and is much restricted in its scope. In short, researchers refer EMR as a patient medical record from various sources related to patient treatment, diagnosis, lab test, history, prescription and allergies that can be accessed from various sites within the organization with the protection of security, patient privacy and confidentiality.

1n 1998, The National Health Society Executive (NHSE) in United States of America (USA) came up with a six level of Electronic Patient Record (EPR) (Beumont, 1999) as shown in Figure 2. Apart from that, Medical Record Institute (MRI) defined five distinct stages of healthcare information system towards the development of true Electronic Health Record (EHR) (Weagermann, 1999) in Gash (1999). The stages are shown in Figure 3.

The first stage is AMR, this is the initial stage of using computers, however in this stage users are still relying on paper record as well as preparing documentation. The second stage is CMR; at this stage the need for paper is totally eliminated. Data is scanned into the system which preserved data integrity. The third stage is EMR, which would be a true enterprise wide application. EMR would allow users to access all patient information available within enterprise. EMR provides facilities such as records, the complaints of the patient, diagnostic process as well as plans of care and placement orders. This stage is more provider-oriented. The fourth stage is EPR, this stage offers multi-provider links for community based, regional, national and international. This stage requires a unique national and international patient provider as well as the infrastructure and technology for this interchange of information. The fifth stage is EHR, where patient plays a role in EHR system. They must do all the aspects of personal data entry (Gash, 1999).

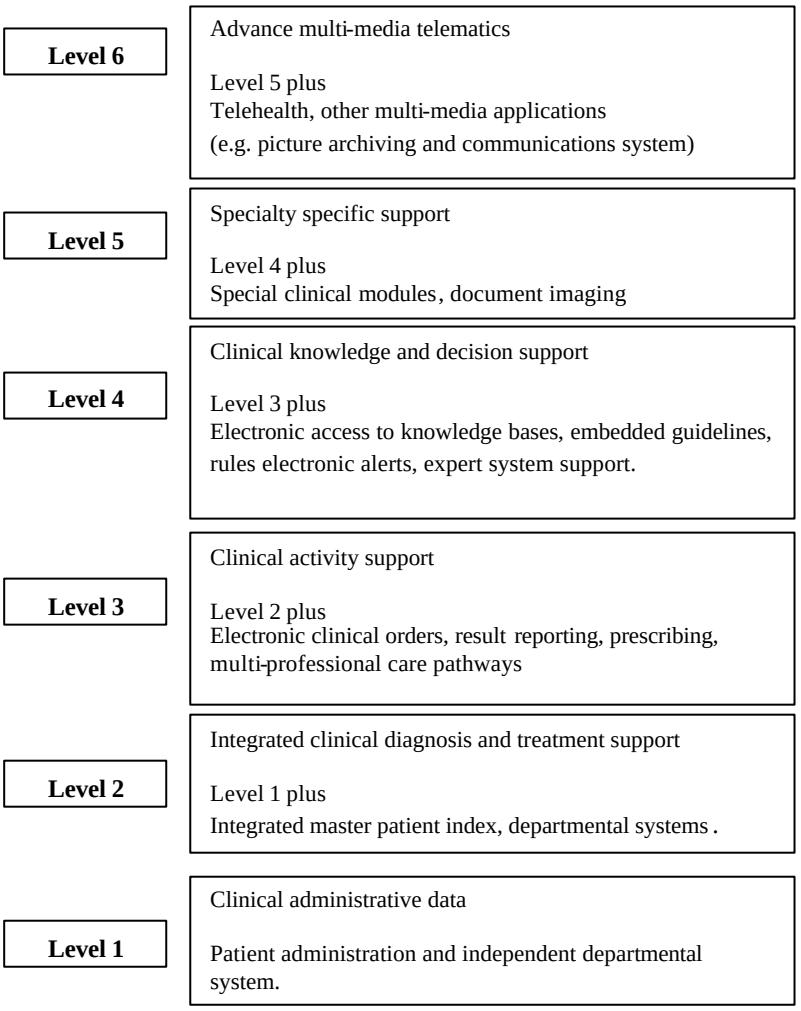

Figure 2: Electronic Patient Record Level (NHSE 1998)

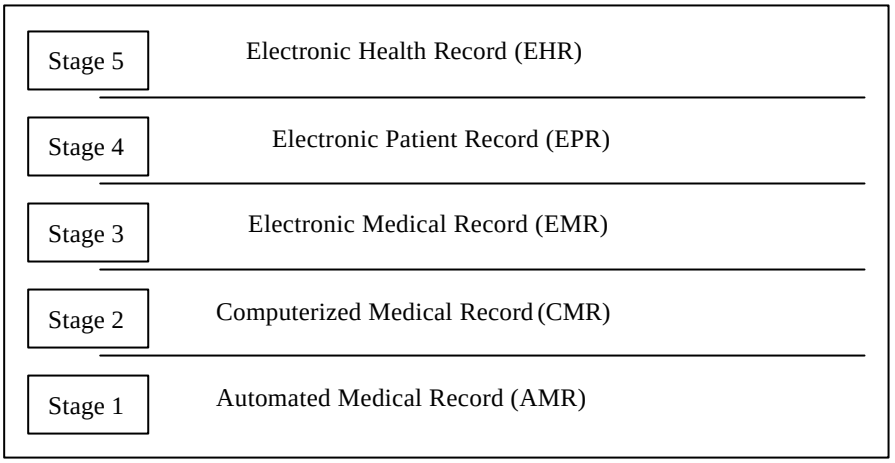

Figure 3: Healthcare Information System Stages

3. Benefits of Electronic Medical Record System

Some health care providers argued the initial capital investment in applying EMR in the organization is very high. However, considering the benefits of implementing EMR system which can offset the costs involved in maintenance, training and upgrading the system, it is worth to do the investment on the system.

3.1 Government and Health Care Providers

EMR provides many benefits to government and health care providers as a whole. It can be accessible from multiple locations and units within the enterprise. Therefore, the time of accessing the patient medical record is reduced. Hence, the productivity will increase and the quality of care will improve. At the same time, it will increase the knowledge of the best clinical practices.

3.2 Administrators

Other benefits are to health administrators. Administrative benefits include easier in creating reports, organizing and locating clinical information, managing plan care, enhancing claiming and ordering processes, reducing the time for billing processes and providing better customer service. Therefore, it can be concluded that in administration tasks, EMR can increase patient care time, reduce health cost and improve the health quality. Traditional ways in administrative processes may face many problems, for examples missing in diagnostic information, unstructured patient data stored may cause

difficulty in finding information on demand with time limitation and needing storage space. In addition, the person in charged in claiming and ordering processes may also do a mistake.

3.3 Clinicians

EMR also gives advantages to clinical processes such as better access to chart, improve clinical decision making and disease management, enhance documentation, simplify patient education, increase free time to spend with patients, and improved perception of care and quality of work life. The introduction of decision support system (DSS) in drug management, test result and disease management give significant impact to clinical processes. Alert flag and reminder provided by DSS in EMR can improve physician work and patient care. DSS also provides the audit trail for security concern that list admissions and modifications by users to each patient's file with a record of the date and time. Therefore, the accessibility and the modification of the patient's file can easily be traced.

Moreover, specific advantages to physician are: (1) all information such as medical and family history, clinical history vital signs, weight of time of current visit, chief complaints, and most recent lab test results are organized in proper format and readily retrievable, (2) the system prompts the physician to ask the right questions, reviews medications, updates information, and checks to see that screening and monitoring test are completed on schedule, and (3) prescriptions and patient education materials can be printed with the click of button (Andrews, 2003).

EMR also benefits the workflow process such as improved data input, reduced transcription costs, improved communication and better management of referrals, lab test results, prescriptions, and drug recalls (Erstad, 2003). Data input can be improved by avoiding duplication of work for example entering the same data that has been done by other staff. Therefore, the time of entering and accessing the information is saved and reduced. All information can be viewed on the screen therefore this functionality will enhance the documentation processes. EMR system can also reduce staff workload and improve work processes.

3.4 Policy Makers and Researchers

As for the policy makers and researchers, EMR can contribute knowledge to improve long term planning for health care industry, accountability and health resource allocation. Overall, the implementation of EMR can improve the quality of care, reduce cost in managing care environment and improve provider efficiency.

4. Factors Affecting EMR Acceptance

Acceptance is defined as the willingness within a user group to employ information technology to the tasks it is designed to support (Dillon & Morris, 1996). Many researchers have stressed the importance of acceptance study. For example, Kirk (2003) urged urgent actions on providing legal and social framework for acceptance and introduction of EMR. Likewise, Gefen (2003), Zdon (1998), Anderson (1997), Moore (1996), Baroudi (1986), Bardram (1997), Bowers (1995), Graham (1996), and Hubona (1996), all discussed similar issue. Moreover, past experiences show that the effort to introduce EMR will result in failure and unanticipated consequences if their technical aspects are over emphasized and their social and organizational factors such as the user acceptance and the diffusion of information system are overlooked (Gefen, 2003, Anderson, 1999, Moore, 1996).

Kirk (2003) has noted that currently there is no social framework for EMR acceptance. The closest framework model, which measures perceived usefulness and perceived ease of use, that can be adopted is the Technology Acceptance Model (TAM) proposed by Davis (1989). Tsiknakis (2002), Einarson (1993), and Neilder (1997) added that poor presentation of patient's data can lead to poorly informed clinical professionals, medication errors, inappropriate repetition of investigation, unnecessary referrals, and waste of clinical time and other resources. Indeed, poor presentation of patient's data is an interface issue, which warrants more investigation.

In obtaining the user acceptance of health care, particularly its system interface, Rosenbaum (1998) proposed six successful techniques:

- Involving the user community in needs analysis and requirements definition.
- Designating members of the user community who are involved in the system design as preceptor (people who receive first training and extensive training).
- Conducting task analysis of the entire work process, not just the parts involving the clinical information system.
- Performing user studies of preliminary paper and pencil prototypes with typical users.
- Conducting iterative usability testing of successive prototypes.
- Visiting hospitals and other settings of use to observe the work process, use of predecessor systems, and beta-test installation.

In addition, Chan (2001), Tang (1994), Teich (in Cimino (1999)), and Brown, et al. (1999) proposed consideration of cognitive process in designing features that match users' capabilities, especially in EMR system.

User interface of the EMR system can be evaluated by Questionnaire User Interface Interaction Satisfaction (QUIS) (Shneiderman (2005, Ed. 4). Shneiderman has proposed four user interface factors that can be used to identify the strengths and weaknesses of the existing system (Slaughter, Norman & Shneiderman, 1995; Chin, et. al., 1988). The four user interface factors consists of screen, terminology and information system, learning, and system capabilities. According to Plaisant, et al. (1997) QUIS can be used to evaluate existing system. She added, the advantages of QUIS is it can be used in a large population, maintain anonymity, can facilitate system comparison with industry standard or with similar system currently in use, and provide open-ended questionnaire that allow the users to express their comment and suggestion. However, QUIS only stressed on the technical part of the system and is unable to identify the user acceptance level of the system under investigation.

In addition to the user interface factors, information quality is also one of the factors that may affect the user acceptance level of IT application (Learum et. al 2001, Learum et. al 2003, Ribiere et. al 1999, DeLeon & McLean, 1992, Bailey & Pearson, 1983). DeLeon and McLean (1992) evaluation framework covers a wide range of measurement including effectiveness of the implementation process, quality of the system, quality of the information, usefulness and ease of use of the system and its information, and also the overall impacts on the individual, group and the organization (Lau, 2001).

Other factors as suggested by Learum et. al. (2001, 2003) in HIS evaluation questionnaire are: Content, Accuracy, Format, Ease of use and Timeliness. Ribieri et. al (1999) believed customer evaluates quality of the system integration and quality of data delivered by the system in everyday use. These quality aspects of the system might effect the used of the system in term of usefulness and system efficiency. He stressed that if HIS do not adapt to common tasks, too complex to use or to understand, not user friendly, and do not meet their expectation, it will be ignored and even sabotaged (Anderson, 1997). In addition, there are also quality factors proposed by Bailey and Pearson (1983) that can be used to asses user satisfaction of IT application: accuracy, completeness, current, sufficient, understandable, security, standardized, timely, and format of layout.

The above discussion shows the importance of user interface factors and information quality that may affect user acceptance level of EMR system. User acceptance or resistance of information technology has been studied by many researchers in the field of management information system (MIS). In the field of software engineering (SE) this social factor should be considered in order to investigate the affect of user acceptance in early system design or within pre or post implementation indeed after certain period of implementation process.

5. Development of an EMR Acceptance Model

Considering the user interface factors that can be used to identify the strengths and weaknesses of the system under investigation and the strength of two determinant factors of TAM: ease of use and usefulness to predict user acceptance of the system, as well as the importance of information quality evaluation of the system, researchers have concluded that the user interface acceptance factors may included:

- four user interface factors: Screen, Terminology and Information System, Learning, and System Capabilities (Shneiderman, 2004, Ed. 4);
- user behavioral factors (Shneiderman, 2004, Ed. 4; Davis et. al, 1986);
- information quality factors: Accuracy, Completeness, Current, Sufficient, Understandable, Security, Standardized, Timely, and Format of layout (Bailey and Pearson, 1983); and
- Perceived Usefulness and Perceived Ease of Use (Davis et. al, 1989).

The information quality factors will be used to evaluate standard functionality of EMR: Health Information and Data, Management of Lab Test and Radiology Report, and Order Entry and Order Management (IOM, 2003). These factors can be used to predict the attitude, intention to use and overall user satisfaction of the system where the used of the system is mandated by the top management or government as happened in THIS hospital. In this case, the usage of the system is fully utilized by the doctors, no matter whether they accept or reject the EMR system.

To offset the weaknesses of QUIS which is unable to predict user acceptance level and TAM which is unable to identify the strengths and weaknesses of the user interface of the system, a model is proposed for EMR acceptance. An instrument consisting of items from existing instruments was developed and utilized as the basis for model development. Table 1 details the items and factors loading that have been calculated from 114 respondents.

Table 1: Factor loading for each item

Item Description	Factors Loading	Item No.	Authors
User Acceptance Study Factors **Usefulness factors:**			
1. Using EMR in my job would enable me to accomplish tasks more quickly.	0.714	Item 1 to 6	Usefulness and Ease of Use factors by Davis et. al (1989)
2. Using EMR would improve my job performance.	0.841		
3. Using EMR in my job would increase my productivity.	0.683		
4. Using EMR would enhance my effectiveness on the job.	0.767		

5. Using EMR would make it easier to do my job. 6. I would find EMR useful in my job	0.695 0.703		
Ease of Use factors: 7. Learning to operate EMR would be easy for me. 8. I would find it easy to get EMR to do what I want it to do. 9. My interaction with EMR would be clear and understandable. 10. It would be easy for me to become skillful at using EMR. 11. I would find EMR easy to use.	 0.408 0.569 0.754 0.656 0.640	 Item 7 to 11	
Information Quality Factors for each EMR standard functionality			
12. The information quality of Health Information and Data functionality of EMRsystem is:		Item 12.1 to 12.9	EMR standard functionality: 1) Health Information and Data. 2) Result Management of Lab Test and Radiology. 3) Order Entry and Result Management (IOM,2003).
Accurate 1 2 3 4 5 6 7	0.653		
Complete 1 2 3 4 5 6 7	0.832		
Current 1 2 3 4 5 6 7	0.677		
Suffiecient 1 2 3 4 5 6 7	0.648		
Undestandable 1 2 3 4 5 6 7	0.350		
Standardized 1 2 3 4 5 6 7	0.550		
Secure 1 2 3 4 5 6 7	0.723		
Timely 1 2 3 4 5 6 7	0.533		
Layout of Output 1 2 3 4 5 6 7	0.412		
13. The information quality of Result Management of Lab Test and Radiology Report functionality of System EMR is:		Item 13. 1 to 13.9	Information Quality factors by Bailey and Pearson (1983).
Accurate 1 2 3 4 5 6 7	0.653		
Complete 1 2 3 4 5 6 7	0.832		
Current 1 2 3 4 5 6 7	0.677		
Suffiecient 1 2 3 4 5 6 7	0.648		
Undestandable 1 2 3 4 5 6 7	0.350		
Standardized 1 2 3 4 5 6 7	0.550		
Secure 1 2 3 4 5 6 7	0.723		
Timely 1 2 3 4 5 6 7	0.533		
Layout of Output 1 2 3 4 5 6 7	0.412		
14. The information quality of Order Entry and Result Management of EMR system is:		Item 14.1 to 14.9	

Accurate 1 2 3 4 5 6 7 — 0.653 Complete 1 2 3 4 5 6 7 — 0.832 Current 1 2 3 4 5 6 7 — 0.677 Sufficient 1 2 3 4 5 6 7 — 0.648 Understandable 1 2 3 4 5 6 7 — 0.350 Standardized 1 2 3 4 5 6 7 — 0.550 Secure 1 2 3 4 5 6 7 — 0.723 Timely 1 2 3 4 5 6 7 — 0.533 Layout of Output 1 2 3 4 5 6 7 — 0.412		
Items use 1 to 7 scale of measurement with 1 – Strongly Disagree, 2- Very Disagree, 3-Disagree, 4- Neutral, 5-Agree, 6-Very Agree, and 7 – Strongly Agree. **User Interface Factors** **15. Screen:** **1. The characters on the screen are ease to read.** — **0.306*** 2. The image of the characters is sharp. — 0.523 3. The character shape (font) is very legible. — 0.630 4. Highlighting simplifies task is helpful. — 0.846 5. The use of blinking is helpful. — 0.341 6. The use of bolding is helpful. — 0.677 7. The screen layouts were always helpful. — 0.643 8. The amount of the information can be displayed are adequate. — 0.491 9. The arrangement of information that can be displayed on the screen is logical. — 0.724 10. The sequences of screens are very clear. — 0.594 11. The next screen in a sequence is predictable. — 0.641 12. Going back to the previous screen is possible. — 0.746 13. The progression of work related task is clearly marked. — 0.751 **16. Terminology and System Information:** 1. The uses of terms throughout EMR system are consistent. — 0.762 2. The work related terminology is consistent. — 0.810 3. The computer terminology used in the system is consistent. — 0.812 4. Terminology is always relates well to the work you are doing. — 0.675 5. Computer terminology is used appropriately. — 0.442 6. Terminology on the screen is precise. — 0.755 7. Message which appears on the screen is consistent. — 0.630 8. Position of instructions on the screen is consistent. — 0.591 9. Instruction for commands or functions is clear. — 0.549 10. Instruction for correcting errors is clear. — 0.475	Item 15.1 to 15.13 Item with loading factor <=0.32 was eliminated (**0.306***). Item 16.1 to 16.17	User interface factors (Shneiderman, 2004, Ed. 4)

11. Computer is always keeps you informed about what it is doing.	0.568		
12. Controlling amount of feedback is easy.	0.805		
13. Length of delay between operations is acceptable.	0.595		
14. Error messages prompt out on the screen is helpful.	0.722		
15. Error messages are always clarify the problem.	0.779		
16. Phrasing of error messages is pleasant.	0.628		
17. Learning:			
1. Learning to operate the EMR system is easy.	0.714	Item 17.1	
2. Getting started the EMR system is easy.	0.483	to 17. 12	
3. Learning advance features is easy.	0.779		
4. Time to learn to use the system is fast.	0.706		
5. Exploring new features by trial and error is encouraging.	0.642		
6. Exploring of features is safe.	0.543		
7. Discovering new features is easy.	0.480		
8. Remembering names and use of commands is easy.	0.751		
9. Tasks are always can be performed in a straight forward manner.	0.610		
10. Number of steps per task is not too many or just right.	0.479		
11. Step to complete task is always follow a logical sequence.	0.397		
12. Feedback on the completion of sequence of steps is clear.	0.415		
18. EMR System Capabilities:			
1. EMR system speed is fast enough.	0.739	Item 18.1	
2. Response time for most operation fast enough.	0.859	to 18.12	
3. Rate information is displayed fast enough.	0.892		
4. EMR system is always reliable.	0.487		
5. The system failure seldom occurred.	0.599		
6. The system always warns you about potential problem.	0.680		
7. Correcting your mistakes is easy.	0.817		
8. Correcting typos of input in the system are adequate.	0.895		
9. The system able to undo operations.	0.619		
10. Ease of operation is always depends on your level of experience.	0.375		
11. You can always accomplish tasks knowing only a few commands.	0.661		
12. You can easily use features or shortcut.	0.590		
User Behavioral factors:			
19. Overall Satisfaction of EMR system:			
1. The EMR system is wonderful	0.703	Item 19.1	Shneiderman

2. The EMR system is easy to use	0.545	to 19.6	(2004, Ed.4)
3. I am very satisfy with the existing EMR system	0.814		
4. The existing EMR system is stimulating.	0.408		
5. The existing EMR system is flexible.	0.696		
6. The existing EMR system is adequate power.	0.596		
20. Attitude:			
1. Using EMR is a good idea.	0.634	Item 20.1	Davis et. al
2. Using EMR is a wise idea.	0.847	to 20.4	(1986)
3. I like the idea of using EMR.	0.805		
4. Using EMR would be pleasant.	0.637		
21. Intention to use:			
1. I intend to use EMR in my work.	0.848	Item 21.1	
2. I intend to use EMR everyday.	0.826	to 21.2	

A Cronbach's Alpha test was performed to examine the reliability of the measurement scale, and it was found that the Cronbach's Alpha coefficient value is 0.947. Internal consistency and reliability of the items in the questionnaire was tested using Factor Analysis. According to Comrey in Ali (2005), the loading factor evaluation is based on this scale: Excellent >= 0.71 (50% overlapping variance), Very Good >= 0.63 (40% overlapping variance), Good >= 0.55 (30% overlapping variance), Fair >= 0.45 (20% overlapping variance), and Poor >= 0.32 (10% overlapping variance). Therefore the item that has the loading factor < 3.32 was eliminated from the questionnaire. Finally, an EMR acceptance model was constructed from the formulated and analyzed instrument (see Figure 4).

6. Conclusion

Many researchers have stressed the importance of acceptance study of EMR and since there is currently no social framework for EMR acceptance, a study was conducted to identify factors affecting EMR acceptance. Interface, information quality, perceived usefulness, perceived ease of use and user behavioral (i.e. satisfaction, attitude and intention) were found to be of great concern. In forming an EMR acceptance model, existing instruments were studied and adapted to suit EMR terminologies. Once the factors loading were calculated, a model was proposed. This is an initial model, which requires further association studies before it can be fully finalized. The intention that it is presented in this article is to inform that there is a need for an investigation into the acceptance of EMR among doctors, nurses, clinicians and patients before EMR can successfully be implemented.

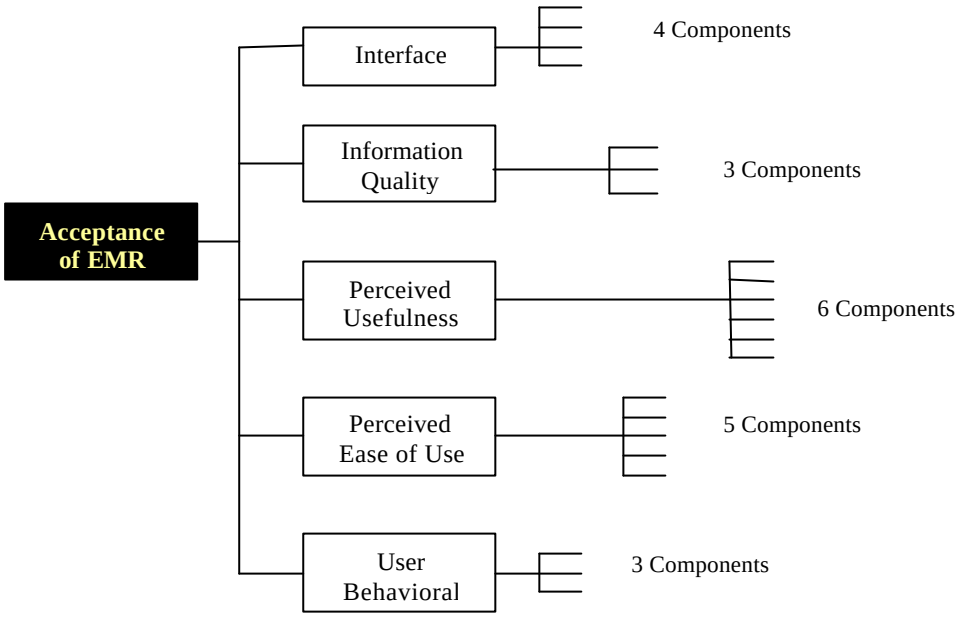

Figure 4: Factors for EMR Acceptance Model

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