ACCESSING THE QUALITY OF ELECTRONIC MEDICAL RECORDS: AN IS INTEGRATED PERSPECTIVE

Yi-Chang Li, Chung-Shan Medical University, 100 Sec. 2 Da-Chin Street, Tai-Chung City, Taiwan 40242, 886-4-22335912,ycli1970@csmu.edu.tw
I-Chiu Chang, Dept. of Information Management, National Chung Cheng University, 168 University Rd., Min-Hsiung Chia-Yi, Taiwan 621,886-5-2721500, misicc@mis.ccu.edu.tw

ABSTRACT

An instrument for measuring EMR quality was validated since EMR can serve as the repositories of data, information, and knowledge. 217 physicians and nurses of 25 hospitals responded the questionnaire. The validity and reliability were examined by CFA. The second-order construct, EMR quality, can be divided into four sub-constructs: the quality of data content, data format, information and knowledge. In addition, the multiple regression analysis revealed that significant positive relationship exists between the EMR quality and user satisfaction. In detail, data content quality and information quality impact on user satisfaction significantly. But data format quality and knowledge quality have no significant impact on user satisfaction.

INTRODUCTION

Traditional paper-based medical records had been taken as a kind of assistance in diagnosis, research and teaching. EMR is defined as the electronic medical data and reports about patients' conditions, images, physiological signals, checkup reports, medical treatment videos, and medical forms [1,2]. EMR systems are integrated information systems that containing data, information, and knowledge and can offer medical professional requisite functions of processing information, supporting decision-making, and advancing knowledge management (e.g. medical education or research). Therefore, for hospitals and medical professional rely on IT in making decisions, poor EMR quality will not only hinder their work efficiency, but also jeopardize patients' safety. So far, little research has been done on EMR quality measurement. Besides, most hospital administrators in Taiwan are from medical circle, so they have rather limited understanding about IT and information management.

Most measuring tools of paper-based medical records quality were based on data format and compliance of law, however, these tools are no longer suitable in the EMR context. Developing measurement of IS quality has always been one of the important issues for IS researchers and practitioners [3,4,5,6,7]. The purpose of this study is to develop an indicator for measuring the quality of EMR. We take into consideration the users' perspective in which the input quality and output quality of an integrated IS like EMRS should be considered as a whole process. Therefore, characteristics of data, information, and knowledge are incorporated into a measurement scale. Then, the study examines its reliability and validity of the instrument. Besides, the influences of EMR quality constructs' on the extent of users' satisfaction on EMRS was also investigated. The instrument can be taken as a reference for quality management in EMR management. Meanwhile the external validity of relevant theories of IS quality can be fostered through the comparisons with pertaining findings in the past.

METHOD

To measure data quality, the items were adapted from [4,8,9,10,11]. The items of information quality were adapted from [12,13]. In searching the measure to gauge knowledge quality, the concept by [6,14] wre selected for the reason that it articulated the assessment of knowledge quality should emphasize on the benefits IT provided on facilitating knowledge activities in organization, such as learning and

acquiring new knowledge and innovative ideas. EMRS itself is not a knowledge management system but a facilitator for supporting knowledge management activities. Under the trend of evidence-based medicine, EMR has become an important source of data in medical research and education. EMRS also enables medical professionals to apply knowledge in their decision making more efficiently. For example, the knowledge of Adverse Drug Events (ADEs) has embedded in inpatient and outpatient computer systems to improve the abilities of physicians in detecting of ADEs event. Therefore three items were developed to measure the construct of knowledge quality.

The instrument was reviewed and revised by five experts, two of them were professors in healthcare IS area and the other three were senior administrators of domestic EMRS. These efforts are done to make the questionnaire more comprehensible and to raise its face validity. In terms of scale assessment, five experts were asked to rate and determine the importance and appropriateness of the items. The percent agreement (PA) is 0.7, which means the content validity of the scale is acceptable. Respondents were asked to rate the gap between their expectation and afterward perception about every EMR quality characteristic. Their opinions are shown through a 5-point Likert scale. Items were shown in appendix.

25 of 93 urban hospitals with size ranked as medical centers or regional hospitals were participated. Rural hospitals were excluded since most of them had insufficient IS resources and were later adopters of EMRS. Thus their medical personnel had less experienced compared with staffs in urban hospitals. Among the 25 hospitals, 4 are medical centers and the others are regional hospitals. Altogether, 1000 questionnaires were distributed. 217 valid responses were returned which yielded the response rate of 21.7%. The respondents consist of 104 doctors (89 males and 15 females) and 113 nursing staffers (5 males and 108 females). About 36.9% of the respondents had work experience more than 5 years.

RESULT

Reliability and validity of the scale of EMR quality were assessed by "confirmatory factor analysis" and "criterion-related validity analysis." Confirmatory factor analysis was used to examine the construct validity including convergent validity and discriminant validity [15]. This study used a first-order factor model and a second-order factor model to examine the scale's stability [16,17]. Data were examined in light of the multivariate normality and model identification. There was no evident unfitness. The results of model improvement revealed that the categorization of four constructs (data content quality, data format quality, information quality, knowledge quality) is more stable than that of three constructs (data quality, information quality, knowledge quality). The two sub-concepts of data quality were regrouped and renamed as "Data Content Quality" and "Data Format Quality." according the opinions of the expert panel. Inadequate questions (I1, I6,D11)are eliminated one by one in accordance with modification index . Finally, the improvement from eliminating questions had been not remarkable and most of the goodness-of-fit indexes of first-order factor model with four constructs were generally acceptable, despite the fact that GFI was a bit lower than standard (χ^2/d.f. = 2.029, GFI=0.87, AGFI=0.84, RMESA=0.069, RMR=0.037).

The results of comparisons the goodness-of-fit indexes among competing models revealed that first order model with four correlated factors and second-order factor model possess similar goodness-of-fit index, which means that the first order model with four constructs can be sufficiently explained by second-order factor to streamline the model expression. Other tests revealed acceptable unidimensionality and convergent, discriminant, criterion-related validity and reliability. The results of CFA was shown as figure 1.

The result of regression revealed that 53.7% of the variance of the extent of user perceived satisfaction on EMRS explained by the extent of EMR quality (f value = 251.327, sig.=0.000<0.05). A further multiple regression analysis respectively examined the impacts of four first-order factors on user satisfaction with EMR. On the one hand, data content quality and information quality were found to

have significant impact on user satisfaction (standardized beta = 0.247, p<0.05; standardized beta =0.444, p<0.001). On the other hand, data format quality and knowledge quality did not have any significant impact on user satisfaction (standardized beta = 0.064, p= 0.434, standardized beta =0.074, p = 0.198).

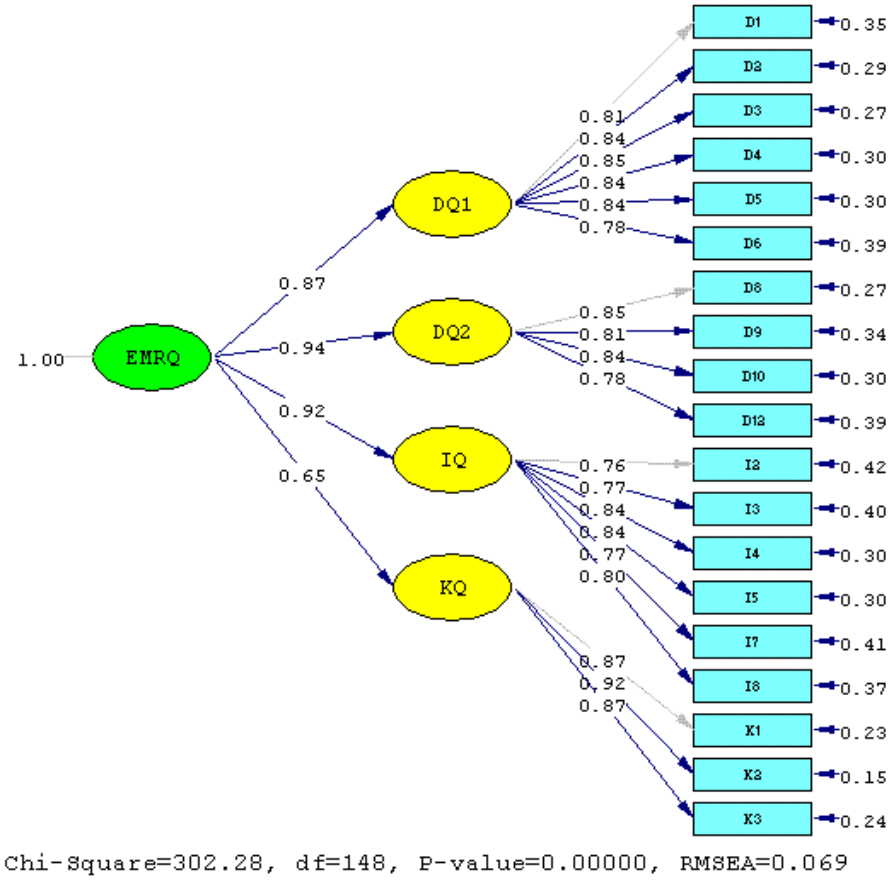

Figure 1 The result of CFA

IMPLICATION

It can be found from the prior literature of data quality, information quality and knowledge quality that there are overlapped attributes and constructs among measurement scales proposed by scholars. From the result of data analysis, it can be inferred that the characteristics of data content and columns (such as accuracy, consistency, instantaneity, and completeness) should be emphasized more since data are the raw materials for information and knowledge. As to information, it is mainly adopted to help solve users' problems of decision making. Users can bring it into full play only when they retrieve and understand it. Therefore, the accessibility and format of information will influence users' understanding and further to pose impacts on information quality. Finally, knowledge quality measures more about whether the learning and innovation can be fulfilled. Another finding from literature review is that few scholars probed into the measurement of data quality, information quality, and knowledge quality at the same time. The reason may be ascribed to that these properties may not be seen as important at the same time. The transformation of data-information-knowledge can be seen as a cycle [18]. In practical, the instrument could be used coping with other methodologies, such as data total quality management [19] or life cycle assessment [20]. Life cycle assessment (LCA) is considered a systematic tool evaluating the impacts occurring throughout the entire life cycle of a product, process or activity. It is widely used in environmental- impact decision making and product-design decision making. This 'cradle-to-grave'

approach leads to insight into the overall performance and the relative contributions of the different stages in its lifetime. The sub-constructs of our instrument could be used as an evaluating tool in different stages of EMRS utilization.

Data content refers to the raw data recorded into an EMRS by the medical professionals. Information means the output of an EMRS e.g. report, statistic, analysis, and so on. Both data content and information have direct impact on the outcome of medical and administrative decision making. The purposes of the medical record are numerous and users of the record have different foci and needs. Correspondingly, the information in the medical record is diverse, voluminous and of variable quality. Different kinds of information provided by the EMRS have variable relevance for different kinds of users. Information considered of little importance by some users may be important to others. Data entered into an EMRS are more likely to be of high quality when the user responsible for data entry considers the information to be important.

Data format quality represents the structure of medical records and the mechanism for controlling data entry. Clinical personnel may regard this system supplementary of modest value, as it has no direct significance for tasks related to patient care. Basic mechanisms for retrieving and presenting information in EMRS may include mechanisms for navigating the record according to when the information was produced, who or what produced the information and how the information has been categorized according clinical relevance. For example, when navigating to a specific discharge summary in a document based system, information about who produced it, when it was produced and the fact that the document has been categorized as a "discharge summary" may all be exploited to locate the document. This way of retrieving information depends on how information in the record system is organized and is frequently based on other data than those in focus by ordinary users of the system. The purpose of some data in the medical record is to identify and characterize the relevant information in the medical record. This information, representing the structure of the record, may be embedded in the data model design and often provided automatically by the system, e.g. patient identifiers, timestamps etc., or the users of the system may enter them manually into the system. The role for EMRS may not always be evident to clinical users, especially if the EMRS is complex and users are marginally trained. Subsequently, the efforts spent on ensuring high quality of structure and model of the data record may have variable effects, but often intangibly to medical professionals.

The insignificance of knowledge quality's effect on user satisfaction reflected the wide range of sophistication and strategic usage of EMRS among hospitals. For a hospital with highly sophisticated EMRS and with strategic view of IT resources, EMRS may have chances to illustrate their value in individual or organizational learning. For example, some pioneer medical centers in Taiwan have built data warehouse of medical records across internal departments and provided data analysis services to medical researchers or clinic researchers. The image and data stored in PACS is also retrievable under authorization for research or training purpose. However, most of hospitals are struggling in building EMR applications and IT infrastructure. These hospitals still have a long way to go to effectively use of EMRS for facilitating knowledge management activities.

CONCLUSION

An instrument for measuring EMR quality was developed and evaluated in an attempt to facilitate hospitals' EMR management. Besides, the study also made an academic contribution in exploring the IS quality issues in healthcare context. Although EMRS is also a kind of information systems, prior results about measurement of the IS quality might not be appropriate for EMR quality. Meanwhile, the study can also be the cornerstone for subsequent research, e.g. the influences of EMRS quality on medical professionals' work efficiency, or their impacts on medical quality such as patient safety. In the practical

side, the instrument can provide assistance in managing EMR quality, and serve as a reference for hospitals to undertake comprehensive quality management activities.

Due to the limit in sample size, the test-retest reliability is not examined. Therefore, external validity of the scale should be verified in future studies. Because of the poor accessibility to name-lists of doctors and nursing staff, the researcher did not adopt random sampling. Hence, the homogeneity of characteristics between collected sample and the population can not be analyzed. Furthermore, different kinds of hospitals (e.g. medical center/rural hospital) might possess different management goals. This may bring different expectation to EMRS. In order to make the sample more representative, future researchers should conduct stratified sampling on hospitals of different sizes or levels.

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APPENDIX

D1 Data records in EMR are correct
D2 Data records in EMR are timely
D3 Consistency exists between pertaining data records in EMR
D4 Data records in EMR are no missing
D5 Data records in EMR are trustable
D6 Data records in EMR are useful
D7 Definition of data columns are consistent with that of users' definition *(deleted)
D8 Data format are easy to access for users in work
D9 Data column's definition matches the acknowledged standard of EMR
D10 Data column format is proper*(deleted)
D11 Data column format is accurate
D12 Data column definition is clear
I1 The output of EMR system is complete for users in work *(deleted)
I2 The output of EMR system is trustable
I3 The output of EMR system is accurate
I4 The output of EMR system is ease-to-read
I5 The output of EMR system is useful to users in work
I6 The output of EMR system is detailed enough *(deleted)
I7 The output of EMR system can be provided in time when users need it
I8 The output of EMR system is relevant to users in work
K1 EMR is beneficial to learning new knowledge
K2 EMR is beneficial to researching or inventing useful knowledge
K3 EMR is beneficial to applying knowledge to works

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