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## **Applying the modified delphi method to identify the Taiwanese electronic health record systems evaluation framework and instrument**

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### Abstract

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### Disciplines

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# APPLYING THE MODIFIED DELPHI METHOD TO IDENTIFY THE TAIWANESE ELECTRONIC HEALTH RECORD SYSTEMS EVALUATION FRAMEWORK AND INSTRUMENT

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## Abstract

*The aim of this research is to design an appropriate conceptual evaluation framework with a draft instrument for validating the structure of the Taiwanese EHR systems evaluation framework. According to the knowledge of "Triangulation research method" and both quantitative and qualitative approaches, the modified Delphi method was applied to refine the proposed instrument into practicable for real medical environment based on a quantitative approach. In addition, by calculating content validity index for items (I-CVI) and content validity index for scales (S-CVI), it also indicates the degree of consensus between and within questions in the proposed instrument. In short, an appropriate instrument for achieving its target was generated in this research.*

*Keywords: Delphi method, Electronic Health Record Systems, EHRs evaluation, Content validity Index.*

# 1 INTRODUCTION

Information systems (IS) are not only concerned with the application of modern technology to assist with medical services, but also to reduce medical errors and improve the quality of patient care. Accordingly, Electronic Health Record systems (EHRs) play an important role in modern clinical service based on the development of information technology. Awareness of EHRs success is important, as that would assist in providing suitable EHRs for satisfying the requirements of clinical service. It is because EHRs not only help the management of administration and finances for improving work efficiency in clinical services, but also help to reduce human errors in patient care. Promoting EHRs have been a national goal in Taiwan, therefore, it is essential to (1) understand end-user' opinion for identifying whether EHRs success would help to recognize the strengths and weaknesses of such systems; (2) provide useful suggestions to improve the functions of EHRs for patient care; (3) realize the impact of using such systems in clinical service. Moreover, with proper success assessment, it offers evidence-based information for health care executives and EHRs developers, the importance of providing a suitable user-centred EHR system for patient care. This will lead to safer and acceptable EHRs. As a result, it needs an appropriate evaluation instrument to assess above aims.

The Declaration of Innsbruck suggested that Evaluation studies should be grounded on scientific theory and conduct with rigorous approaches (Ammenwerth, Brender et al. 2004). This research applies the issue of "Socio-Technical theory" (Bostrom & Heinen 1977) and "User-centred perspective" (Hesse & Shneiderman 2007) to establish a conceptual evaluation framework and design an appropriate instrument for evaluating Taiwanese EHRs. In order to recognize the most appropriate factor/attributes in evaluating EHRs, this study applies the strategy of "Triangulation research method" in health information systems research, by triangulation of investigator and method. This article validates the appropriate evaluation framework applicable for EHRs by applying the strategy of modified Delphi method (Snyder-Halpern 2001), which could be regarded as a reference for supporting investment decisions in health care. In addition, it also presented the results of content validation (Polit & Beck 2006) by calculating content validity index (CVI) for items (I-CVI) (Polit & Beck 2006) and content validity index for scales (S-CVI) (Hubley & Palepu 2007) to validate the proposed evaluation framework and construct an appropriate questionnaire for the evaluation of Taiwanese EHRs.

# 2 BACKGROUND AND CONCEPTUAL EVALUATION FRAMEWORK

A comprehensive framework for evaluating Taiwanese EHRs success needs to consider the features of the Taiwanese healthcare delivery system (a centralized medical system) and related regulations, such as the Medical Act, the National Health Insurance (NHI) and the Taiwanese Hospital Accreditation Program. In other words, the operational strategies of healthcare administration are affected by the outer healthcare environment in Taiwan, such as health policies and national health insurance. Secondly, a user-centred evaluation framework needs to cover various aspects, therefore, with regard to the knowledge of Evidence-based Health Care Management (Wan 2002), the issue of Social-technical theory (Bostrom & Heinen 1977), the issue of Structure-Process-Outcome (S-P-O) model (Donabedian 2003) and the meaning of Health Information System (HIS) evaluation (Ammenwerth, Graber et al. 2003), it needs to understand the relationships between the technology itself and its users for implementing EHRs based on end-users' opinion of using such systems.

In order to satisfy above requirements and combining the knowledge of aforementioned issues, this study proposed that structure covers aspects of organizational and technology; process equates to human aspects; outcomes are related to net benefits. In addition, the DeLone and McLean IS success model (DeLone & McLean 1992) had been combined with the S-P-O model, however, it still needs empirical research to identify whether the updated D&M IS success model could be combined with the S-P-O model and a Social-technical approach in EHR systems evaluation. Moreover, a patient is regarded as an outer customer and a healthcare professional as an inner customer within the issue of organizational behaviour. In order to improve the quality of patient care for outer customers, it is essential for health care executives to firstly improve the work satisfaction of its inner customers.

Accordingly, Organizational aspects need to concern about Healthcare environment (External organization) and Organizational Behaviours (Internal organization). In addition, EHRs include patients' health information, any error or inaccuracy can have impact on patient care; regarding clinical data of EHR and the development of both intranet and internet in hospitals, therefore, clinical data quality (D'Onofrio & Gendron 2001) and safety quality (Win 2004; Su, Win et al. 2006) are also important for the EHRs. Furthermore, realizing an end-user's attitude of using such systems will provides sufficient information for health care executives to access end-users' opinion and to recognize that whether the net benefits of implementing EHR will affect the strategies of hospital management. In short, this study considers that the aspects of Environment cover the dimensions of Healthcare Environment (HE) and Organization Behaviours (OB); the aspects of Technology cover the dimensions of System Quality (Sys\_Q), Medical Data Quality (MDQ), Service Quality (Ser\_Q), and Safety Quality (Safe\_Q); the aspects of Human cover the dimensions of User Usage (UU) and User Satisfaction (US); the aspects of Net Benefits covers the dimensions of Organization Net Benefits (ONB) (Table 1 and Figure 1).

Aspects	Elements	Operational Definitions
Organizational	Healthcare Environment (HE)	Realizing end-users' impression of national health policies of EHRs.
	Organizational Behaviours (OB)	Recognizing end-users' impressions of the reasons and motivation to implement EHRs within a hospital.
Technology	System Quality (Sys_Q)	Identifying end-users' opinions of the performance distinctiveness of the EHRs processing it provides.
	Medical Data Quality (MDQ)	Identifying end-users' opinions of the output information produced by the EHRs.
	Service Quality (Ser_Q)	Considering how to provide accessible help to the stakeholders of the EHRs by the technological vender based on identifying end-users' judgment.
	Safety Quality (Safe_Q)	Identifying end-users' opinions of risk management within EHRs.
Human	User Use (UU)	Measuring the use of the EHR based on end-users' judgment.
	User Satisfaction (US)	Measuring the users' responses by using the output information of EHRs.
Net Benefits	Organizational Net Benefits (ONB)	Realizing the impact and goodness of implementing EHRs in patient care performance based on identifying end-users' judgment.

Table 1. Definitions of the conceptual user-centred evaluation framework

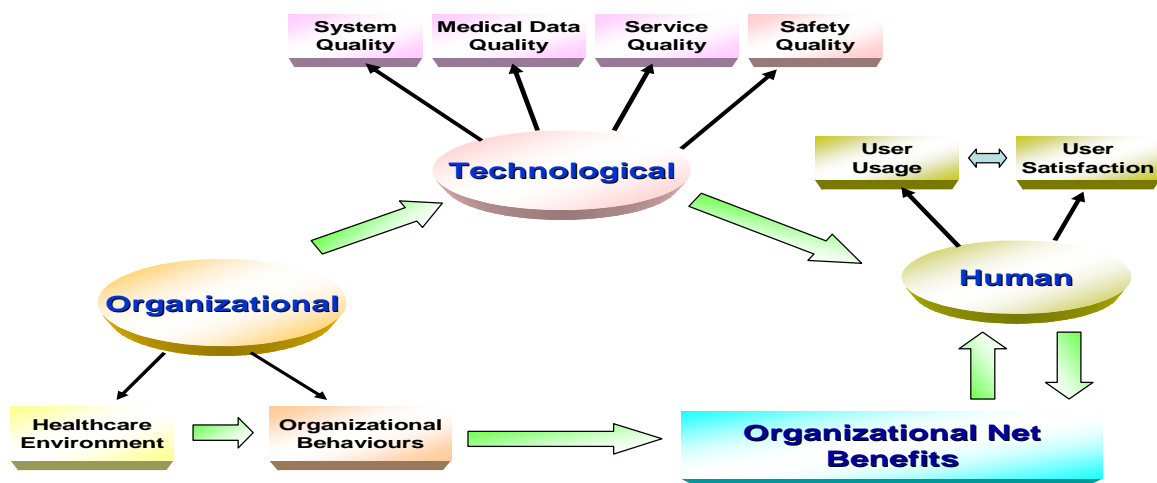


Figure 1. Taiwanese EHRs conceptual evaluation framework

### 3 RESEARCH METHOD

According to the features of the modified Delphi method, the process of such a technique is commonly being applied in identifying the content validity of an instrument (Takemura, Liu et al. 2006; Rushton & Lindsay 2008). Accordingly, there are several main elements in the Delphi method in order to obtain the most consistent agreement on each question of a questionnaire from a group of specialists (Snyder-Halpern 2001; van Steenkiste, Jacobs et al. 2002; Daniel & White 2005): (1) anonymity: it is nameless in applying such a method between experts; (2) iteration: it needs to perform the Delphi method at least twice on the same question for experts to reconsider their responses until consensus is reached; (3) controlled feedback: all inappropriate questions are removed by calculating each content validity index for items (I-CVI) and the overall content validity index for scales (S-CVI) of a evaluation instrument (S-CVI is the Mean of I-CVI); (4) aggregation of group answers: converting individual viewpoint into group consensus by providing results of each round to participants of the Delphi group. In order to design a suitable evaluation instrument by applying the knowledge of triangulation research method: A. for method triangulation, (1) a quantitative approach indicates the degree of consensus between and within questions by calculating I-CVI and S-CVI to determinate which question need to be removed from the instrument; (2) a qualitative approach provides a reference to modify wording and/or syntaxes of those questions which could be kept from results of I-CVI and S-CVI. B. for investigator triangulation, thirty participants (including medical doctors, nurses, medical technicians, high level healthcare administrators, and the director of the department of information management) were recruited as participants in this Delphi group. Experts within the Delphi group were requested to answer each question in the three main components (Importance, Feasibility, and Confidence).

In order to confirm the content validity or face validity, the prepared evaluation instrument (appendix 1) consists of three main components: (1) **Importance**: the significance of each evaluation question in its evaluation element; (2) **Feasibility**: the practicality of each evaluation question in a real medical environment; (3) **Confidence**: to measure experts' opinions of whether or not they trust that the results of each question could be used to evaluate end-user's opinion of using EHRs. This study adopted a five-point Likert scale (1=strongly disagree; 2=disagree; 3=somewhat disagree; 4=agree; 5=strongly agree) as the answer format (Lynn 1986).

Content validity: *"concerns the degree to which a sample of items, taken together, constitutes an adequate operational definition of a construct"* (Polit & Beck 2006). Therefore, a quantitative approach of the Delphi method could be used to identify the content validity by calculating I-CVI (the value of the I-CVI is the summation of agreement, 4: agree and 5: highly agree) divided by the total number of experts) to determinate which question need to be removed from the proposed instrument, and the content validity index for S-CVI (adopting the average proportion of items which were approved by the experts and calculating this as the average of the I-CVI values) to recognize the proportion of agreement within the instrument. The determinate criterion (cut-off point) of I-CVI is 0.78 (78%) and 0.90 (90%) for the S-CVI/Ave (Polit & Beck 2006).

The special intention of each round is: (1) Round I focuses on ranking the aforementioned three main components in each question, and requesting experts to provide their viewpoint of each question if possible; (2) Round II not only repeats the same process of Round I for experts to reconsider their response to each question, but also requests experts to modify the wording and syntax of each question to refine this prepared instrument. If the degree of consensus is stable among experts in Round II, this will complete the process of performing the Delphi method; otherwise, it will be repeated until all inappropriate questions are removed by calculating each I-CVI and the overall S-CVI of the proposed evaluation instrument.

### 4 RESULTS

It took around nine weeks (from 9<sup>th</sup> October to 11<sup>th</sup> December 2006) to collect data from the Delphi Group twice, due to the degree of consensus stability among experts in Round II. In **Round I**, 23 of 30 experts (76.67%) responded to the questionnaire: 10 were medical doctors, 6 were executive nursing staff, 5 were executive healthcare administrators, and 2 were executive managers of

information management. In other words, the ratio of participants (clinical vs. non-clinical) was close to **2.3:1**; sixteen were health professionals and the others were executive managers. In **Round II**, 19 of 23 experts (82.60%) responded: 8 were medical doctors, 5 were executive nursing staff, 4 were executive healthcare administrators, and 2 were executive managers of information management. In other words, the ratio of participants (clinical vs. non-clinical) was close to **2.1:1**; 13 were health professionals and the others were executive managers.

Based on the results of the two-interactive Delphi methods, the results of I-CVI (Table 2) suggest that the following seven questions: HE2, OB2, OB4, UU4, UU5, US2 and US4-1 need to be removed from the proposed instrument. Taking HE2 for example, the original content of HE2 is “Do you know that all the hospitals around your hospital are implementing EHRs in their patient service”, in other words, several experts of the Delphi group suggested that such a question is not relevant (rated 1 or 2 and 3) to the underlying construct (Healthcare Environment). For OB4, the content of the question is “You agreed with the leadership and administration of top managers for adopting EHR within your hospital?” Experts suggested that such a question is inappropriate in this study due to its being a sensitive issue of organizational culture and end-users would not tell the truth. As a result, this could be used to explain why the values of I-CVI in such questions are lower than 78% in those three components (Importance, Feasibility and Confidence).

In addition, five questions (HE3, HE4, UU2, UU3 and US3) need to be modified to be more relevant to its proposed evaluation element. For example, the original content of **HE3** was “Implementing EHR helps your hospital to improve the capacity of clinical service within its location.” However, experts suggested that such a question needs to be modified as follow: (1) Implementing EHR helps your hospital to improve the competition of clinical service within its location. (2) Implementing EHR helps your hospital to enhance the capacity of patient care within its location. Accordingly, this study recalculated the values of S-CVI/Ave in the element of HE, OB, UU and US after those seven questions are removed from the evaluation element in Round II.

	First round (n=23)								Second round (n=19)							
	A		B		C		D		A		B		C		D	
Important	N	%	N	%	N	%	Mean	%	N	%	N	%	N	%	Mean	%
HE1	1	4.35	0	0.00	22	95.65	4.39	87.80	0	0.00	0	0.00	19	100.00	4.37	87.37
HE2	3	13.04	6	26.09	14	60.87	3.61	72.20	1	5.26	4	21.05	14	73.68	3.89	77.89
HE3	0	0.00	1	4.35	22	95.65	4.35	87.00	0	0.00	1	5.26	18	94.74	4.42	88.42
HE4	0	0.00	2	8.70	21	91.30	4.30	86.00	0	0.00	1	5.26	18	94.74	4.32	86.32
OB1	1	4.35	2	8.70	20	86.96	4.13	82.60	0	0.00	1	5.26	18	94.74	4.16	83.16
OB2	2	8.70	1	4.35	20	86.96	4.13	82.60	2	10.53	4	21.05	13	68.42	3.79	75.79
OB3	2	8.70	4	17.39	17	73.91	3.78	75.60	0	0.00	2	10.53	17	89.47	4.32	86.32
OB4	4	17.39	4	17.39	15	65.22	3.74	74.80	15	78.95	1	5.26	3	15.79	1.95	38.95
OB5	1	4.35	2	8.70	20	86.96	4.43	88.60	0	0.00	1	5.26	18	94.74	4.42	88.42
OB6	1	4.35	3	13.04	19	82.61	4.26	85.20	0	0.00	0	0.00	19	100.00	4.53	90.53
OB7-1	1	4.35	2	8.70	20	86.96	4.22	84.40	0	0.00	1	5.26	18	94.74	4.42	88.42
OB7-2	1	4.35	1	4.35	21	91.30	4.22	84.40	0	0.00	1	5.26	18	94.74	4.47	89.47
OB7-3	0	0.00	1	4.35	22	95.65	4.35	87.00	0	0.00	1	5.26	18	94.74	4.37	87.37
OB8	1	4.35	0	0.00	22	95.65	4.30	86.00	0	0.00	0	0.00	19	100.00	4.63	92.63
Sys Q1	2	8.70	1	4.35	20	86.96	4.13	82.60	0	0.00	1	5.26	18	94.74	4.32	86.32
Sys Q2	1	4.35	2	8.70	20	86.96	4.13	82.60	0	0.00	1	5.26	18	94.74	4.47	89.47
Sys Q3	0	0.00	1	4.35	22	95.65	3.78	75.60	0	0.00	1	5.26	18	94.74	4.37	87.37
Sys Q4	1	4.35	5	21.74	17	73.91	3.74	74.80	0	0.00	1	5.26	18	94.74	4.47	89.47
Sys Q5	0	0.00	0	0.00	23	100.00	4.43	88.60	0	0.00	1	5.26	18	94.74	4.58	91.58
Sys Q6	0	0.00	4	17.39	19	82.61	4.26	85.20	0	0.00	1	5.26	18	94.74	4.53	90.53
Sys Q7	0	0.00	0	0.00	23	100.00	4.22	84.40	0	0.00	1	5.26	18	94.74	4.47	89.47
Sys Q8	1	4.35	0	0.00	22	95.65	4.22	84.40	0	0.00	0	0.00	19	100.00	4.63	92.63
Sys Q9	0	0.00	0	0.00	23	100.00	4.35	87.00	0	0.00	1	5.26	18	94.74	4.47	89.47
MDQ1	1	4.35	1	4.35	21	91.30	4.48	89.60	1	5.26	0	0.00	18	94.74	4.47	89.47
MDQ2	0	0.00	0	0.00	23	100.00	4.57	91.40	0	0.00	0	0.00	19	100.00	4.58	91.58
MDQ3	0	0.00	1	4.35	22	95.65	4.57	91.40	0	0.00	1	5.26	18	94.74	4.47	89.47
MDQ4	0	0.00	2	8.70	21	91.30	4.57	91.40	0	0.00	0	0.00	19	100.00	4.47	89.47
MDQ5	0	0.00	1	4.35	22	95.65	4.43	88.60	0	0.00	0	0.00	19	100.00	4.42	88.42

MDQ6	0	0.00	1	4.35	22	95.65	4.43	88.60	0	0.00	0	0.00	19	100.00	4.47	89.47
MDQ7	1	4.35	1	4.35	21	91.30	4.30	86.00	0	0.00	0	0.00	19	100.00	4.47	89.47
MDQ8	0	0.00	1	4.35	22	95.65	4.57	91.40	0	0.00	1	5.26	18	94.74	4.47	89.47
MDQ9	0	0.00	0	0.00	23	100.00	4.48	89.60	0	0.00	1	5.26	18	94.74	4.63	92.63
MDQ10	1	4.35	0	0.00	22	95.65	4.57	91.40	0	0.00	0	0.00	19	100.00	4.58	91.58
Ser Q1	0	0.00	2	8.70	21	91.30	4.43	88.60	0	0.00	1	5.26	18	94.74	4.47	89.47
Ser Q2	0	0.00	1	4.35	22	95.65	4.43	88.60	0	0.00	1	5.26	18	94.74	4.53	90.53
Ser Q3	3	13.04	0	0.00	20	86.96	4.13	82.60	0	0.00	1	5.26	18	94.74	4.37	87.37
Ser Q4	1	4.35	2	8.70	20	86.96	4.35	87.00	0	0.00	1	5.26	18	94.74	4.47	89.47
Ser Q5	0	0.00	1	4.35	22	95.65	4.35	87.00	0	0.00	1	5.26	18	94.74	4.53	90.53
Ser Q6	0	0.00	3	13.04	20	86.96	4.35	87.00	0	0.00	1	5.26	18	94.74	4.42	88.42
Ser Q7	1	4.35	1	4.35	21	91.30	4.52	90.40	0	0.00	1	5.26	18	94.74	4.63	92.63
Safe Q1	0	0.00	1	4.35	22	95.65	4.7	94.00	0	0.00	1	5.26	18	94.74	4.63	92.63
Safe Q2	2	8.70	1	4.35	20	86.96	4.43	88.60	0	0.00	1	5.26	18	94.74	4.53	90.53
Safe Q3	0	0.00	0	0.00	23	100.00	4.78	95.60	0	0.00	0	0.00	19	100.00	4.79	95.79
Safe Q4	1	4.35	2	8.70	20	86.96	4.52	90.40	0	0.00	1	5.26	18	94.74	4.68	93.68
Safe Q5	0	0.00	0	0.00	23	100.00	4.61	92.20	0	0.00	1	5.26	18	94.74	4.68	93.68
Safe Q6	1	4.35	0	0.00	22	95.65	4.61	92.20	0	0.00	1	5.26	18	94.74	4.74	94.74
Safe Q7	0	0.00	1	4.35	22	95.65	4.57	91.40	0	0.00	1	5.26	18	94.74	4.58	91.58
Safe Q8	0	0.00	2	8.70	21	91.30	4.48	89.60	0	0.00	0	0.00	19	100.00	4.74	94.74
Safe Q9	1	4.35	0	0.00	22	95.65	4.35	87.00	0	0.00	1	5.26	18	94.74	4.42	88.42
Safe Q10	0	0.00	1	4.35	22	95.65	4.48	89.60	0	0.00	1	5.26	18	94.74	4.79	95.79
Safe Q11	1	4.35	2	8.70	20	86.96	4.17	83.40	0	0.00	1	5.26	18	94.74	4.68	93.68
UU1-1	2	8.70	1	4.35	20	86.96	4.13	82.60	0	0.00	1	5.26	18	94.74	4.68	93.68
UU1-2	2	8.70	2	8.70	19	82.61	4.26	85.20	0	0.00	0	0.00	19	100.00	4.53	90.53
UU1-3	1	4.35	2	8.70	20	86.96	4.26	85.20	0	0.00	0	0.00	19	100.00	4.53	90.53
UU1-4	3	13.04	1	4.35	19	82.61	3.96	79.20	0	0.00	0	0.00	19	100.00	4.37	87.37
UU2	2	8.70	4	17.39	17	73.91	3.96	79.20	0	0.00	2	10.53	17	89.47	4.37	87.37
UU3	1	4.35	0	0.00	22	95.65	4.30	86.00	0	0.00	2	10.53	17	89.47	4.26	85.26
UU4	3	13.04	1	4.35	19	82.61	4.13	82.60	3	15.79	3	15.79	13	68.42	3.89	77.89
UU5	4	17.39	0	0.00	19	82.61	3.74	74.80	4	21.05	1	5.26	14	73.68	3.79	75.79
US1	1	4.35	1	4.35	21	91.30	4.26	85.20	0	0.00	1	5.26	18	94.74	4.37	87.37
US2	4	17.39	2	8.70	17	73.91	3.83	76.60	4	21.05	1	5.26	14	73.68	3.89	77.89
US3	1	4.35	1	4.35	21	91.30	4.30	86.00	0	0.00	0	0.00	19	100.00	4.42	88.42
US4-1	4	17.39	4	17.39	15	65.22	3.52	70.40	8	42.11	1	5.26	10	52.63	3.11	62.11
US4-2	1	4.35	3	13.04	19	82.61	4.17	83.40	0	0.00	1	5.26	18	94.74	4.37	87.37
US4-3	0	0.00	1	4.35	22	95.65	4.43	88.60	0	0.00	0	0.00	19	100.00	4.42	88.42
US4-4	1	4.35	1	4.35	21	91.30	4.35	87.00	0	0.00	1	5.26	18	94.74	4.21	84.21
US5-1	0	0.00	0	0.00	23	100.00	4.39	87.80	0	0.00	1	5.26	18	94.74	4.37	87.37
US5-2	2	8.70	2	8.70	19	82.61	4.17	83.40	0	0.00	1	5.26	18	94.74	4.37	87.37
US5-3	1	4.35	0	0.00	22	95.65	4.26	85.20	0	0.00	1	5.26	18	94.74	4.42	88.42
ONB1	0	0.00	2	8.70	21	91.30	4.48	89.60	0	0.00	1	5.26	18	94.74	4.47	89.47
ONB2	0	0.00	1	4.35	22	95.65	4.43	88.60	0	0.00	1	5.26	18	94.74	4.32	86.32
ONB3	1	4.35	2	8.70	20	86.96	4.13	82.60	0	0.00	1	5.26	18	94.74	4.47	89.47
ONB4	0	0.00	2	8.70	21	91.30	4.30	86.00	0	0.00	0	0.00	19	100.00	4.47	89.47
ONB5	1	4.35	2	8.70	20	86.96	4.13	82.60	0	0.00	1	5.26	18	94.74	4.32	86.32
ONB6	0	0.00	1	4.35	22	95.65	4.48	89.60	0	0.00	1	5.26	18	94.74	4.47	89.47
ONB7	2	8.70	2	8.70	19	82.61	4.09	81.80	0	0.00	1	5.26	18	94.74	4.42	88.42
<b>Feasibility</b>																
HE1	1	4.35	2	8.70	20	86.96	3.91	78.20	0	0.00	1	5.26	18	94.74	4.26	85.26
HE2	3	13.04	4	17.39	16	69.57	3.74	74.80	1	5.26	4	21.05	14	73.68	3.89	77.89
HE3	0	0.00	1	4.35	22	95.65	4.30	86.00	0	0.00	1	5.26	18	94.74	4.26	85.26
HE4	1	4.35	4	17.39	18	78.26	3.96	79.20	0	0.00	1	5.26	18	94.74	4.32	86.32
OB1	1	4.35	1	4.35	21	91.30	4.04	80.80	0	0.00	1	5.26	18	94.74	4.26	85.26
OB2	3	13.04	1	4.35	19	82.61	4.25	85.00	3	15.79	2	10.53	14	73.68	3.79	75.79
OB3	4	17.39	3	13.04	16	69.57	3.65	73.00	0	0.00	2	10.53	17	89.47	4.21	84.21
OB4	6	26.09	4	17.39	13	56.52	3.43	68.60	15	78.95	1	5.26	3	15.79	2.00	40.00
OB5	0	0.00	1	4.35	22	95.65	4.35	87.00	0	0.00	1	5.26	18	94.74	4.37	87.37
OB6	2	8.70	5	21.74	16	69.57	3.96	79.20	0	0.00	0	0.00	19	100.00	4.37	87.37
OB7-1	1	4.35	1	4.35	21	91.30	4.26	85.20	0	0.00	1	5.26	18	94.74	4.47	89.47
OB7-2	2	8.70	0	0.00	21	91.30	4.22	84.40	1	5.26	3	15.79	15	78.95	4.16	83.16
OB7-3	3	13.04	0	0.00	20	86.96	3.96	79.20	0	0.00	1	5.26	18	94.74	4.42	88.42
OB8	0	0.00	2	8.70	21	91.30	4.04	80.80	0	0.00	0	0.00	19	100.00	4.53	90.53
Sys Q1	2	8.70	2	8.70	19	82.61	4.04	80.80	0	0.00	1	5.26	18	94.74	4.26	85.26
Sys Q2	1	4.35	5	21.74	17	73.91	4.00	80.00	0	0.00	0	0.00	19	100.00	4.37	87.37
Sys Q3	0	0.00	1	4.35	22	95.65	4.22	84.40	0	0.00	1	5.26	18	94.74	4.32	86.32



Sys Q4	1	4.35	3	13.04	19	82.61	4.04	80.80	0	0.00	1	5.26	18	94.74	4.37	87.37
Sys Q5	1	4.35	1	4.35	21	91.03	4.39	87.80	0	0.00	1	5.26	18	94.74	4.53	90.53
Sys Q6	0	0.00	3	13.04	20	86.96	4.35	87.00	0	0.00	1	5.26	18	94.74	4.37	87.37
Sys Q7	0	0.00	1	4.35	22	95.65	4.39	87.80	0	0.00	1	5.26	18	94.74	4.37	87.37
Sys Q8	0	0.00	1	4.35	22	95.65	4.35	87.00	0	0.00	0	0.00	19	100.00	4.47	89.47
Sys Q9	0	0.00	0	0.00	23	100.00	4.39	87.80	0	0.00	1	5.26	18	94.74	4.42	88.42
MDQ1	1	4.35	0	0.00	22	95.65	4.52	90.40	1	5.26	0	0.00	18	94.74	4.47	89.47
MDQ2	0	0.00	1	4.35	22	95.65	4.52	90.40	0	0.00	1	5.26	18	94.74	4.47	89.47
MDQ3	0	0.00	1	4.35	22	95.65	4.52	90.40	0	0.00	1	5.26	18	94.74	4.53	90.53
MDQ4	0	0.00	1	4.35	22	95.65	4.65	93.00	0	0.00	0	0.00	19	100.00	4.47	89.47
MDQ5	0	0.00	2	8.70	21	91.30	4.26	85.20	0	0.00	0	0.00	19	100.00	4.47	89.47
MDQ6	0	0.00	1	4.35	22	95.65	4.43	88.60	0	0.00	1	5.26	18	94.74	4.42	88.42
MDQ7	0	0.00	1	4.35	22	95.65	4.30	86.00	0	0.00	0	0.00	19	100.00	4.47	89.47
MDQ8	0	0.00	1	4.35	22	95.65	4.43	88.60	0	0.00	1	5.26	18	94.74	4.53	90.53
MDQ9	0	0.00	0	0.00	23	100.00	4.57	91.40	0	0.00	0	0.00	19	100.00	4.58	91.58
MDQ10	0	0.00	1	4.35	22	95.65	4.43	88.60	0	0.00	0	0.00	19	100.00	4.47	89.47
Ser Q1	3	13.04	2	8.70	18	78.26	3.96	79.20	0	0.00	1	5.26	18	94.74	4.32	86.32
Ser Q2	4	17.39	1	4.35	18	78.26	3.91	78.20	0	0.00	1	5.26	18	94.74	4.32	86.32
Ser Q3	2	8.70	2	8.70	19	82.61	4.17	83.40	1	5.26	0	0.00	18	94.74	4.21	84.21
Ser Q4	1	4.35	2	8.70	20	86.96	4.13	82.60	0	0.00	0	0.00	19	100.00	4.37	87.37
Ser Q5	1	4.35	3	13.04	19	82.61	4.00	80.00	0	0.00	1	5.26	18	94.74	4.47	89.47
Ser Q6	1	4.35	0	0.00	22	95.65	4.30	86.00	0	0.00	0	0.00	19	100.00	4.47	89.47
Ser Q7	3	13.04	2	8.70	18	78.26	3.96	79.20	0	0.00	0	0.00	19	100.00	4.53	90.53
Safe Q1	0	0.00	2	8.70	21	91.30	4.61	92.20	0	0.00	1	5.26	18	94.74	4.58	91.58
Safe Q2	2	8.70	1	4.35	20	86.96	4.35	87.00	0	0.00	1	5.26	18	94.74	4.42	88.42
Safe Q3	0	0.00	0	0.00	23	100.00	4.70	94.00	0	0.00	1	5.26	18	94.74	4.63	92.63
Safe Q4	1	4.35	1	4.35	21	91.30	4.43	88.60	0	0.00	0	0.00	19	100.00	4.47	89.47
Safe Q5	0	0.00	0	0.00	23	100.00	4.65	93.00	0	0.00	1	5.26	18	94.74	4.58	91.58
Safe Q6	1	4.35	0	0.00	22	95.65	4.52	90.40	0	0.00	1	5.26	18	94.74	4.53	90.53
Safe Q7	0	0.00	2	8.70	21	91.30	4.43	88.60	0	0.00	1	5.26	18	94.74	4.53	90.53
Safe Q8	0	0.00	1	4.35	22	95.65	4.52	90.40	0	0.00	1	5.26	18	94.74	4.53	90.53
Safe Q9	1	4.35	1	4.35	21	91.30	4.30	86.00	0	0.00	0	0.00	19	100.00	4.37	87.37
Safe Q10	0	0.00	0	0.00	23	100.00	4.48	89.60	0	0.00	0	0.00	19	100.00	4.63	92.63
Safe Q11	1	4.35	1	4.35	21	91.30	4.22	84.40	0	0.00	0	0.00	19	100.00	4.79	95.79
UU1-1	1	4.35	1	4.35	21	91.30	4.09	81.80	0	0.00	1	5.26	18	94.74	4.37	87.37
UU1-2	1	4.35	2	8.70	20	86.96	4.22	84.40	0	0.00	0	0.00	19	100.00	4.37	87.37
UU1-3	0	0.00	2	8.70	21	91.30	4.26	85.20	0	0.00	0	0.00	19	100.00	4.32	86.32
UU1-4	2	8.70	1	4.35	20	86.96	4.04	80.80	0	0.00	0	0.00	19	100.00	4.37	87.37
UU2	1	4.35	1	4.35	21	91.30	4.13	82.60	0	0.00	2	10.53	17	89.47	4.32	86.32
UU3	0	0.00	1	4.35	22	95.65	4.43	88.60	0	0.00	2	10.53	17	89.47	4.21	84.21
UU4	4	17.39	0	0.00	19	82.61	3.91	78.20	4	21.05	1	5.26	14	73.68	3.74	74.74
UU5	2	8.70	0	0.00	21	91.30	4.00	80.00	4	21.05	1	5.26	14	73.68	3.74	74.74
US1	1	4.35	0	0.00	22	95.65	4.22	84.40	0	0.00	0	0.00	19	100.00	4.58	91.58
US2	4	17.39	2	8.70	17	73.91	3.83	76.60	3	15.79	2	10.53	14	73.68	3.84	76.84
US3	1	4.35	0	0.00	22	0.96	4.35	87.00	0	0.00	1	5.26	18	94.74	4.42	88.42
US4-1	3	13.04	4	17.39	16	69.57	3.61	72.20	11	57.89	1	5.26	7	36.84	2.68	53.68
US4-2	1	4.35	3	13.04	19	82.61	4.17	83.40	1	5.26	1	5.26	17	89.47	4.16	83.16
US4-3	0	0.00	1	4.35	22	95.65	4.35	87.00	0	0.00	1	5.26	18	94.74	4.37	87.37
US4-4	1	4.35	2	8.70	20	86.96	4.26	85.20	0	0.00	1	5.26	18	94.74	4.21	84.21
US5-1	0	0.00	1	4.35	22	95.65	4.35	87.00	0	0.00	1	5.26	18	94.74	4.47	89.47
US5-2	2	8.70	1	4.35	20	86.96	4.26	85.20	0	0.00	1	5.26	18	94.74	4.37	87.37
US5-3	1	4.35	0	0	22	95.65	4.35	87.00	0	0.00	0	0.00	19	100.0	4.58	91.58
ONB1	2	8.70	2	8.70	19	82.61	3.96	79.20	0	0.00	3	15.79	16	84.21	4.26	85.20
ONB2	0	0.00	1	4.35	22	95.65	4.30	86.00	0	0.00	0	0.00	19	100.00	4.47	89.40
ONB3	1	4.35	2	8.70	20	86.96	4.09	81.80	0	0.00	0	0.00	19	100.00	4.53	90.60
ONB4	0	0.00	3	13.04	20	86.96	4.22	84.40	0	0.00	1	5.26	18	94.74	4.32	86.40
ONB5	2	8.70	0	0.00	21	91.30	3.96	79.20	0	0.00	3	15.79	16	84.21	4.26	85.20
ONB6	1	4.35	0	0.00	22	95.65	4.30	86.00	0	0.00	1	5.26	18	94.74	4.47	89.40
ONB7	2	8.70	1	4.35	20	86.96	4.17	83.40	0	0.00	2	10.53	17	89.47	4.37	87.40
<b>Confidence</b>																
HE1	1	4.35	4	17.39	18	78.26	3.87	77.40	0	0.00	1	5.26	18	94.74	4.16	83.16
HE2	5	21.74	5	21.74	13	56.52	3.39	67.80	1	5.26	5	26.32	13	68.42	3.84	76.84
HE3	0	0.00	2	0.09	21	91.30	4.17	83.40	0	0.00	1	5.26	18	94.74	4.26	85.26
HE4	1	4.35	3	13.04	19	82.61	3.91	78.20	0	0.00	1	5.26	18	94.74	4.37	87.37
OB1	2	8.70	2	8.70	19	82.61	3.91	78.20	0	0.00	2	10.53	17	89.47	4.21	84.21
OB2	2	8.70	3	13.04	18	78.26	4.13	82.60	2	10.53	3	15.79	14	73.68	3.84	76.84

OB3	3	13.04	6	26.09	14	60.87	3.61	72.20	0	0.00	3	15.79	16	84.21	4.11	82.11
OB4	7	30.43	4	17.39	12	52.17	3.26	65.20	12	63.16	1	5.26	6	31.58	2.42	48.42
OB5	1	4.35	2	8.70	20	86.96	4.13	82.60	0	0.00	2	10.53	17	89.47	4.21	84.21
OB6	2	8.70	5	21.74	16	69.57	3.87	77.40	0	0.00	1	5.26	18	94.74	4.32	86.32
OB7-1	1	4.35	0	0.00	22	95.65	4.22	84.40	0	0.00	2	10.53	17	89.47	4.26	85.26
OB7-2	2	8.70	12	52.17	9	39.13	4.3	86.00	0	0.00	1	5.26	18	94.74	4.42	88.42
OB7-3	1	4.35	3	13.04	19	82.61	3.87	77.40	0	0.00	1	5.26	18	94.74	4.42	88.42
OB8	1	4.35	3	13.04	19	82.61	4.04	80.80	0	0.00	0	0.00	19	100.00	4.47	89.47
Sys Q1	3	13.04	2	8.70	18	78.26	3.78	75.60	0	0.00	1	5.26	18	94.74	4.26	85.26
Sys Q2	1	4.35	5	21.74	17	73.91	3.91	78.20	0	0.00	1	5.26	18	94.74	4.37	87.37
Sys Q3	1	4.35	2	8.70	20	86.96	4.00	80.00	0	0.00	1	5.26	18	94.74	4.21	84.21
Sys Q4	1	4.35	3	13.04	19	82.61	3.96	79.20	0	0.00	1	5.26	18	94.74	4.26	85.26
Sys Q5	1	4.35	3	13.04	19	82.61	4.22	84.40	0	0.00	1	5.26	18	94.74	4.47	89.47
Sys Q6	0	0.00	5	21.74	18	78.26	4.22	84.40	0	0.00	2	10.53	17	89.47	4.26	85.26
Sys Q7	0	0.00	3	13.04	20	86.96	4.13	82.60	0	0.00	1	5.26	18	94.74	4.32	86.32
Sys Q8	1	4.35	2	8.70	20	86.96	4.26	85.20	0	0.00	0	0.00	19	100.00	4.37	87.37
Sys Q9	0	0.00	4	17.39	19	82.61	4.00	80.00	0	0.00	1	5.26	18	94.74	4.26	85.26
MDQ1	0	0.00	1	4.35	22	95.65	4.43	88.60	0	0.00	1	5.26	18	94.74	4.37	87.37
MDQ2	0	0.00	2	8.70	21	91.30	4.39	87.80	0	0.00	1	5.26	18	94.74	4.37	87.37
MDQ3	0	0.00	1	4.35	22	95.65	4.39	87.80	0	0.00	1	5.26	18	94.74	4.47	89.47
MDQ4	1	4.35	3	13.04	19	82.61	4.13	82.60	0	0.00	0	0.00	19	100.00	4.37	87.37
MDQ5	0	0.00	3	13.04	20	86.96	4.13	82.60	0	0.00	1	5.26	18	94.74	4.32	86.32
MDQ6	0	0.00	2	8.70	21	91.30	4.17	83.40	0	0.00	1	5.26	18	94.74	4.32	86.32
MDQ7	2	8.70	1	4.35	20	86.96	4.04	80.80	0	0.00	1	5.26	18	94.74	4.37	87.37
MDQ8	0	0.00		0.00	23	100.00	4.39	87.80	0	0.00	1	5.26	18	94.74	4.53	90.53
MDQ9	0	0.00		0.00	23	100.00	4.48	89.60	0	0.00	0	0.00	19	100.00	4.47	89.47
MDQ10	0	0.00	1	4.35	22	95.65	4.52	90.40	0	0.00	0	0.00	19	100.00	4.53	90.53
Ser Q1	1	4.35	4	17.39	18	78.26	4.04	80.80	0	0.00	1	5.26	18	94.74	4.32	86.32
Ser Q2	1	4.35	4	17.39	18	78.26	4.04	80.80	0	0.00	1	5.26	18	94.74	4.26	85.26
Ser Q3	3	13.04	4	17.39	16	69.57	3.70	74.00	1	5.26%	0	0.00	18	94.74	4.16	83.16
Ser Q4	1	4.35	3	13.04	19	82.61	4.09	81.80	0	0.00	1	5.26	18	94.74	4.32	86.32
Ser Q5	0	0.00	1	4.35	22	95.65	4.22	84.40	0	0.00	1	5.26	18	94.74	4.53	90.53
Ser Q6	0	0.00	5	21.74	18	78.26	4.17	83.40	0	0.00	1	5.26	18	94.74	4.42	88.42
Ser Q7	1	4.35	3	13.04	19	82.61	4.09	81.80	0	0.00	1	5.26	18	94.74	4.37	87.37
Safe Q1	0	0.00	2	8.70	21	91.30	4.43	88.60	0	0.00	1	5.26	18	94.74	4.53	90.53
Safe Q2	1	4.35	2	8.70	20	86.96	4.35	87.00	0	0.00	1	5.26	18	94.74	4.37	87.37
Safe Q3	0	0.00	1	4.35	22	95.65	4.61	92.20	0	0.00	0	0.00	19	100.00	4.53	90.53
Safe Q4	0	0.00	1	4.35	22	95.65	4.43	88.60	0	0.00	1	5.26	18	94.74	4.47	89.47
Safe Q5	0	0.00	1	4.35	22	95.65	4.43	88.60	0	0.00	1	5.26	18	94.74	4.58	91.58
Safe Q6	0	0.00	1	4.35	22	95.65	4.48	89.60	0	0.00	1	5.26	18	94.74	4.58	91.58
Safe Q7	1	4.35	2	8.70	20	86.96	4.26	85.20	0	0.00	1	5.26	18	94.74	4.42	88.42
Safe Q8	1	4.35	1	4.35	21	91.30	4.22	84.40	0	0.00	1	5.26	18	94.74	4.53	90.53
Safe Q9	1	4.35	3	13.04	19	82.61	4.13	82.60	0	0.00	1	5.26	18	94.74	4.26	85.26
Safe Q10	0	0.00		0.00	23	100.00	4.43	88.60	0	0.00	1	5.26	18	94.74	4.53	90.53
Safe Q11	0	0.00	1	4.35	22	95.65	4.26	85.20	0	0.00	0	0.00	19	100.00	4.63	92.63
UU1-1	2	8.70	2	8.70	19	82.61	3.87	79.20	0	0.00	1	5.26	18	94.74	4.37	87.37
UU1-2	1	4.35	2	8.70	20	86.96	4.09	81.80	0	0.00	1	5.26	18	94.74	4.21	84.21
UU1-3	1	4.35	3	13.04	19	82.61	4.04	80.80	0	0.00	1	5.26	18	94.74	4.21	84.21
UU1-4	1	4.35	1	4.35	21	91.30	4.22	84.40	0	0.00	1	5.26	18	94.74	4.26	85.26
UU2	0	0.00	3	13.04	20	86.96	4.13	82.60	0	0.00	3	15.79	16	84.21	4.05	81.05
UU3	1	4.35	1	4.35	21	91.30	4.13	82.60	0	0.00	2	10.53	17	89.47	4.26	85.26
UU4	1	4.35	1	4.35	21	91.30	4.22	84.40	3	15.79	2	10.53	14	73.68	3.89	77.89
UU5	2	8.70	2	8.70	19	82.61	3.87	77.40	2	10.53	3	15.79	14	73.68	3.84	76.84
US1	1	4.35	1	4.35	21	91.30	4.17	83.40	2	10.53	1	5.26	16	84.21	4.00	80.00
US2	3	13.04	2	8.70	18	78.26	3.83	76.60	0	0.00	6	31.58	13	68.42	4.00	80.00
US3	0	0.00	1	4.35	22	95.65	4.39	87.80	1	5.26	2	10.53	16	84.21	4.05	81.05
US4-1	1	4.35	5	21.74	17	73.91	3.83	76.60	11	57.89	1	5.26	7	36.84	2.68	53.68
US4-2	1	4.35	3	13.04	19	82.61	4.09	81.80	0	0.00	0	0.00	19	100.00	4.53	90.53
US4-3	0	0.00	2	8.70	21	91.30	4.30	86.00	1	5.26	2	10.53	16	84.21	4.11	82.11
US4-4	1	4.35	3	13.04	19	82.61	4.09	81.80	0	0.00	1	5.26	18	94.74	4.32	86.32
US5-1	0	0.00	2	8.70	21	91.30	4.17	83.40	0	0.00	1	5.26	18	94.74	4.26	85.26
US5-2	0	0.00	2	8.70	21	91.30	4.17	83.40	0	0.00	1	5.26	18	94.74	4.47	89.47
US5-3	1	4.35	2	8.70	20	86.96	4.04	80.80	0	0.00	0	0.00	19	100.00	4.53	90.53
ONB1	1	4.35	2	8.70	20	86.96	4.04	80.80	1	5.26	0	0.00	18	94.74	4.37	87.37
ONB2	0	0.00		0.00	23	100	4.26	85.20	0	0.00	0	0.00	19	100.00	4.47	89.47
ONB3	0	0.00	3	13.04	20	86.96	4.13	82.60	0	0.00	0	0.00	19	100.00	4.53	90.53

ONB4	1	4.35	3	13.04	19	82.61	3.96	79.20	0	0.00	1	5.26	18	94.74	4.32	86.32
ONB5	3	13.04	1	4.35	19	82.61	3.78	75.60	0	0.00	1	5.26	18	94.74	4.47	89.47
ONB6	1	4.35	3	13.04	19	82.61	4.13	82.60	0	0.00	1	5.26	18	94.74	4.47	89.47
ONB7	1	4.35	3	13.04	19	82.61	4.09	81.80	0	0.00	1	5.26	18	94.74	4.42	88.42
A: Items rated 1 or 2; B: Items rated 3; C: Items rated 4 or 5; D: Mean of Items rated by all experts																

Table 2. Results of I-CVI within the modified Delphi method

According to the results of S-CVI in Table 3, some questions of the original elements of HE, OB, UU and US needed to be removed from the proposed instrument. Therefore, after those unsuitable questions were removed from the instrument, the values of S-CVI/Ave are greater than 90% (cut-off point); in other words, the elements of HE, OB, UU and US achieve high content validity and such instrument could be used to evaluate end-users' opinion of using EHRs.

		HE			OB			Sys_Q		
		A	B	C	A	B	C	A	B	C
First round (n=23)	N	79	76	71	96	190	168	189	185	170
	%	85.87	82.61	77.17	85.22	82.61	73.04	91.3	89.37	82.13
Second round (n=19)	N	69	68	67	161	159	160	163	164	162
	%	90.79	89.47	88.16	84.74	83.68	84.21	95.32	95.91	94.74
Revised		96.49	94.74	94.74	95.40	94.01	92.11			
		MDQ			Ser_Q			Safe_Q		
		A	B	C	A	B	C	A	B	C
First round (n=23)	N	219	220	213	146	136	130	237	238	234
	%	95.22	95.65	92.61	90.68	84.47	80.75	93.68	94.07	92.49
Second round (n=19)	N	186	185	183	126	129	126	200	202	200
	%	97.89	97.37	96.32	96.74	96.99	96.74	95.69	96.65	95.69
Revised										
		UU			US			ONB		
		A	B	C	A	B	C	A	B	C
First round (n=23)	N	155	165	160	200	202	199	145	144	139
	%	84.24	89.67	86.96	86.96	87.83	86.52	90.06	89.44	86.34
Second round (n=19)	N	136	138	133	170	166	160	127	123	128
	%	89.47	90.79	87.5	89.47	87.37	84.21	95.49	92.48	96.24
Revised		95.61	95.61	92.11	96.06	95.40	92.11			
A: Important; B: Feasibility; C: Confidence										

Table 3. Results of S-CVI within modified Delphi method

## 5 DISCUSSION AND CONCLUSION

As it aforementioned that there are four features of the Delphi method: anonymity (nameless), iteration (at least twice), controlled feedback (removed inappropriate questions), and aggregation of group answers (converting individual viewpoint into group consensus). The modified Delphi method enables this study to provide a prepared questionnaire for Delphi group to reflect on the specific aim of the instrument, and to anonymous write their comments on each question. The process of this method will generate both quantitative (I-CVI and S-CVI) and qualitative results for confirming the content validity of each question: (1) a quantitative approach helps to remove inappropriate questions; (2) a qualitative approach assists in providing sufficient evidence for explaining the reason for eliminating questions from the proposed instrument. In short, a qualitative approach to the Delphi method not only helps to explain the reasons for removing questions, but also assists in revising the content, wording and syntax of each question for targeting a specific research theme among a panel of experts. By the way of two-interactive Delphi method, accordingly, the overall process of both I-CVI and S-CVI helped to ensure the content validity of each question and element. Each question and element in this instrument contains high content validity. Consequently, the number of questions was reduced from 76 to 74, with a free-text added to measure end-users' opinion of using EHRs in Taiwan.

Table 3 indicates that questions in the aspect of Technological and Net Benefits were not changed; however, there is a minor modification in the aspects of Organizational and Human. Significantly, all experts in the Delphi group were executive managers in hospitals. The results of using the two-interactive Delphi method indicate that questions in System Quality, Medical Data Quality, Service Quality, Safety quality and Organizational Net Benefits are appropriate for supporting decision-making; questions that needed to be removed were not relevant to the underlying construct. These responses from a panel of experts enabled the conversion of individual subjective viewpoints into a group objective consensus. This result indicates that the selections of experts as the participants of the Delphi group are important, because they are related to the specific research theme of this study.

Previous research has recommended the Delphi as being an appropriate method in identifying the content validity of an instrument (Takemura, Liu et al. 2006; Rushton & Lindsay 2008). Accordingly, a modified Delphi method and the method of both investigators and data were used in this study to develop a suitable instrument for measuring Taiwanese EHRs success. In order to clarify the main function of modified Delphi method and to explain the method of computing I-CVI/S-CVI for confirming the content validity of the proposed instrument, this study also explained its three main elements: (1) function and intention of the Delphi group; (2) selecting appropriate participants as the Delphi group; (3) methods of identifying content validity index (CVI): the cut-off point of I-CVI being 78% (90% for S-CVI).

Results of using the two-interactive Delphi method were discussed based on both quantitative and qualitative research approaches. Twenty-three of thirty experts (76.67%) responded to Round I, and nineteen of twenty-three (82.60%) responded to Round II, the degree of consensus being stable among experts in Round II. The overall results of the two-iterative Delphi method indicate that seven questions (HE2, OB2, OB4, UU4, UU5, US2 and US4-1) need to be removed from the proposed instrument, and that five questions (HE3, HE4, UU2, UU3 and US3) need to be modified to be more relevant to the proposed evaluation element. Finally, the number of questions was reduced from 76 to 74, with a free-text added to measure end-users' opinion of using EHR system in Taiwan (Table 4).

Evaluation Elements	Original	Delphi Method		
		Revised	Removed	Modified
Organizational Aspect				
Healthcare Environment *	4	5	HE2	HE3, HE4
Organization Behaviours *	10	8	OB2, OB4	
Technological Aspect				
System Quality	9	9	--	--
Medical Data Quality	10	10	--	--
Service Quality	7	7	--	--
Safety Quality	11	11	--	--
Human Aspect				
User Usage *	8	8	UU4, UU5	UU2, UU3
User Satisfaction *	10	9	US2, US4-1	US3
Net Benefits Aspect				
Organizational Net Benefits	7	7	--	--
Total	76	74		
* questions have be removed or revised; -- there is no change				

Table 4: the development of instrument in each version (Unit: questions)

A “good” research instrument needs to demonstrate **construct validity** and **reliability** with larger samples for ensuring both “reliability” and “validity” (Ammenwerth, Kaiser et al. 2003). However, the first phase for providing a good instrument is to confirm its content validity. For performing the Delphi method, therefore, selecting “experts” as the participants of the Delphi group are very important because they need to understand and have experiences which are related to the specific research theme of performing such method. The results of

this study identify that the modified Delphi method is indeed a useful technique to combine both quantitative (can be processed statistically) and qualitative (anonymous written explanations in conjunction with controlled feedback) research approaches in designing a suitable instrument. A qualitative approach provided a reference to modify the wording and/or syntax of questions for implementing such instrument in real medical environment. In short, based on results of this study, an appropriate instrument was provided to measure end-users' opinions of using EHR systems in Taiwan.

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## Appendix 1: questionnaire for the modified Delphi method

### Part A : Healthcare Environment

1. The Department of Health (DOH) is willing to assist hospitals to establish EHRs in Taiwan.
2. Do you know that all the hospitals around your hospital are implementing EHRs in their patient service?
3. Implementing EHRs helps your hospital to improve the capacity of clinical service within its location.
4. Implementing EHRs not only helps your hospital to establish a patient-centred medical environment based on the issue of patient safety, but also increase the chance to cooperate with other hospitals.

### Part B : Organizational Behaviour

1. Healthcare professionals are willing to adopt and accept new medical technology products in your hospital for patient care and clinical service.
2. Implementing EHRs is a kind of operational strategy to perform the issue of patient safety and obey the regulation of hospital accreditation in your hospital.
3. Implementing EHRs is a kind of executive policy to perform the issue of patient safety.
4. You are agreed with the leadership and administration of top managers to adopt EHRs within your hospital.
5. Implementing EHRs are decided and supported by top managers in your hospitals.
6. Healthcare professionals are willing to support the implementation of EHRs within your hospital.
7. Please select an appropriate item to present your opinion about the reason that your hospital is willing to adopt EHRs.
  - (1) Obeying related regulations, laws, and national goal to perform EHRs which were executed by the DOH of central government.
  - (2) Satisfying the requirements of the program of Hospital Accreditation in Taiwan.
  - (3) Performing the issue of patient safety of health care in clinical service.
8. Implementing EHRs needs to satisfy the specific requirements of different departments by providing unique features and functions in your hospital.

### Part C: System Quality

1. The EHRs have the capability to permit an end-user importing/exporting data from other applications.
2. The application of the EHRs is correctness and responds to your commands consistently.
3. The application of the EHRs is ease to get access to operate such system and helps you to provide better patient service.
4. Unauthorized users can not use the EHRs based on the issue of operating regulations, (without personal unique passwords).
5. The hardware of the EHRs is easy for new members to use such system without reading user guideline.
6. The application of the EHRs will be able to understand the operation of such system easily by its interfaces.
7. The application of the EHRs is confident of the capability to perform your transactions of patient care.
8. You are satisfied with the response time due to the EHRs response to your commands quickly.
9. The EHRs provide unique features and functions to meet the specific requirements of your department, such as hand-drafting to describe the location of disease.

### Part D : Medical Data Quality

1. The EHRs provide error free information.
2. The EHRs present accessibility information of patient care on demand.
3. The EHRs provide useful information includes clinical examine data that you need in clinical diagnosing and decision making.
4. The EHRs offer reliable information of patient care on demand.
5. The EHRs provide constructive and up-to-date information of patient care for different clinical departments.
6. The EHRs supply exactitude information of patient care to support and enhance your clinical decision making.
7. The EHRs provide suitable information that relevant to patient status when you have to making an exact diagnosis.
8. The EHRs offer appropriate information timely to enhance your diagnosis and decision making.
9. The EHRs help you to record and collect patient data on demand for an exact diagnosis.
10. The EHRs assist you to record and organize your specific notes in patient care, such as HIV patients, phthisis patients.

### Part E : Service Quality

1. The Department of Information Management (DIM) staffs provide and possess sufficient knowledge to answer your questions about operating the EHRs
2. The DIM staffs always complete user's request for new applications and /or functions, design, expansion, and executions of the EHRs during a reasonable and acceptable time.
3. The DIM staffs always try their best (good manners, flexible methods, and timely of required time) to respond to your request for changing the functions and/or services of the EHRs.
4. The DIM staffs provide efficient knowledge to help users realize and deal with operational problems of the EHRs.
5. The DIM staffs are courteous and willingness to solve your problem of operating the EHRs and make you to feel comfortable with their attitude..
6. The DIM staffs provide essential education and training programs to help you to operate the EHRs.
7. The DIM staffs always provide sufficient support and technology skills to maintain the hardware and software of the EHRs.

### Part F : Safety Quality

1. The EHRs display a patient's name in each screen to help you recognize patients' identification.
2. Using unique password to limit and control the access to the EHRs can protect patients' privacy.
3. Using each unique password limits your authority to protect patients' secrecy of disease history.
4. The functions of security in the EHRs are sufficient to defend attack from virus and unauthorized users.
5. Using unique password to manage the access to the EHRs is one of the best ways to perform the issue of consent of patient medical records.
6. The EHRs provide easily understandable procedures for disaster malfunction recovery.
7. The EHRs save your working file automatically while you are recording patient data.
8. The EHRs perform a usual and routine backup.
9. The EHRs help you to double check the dose of drug and for enhancing patient safety.
10. The function of drag interaction alerts helps you to reduce medical errors.
11. This EHR systematically check and identify typing error while you are recording patient data.

### Part G : User Use

1. Comparing The EHRs with the traditional paper (hand-writing) medical records that you used, please present your opinion of this EHR depending on your daily work
  - (1) The EHRs help you to complete medical record easier than the traditional ones.
  - (2) The EHRs help you to search for a patient's previous data easier than the traditional ones.
  - (3) The EHRs help you to confirm a patient's medical history and discover potential disease than the traditional ones.
  - (4) The EHRs provide you a comprehensive medical record than the traditional ones.
- 2-1 The locations and numbers of computers where they stand are appropriate for users to operate The EHRs.
- 2-2 The interfaces of this EHR are convenient for you to operate this EHRs in key-in patient record.
- 3-1 What is the average frequency for you to use computer in your daily work?
  - (1) None. (2) One time per month. (3) Several times per month.
  - (4) Several times per week. (5) Several times per day.
- 3-2 How much time do you use the EHRs in your daily work?
  - (1) None. (2) Less than half an hour. (3) More than half an hour and less than one hour. (4) More than one hour and less than three hours.
  - (5) More than three hours.

### Part H : User Satisfaction

1. The EHRs are very easy to use and you are happy to use it.
2. The EHRs need advance skills of computer operation to use it.
3. The presentation style of patient information and the interface in the EHRs help you to make an exact diagnosis.
4. Please select an appropriate item to present your personal expectation of the potential benefits by using the EHRs that support your daily work within your hospitals.
  - (1) The EHRs provide you new cure methods for patient care.
  - (2) The EHRs assist within your hospitals to advance the procedures of clinical service. The EHRs assist within your hospitals to improve the procedures of medical records management.
  - (3) The EHRs assist within your hospitals to enhance the procedures of healthcare administration.
5. Please select an appropriate item to present your overall satisfaction at the EHRs.
  - (1) The EHRs indeed help you to write correct patient records.
  - (2) The EHRs indeed help you to save your time in writing patient records.
  - (3) The EHRs indeed help you to save your time in waiting for patient records delivery when comparing with the traditional paper records.

### Part I : Organization Net Benefits

1. The EHRs help your hospital to enhance the quality of patient service based on the issue of patient safety.
2. The EHRs help your hospital to enhance the quality of medical records writing based on the issue of patient safety.
3. The EHRs help health professionals doing things right in patient care based on the issue of patient safety.
4. The EHRs help health professionals doing right things in clinical service based on the issue of patient safety.
5. The EHRs help health professionals to reduce medical error in writing medical records.
6. The EHRs help health professionals to communicate transmits patient information of consultations between different departments..
7. The EHRs help your hospital to reduce operating cost when compares with traditional paper medical records.