SEMARAK ILMU PUBLISHING

Journal of Advanced Research in Applied Sciences and Engineering Technology

Journal homepage:
https://semarakilmu.com.my/journals/index.php/applied_sciences_eng_tech/index
ISSN: 2462-1943

The Determination of Factors for ICT Quality Assessment Model

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ABSTRACT

Information and Communication Technology (ICT) is a crucial asset in business processes and high ICT quality allows for highly efficient business processes. Measuring ICT quality is identified as a crucial step towards ensuring high-quality ICT service. Over the years several ICT assessment models have been developed and each year the factors of measurement are constantly updated. This is due to constant change in technology trends and the user requirements. Thus, any existing factors within models developed previously require review and update if necessary. Therefore, the most relevant factors for ICT assessment model are investigated in this study. Through literature review a set of updated factors are developed and expert review were used to validate the factors. Factors determined in this study are: Software System and Application, Computing Hardware, Network and Communication, Lifelong Learning organizational Governance, Ecosystem Support, Security and Official Recognition. The updated and validated factors shall help future researchers in developing a model to assess ICT compliancy for measuring readiness in providing quality ICT services.

Keywords:
ICT service quality; e-readiness; ICT maturity model; organization

1. Introduction

Current organizations heavily rely on the use of Information and Communications Technology (ICT) to run their businesses, support their operations and, most importantly, serve their customers. High quality ICT services can enable greater competitiveness and better communications for the users and their clients. Edward Deming defines quality as "Good quality means a predictable degree of uniformity and dependability with a quality standard suited to the customer" [1]. The requirements for an item to be of high quality are often set by the interested party measuring the preferred item and are mostly everchanging through time. This is beneficial since everchanging means that there exist continuous improvement of the item of interest and continuous improvement can lead to better fulfilment of user satisfaction [2,3].

In the late 1990s, a concept was developed to offer a unified framework for assessing the extent of the digital divide between more developed and less developed or developing countries [4]. E-Readiness has several definitions and interpretations due to its dependence on people, contexts and

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https://doi.org/10.37934/araset.57.1.316325

objectives [5]. However, in general, it refers to the level of preparedness in accessing network infrastructures and technologies, while an ICT maturity model comprises a sequence of maturity levels for a specific class of objects [6,7]. The existence of hundreds of different ICT maturity models makes it imperative for any organization to know which specific tool to use to assess their maturity level accurately [8]. Bridges.org has categorized the E-Readiness assessments into four main branches of assessments and based on these description ICT maturity model can be regarded as a similar concept [5]. Table 1 summarizes categories of E-Readiness assessment defined by Bridges.org.

Table 1
Bridges.org categorization of e-readiness assessment [5]

Categories	Description	Example
Ready-to-use tools	Several tools are made available online to be used by the public.	Centre for International Development (CID) at Harvard University in 2000 [9].
Case Studies	Case studies were done numerous times for countries in assessing the countries' specific ICT development and implementation levels	International Telecommunication Union (ITU) [10].
Third party surveys and reports	Most of the reports goals are to review the digital divide among the world by ranking and rating the countries based on their ICT indicators or factors	Networked Readiness Index (NRI) [11].
Others	Any other models that are assessing and evaluating ICT adoption and utilization which includes digital divide reports and position papers.	-

Researchers have also explored Electronic Learning (E-Learning) and Electronic Government (E-Government) to satisfy these industry requirements. E-learning refers to the learning practices by numerous sets of services available online via the Internet [12].

The cause of the countless models exist for ICT assessment is such that every year, the technology trend changes and so do user requirements. Or an indirect to the measurement such as new policy introduced as exampled by United Nation goals of sustainability which is introduced in 2015 [13]. Thus, the gap to be addressed in this study is the need to update the factors for ICT assessment model. This gap is in line with the suggestion made by Masouleh, Allahyari & Atani [14] where the authors proposed the need for broader research efforts to explore previously unexamined indicators or factors and recommended further examination to enhance the framework. This recommendation is consistent with Sanaei [15] suggestion that all models should be redesigned to comprehensively fulfil user measurement objectives. Kiratu & Ruhiu [16] also underscored their framework's utility and emphasized the necessity for additional investigation, particularly in identifying relevant organizational factors for assessing digital readiness in public institutions.

The focus of this study is thus addressing on the review of factors used in previous models and to update and validate them if necessary. The research objective is to identify the most relevant factors as of the current research date and validate them through experts' review. Therefore, the significance of this study lies in its potential to assist future researchers in formulating an updated ICT assessment model.

2. Method

Three phases are involved within this study. The first one is the conceptual study, followed by component analysis and lastly the factor validation. The research methods are summarized in the Figure 1 below.

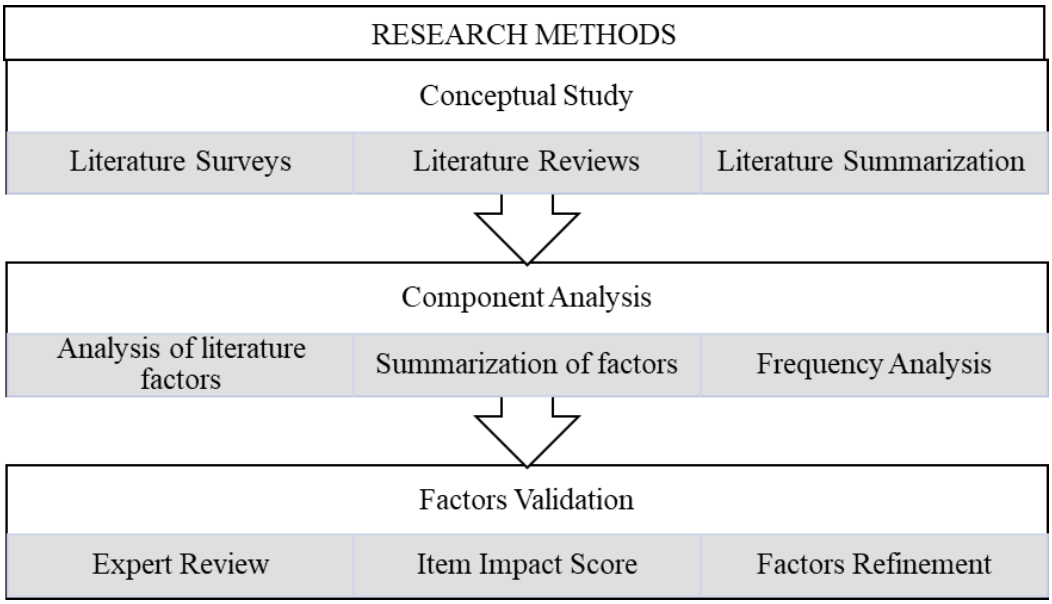

Fig. 1. Research methods phases in this study quality

This study primarily relies on literature surveys and reviews to develop its research. The focus is on assessing factors used in assessment quality of ICT services, primarily under the concepts of E-Readiness and ICT Maturity Model. The review involves evaluating previous assessment models within the concept, identifying the factors used for assessing ICT service quality at the organizational level. This review helps the study understand the current issues in ICT quality assessment, relevant measurement factors and identifies areas where the study can contribute. Based on the insights gained from the reviews, an initial set of factors is proposed. Figure 2 below represent the steps within phase 1 of the study; conceptual study.

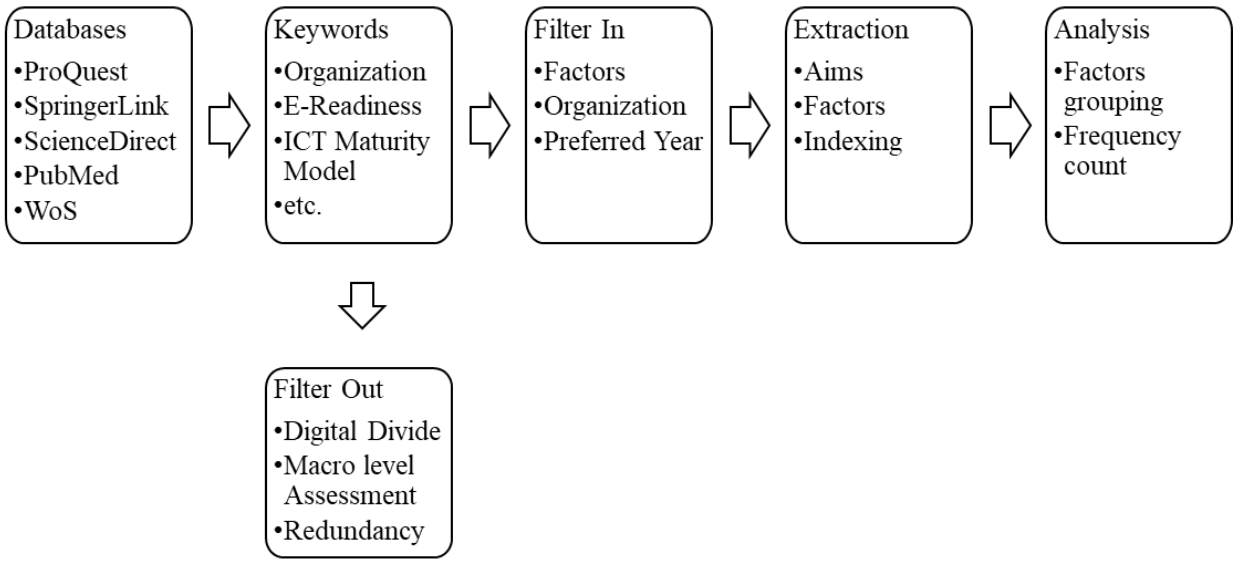

Fig. 2. Approach taken in finding and analysing the relevant literatures source

Following Kitchenham's [17] systematic review procedures, this study conducted a comprehensive search for relevant articles and materials in digital libraries like ProQuest, ScienceDirect and SpringerLink. To identify appropriate measurement tools, also known as inclusion criteria, the study used several keywords such as "E-Readiness," "ICT readiness level," "ICT

Measurement Tools," "IT readiness level," "Digital maturity model," "ICT Maturity Model," and "ICT Maturity levels." To avoid duplication of information, the review also applied exclusion criteria, ensuring unique and distinct papers were included. The focus of this study was on tools and models that specifically address organizational-level ICT readiness indicators or factors, excluding those related to the digital divide among countries or macro-level assessments. Additionally, highly specific ICT maturity models, such as those targeting accessibility for disabled persons, were not considered. The selected papers and articles were limited to those published between 2005 and 2021, prioritizing recent research. The study ends up with 22 papers deemed as relevant. The method of research using literature study as their primary source to develop their own factors in ICT assessment model was also used by many for example by Chanyagorn and Kungwannarongkun [18], Tarvid [19] and Sanaei [15].

In Phase 2, factors are extracted from the materials selected previously. The factors are given special attention and interpreted based on their categories and summaries. The papers' listed factors were then classified into groups based on their similarities in characteristics. The occurrence of each factor in the literature was calculated and tabulated using a frequency analysis, following the approach of Đurek and Ređep [6] and Masouleh, Allahyari and Atani [14]. This analysis helps identify the most significant factors. The same approach of grouping factors and counting their occurrences to determine highly referenced clusters was also employed by Haselberger [20]. Flamini and Naldi [21] similarly used frequency counts to identify preferred publication outlets. Frequency analysis is chosen as a method in this research methodology as it is a straightforward method that allows researchers to describe and summarize data effectively. By counting how often different values occur, researchers can identify common patterns and gain insights from the dataset. It's accessible to researchers with various levels of statistical knowledge since it doesn't involve complex calculations. The results can be presented in tables, charts or graphs, making it easy to communicate findings to both experts and non-experts.

In Phase 3 of the study, Lynn [22] suggested a minimum of three experts for result validation. Fathian, Akhavan and Hoorali [23] and Housein, Yahaya, Deraman and Odun-Ayo [24] also utilized experts for validation, employing an odd number of experts. For this phase, experts were defined as individuals with more than five years of experience in the relevant field of the assessment study. This recommended span of experience aligns with the years suggested by Zulkifli Abai *et al.,* [25]. Using expert review in research is considered despite the additional time it may require because it helps identify and rectify errors in research design, methodology and analysis, resulting in more accurate and reliable findings [26,27]. Expert review also enhances the research's credibility by subjecting it to rigorous scrutiny from field experts, making it more likely for other researchers and the public to accept the research findings [28]. Expert review also prevents publication bias, ensuring that all comments and feedback, positive or negative, are considered in the results presentation. Additionally, the diverse perspectives and expertise of each expert contribute to validating the proposed model from multiple angles.

During the first stage of the validation phase, the factors are validated using questionnaires and direct face-to-face interviews with chosen field experts. The experts were required to answer all the questions provided in the instrument to capture the required objectives of the study. Printed questionnaires were brought to the experts during the interviews and the validation instrument consisted of two parts: the first part covered the expert's demography, while the second part focused on the proposed set of factors, seeking the experts' input on the relevancy of factors listed, with a space provided for any additional ideas or suggestions they had.

The experts' review rating data was utilized to validate the factors using an established analysis method called the Item Impact Score [29], where the impact score was calculated as Eq. (1).

$$Item\ Impact\ Score = Frequency\ \times\ Importance \quad (1)$$

In this formula, "Frequency" represented the number of respondents who rated the item 4 or 5 and "Importance" was the mean score on the 1–5 rating scale. The validation process using Item Impact Score was also carried out by Nayeri, Yadegary, Seylani and Navab [30]. Items with a score of 1.5 or higher (indicating a mean frequency of 50% and a mean importance of 3 on the 5-point Likert scale) were retained, while those with lower scores were eliminated Lacasse [31]. Fathian, Akhavan and Hoorali [23] and Housein, Yahaya, Deraman and Odun-Ayo [24] all conducted result refinement based on expert feedback. This refinement is expected to validate the final factors investigated in this study.

3. Result

Based on the literature reviewed, a set of factors were proposed by extracting and adapting the factors of interest. These factors are categorized into eight groups, which include Software System and Application, Computing Hardware, Network and Communication, Security organizational Governance, Lifelong Learning, Ecosystem Support and Official Recognition. Table 2 below summarizes how the factors in the literature are grouped.

Table 2
Factor grouping criteria

Factor Group	Grouping Criteria
Software System and Application	Factors that point to systems or programs that are provided internally or externally to help employees conduct their responsibility and rights
Computing Hardware	Factors that point to hardware appliances to allow networked system
Network and Communication	Factors that point to performance and potential of the organization network system
Organizational Governance	Factors that point to administration and implementation of ICT protocol and guidelines by the organization
Lifelong Learning	Factors that point to ICT lesson and encouragement for users
Ecosystem Support	Factors that point to system and staff supporting equipment and person
Security	Factors that point to system or equipment providing protection to organisation data
Official Recognition	Factors that point to other certification or recognition of ICT compliancy effort by the organization

After categorizing the factors from literature according to above, the frequency of each factor group is calculated. Table 3 below summarizes the factors obtained from the literatures and their frequency.

Table 3
Factors and their frequency

Author	Software System and Application	Computing Hardware	Network and Communication	Organizational Governance	Lifelong Learning	Ecosystem Support	Security	Official Recognition
Chanyagorn & Kungwannarongkun [18]	X	X	X	X	X	X	X	
Sanaei [15]			X	X			X	
Manrıquez [32]	X		X					
Goh & Blake [33]			X	X	X			
Apleni & Smuts [34]			X	X	X			
Irfan, Putra, Alam, Subiyakto & Wahana [35]			X	X			X	
Masouleh, Allahyari & Atani [14]	X	X	X	X	X	X	X	X
Fathian, Akhavan & Hoorali [23]	X		X	X	X	X	X	
Kiratu & Ruhiu [16]	X	X	X	X	X	X	X	
Ali, Hassanein & Mazen [36]		X	X	X				
Abdelghaffar & Elmessiry [37]		X	X	X				
Alghamdi, Rampersad & Goodwin [38]	X	X	X	X		X		
Fahad *et al.,* [12]	X	X	X	X			X	
Ramayah, Yan & Sulaiman [39]	X	X	X	X			X	
Nabavi & Davidrajuh [40]	X	X	X	X		X	X	
Gupta, Shakya & Marasini [41]	X	X	X	X		X	X	
Tarvid [19]	X		X	X	X	X	X	
Rohayani, Kurniabudi & Sharipuddin [42]	X	X	X	X				
Pham [43]	X		X	X				
Kuusisto, Kääriäinen, Hänninen & Saarela [44]	X	X	X	X	X			
Kalema & Mokgadi [45]			X	X				
Hidayat *et al.,* [46]	X		X	X		X	X	
Frequency	8	12	22	21	8	9	12	1

Three experts were interviewed to validate the factors. The first expert has over five years of experience as an IT officer in an education organization. The second expert is an ICT-related lecturer with more than five years of teaching experience and significant involvement in ICT projects. The final expert is an ICT graduate teacher from a public school, with over five years of experience in the ICT field and responsible for managing the school's ICT infrastructure. All three respondents are considered legitimate experts due to their extensive experience in the ICT-related field. The factors from the literature are listed in a table, each with its corresponding definition. They are organized to ensure a clear understanding of each factor's domain. Experts were then asked to rate and comment the factors and their corresponding definitions whether the factors and definitions are on impactful for ICT assessment model. The rating given by the experts for each item is tabulated in Table 4 below. The ratings by the experts are columnized by respondent number; 1, 2 and 3 accordingly. The ratings were given based on a scale of 1 to 5 where 1 corresponds to the lowest score and 5 corresponds to the highest score.

Table 4
Factor and definition rating by experts

Respondent	1	2	3
Item			
Software System and Application (SS)	5	5	4
Definition: Systems or programs that are provided internally or externally to help employees conduct their responsibility and rights	5	4	4
Computing Hardware (CH)	5	5	5
Definition: Hardware appliances to allow networked system.	5	5	5
Network and Communication (NC)	5	5	5
Definition: Performance and potential of the organization network system.	5	5	5
Lifelong Learning (LL)	5	3	5
Definition: Employees are encouraged on learning of ICT usage and utilization by the organization.	5	5	4
Organizational Governance (OG)	5	5	5
Definition: Administration and implementation of ICT protocol and guidelines by the organization.	5	4	5
Ecosystem Support (ES)	5	2	5
Definition: System and staff supporting equipment and person.	5	5	5
Security (S)	5	5	5
Definition: Security holes are explored and protected sufficiently on equipment and people fronts.	5	4	5
Official Recognition (OR) [Bonus]	5	5	4
Definition: Other certification or recognition of ICT compliancy effort by the organization.	5	5	4

4. Conclusion

Using item impact score analysis detailed in Method's section, the factors and their definitions impact scores are calculated based on the rating given by the experts in Table 4 previously. The calculated item impact score for each item is tabulated below in Table 5. Based on the literature suggestion in Method's section, all items with scores below 1.5 are to be excluded from the model while item with impact score equal to or higher than 1.5 are considered impactful and should be kept in the model.

Table 5
Item impact score results

Item	Factor Impact Score	Definition Impact Score
SS	4.7	4.3
CH	5.0	5.0
NC	5.0	5.0
LL	4.3	4.7
OG	5.0	4.7
ES	2.7	5.0
S	5.0	4.7
OR	4.7	4.7

The item impact score analysis conducted in this study provided valuable insights into the relevance of the factors and their definitions. By calculating impact scores based on expert ratings, we were able to discern the significance of each item, as presented in Table 5. Consistent with established criteria, items scoring below 1.5 were excluded from the model, while those scoring 1.5 or higher were deemed impactful and retained.

Our study's expert review yielded impact scores ranging from 2.4 to 5.0 for each item, indicating the relevance of all factors proposed previously. Consequently, it is imperative to include these factors when developing ICT assessment model. Notably, no additional factors were suggested by

the experts when asked, affirming the comprehensiveness of the proposed model. Furthermore, insightful comments provided by experts underscored the importance of addressing specific aspects such as security comprehensively, encompassing both physical and virtual dimensions.

The consensus among experts through this heuristic validation approach reaffirmed the criticality of the proposed factors. It is evident that these factors are instrumental in effectively capturing the intended ICT assessment.

Looking ahead, future research should explore factors the relationships between factors within the same group. Such analysis would provide deeper insights into the interplay among different aspects of ICT assessment factors, enhancing our understanding of their collective impact. Furthermore, the relationship study might help in determining the weightage distribution of these factors within the ICT assessment model. By undertaking this recommendation, researchers can further refine ICT assessment models and advance the pursuit of high-quality ICT services.

Acknowledgement
This research was funded by a grant from Ministry of Higher Education of Malaysia Education under the Fundamental Research Grant Scheme (UMT FRGS Vot 59561).

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