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# E-Health Readiness for Teams: A Comprehensive Conceptual Model

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**Abstract.** The use of information technology in the delivery of healthcare services is pervasive but faces many barriers. We propose a four-factor comprehensive conceptual model to provide a measure of interdisciplinary healthcare readiness to provide healthcare services using e-health. We incorporate factors from a series of focus group studies and the wider literature and construct a conceptual model. We utilise the Delphi method to establish content validity and use a series of Q sorts for initial construct validity. This model will improve patient outcomes through healthcare teams identifying barriers to using e-health effectively and efficiently.

**Keywords.** Telemedicine, patient care team, readiness, conceptual model, Delphi technique, q-sort, q-methodology

## Introduction

The use of information and communication technology (ICT) in the delivery and administration of healthcare services has had transformative effects on the services able to be delivered to patients effectively and efficiently; this is despite ICT long being implicated in the rise of healthcare expenditure [1,2]. Continued use of ICT in healthcare is inevitable, however greater efficiency and effectiveness in the use of health technologies by clinicians, specifically those operating in interdisciplinary healthcare teams, is needed to allow for improved patient outcomes—a characteristic currently lacking [3,4].

We propose a preliminarily validated comprehensive conceptual model of four factors to provide a measure of e-health readiness in interdisciplinary healthcare teams with the aim of improving healthcare service delivery, and ultimately patient health outcomes.

## 1. Background

The literature has, to present focussed on the identification of factors and the construction of models predominately with concern to physicians and other clinicians'

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acceptance of e-health technology working as individuals—a measure of readiness of interdisciplinary healthcare teams to use e-health technology has not been formed.

An exception to this focus was a qualitative study of a series of three focus group interviews and one individual practitioner interview to identify themes affecting the use of e-health by interdisciplinary healthcare teams providing care to patients with traumatic brain injury [5]. Content and thematic analyses were performed on the transcripts of each focus group session and interview with six themes and multiple sub-themes emerging from the analyses—these themes are (1) Organisational structure and process; (2) Culture and attitudes; (3) External organisations; (4) Training and support; (5) Technology, facilities, and infrastructure; and (6) Policies and guidelines.

Further factors were identified in the broader literature including technological acceptance by physicians [6–8] and patients [18,19]; team performance [9–13], engagement and change acceptance [14–17]; and patient e-health literacy [20–23].

A number of technology acceptance factors for physicians were identified and validated in three studies [6–8] using confirmatory factor analysis with data from physicians in three countries. Significant factors included attitude, subjective norms, and perceived usefulness [6]; social norms and personal norms [7]; and technology support and training, compatibility, and intention to use [8].

Factors affecting team performance are varied and numerous however two factors were found in multiple studies to be significant to team performance improvement—team training [9–11,24,25] and team communication [10–13].

Organisational factors affecting change and technology acceptance were identified within the literature with culture [14,15,24], incentivisation [14,15], resource availability [8,24], and organisational support for change [8,16,17,26] having a significant effect on an organisation's ability to manage change and innovation.

The fourth area from which factors emerged were patient centric factors involving patient acceptance of technology and e-health literacy. With respect to patient acceptance, significant factors were characteristics of patients, technological functionality, the e-health services available to the patient, and the extent of normalisation of the technology [18,19]. Factors directly affecting the ability for patients to use the technology also emerged in 'toolkits' such as eHEALS [20] based on the six factor Lily model [27] which is concerned patient use of online health information, as well as the e-health Literacy Assessment Toolkit (eHLA) [28] which extends the eHEALS model.

Each of the factors identified are to be considered as part of the initial basis of a comprehensive conceptual model for the measurement of interdisciplinary healthcare team readiness.

## 2. Methods

There are three primary stages of the methodology in the construction of the model: (1) initial model formation; (2) model content validation; and (3) model construct validation.

### *2.1. Model Formation*

The HOT-fit model structure [29] was used for the initial categorisation of factors owing to its emphasis on the fit between human, technological, and organisational factors [30]. The unit of analysis for the model was also established as being the interdisciplinary healthcare team. Each of the factors identified in the literature were written as short descriptive sentences describing the principal entity in the factor and the nature of the factor or theme.

Each of the descriptive items were clustered into the most relevant category of: (1) User factors (analogous to human factors); (2) Organisational and external factors; and (3) Technology factors.

### *2.2. Model Validation*

The model was refined using the Delphi method [31] with a panel of five experts, recruited using a snowballing technique, with domain expertise in health service delivery, health informatics, and information technology. Each expert was present for each round and provided input and feedback throughout the process. It was initially estimated that the process would require 3–5 iterations [32].

Each round of the process was carried out with four experts being physically present and one expert participating through teleconferencing facilities, and was completed over a period of 1–1:30 hours every 3–4 weeks. Each panel member was given an electronic copy of the model with audio visual equipment used to display the current item being considered to lessen the likelihood of information overload [33].

For each round of the Delphi method, both the structure of the model and the content of the model was considered and consensus was sought as to the item or construct's suitability. Both verbal and written feedback was provided by each panel member. The feedback from the panel was incorporated into a refined model for the subsequent iteration. This process was continued until consensus was reached by the panel—occurring after three rounds.

The construct validity was preliminarily tested using Q methodology [34] through a sequence of Q sorts [35]. Participants were health technology innovation students with backgrounds of clinical, health administration, and engineering and were asked to undertake an open and a closed card sort of the 59 model items.

Participants were given instructions on completing the open card sort task and brief background information. Participants were not informed of the structure or constructs of the proposed model at this stage.

Each participant performed an open card sort where they were given all 59 items to sort into exactly four clusters and to provide a meaningful name for each cluster. The resulting cluster name and included items were recorded for later analysis.

Participants were then instructed on completing a closed card sort task where they were given the names of the four factors as established in the Delphi process: (1) External Factors; (2) Team Capabilities; (3) Patient Capabilities; and (4) Technology Capabilities, and were required to sort the 59 items into the four categories given. These categorisations were recorded.

The results of the open card sort were placed into a hierarchical clustering using Ward's method [36] constrained to four clusters and the category names created by participants were thematically analysed to extract a representative name. These emergent four clusters were compared against the a priori model. The closed card sort was analysed for convergence of item placement where the proportion of item placement against each category was calculated for each item.

## 3. Results and Discussion

The initial model formation resulted in the creation of ten clusters which were formed from the categorisation of items from the literature. These resources were: (1) strategic assets; (2) operational assets; (3) cultural assets; (4) clinician attitude; (5) clinician ability; (6) patient attitude; (7) patient ability; (8) EMR maturity; (9) technology support; and (10) technology access. These ten clusters were categorised into the three clusters derived from the HOT-fit model. This model was presented as the initial conceptual model to the Delphi panel.

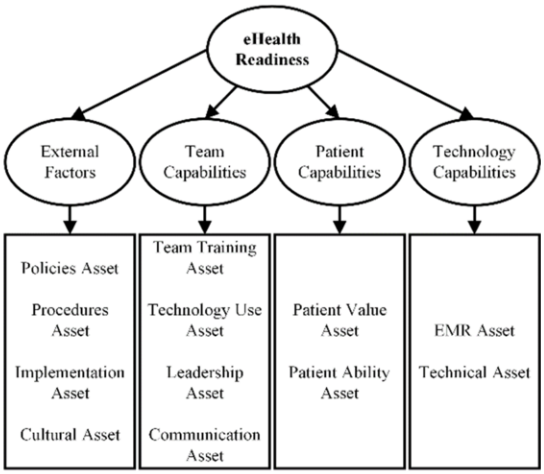


**Figure 1.** Proposed conceptual readiness model.

The Delphi method was used and consensus was achieved on round three with the final model (Figure 1) consisting of four factors: (1) External Factors; (2) Team Capabilities; (3) Patient Capabilities; and (4) Technology Capabilities with 59 items within the model.

The Q sort was attempted by 12 participants with 9 participants completing the open card sort and 10 participants completing the closed card sort. Figure 2 shows the open card sort dendrogram—the cluster names were determined to be (1) Organisation; (2) Users; (3) EMR; and (4) Other Technology. It can be seen that the inter-cluster distance between Clusters 3 and 4 is minimal and it would be reasonable to merge these clusters where the number of clusters is unrestricted—giving rise to the original HOT-fit structure. The emergent clusters do not entirely reflect the factors of the a priori model—External Factors however maps completely to the Organisation cluster.

The Users cluster consists entirely of items from the Team Capabilities and Patient Capabilities factors indicating participants do not consider these two aspects to be separate. As the inter-cluster distance between the EMR and Other Technology cluster in Figure 2 is minimal it is likely that participants do not consider these to be separate constructs. As such these two clusters completely map to the Technology Capabilities cluster in the a priori model. The open card sort suggests that the External Factors and Technology Capabilities constructs are valid—however rewording of the Team

Capabilities and Patient Capabilities items is needed to achieve construct validity for these two clusters and the whole model.

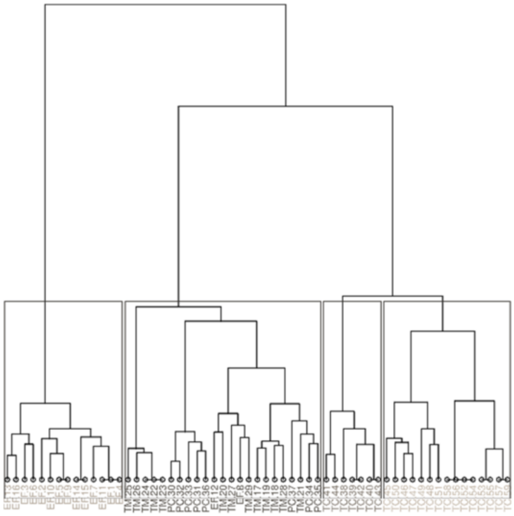

**Figure 2.** Open card sort dendrogram.

The closed card sort results had greater indication of construct validity with six items, all Technology Capabilities items, having less than 60% consensus on the placement of the item and being flagged for revision. There were an additional two Technology Capabilities items which were categorised by participants 70% and 80% of the time into a different category to that of the conceptual model. These results indicate that there is reasonable consensus among participants as to the categorisation of model items when given factor names. Those items with low or incorrect convergence will need to be reworded and the card sort tasks repeated to further determine the construct validity of the proposed conceptual model. If the items are consistently miscategorised then these items may need to be removed from the model.

## 4. Conclusion

E-health technologies are likely to continue to transform the delivery of healthcare services to patients—however implementations are expensive and prone to failure. We propose a four-factor model consisting of 59 items to provide for a measure of readiness of healthcare teams in using e-health to delivery care. We propose a framework which—notwithstanding the inherent methodological limitations with respect to content and construct validation—allows for further validation of the comprehensive conceptual model in addition to the validation performed in this study using the Delphi method and Q methodology. This model will allow healthcare teams to be identified who are able to efficiently and effectively use e-health technologies in their practice and minimise the occurrence of costly failure through healthcare teams being unable to use the technology implemented and improve patient outcomes.

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