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E-Health Readıness Scale of Health Instıtutıons: Development, Valıdıty and Relıabılıty[1]

Sağlık Kurumlarının E-Sağlığa Hazırbulunuşluğu Ölçeği: Geliştirme, Geçerlilik ve Güvenirlik Çalışması

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ABSTRACT
The use of information and communication technologies, known as e-health, in health services is rapidly increasing. This study aims to develop a measurement tool that can evaluate the readiness of health institutions for e-health applications and to test its validity and reliability. In this research, which was conducted with an exploratory sequential mixed method research, the qualitative research phase was primarily conducted. At this stage, semi-structured interviews were conducted with eight experts in the relevant field, and the data obtained were analyzed with the MAXQDA 2020 program. At this stage, an item pool consisting of six sub-dimensions and 40 items was created for the e-health readiness scale of health institutions. These items were reduced to 33 after the expert opinion and content validity stages. The draft scale of e-health readiness of health institutions was applied to an appropriate sample in the quantitative research stage, and the reliability and construct validity of the scale were examined with the R-Project 2021 program. As a result of these analyses, the scale of health institutions' e-health readiness consists of four sub-dimensions and 25 items: acceptance and readiness for use, self-sufficiency, technology and infrastructure readiness, and structural readiness.

Anahtar Kelimeler
e-sağlık, karma yöntemler, bilgi ve iletişim teknolojileri, sağlık kurumları.

ÖZ
Sağlık hizmetlerinde e-sağlık olarak bilinen bilgi ve iletişim teknolojilerinin kullanımı hızla artmaktadır. Bu çalışmada sağlık kurumlarının e-sağlık uygulamalarına hazır olma durumlarını değerlendirebilecek bir ölçme aracı geliştirilerek geçerlik ve güvenirliliği sınanması amaçlanmıştır. Keşfedici ardışık karma yöntem araştırmasıyla yürütülen bu araştırmada öncelikle nitel araştırma aşaması yürütülmüştür. Bu aşamada ilgili alanda uzman sekiz kişiyle yarı yapılandırılmış görüşmeler yapılmış ve elde edilen veriler MAXQDA 2020 programı ile analiz edilmiştir. Bu aşamada sağlık kurumlarının e-sağlık hazırlığı ölçeği için altı alt boyut ve 40 maddeden oluşan bir madde havuzu oluşturulmuştur. Uzman görüşü ve içerik geçerliliği aşamalarından sonra bu maddeler 33'e düşürülmüştür. Sağlık kurumlarının e-sağlık hazırlığı taslak ölçeği nicel araştırma aşamasında uygun bir örnekleme uygulanmış ve ölçeğin güvenirliliği ve yapı geçerliliği R-Project 2021 programı ile incelenmiştir. Yapılan analizler sonucunda sağlık kurumlarının e-sağlık hazır bulunuşluğu ölçeği; kabul ve kullanıma hazır olma, öz yeterlilik, teknoloji ve altyapı hazır bulunuşluğu ve yapısal hazır bulunuşluk olmak üzere dört alt boyuttan ve 25 maddeden oluşmaktadır.

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1. Introduction

During the Covid-19 epidemic, all aspects of the healthcare sector, including healthcare institutions and patients, have had to reorganize and adapt to new situations. In this period, the trend towards digital health applications has increased in order to reduce infectious risks to lower levels by reducing physical contact between healthcare providers and patients.

In addition to epidemic periods, geographical limitations also cause the rapid development of digital health applications in the healthcare sector. Digital health applications, which allow individuals living in rural and urban centers to benefit from health services equally, may also bring with them some risks. One of these risks is that healthcare providers and patients are not prepared for the practices in the relevant field. This situation causes the time and effort spent on digital health applications in the healthcare sector to be wasted and leads to financial losses. In order to minimize or eliminate such losses, it is necessary to evaluate the preparedness of the relevant parties and take the necessary measures. In this context, the aim of the research is to discover and test the validity and reliability of a measurement tool that can evaluate the readiness of health institutions for e-health applications. Baur and Deering (2000) e-health; It is defined as the use of electronic technologies in health and public health, including personal care, consultancy, e-health commerce, data warehouses, registry service and detection of factors that threaten public health. The focus of the traditional healthcare system is on the care of the patient rather than on improving health. In e-health applications, the emphasis is on preventive and widespread health services (Tan, 2005). E-Health system is an area that brings a new service concept in the health sector by providing speed and dynamism as well as efficiency and flexibility (Kılıç, 2017). Additionally, e-health applications use highly efficient innovative systems to minimize human-caused medical errors. This reduces the need for travel and waiting times. There are also some obstacles to accessing such benefits of e-health applications. These obstacles include fear of change, resistance to change, and concerns about security and privacy (Tan, 2005; Gaddi, 2013; Mazloomi, 2018). E-health readiness refers to the readiness of health institutions or communities for possible changes that may develop with information and communication technologies (Qureshi et al., 2012).

Among the World Health Organization (WHO)'s 2020-2025 Global Health Strategic Goals; "Analyze the state of digital health networks and partnerships at national, regional and global levels to promote and engage in collaborations and partnerships to support successful global digital health transformation" and "Inform relevant stakeholders, regulatory bodies and stakeholders to support the implementation of digital health transformation at the national or regional level." "Identify and connect with regional e-Health/digital health networks". In this context, it is believed that evaluating the readiness for e-health applications will contribute to both the achievement of the determined goals and the relevant literature. In the relevant literature, Yusif et al. (2017) determined, as a result of their systematic analysis of studies evaluating the current e-health readiness, that e-health readiness at both individual and institutional levels was evaluated through different themes and structures. The authors stated that there are no reliable measurement tools even for the most commonly used constructs. Mauco et al. (2020) also underlined in their study that there is a need to develop different evaluation tools for various stakeholders as well as managers and healthcare providers.

When the studies in the literature are examined, studies that evaluate readiness for a single digital health application are frequently encountered, rather than studies that evaluate readiness for e-health applications in general. Wubante et al. (2022) evaluated whether healthcare providers working in private hospitals were ready for telemedicine and examined the factors affecting this readiness. The research reported that the majority of healthcare professionals are ready to adopt telemedicine and that preparation for telemedicine can improve the quality of healthcare services. Hailegebreal et al. (2023) examined whether healthcare providers are ready to adopt the Electronic Medical Records (EMK) system. As a result of this research, it was determined that the majority of the participants had a good knowledge of the EMK system. It was also determined that the majority of participants had a positive attitude towards the EMK system and were generally ready for EMK. However, the general evaluation of e-health readiness is important in increasing the efficiency and effectiveness of patient care, improving patient safety and service quality, enabling healthcare institutions to better manage large data sets, and providing the opportunity to provide healthcare services to a wider range of patients, especially in rural and hard-to-access settlements. It is believed that there will be effects. Evaluating e-health readiness will allow healthcare institutions to make strategic plans for the future by evaluating their current situation. It is believed that the e-health readiness scale of health institutions developed within the scope of this research can make a comprehensive evaluation with high reliable coefficients.

2. Method

The main purpose of this study is to evaluate the degree of preparedness of healthcare institutions in terms of implementation of e-health initiatives. To achieve this goal, a research methodology known as the exploratory

sequential mixed methods model was used. Mixed methods research requires the use of both quantitative and qualitative methods in data collection(Greene et al., 1989). While the quantitative method focuses on the collection and analysis of numerical data, the qualitative method emphasizes the collection and analysis of textual data. In the exploratory sequential mixed methods design (qualitative → quantitative), first qualitative data are collected and analyzed. Qualitative findings are then used in the development of the second stage, the quantitative method stage. In this context, the purpose of the exploratory sequential mixed design, which is one of the mixed methods research designs, is to create a scale or to create variables determined based on qualitative data and apply them quantitatively (Toraman, 2021).

This research was conducted between 14.07.2021 and 22.12.2022.The research consists of qualitative data collection consisting of expert interviews, qualitative data analysis, tool development based on interview data, quantitative data collection using an online survey tool with an appropriate number of participants, and finally analysis of quantitative data. The following sections will describe the qualitative and quantitative procedures used to develop and validate the e-health readiness scale.

2.1. Qualitative Research Phase

In the qualitative phase of the research, it is desired to discover the dimensions of e-health readiness. The data was obtained by interviewing people who are experts and experienced in the relevant field. In a study, by using the interview technique, an attempt is made to enter the inner world of the person participating in the interview and to understand and comprehend the events from their own perspective (Patton, 1987). In the semi-structured interview technique, researchers create interview questions in advance, but can change the interview questions according to the progress of the interview (Güler et al., 2015; Güçlü, 2019).

Participants

Experts who will participate in the semi-structured interview were determined according to the purposeful sampling method. Experts were selected from those who would contribute the most to the research using the snowball sampling method, which is one of the non-probability sampling methods within the scope of purposeful sampling methods. Chain access logic prevails in snowball sampling (Güler et al., 2015). The selection of experts consists of professionals with experience in the sector and academicians with academic studies in this field. Before starting the interviews, expert selection criteria were clearly determined and the interview questions were presented to the selected experts for their opinions and necessary corrections were made. In this context, a total of eight experts, four physicians and four academicians, participated in the research. Participants were coded as P1-P2-...-P8.

Based on the information in the literature, the interview concludes when the researcher begins to repeat expressions that may be the answer to the research question and thus reaches a saturation level (Glaser and Strauss, 1967; cited in Yıldırım and Şimşek, 2018). During the last two interviews, it was determined that the issues emphasized by the previous participants were repeated and the interviews were concluded.

Interviews continued until data saturation was reached. The researcher first began the interviews with the question "What does it mean to be ready for e-health?" It started with a general question. According to the answers given by experts, "What is required for health institutions to be prepared for e-health?" Interviews continued with buffer questions such as:

In data analysis, the researchers first converted the voice recordings into transcripts, and then all transcripts were reviewed together with the voice recordings. In qualitative research data analysis, thematic analysis stages were taken into consideration. Thematic analysis, as a qualitative data analysis method, serves the purpose of identifying, examining and documenting themes in the data (Braun and Clarke, 2006).

After the data was transferred to the MAXQDA 2020 program, another researcher was involved in the code guide creation, theme definition and data analysis processes. Researchers independently analyzed the data in accordance with the code guide. The consistency between the coders was examined and necessary adjustments were made.

2.2. Quantitative Research Phase

This phase of the study was determined according to qualitative research findings. It was wondered to examine the structural validity of the Health Institutions' E-Health Readiness Scale, which consists of 6 dimensions discovered based on qualitative research findings, and to what extent the quantitative findings would support the qualitative findings.

Sample size and sampling technique: Gorsuch (1983) recommended a minimum of five participants per variable or at least one hundred participants per analysis (as cited in Bryman and Cramer, 2001). Therefore, within the scope of the exploratory factor analysis of the research, the sample was 340; Within the scope of confirmatory factor analysis, the sample was determined as 260. While determining the sample, convenience sampling method,

which is one of the non-probability sampling types, was applied. In convenience sampling, researchers carry out the application phase using the sample they can most easily reach until the sample they need is reached (Gürbüz and Şahin, 2014). In this study conducted during the pandemic, the convenience sampling method was preferred due to the time constraints of the study and the difficulties in accessing health institutions. The limited access to health institutions and employees during the pandemic period revealed the need for fast and secure data collection. For this reason, the researchers adopted the convenience sampling method in order to carry out the data collection process in the fastest and most effective way. In this context, data were obtained through a scale from physicians and nurses after obtaining the necessary permission from the provincial health directorate of a province in Turkey and the chief physician of the hospitals. Research data were collected between July 2021 and January 2022.

In the application of the scale, the items in the scale were applied using 5-point Likert type scaling. Answering the items was structured as "Strongly Disagree-1", "Disagree-2", "Undecided-3", "Agree-4", "Strongly Agree-5" and questions were also included for demographic information.

Data analysis: Exploratory factor analysis (EFA) was used to determine the sub-dimensions of the scale used in the research. The most appropriate number of factors for the scale was determined using Kaiser's eigenvalue≥1 rule (Kaiser, 1960). This rule is a widely used method to determine the significance level of factors and is widely accepted in the literature as providing reliable results when evaluating the share of factors in the total variance (Kaiser, 1960; Fabrigar et al., 1999). In particular, we believe that this rule is appropriate to accurately reflect the multidimensional structure of our data set. For EFA, Varimax method was used in the rotation process and Principal Component method was used in the estimation process. The Varimax rotation method aims to maximize factor loadings based on the assumption of independence between factors. This method is frequently preferred in the literature because it makes the factors easier to interpret and clarifies the relationships between factors (Thurstone, 1947; Tabachnick and Fidell, 2007). For this reason, we preferred Varimax rotation when determining the different dimensions of our scale. In the EFA stage, since the scale items had an ordinal measurement level, dimension reduction operations were carried out with the Polychoric correlation matrix (Şencan and Fidan, 2020). The polychoriac correlation matrix was used to more accurately reflect the relationships between variables, especially those with an ordinal data structure. This method allows for more consistent results by taking into account nonlinear relationships between variables (Holgado-Tello et al., 2010; Jöreskog, 1994). Therefore, the polychoriac correlation matrix was preferred to accurately determine the factor structure of our scale.In addition, assumptions such as the Kaiser Meier Olkin (KMO) sampling adequacy statistic and Bartlett's sphericity test, which are among the basic assumptions of the EFA process, were examined. In the last stage, Cronbach's alpha reliability analysis was applied to evaluate the internal consistency of the developed scale. In the next stage, confirmatory factor analysis (CFA) was applied to test the validity of the developed scale. Since the data was Likert type in the estimation phase of CFA, the diagonal weighted least squares (DWLS) technique was preferred. DWLS is recommended in the literature as an appropriate estimation method, especially for small sample sizes and non-normal distributions (Muthén, 1984; Finney and DiStefano, 2013).

All statistical analyzes were carried out using the R-Project program (Team, 2021) and the lavaan (Rosseel, 2012) package. The confidence level in the study was evaluated as 95%.

3. Findings

Findings of the qualitative study: In the relevant literature, it has been observed that the level of e-health readiness among health sector stakeholders is most frequently evaluated in health institutions. In these studies, researchers evaluated the preparedness of healthcare institution managers and healthcare providers (Yusif et al., 2017). Participants (P) who participated in the interview within the scope of this study agree that the readiness of health institutions for e-health should be evaluated.

Definitions regarding the common themes discovered according to the results of the qualitative data analysis conducted to determine the dimensions of e-health readiness of health institutions are given below:

The organizational dimension can be defined as the degree to which the institutional environment and culture support and encourage the awareness, implementation and use of e-health innovations. For example, relevant working arrangements, job designs, feedback system as well as whether there is sufficient personnel are evaluated under this dimension. When the relevant studies in the literature are examined, in some studies the organizational and organizational dimension is evaluated as an independent factor (Mauco et al., 2018; Yusif et al., 2017), while in some studies the relevant dimension is evaluated as being related to the scope of the structural preparation dimension (Justice et al., 2012; Pujani et al., 2018; Kiberu et al., 2021). Based on the qualitative research findings of this study, the organizational dimension was evaluated as an independent dimension in the draft scale.

Sample participant comments:

- *There must be manpower to run these systems and managers to manage them (P6).*

- When doing something, it is necessary to think holistically. The technician who will use a device must have the emergency system ready to bring that patient there. There also needs to be a physician who knows how to use this system (P8).
- With e-health applications, the need for manpower will be replaced by machinery. In other words, when another employee is on duty at the next desk of an employee, that person can hand over his/her seat to the computer. In this context, you need to consider his mental health, whether he can work alone, and where and how he will interact with other people within the work design (P1).
- I think that a strategic plan should be created, especially in a way that is open to initiatives in the field of e-health applications, new business models that can be established here, and new health service delivery models (P5).

The legal-legal dimension means that legal regulations and legal sanctions must be regulated. This dimension, which is also referred to as policy preparation in the relevant literature; It refers to the existence of a set of declarations, regulations, laws and judicial interpretations that guide and govern the lifecycle of e-health (Kiberu et al., 2021). As with the organizational dimension, there are studies in the literature that consider the legal dimension as an independent dimension (Khoja et al., 2007), as well as studies that associate it with the structural dimension (Justice et al., 2012; Pujani et al., 2018; Kiberu et al., 2021).) is available. In this study, the relevant dimension was included in the evaluation as an independent dimension based on qualitative research findings.

Sample participant comments:
- Laws and regulations play an important role in the acceptance of e-health applications (P2).
- First of all, legal procedure is needed. First you need to pass the law. E-health applications must operate on legal grounds for reimbursement institutions and patients. This is clear (P2).
- The legal infrastructure for e-health applications must be established and developed with the public interest in mind. (P3)
- How much legal legislation exists regarding the protection and security of patient data? Although information privacy is a concern, there is a need for legislation directly related to the security of patients' data. In other words, at that point, the more adequate the legislation is, the more ready the e-health application will be (P4).
- Now, considering the first things I said about medicine, there is currently a lot of deficiency in the legal part. In other words, legislation regarding e-health applications is lacking (P5).
- Legislation must be ready when e-health applications are implemented (P7).

With the educational dimension, it is stated that the personnel who will use health applications should be trained on the applications and informed about legal liability and cyber security awareness. Although the content of this dimension is related to the structural dimension in the literature, it was evaluated as an independent dimension in the draft scale developed in the first stage of this study.

Sample participant comments:
- So people are afraid of what they don't know. The unknown scares people. People need to have a smooth transition here. This education should be given by teaching people and showing its benefits rather than forcing them. (P3).
- So you have to be ready for this. The system needs to be established and people need to be trained to use it P6).
- We have made really great applications, especially in the field of computing. This area has become very beautiful, but it is very important that the personnel in the field are qualified to implement these. In other words, in-service training should be implemented starting from the provincial health level and programmed very well (P8).

With the technological and infrastructure dimension, it was aimed to determine whether health institutions have sufficient technological and infrastructure resources required for e-health applications. It is stated in the literature that the technological sub-dimension of e-health readiness is related to the determinants of accessibility such as the ability to purchase and develop capacity, as well as an institution's physical access to technology (Khoja et al. 2007).

Sample participant comments:
- Software and hardware are also needed to ensure the readiness of health institutions. Health personnel will have mobile devices (P2).
- Infrastructure, software, etc. for healthcare personnel to be ready for e-health applications. facilities must be sufficient. We cannot expect them to produce or demand these themselves (P5).

Under the acceptance and readiness for use dimension, it evaluates the extent to which members of healthcare institutions are exposed to the concept of e-health and its perceived benefits as well as its negative effects (Mauco et al., 2020). This dimension aims to evaluate whether healthcare providers find e-health applications useful, their mental transformation, motivation and fear of job loss.

Sample participant comments:

- Healthcare professionals need to be convinced about how their work will be easier and better with e-health applications. (P1).
- We also need mental preparation for healthcare personnel to be ready. Again, who should want this? Parties providing and receiving health care must have a mental vision and be consciously prepared (P2).
- Healthcare personnel must be trained to use telemedicine. This both initiates their mental preparation and enables them to develop skills in e-health applications. Because skill is also required in that field (P6).
- That is why the mental transformation in physicians' minds is important and the practice needs to be clarified (P7).

The self-efficacy dimension measures the perception of healthcare personnel as to whether their own capacities are suitable for e-health applications. There is no direct equivalent of this dimension in the literature.
Sample participant comments:
- Therefore, the division of labor will need to be redesigned, taking into account both the technical equipment of the personnel and what they can do (P1).
- We have made really great applications, especially in the field of computing. Thanks to this, the field of computing has become very beautiful, but it is very important that the personnel in the field are qualified to apply these (P8).

Reliability and validity show the interpretive validity of qualitative research by including direct quotations in qualitative research and showing to what extent the participants' perspectives and thoughts are correctly understood by the researcher (Güçlü, 2019:396). In order to ensure the interpretive validity of the qualitative data obtained within the scope of this article, sample quotations are included above along with the definitions of the dimensions. The coding made based on these quotations and the resulting dimensions are presented in Table 1. Since it is not possible to present all the quotations for each discovered code in this article, quotations for some codes are presented.

Table 1. Codes and Themes of E-Health Readiness Dimensions of Health Institutions

	Sub Deminsions	**Codes**
E-Health Readiness Dimensions of Health Institutions	**Organizational Dimension**	New business designs Renewal of working order Reorganization of workflows Having managers who can run the applications Automation is not perceived as a threat Feedback mechanism Sufficient personnel to provide new job opportunities
	Legal Dimension	Organizing the necessary procedures Legal sanctions Adequate legislation
	Education Dimension	Legal awareness Cyber security awareness Providing application training
	Technological and Infrastructure Dimension	Adequate infrastructure Adequate software Adequate equipment
	Attitude Dimension	Being persuaded Find it helpful Mental preparation Fear of losing job Having motivation
	Self-sufficiency Dimensison	Capacity of staff Qualifications of the staff

In order to ensure consistency in the reproducibility of qualitative research, it is necessary to ensure the participation of more than one researcher in the research process (Şencan, 2005:535-536). During the analysis of the data obtained within the scope of this study, the researchers analyzed a certain part of the transcripts independently of each other and checked whether the harmony between the coders was achieved. This

compatibility was examined through the MAXQDA 2020 program. At this stage, the Kappa statistics technique recommended by Cohen (1960) was used to evaluate the agreement between researchers. The Kappa value calculated among the researchers was found to be 0.75. This shows that a significant degree of agreement has been achieved among researchers (see Barret, 2001). Inconsistencies were eliminated by comparing the coding made by the researchers.

In the stability analysis, the researcher repeated the coding process of the obtained data twice at regular intervals. The Kappa value, which indicates consistency between coding made in different time periods, was determined as 0.92. This shows that there is a significant degree of agreement regarding researcher internal consistency (see Barret, 2001). Inconsistencies were eliminated by comparing two different codings made by the researcher.

In order to ensure accuracy and consistency, the coding and thematization results of the research findings were developed by taking into account previous studies in the literature on e-health. While defining the dimensions in the findings phase of qualitative research data, relevant studies were included.

Scale Development: During the creation of the item pool to be included in the draft scale, 40 draft items were written based on the e-health readiness dimensions of health institutions and the codes in the relevant dimensions, which emerged as a result of the analysis of interviews with experts on e-health. The items in the draft scale were submitted to the opinion of relevant field and Turkish language experts to evaluate the suitability of including them in the main scale.

Content validity findings regarding the decision of whether the items in the e-health readiness draft scale of health institutions will be included in the main scale are presented in Table 2.

Table 2. Content Validity Rates of the Draft Scale Items for E-Health Readiness of Health Institutions

Item	**CVR**	**Item**	**CVR**
Item 1	1	Item 22	1
Item 2	1	Item 23	0,25
Item 3	1	Item 24	1
Item 4	1	Item 25	0,75
Item 5	1	Item 26	1
Item 6	1	Item 27	1
Item 7	1	Item 28	1
Item 8	1	Item 29	1
Item 9	1	Item 30	1
Item 10	0,25	Item 31	1
Item 11	0,25	Item 32	1
Item 12	1	Item 33	1
Item 13	1	Item 34	1
Item 14	0,25	Item 35	0,75
Item 15	1	Item 36	0,25
Item 16	1	Item 37	0,25
Item 17	0,25	Item 38	1
Item 18	1	Item 39	0,75
Item 19	1	Item 40	1
Item 20	1		
Item 21	1		
Total Number of Experts 8			
	Content Validity Criteria 0,75		
	Content Validity Index 0,97		

It was decided whether the items in the draft scale would be included in the main scale or not according to Table 2. Accordingly, seven items (Item 10, Item 11, Item 14, Item 17, Item 23, Item 36, Item 37) that were observed to have a lower value than the CVR were removed from the scale. Necessary corrections were made to some items in the scale (Item 25, Item 35, Item 39), taking into account the suggestions of experts. After removing 7 items from the draft scale, CVI was calculated and found to be 0.97. According to the information in the literature, the fact that the CVI value is greater than the KGS indicates that the content validity of the scale is statistically significant (Lawshe, 1975; cited in Yeşilyurt and Çapraz, 2018). According to this information, it was concluded that CVI (0.97) > CVC (0.75) from the values obtained from the draft scale.

As a result, the draft scale consisting of 40 items was reduced to 33 items after the expert opinion and content validity stages. The analyzes carried out to test the construct validity of the developed e-health readiness tool of health institutions were mentioned at the quantitative research stage.
Within the scope of quantitative data analysis findings, first Exploratory Factor Analysis (EFA) findings and then Confirmatory Factor Analysis (CFA) findings will be included.

Descriptive Analysis Results

Frequency analysis results were examined according to the demographic characteristics of the participants included in the study. According to the findings, 5.9% of the participants are 20-24 years old, 12.1% are 25-29 years old, 17.4% are 30-34 years old, 12.1% are 35-39 years old, 20.9% are 40-44 years old, 15.3% are 45-49 years old and 16.5% are 50 and over. 67.1% of these participants are women and 32.9% are men. According to their professional status, 33.9% of the participants are doctors and 66.2% are nurses. Additionally, according to their total service period, 2.1% of the participants are less than 1 year, 11.2% are 1-4 years, 13.8% are 5-9 years, 17.1% are 10-14 years, 55.9% are 15 years and 15 years. They expressed it as above.

Exploratory Factor Analysis Findings

Table 3 shows the KaiserMeierOlkin (KMO) and Bartlett sphericity test results of the EFA findings of the e-health readiness dimensions scale of healthcare institutions. When Bartlett's sphericity test is examined, there is a statistically significant correlation between the items of the e-health readiness dimensions scale of health institutions ($p < 0.05$). Additionally, the KMO statistic is over 0.7 (KMO=0.930>0.7). In light of this finding, the e-health readiness dimensions scale of health institutions is sufficient for sampling.

Table 3. Basic Assumptions of the EFA Process of the E-Health Readiness Scale of Health Institutions

KMO	0.930
Bartlett Sphericity test	4732.643
P	<0.001

Table 4 shows the factor loadings, communality and variance explanation rates obtained as a result of EFA for the e-health readiness dimensions scale of health institutions. According to Kaiser's eigenvalue≥1 rule, the scale is represented under 4 sub-dimensions.

Table 4. EFA Results for the Items of the E-Health Readiness Scale of Health Institutions

Factor	**Item**	**Factor Loadings**	**Communality**	**VER**
Structural Preparation	I24-Employees in our organization receive training on e-health applications (e-pulse, online examination, telemedicine, etc.) periodically	0.870	0.776	0.263
	I28-In our institution, trainings are organized to raise awareness of legal responsibility of healthcare personnel in e-health applications (e-pulse, online examination, telemedicine, etc.).	0.814	0.693	
	I22-Trainings are organized to increase the cyber security awareness of our company's employees.	0.811	0.681	
	I23-Our institution has a feedback system where problems related to e-health applications (e-pulse, e-prescription, telemedicine, etc.) are reported.	0.795	0.675	
	I21- New employment is made in our institution, if necessary, for e-health applications (e-pulse, e-prescription, telemedicine, etc.).	0.692	0.678	
	I6- In our institution, sufficient in-service training is provided on e-health applications (e-pulse, online examination, telemedicine, etc.).	0.679	0.622	
	I25-Legal regulations regarding e-Health applications (e-pulse, e-prescription, telemedicine, etc.) are sufficient.	0.677	0.629	
	I29-Our institution has sufficient manpower to carry out e-health applications (e-pulse, e-prescription, telemedicine, etc.).	0.646	0.668	
	I17-There are managers in our institution who are competent to manage e-health applications (e-pulse, e-prescription, telemedicine, etc.).	0.622	0.568	
	I27-Within the scope of e-Health applications (e-pulse, e-prescription, telemedicine, etc.), in case the patient is misled, it is clear who will be responsible.	0.588	0.550	

Acceptance and Readiness for Use	I16-The working order of our institution is rearranged in accordance with e-health applications (e-pulse, e-prescription, telemedicine, etc.).	0.586	0.499	0.157
	I18-In our institution, new business designs are developed together with e-health applications (e-pulse, e-prescription, telemedicine, etc.).	0.546	0.541	
	I9-I find it necessary for e-health applications (e-pulse, online examination, telemedicine, etc.) to become widespread while providing health services.	0.758	0.743	
	I7-Using e-Health applications (e-pulse, online examination, telemedicine, etc.) increases the quality of my work.	0.734	0.742	
	I2-I am willing to use e-health applications (e-pulse, online examination, telemedicine, etc.) while providing health services.	0.706	0.748	
	I20-I prefer to use e-health applications (e-pulse, e-prescription, telemedicine, etc.) when providing health services.	0.692	0.719	
	I1-I believe that e-Health applications (e-pulse, online examination, telemedicine, etc.) will make my job easier.	0.671	0.756	
	I13-Making financial gain by using e-health applications (e-pulse, e-prescription, telemedicine, etc.) while providing health services motivates me.)	0.628	0.502	
	I10-I am qualified to use e-Health applications (e-pulse, e-prescription, telemedicine, etc.).	0.782	0.662	
Self-Efficacy	I33-I have the technological knowledge to carry out e-Health applications.	0.774	0.733	0.131
	I26-I have the habit of using e-health applications (e-pulse, e-prescription, telemedicine, etc.) when providing health services.	0.773	0.721	
	I12-I can easily learn e-Health applications (e-pulse, e-prescription, telemedicine, etc.).	0.753	0.639	
Technology and Infrastructure	I5-The internet infrastructure required for e-health applications in our institution is sufficient.	0.742	0.647	0.111
	I30-The technical infrastructure (server, network, etc.) required for e-health applications (e-pulse, e-prescription, telemedicine, etc.) in our institution is at a sufficient level.	0.695	0.739	
	I19-Our institution has a sufficient number of technological tools (computer, printer, etc.) to use e-health applications (e-pulse, e-prescription, telemedicine, etc.).	0.650	0.618	

VER: Variance explanation ratio

When the analysis results were examined, items M3, M4, M8, M11, M14, M15, M31, M32 were removed from the analysis because the factor loadings were below 0.40 in all factors. It was determined that the factor loadings of all other items were higher than 0.50 and all communality values were higher than 0.30. Additionally, the variance explanation rates are 0.236, 0.157, 0.131 and 0.111, respectively. According to the EFA results, the scale items of the e-health readiness dimensions of health institutions scale are grouped under 4 factors with a total variance explanation rate of 66.2%.

Table 5. Reliability Analysis Results of the E-Health Readiness Scale of Health Institutions

Factor	Item	Mean	SD	AR	IDA	Cronbach Alfa
Structural Preparation	I24	2.738	1.144	0.797	0.912	0.922
	I28	2.732	1.062	0.753	0.914	
	I22	2.653	1.161	0.742	0.914	
	I23	2.971	1.102	0.755	0.914	
	I21	3.079	1.096	0.704	0.916	
	I6	2.729	1.174	0.714	0.915	
	I25	3.006	1.022	0.704	0.916	
	I29	3.124	1.151	0.709	0.916	
	I17	3.071	1.067	0.692	0.916	
	I27	3.041	1.009	0.674	0.917	
Acceptance and Use Readiness	I16	3.226	0.968	0.627	0.919	0.851
	I18	3.215	1.015	0.604	0.920	
	I9	3.900	1.005	0.801	0.807	
	I7	3.706	1.048	0.762	0.813	
	I2	3.926	0.970	0.834	0.805	
	I20	3.697	0.915	0.725	0.821	
	I1	4.082	0.995	0.774	0.816	
Self-Efficacy	I13	3.300	1.223	0.376	0.889	0.808
	I10	3.626	1.036	0.698	0.758	
	I33	3.562	0.962	0.736	0.741	

	I26	3.556	0.944	0.720	0.748	
	I12	3.965	0.858	0.628	0.785	
	I5	3.503	1.179	0.612	0.773	
Technology and Infrastructure	I30	3.206	1.069	0.782	0.614	0.773
	I19	3.479	1.093	0.707	0.695	

AR: Adjusted R, IDA: Alpha when item is deleted

Table 5 shows the descriptive statistics and Cronbach Alpha reliability analysis results obtained from the subscales of the e-health readiness scale of healthcare institutions. According to the findings, all corrected correlation values for the items of the subscales of the e-health readiness dimensions of healthcare institutions scale are positive. In addition, it is seen that there is no significant increase in the reliability coefficient when items are removed from the subscales. In light of these findings, Cronbach alpha coefficients for the subscales of the e-health readiness dimensions of health institutions scale are 0.922, 0.851, 0.808 and 0.773, respectively. In addition, the overall Cronbach's alpha coefficient of the e-health readiness dimensions scale of health institutions was determined as 0.933.

Confirmatory Factor Analysis Findings

Reliability and validity analyzes of the e-health readiness dimensions of health institutions scale developed in this section were carried out with 260 samples. In this context, Cronbach Alpha reliability analysis was applied to examine the internal consistency of the developed scale. Descriptive statistics of the items of the developed scale are also given along with the reliability analysis findings. Mean (Mean) and standard deviation (SD) values were calculated from descriptive statistics. In the next stage, confirmatory factor analysis (CFA) was applied to test the validity of the developed scale.

Table 6. Reliability Analysis Results of the E-Health Readiness Scale of Health Institutions

Dimension	Item	M	SD	AC	IDA	Alfa
	I24	2.608	1.054	0.689	0.880	
	I28	2.523	1.004	0.723	0.879	
	I22	2.608	1.108	0.632	0.883	
	I23	2.873	0.992	0.665	0.882	
	I21	3.208	1.056	0.591	0.886	
Structural Preparation	I6	2.673	1.064	0.633	0.883	0.894
	I25	2.938	0.911	0.644	0.883	
	I29	2.938	1.082	0.613	0.885	
	I17	3.077	1.018	0.592	0.886	
	I27	3.123	1.002	0.564	0.887	
	I16	3.362	0.979	0.544	0.888	
	I18	3.392	0.930	0.356	0.897	
	I9	4.200	0.804	0.686	0.776	
	I7	3.904	0.893	0.622	0.786	
Acceptance and Use	I2	4.169	0.858	0.745	0.762	0.822
Readiness	I20	3.938	0.784	0.645	0.785	
	I1	4.285	0.881	0.705	0.769	
	I13	3.581	1.217	0.301	0.878	
	I10	3.631	0.939	0.553	0.693	
Self-Efficacy	I33	3.527	0.902	0.595	0.668	0.752
	I26	3.542	0.914	0.561	0.687	
	I12	4.150	0.706	0.498	0.724	
	I5	3.462	1.088	0.654	0.734	
Technology and Infrastructure	I30	3.062	1.056	0.681	0.706	0.806
	I19	3.404	1.037	0.626	0.763	

M: Mean, SD: Standart deviation, AC: Adjusted correlation, IDA: Alpha when item is deleted

Table 6 shows the descriptive statistics and Cronbach Alpha reliability analysis results obtained from the subscales of the e-health readiness scale of healthcare institutions. When the reliability analysis results were examined, the corrected correlation values of the subscale items of the e-health readiness dimensions of health institutions scale were found to be positive. In addition, it is seen that there is no significant increase in the reliability coefficient

when items are removed from the subscales. In light of these findings, Cronbach Alpha coefficients for the general and subscales of the e-health readiness dimensions scale were determined as 0.921, 0.894, 0.822, 0.752 and 0.806, respectively.

Table 7. Fit Index Values of CFA Findings of the E-Health Readiness Scale of Health Institutions

Chi-square (df)	GFI	AGFI	CFI	TLI	RMSEA	SRMR
364.316 (269)	0.961	0.953	0.983	0.981	0.037	0.076

df: degrees of freedom

Table 7 shows the fit index values of the CFA findings of the e-health readiness scale of health institutions. When the CFA findings are examined, the chi-square/df=1.354 value is below 2. On the other hand, GFI, AGFI, CFI and TLI values are above 0.95. Additionally, the RMSEA value was determined to be below 0.05 and the SRMR value was below 0.08. When these findings are evaluated, the validity results for the e-health readiness dimensions scale of health institutions indicate excellent fit.

Table 8. CFA Statistics of the E-Health Readiness Scale of Health Institutions

Dimension	Item	Beta	SE	z-statistic	P
Structural Preparation	I24	1			
	I28	1.020	0.059	17.352	<0.001
	I22	0.974	0.059	16.480	<0.001
	I23	0.887	0.055	16.086	<0.001
	I21	0.959	0.060	15.975	<0.001
	I6	1.012	0.060	16.820	<0.001
	I25	0.856	0.053	16.241	<0.001
	I29	1.035	0.061	16.870	<0.001
	I17	0.979	0.059	16.544	<0.001
	I27	0.906	0.056	16.093	<0.001
	I16	0.859	0.055	15.717	<0.001
	I18	0.511	0.044	11.557	<0.001
Acceptance and Use Readiness	I9	1			
	I7	1.213	0.106	11.491	<0.001
	I2	1.267	0.109	11.631	<0.001
	I20	1.132	0.097	11.619	<0.001
	I1	1.200	0.107	11.221	<0.001
	I13	0.531	0.080	6.646	<0.001
Self-Efficacy	I10	1			
	I33	1.119	0.101	11.110	<0.001
	I26	1.281	0.111	11.560	<0.001
	I12	0.762	0.072	10.638	<0.001
Technology and Infrastructure	I5	1			
	I30	1.086	0.066	16.366	<0.001
	I19	0.896	0.059	15.062	<0.001

SE: Standard eeror

Table 8 shows the CFA statistics of the e-health readiness scale of healthcare institutions. When the findings are examined, it is seen that all sub-items of the e-health readiness scale of health institutions are collected in a statistically significant way ($p < 0.05$). In addition, the path coefficients of all items under the sub-dimensions were found to be positive ($\beta > 0$).

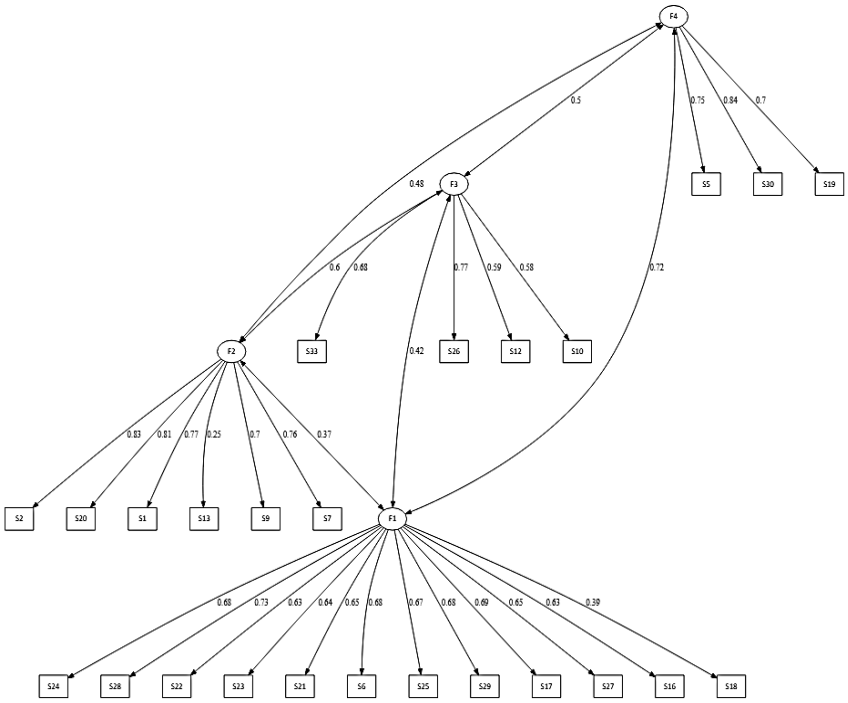

Figure 2. CFA Results of the E-Health Readiness Dimensions Scale of Health Institutions

Figure 2 shows the CFA results of the e-health readiness scale of healthcare institutions. According to the graphical structure obtained as a result of CFA, the standardized load values of all items are positive and above 0.30.
The extent to which the findings obtained in the qualitative research phase of the research were supported by the findings obtained in the quantitative research phase (integration of qualitative findings and quantitative findings) was discussed in the discussion section of the research.

4. Discussion

The e-health readiness scale of health institutions obtained as a result of the qualitative research phase was discovered in a six-dimensional structure in the qualitative data analysis findings. When the explanatory factor analysis findings of the draft scale developed to determine the e-health readiness level of health institutions are examined, it is seen that the relevant scale has a four-dimensional structure. It was observed that the items related to the organizational, legal-legal and educational dimensions in the qualitative research findings were combined into a single factor. Since there is no common opinion in the studies in the literature about whether the relevant dimensions should be considered as independent dimensions or a single dimension, this study aimed to test whether they can be verified by first examining them separately and then verifying them. However, these research findings supported the findings of studies in the literature that considered the three relevant dimensions as a single factor (Pujani et al., 2018; Kiberu et al., 2021). In the relevant literature, studies conducted to determine the e-health readiness of healthcare institutions mentioned "" "structural preparation" dimension is included. The structural dimension means whether an organization has sufficient resources (e.g. human capacity, training, legislation and appropriate equipment, etc.) to be able to provide reliable e-health services (Kiberu et al., 2021). According to this information, "organisational, legal-legal and educational" dimensions have been combined under the "structural dimension" in the scale of e-health readiness of primary health institutions.
The other three dimensions discovered in the qualitative research findings (acceptance and readiness for use, self-efficacy dimensions, technological and infrastructure dimension) are also supported by the quantitative research findings.

In a study conducted in Uganda by Kiberu et al. (2021), the e-health readiness levels of healthcare institutions were evaluated and how infrastructure, technology, human resources and legal regulations affected this process were examined. The importance of the structural readiness dimension was emphasized in this study. Similarly, in our study, structural readiness plays a critical role in the level of readiness of institutions for e-health applications.

This finding underlines the impact of structural factors on technological adaptation and implementation success in healthcare services.

Similarly, Pujani et al. (2018) examined the readiness in the process of adopting e-health applications in regional public hospitals in Indonesia and drew attention to the importance of factors such as technological infrastructure and staff training. Our findings are consistent with this study and show that technological infrastructure and staff training are determining factors in the adoption of e-health applications. This comparison shows that our study correctly identified the basic elements required for the successful implementation of e-health applications.

In addition, Hailegebreal et al. (2023) conducted a study in Ethiopia to assess whether healthcare professionals were ready to implement the Electronic Medical Record (EMR) system. In this study, the knowledge level and positive attitudes of healthcare professionals were determined as important indicators of readiness for e-health applications. The findings in our study are parallel to these results and reveal that the knowledge level and attitudes towards e-health applications are critical factors in the adaptation process of healthcare institutions to these technologies.

5. Conclusion

With this study, the "e-health readiness scale of health institutions", consisting of 25 items in total with four sub-dimensions: structural readiness, acceptance and use readiness, self-efficacy, technology and infrastructure, was developed to evaluate the readiness of health institutions for e-health. The overall Cronbach's Alpha reliability coefficient of the e-health readiness scale of health institutions was calculated as 0.921, and the reliability coefficient of its sub-dimensions was calculated as 0.894, 0.822, 0.752 and 0.806, respectively. When e-health readiness assessment frameworks in the studies in the literature are examined, it is seen that the dimensions obtained in this study support previous studies. For example, Kiberu et al. (2021) in their study, they discussed the structural preparedness dimension, which expresses whether an organization has sufficient resources (human capacity, training, policy and appropriate equipment) to provide reliable health services, within the scope of the e-health readiness evaluation framework. Mauco et al. (2020), in their study, discussed the acceptance and readiness for use dimension, in which healthcare personnel evaluate the extent to which they are exposed to e-health and its perceived benefits as well as its negative effects, within the scope of e-health readiness dimensions. Bhalla et al. (2016) discussed the self-efficacy dimension, which expresses a person's beliefs and expectations regarding their ability to perform a task, in the e-health readiness scale they developed. Studies in the literature (Ojo et al., 2007; Khoja et al., 2007; Wickramasinghe et al., 2005; Kiberu et al., 2021) show that existing hardware, software, networks and internal information and communication technologies resources enable healthcare providers to use clinical innovations and information and communication technologies. It is seen that the technology and infrastructure dimension, which refers to the ability to support the needs, is considered within the scope of e-health readiness evaluation dimensions.

The validity and reliability of the e-health readiness scale of health institutions were determined within the scope of this research. It is recommended that future researchers use this scale to examine the e-health readiness of health institutions in regional, institutional and demographic contexts. Thanks to this scale, healthcare institutions will be able to determine in which areas they need improvement within the scope of digital health applications and develop strategies to plan and implement e-health applications in the most effective way. Healthcare institutions can objectively evaluate their current status regarding e-health applications using this scale. In internal evaluations, this scale can guide the process of identifying weak points and developing improvement strategies in these areas.

The findings provide a clear roadmap for management teams of healthcare institutions on which areas they should focus on to improve e-health applications. In this way, limited resources can be used more efficiently.

Based on the findings in the self-efficacy dimension, the necessary training and development programs can be designed for healthcare professionals to use e-health technologies more effectively. This will increase the level of technology adoption of employees in the long term.

As a result, this developed scale is a reference in the field of e-health and can be a critical measurement tool in the preparation of national and international health institutions for e-health applications. This is important both for institutions providing healthcare services and for improving the quality of care of patients.

The obtained e-health readiness scale can be used as an important tool in increasing the operational efficiency of healthcare institutions, improving service quality and ensuring the efficient use of resources. This scale allows for

the identification of technological and infrastructure deficiencies, enabling rapid improvements in these areas. In addition, effective adoption of e-health applications can have direct positive effects in critical areas such as patient satisfaction, data security and service accessibility. Through this scale, institutions can better plan and distribute their existing resources, and can use it as a guide, especially in planning new technological investments.
Among the potential limitations that may be encountered in the application of the obtained e-health readiness scale, cultural and regional differences, technological maturity levels and human resource adequacy play an important role. Infrastructure and resource problems of health institutions in different geographical regions may require adaptation to local conditions in the application of the scale. In addition, large differences between the technological maturity levels of health institutions may limit the full applicability of the scale in some institutions. Finally, since the effective use of e-health applications depends on adequately trained human resources, lack of training may limit the applicability of the findings obtained from the scale. Therefore, it is important to take these factors into account during the application of the scale.

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Etik, Beyan ve Açıklamalar

1. Etik Kurul izni ile ilgili;
☑ Bu çalışmanın yazarı, Etik Kurul İznine gerek olmadığını beyan etmektedir.

2. Bu çalışmanın yazarı, araştırma ve yayın etiği ilkelerine uyduklarını kabul etmektedir.

3. Bu çalışmanın yazarı kullanmış oldukları resim, şekil, fotoğraf ve benzeri belgelerin kullanımında tüm sorumlulukları kabul etmektedir.

4. Bu çalışmanın benzerlik raporu bulunmaktadır.