Original Paper

Development of the Technology Readiness Inventory for Professionals in Dutch Addiction Care: Instrument Development and Validation Study

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Abstract

Background: For the successful adoption of technology in health care, professionals need to possess or develop a range of technology competencies, attitudes, and resources. However, a comprehensive and psychometrically sound questionnaire to assess the full scope of attributes that constitute health care professionals' technological readiness is lacking.

Objective: The objective of our study was to take a preliminary step in developing a feasible, valid, and reliable questionnaire to assess addiction care professionals' technology readiness, initially conceptualized as covering their technology competencies and their willingness to adopt technology in their practice. An existing, not-yet-validated item set of 90 items across 19 subscales covering these aspects in health and well-being education settings was adapted for addiction care professionals and administered in a cross-sectional online survey among addiction care professionals (n=334) in the Netherlands.

Methods: Item analysis and exploratory factor analysis were used to reduce the number of items and empirically determine the underlying factor structure of the inventory.

Results: Exploratory factor analysis suggested that the original 19 rationally derived subscales ultimately tapped into three reliable factors underlying the concept of technological readiness of professionals: (1) technology competencies (ω=0.94), (2) attitude toward the use of technology (ω=0.93), and (3) facilitating conditions (ω=0.89). The Pearson intercorrelations were an *r* value of 0.53 (*P*<.001) between factors 1 and 3, an *r* of 0.47 (*P*<.001) between factors 1 and 2, and an *r* of 0.36 (*P*<.001) between factors 2 and 3, indicating that the questionnaire measures related but sufficiently distinct underlying constructs, supporting their discriminant validity.

Conclusions: The 90 items in the original item set were reduced to 49 items that together provide a preliminary step toward a psychometrically sound and feasible inventory for measuring the technology readiness of professionals in an addiction care context. Further research is needed to thoroughly validate the questionnaire, including different health care settings, and to confirm its dimensionality, reliability, convergent and discriminant validity, and criterion validity.

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Introduction

Using eHealth in health care offers a strategy for addressing the challenges of staff shortages and increasing health care costs [1,2]. eHealth can be defined as "the use of technology to support health, well-being and healthcare" [3]. This broad definition entails different types of technology, including telehealth (videoconferencing between a patient and a treatment provider), online therapy (eg, internet-delivered cognitive behavioral therapy), and virtual reality (eg, for treating addiction, depression, anxiety, and so on). eHealth helps empower people and can improve accessibility and quality of care [3]. Despite these benefits, the use of eHealth in health care is not yet standard clinical practice.

The lack of eHealth uptake and integration can be attributed to several factors, including the inherent complexity, unpredictability, and nonlinearity of health care systems [4,5]; limited availability of resources [6]; and insufficient technological readiness among health care professionals [7]. In line with the definition of technology readiness proposed by Parasuraman [8] as "people's propensity to embrace and use new technologies for accomplishing goals in home life and at work," this study adopts a broad conceptualization of technology readiness that encompasses both the willingness to adopt new technologies and the competencies required to use them effectively. From this perspective, the willingness to adopt technology and competencies are considered complementary dimensions of technology readiness among health care professionals.

Neither construct yet has a complete and widely accepted definition. However, in this study, willingness to adopt technology is seen as the decision-making process by end users to begin using new technologies, maintaining a positive yet critical attitude toward the use of technology and accepting co-occurring changes in workflows [9,10]. The second construct, technology competencies, entails knowledge of and attitude toward the use of eHealth [11], digital literacy, critical thinking about applying technology, problem-solving skills, and confidence in technology and in the professional's own ability to use technology [10].

For predicting and identifying the determinants that play a role in the adoption and acceptance of technology, various well-known theoretical models have been developed, including the diffusion of innovations theory [12], the technology acceptance model (TAM) [13], and the unified theory of acceptance and use of technology (UTAUT) [14]. These models highlight several factors that influence technology adoption and use, such as perceived usefulness, perceived ease of use, performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC). However, Lee et al [15] argue that their practical value is limited because they tend to ignore the context-specific determinants and the complexity of health care contexts that play a role in the adoption or nonadoption of technology. Technology acceptance (and adoption) may be shaped not only by individual perceptions of technology but also by professional (eg, colleagues' opinions and professional norms) and organizational factors (eg, organizational culture toward innovation and organizational infrastructure) [16]. Furthermore, while these models provide valuable insights into technology adoption and acceptance, they were not specifically designed to measure willingness to adopt technology as a distinct construct. Rather, they focus on determinants of acceptance, adoption, behavioral intention (BI), and actual use. Willingness to adopt technology can be considered a preceding disposition that reflects an individual's openness and readiness to embrace new technologies before decisions regarding acceptance, adoption, or actual use are made. Therefore, these models not only have limited practical applicability but also provide only an indirect approximation of willingness to adopt technology.

To measure digital health competencies in health care professionals, Ferreira and Magalhães [17] identified a total of 14 instruments that assess health care professionals' digital health competencies in their scoping review, illustrating the multifaceted nature of the construct. Most importantly, they showed that there is no consensus about the definition of the construct, there are different labels for similar constructs (eg, eHealth literacy or digital health competencies), and there is a scarcity of validated tools that comprise all relevant, rationally derived subscales of competencies. Consequently, there is not yet a generally accepted and validated questionnaire that measures the full scope of technology competencies in professional health care settings.

Therefore, although models are available to assess technology adoption and technology competencies, no questionnaire currently exists that captures the full scope of technology readiness. Because the Dutch context of health care and education calls for a practical tool to measure this full scope, a preliminary and not yet structurally validated set of 90 items measuring teachers' willingness to adopt technology and technology competencies was recently developed in the Netherlands [10] for the context of health care and well-being education, following the steps of the AMEE (Association for Medical Education in Europe) Guide on questionnaire development [18]: (1) literature review, (2) focus group interviews, (3) synthesizing data from the literature review and focus groups, (4) item development, (5) expert validation and refinement of items, (6) cognitive interviews with potential respondents to test the comprehensibility of the items, and (7) pilot testing.

In this item set, the proposed subscales of technology readiness were derived from a systematic selection of relevant items from previously validated instruments (step 3), such as the (extended) UTAUT [14,19], technology readiness and

acceptance model [20,21], Digital Literacy Scale [22], and Students' Digital Competence Scale [23], followed by expert consultation (step 5) to ensure that the resulting item set would be both practically applicable and feasible for routine use (see Multimedia Appendix 1 for all items and their sources). This process resulted in a final item set, organized into the following subscales related to the willingness to adopt technology: attitude toward technology (AT), attitude toward educating colleagues (in applying technology; AE), self-efficacy (SE), external influence (EI), BI, FC, and knowledge of and experience with technology. The subscales of technology competencies consisted of assumed basic and advanced competencies, in accordance with the Dutch technology competency model [24] (see Multimedia Appendix 2 for an overview). The rationally derived subscales of basic technology competencies were changing care through technology, finding technology, being confident in using technology, skillfully using technology, and instructing your client about technology. Rationally derived subscales of advanced technology competencies were leading, deepening, connecting, informing, improving, and replacing. Ethical reflection is an overarching skill in the model.

Although willingness to adopt technology and technology competencies formed the core constructs of interest, items representing related determinants that were repeatedly identified across existing instruments were also included. Therefore, the 19 subscales not only encompass willingness to adopt technology and technology competencies but also attitudes toward technology and organizational and contextual factors that may shape technology readiness. Building on the proposed subscales, the present study aimed to identify and validate the underlying factorial structure that characterizes professionals' readiness to work with technology. This is important to further substantiate the concept of technological readiness. For the preliminary development of this new scale, the context of addiction care was chosen, as this is one of the health care sectors where staff shortages and high workloads call for the implementation of eHealth technologies, making technological readiness of professionals an important issue.

Methods

Ethical Considerations

This study was conducted at Tactus Addiction Care in the eastern part of the Netherlands and was approved by the Ethical Committee of the University of Twente in May 2023 (reference number 230334) and the Scientific Committee of Tactus Addiction Care in June 2023.

Participants were asked to complete the online survey on Qualtrics after reading the study information and providing informed consent.

Study Design

Following the design of a cross-sectional online survey study, we field tested the technology readiness 90-item set among a convenience sample of care providers at a Dutch addiction care institute, with the aim of developing a feasible and psychometrically sound inventory for application in various care settings. Feasibility refers to minimizing respondent burden by eliminating redundant or noninformative items, whereas psychometric soundness requires that the remaining items coherently measure the intended construct and demonstrate adequate consistency. Field-testing aligns with step 7 of the AMEE Guide for developing questionnaires, which emphasizes the importance of preliminary testing to evaluate item quality and refine the instrument [18].

Participants

Potential participants were treatment providers (N=998) working in the primary care process (eg, social workers, psychologists, nurses, and psychiatrists) at Tactus Addiction Care. Tactus Addiction Care contains over 1600 employees, working in 46 different locations for care, cure, and assisted living, treating thousands of patients [25].

Measurements

The item pool (Multimedia Appendix 1) consisted of 90 items with a 5-point Likert-type response scale (ranging from "strongly disagree" to "strongly agree"), divided into 19 subscales. These subscales were rationally constructed based on theoretical models and existing questionnaires, such as the UTAUT [14], extended UTAUT [19], technology readiness and acceptance model [20,21], Dinamo 6.0 [26], and expert insights. Technology competencies were derived from the Dutch technology competency model [24].

The willingness-to-adopt subscales were (1) AT, (2) AE, (3) SE, (4) EI, (5) BI, (6) FC, and (7) knowledge of and experience with technology (KET). The subscales of 5 basic competencies in using technology were (8) changing (CHA), (9) finding (FIN), (10) being confident (COF), (11) skillfully using technology (SU), and (12) instructing (INS). Finally, the subscales of 6 advanced technology competencies were (13) leading (LEA), (14) deepening (DEE), (15) connecting (CON), (16) informing (INF), (17) improving (IP), (18) replacing (REP), and (19) an overarching skill of ethical reflection (ER).

With expert consultation between the coauthors (MGP and JELV) and the first author (RV), the version for the health and well-being educational context was transposed to a new inventory of items suitable for addiction care professionals without changing the meaning and number of items. Before administering the inventory, 3 experts (2 researchers and an eHealth specialist) provided feedback on the adaptation of the items from the educational context to addiction care, as well as on the wording and flow of the items and instructions. Based on this feedback, the instructional text was shortened, and the wording of some items was adjusted to increase comprehensibility.

Procedure

Participants were recruited via their institutional email addresses after being informed by their managers. They completed the online survey in Qualtrics, which took approximately 20 to 30 minutes.

To increase the response rate, managers were asked to motivate their team members, respondents could win a cake for their entire team, and initial nonrespondents received up to a maximum of 6 reminders.

Data Analysis

Data were analyzed using IBM SPSS version 29 [27]. Discontinued questionnaires with nonrandom missing values (n=53) were excluded from the analysis.

In several iterations, item-reduction analyses were performed to decrease the number of items. The results of each iterative step were discussed by the team of authors.

First, we performed an additional examination of the content of the items and removed those that were negatively, ambiguously, or vaguely formulated (eg, "Technology lowers the quality of relationships by reducing personal interaction"). Negatively formulated items can increase measurement error [28] and cause misinterpretations and method effects (creating artificial factors for positively and negatively worded items) [29,30].

Second, we followed the recommendation by Artino et al [18] to review the distribution of the data by using the variance within items. In our study, items with relatively high variances were considered beneficial, as they are better capable of distinguishing individual differences in technological readiness levels among individuals. Consequently, items with a relatively low variance (<0.6) were discarded. This threshold score represents 15% of the maximum possible variance in our dataset.

Third, item homogeneity was gauged by calculating the interitem-correlation with Spearman ϱ across the entire dataset. Item pairs that correlated very highly (ϱ>0.7), indicating item redundancy, were then discussed within the team (RV, JvdN, MP, and SK) based on their content. For each redundant pair, the item with the clearest wording was retained.

Fourth, low-correlating item pairs (ϱ<0.4) within assumed subscales were discussed between the authors, because low-correlating item pairs do not fit within the same subscale. For each item pair, the item with the most concise wording was retained.

Fifth, Cronbach α and item-rest correlations were computed within the assumed subscales. Items exhibiting a low item-rest correlation (r<0.4) that also had ambiguous content, and whose removal yielded a positive contribution to the α value, were discarded. After discarding items in a subscale, several iterations of this analysis were performed until there were no more items with low item-rest correlations.

Because the initial 90-item pool consisted of 19 rationally derived subscales that had not been established as distinct latent constructs, no a priori factor structure was assumed. Therefore, exploratory factor analysis (EFA) with principal axis factoring was used on the remaining items to examine the empirical underlying structure of the item set and identify potential latent factors. An oblique rotation (direct oblimin) was conducted, assuming that there would be some degree of correlation between latent factors. The Kaiser-Meyer-Olkin (KMO) measure was used to examine sampling adequacy, with a minimum criterion of 0.5 [31], and the average communality was calculated to assess sample size. In addition, the Bartlett test of sphericity was performed to determine whether the correlation matrix was significantly different from an identity matrix. If the associated chi-square test proved to be significant, data were considered sufficiently correlated to perform a factor analysis. Items with factor loadings under 0.3 were left out in subsequent EFA iterations. Cross-loadings between factors were examined to assess the distinctiveness of the constructs and to identify potential overlap between items across factors. The number of factors to retain was based on the Cattell scree plot [32]. After discussion among the authors, more items were discarded in the final iteration of the EFA because their content did not sufficiently represent the label of the factor on which they loaded. Subsequently, the McDonald omega was calculated to test the composite reliability of each final latent variable (factor). Values between 0.70 and 0.95 were considered indicative of good internal consistency [33].

Results

Study Sample

The survey was sent to all 998 treatment providers at the addiction care institute. The number of participants who completed the questionnaire was 334 (response rate 33.47%), including 245 (73.4%) women and 85 (25.4%) men and 4 participants who did not want to disclose their gender, with a mean age of 40.4 (SD 12.0) years and a range of 21 to 68 years (see Table 1 for demographics).

Table 1. Sociodemographic characteristics of the study population (N=334).

Characteristic	Value
Age (y; n=331), mean (SD)	40.4 (12.0)
Sex, n (%)	
Female	245 (73.4)
Male	85 (25.4)
Not disclosed	4 (1.2)
Profession, n (%)	
Social worker	90 (26.9)

Characteristic	Value
Nurse	66 (19.8)
Psychologist	46 (13.8)
Psychiatrist	9 (2.7)
Psychomotor therapist	5 (1.5)
(Addiction) physician	3 (0.9)
Other profession	115 (34.4)
Professional experience with technology (y), n (%)	
<1	59 (17.7)
1 to 4	193 (57.8)
5 to 9	52 (15.6)
≥10	30 (9.0)
Educational background, n (%)	
Research university	83 (24.9)
University of applied sciences	184 (55.1)
Vocational secondary education	53 (15.9)
Secondary education	3 (0.9)
Other, not specified	11 (3.3)
Frequency of technology use, n (%)	
Daily use	75 (22.5)
3 to 4 times a week	51 (15.3)
1 to 2 times a week	61 (18.3)
Monthly	69 (20.7)
Almost never	78 (23.4)

Item Reduction Analyses and Internal Construct Validation

All steps taken to reduce the number of items and to retain a feasible, structurally valid, and reliable new questionnaire are depicted in Figure 1 (see Multimedia Appendix 1 for a listing of all 90 items and specific reasons for the 41 items that were removed). In step 1, eight negatively worded items were removed. Next, 4 items were discarded based on a relatively small variance (<0.6) and elusive meaning. Four additional items were removed due to homogeneity (ϱ>0.7). One of those items correlated lower than 0.7 with another item (ϱ=0.65) but was removed nevertheless due to the very similar meaning of the 2 items. Two items were discarded based on a low interitem correlation (ϱ<0.4) with other items within the same assumed subscale in combination with elusive item content. Two items with low item-rest correlation (ϱ<0.4), and which negatively affected Cronbach α within a subscale, were removed. After removal, Cronbach α values and item-rest correlations in the remaining 70 items showed no indication to discard more items at this point.

To examine the structural validity of the questionnaire, an EFA was conducted on the remaining 70 items. The KMO measure of sampling adequacy was 0.94, suggesting that factor analysis should yield distinct and reliable factors. The mean communality was 0.60 (SD 0.10). The KMO values for all individual items were greater than 0.88 and most of them were above 0.90. The Bartlett test of sphericity was significant (χ^2_{1176}=9948.57; P<.001), suggesting that items correlated sufficiently to perform a factor analysis. An initial EFA was executed to decide how many factors to retain. Based on the Cattell scree plot, 3 factors were retained that explained 47.74% of the variance.

A second iteration of EFAs was conducted with a fixed number of 3 factors. The items that clustered on the factors suggested that factor 1 mainly included items measuring technology competencies, factor 2 attitude toward the use of technology, and factor 3 FC necessary to use technology. However, the content of 21 items did not sufficiently match the label of the latent variable (factor) on which they loaded. Consequently, they were removed. Three of these 21 items also had substantial cross-loadings on 2 factors (>0.3; ie, SU02, SE01, and EI05).

With the remaining 49 items, the third and final iteration of EFA was conducted. Multimedia Appendix 3 shows the EFA results of this final iteration after an oblique rotation. This factor model demonstrated a clear solution with all items loading substantially (≥0.40) on their respective factors. The eigenvalues were 15.27, 4.71, and 3.82, and the 3 factors together explained 48.58% of the variance in item responses.

Table 2 presents the composite reliability coefficients, mean scores, and Pearson intercorrelations of the observed subscales. The 3 factors demonstrated good internal consistency, suggesting that the item responses in each factor can be averaged to a reliable subscale score. Intercorrelations between the subscale scores were moderate to strong, indicating that the questionnaire measures related but sufficiently distinct underlying constructs, supporting their divergent validity.

Figure 1. Steps in item reduction analyses. AE: attitude toward educating colleagues (in applying technology); AT: attitude toward technology; BI: behavioral intention; CHA: changing; COF: being confident; DEE: deepening; EI: external influence; ER: ethical reflection; FIN: finding; INF: informing; INS: instructing; IP: improving; KET: knowledge of and experience with technology; LEA: leading; REP: replacing; SE: self-efficacy; SU: skillfully using technology.

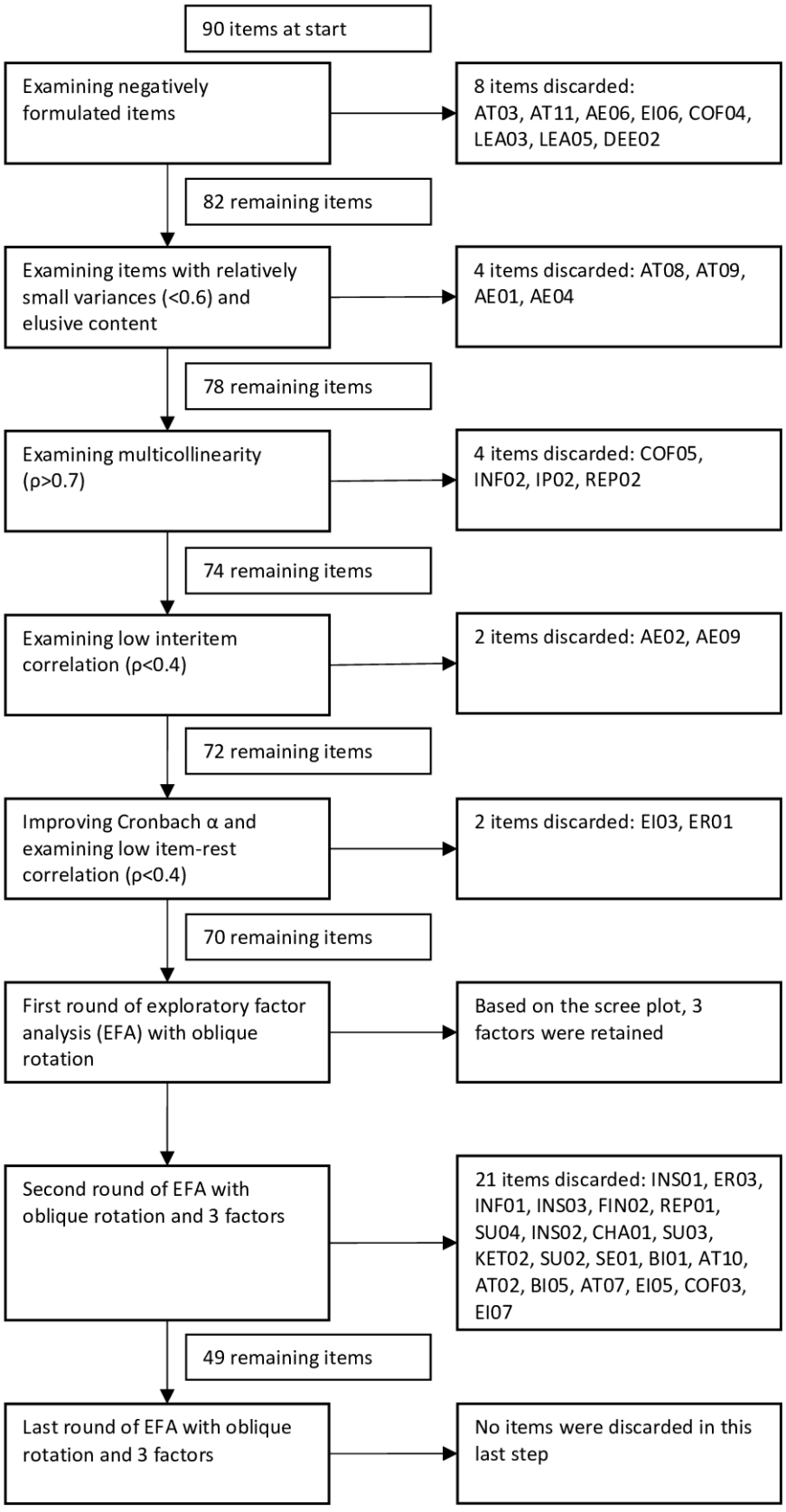


Table 2. Internal consistency, mean scores, and Pearson intercorrelations of the observed factors (N=334).

Factor	Number of items, n	ω (95% CI)	Mean (SD)	Technology competencies	Attitude	Facilitating conditions
1. Technology competencies	20	0.94 (0.93-0.95)	2.87 (0.64)	—[a]		
2. Attitude	19	0.93 (0.91-0.94)	3.66 (0.53)	0.53[b]	—	
3. Facilitating conditions	10	0.89 (0.86-0.91)	2.95 (0.63)	0.47[b]	0.36[b]	—

[a]Not applicable.
[b]Correlation is significant at the 0.01 level (2-tailed).

Discussion

Principal Findings

In this study, we aimed to develop a feasible (ie, brief and comprehensible), internally consistent, and valid self-report measure of technology readiness in addiction care, based on a comprehensive item set originally developed for health education contexts. The analyses contributed to a preliminary step toward a valid, reliable, and compact questionnaire with 49 items measuring 3 related yet sufficiently distinct dimensions of technology readiness. The original item set was derived from a comprehensive collection of models and frameworks that measure comparable concepts, resulting in many subscales. The results show that after EFA, the original nineteen subscales can be reduced to three underlying factors: (1) technology competencies, (2) attitude toward the use of technology, and (3) FC. This suggests that the original subscales may have assumed an overly differentiated depiction of the underlying structure, which is better represented empirically by 3 broader factors. Though the items derive from different theoretical models, they appear to measure the same underlying constructs. By reducing the number of items from 90 to 49 and by exploring which latent constructs can be clearly distinguished, a first step of a new questionnaire, coined the Technology Readiness Inventory for Professionals (TRIP), has been created that can be used in an addiction care context. Together, these 3 latent constructs appear to reflect a higher-order construct that can be interpreted as Technology Readiness for Professionals.

Initially, our conceptualization of technology readiness comprised the constructs of willingness to adopt technology and technology competencies. After the analyses, the items initially related to willingness to adopt technology were further clustered into 2 distinct constructs: attitude toward the use of technology and the FC provided by the organization needed to be able to use technology. Together with technology competencies, all 3 related constructs conceptualize the overarching construct of technology readiness of professionals. Therefore, following and extending the definition of Parasuraman [8], in the context of our study, we define technology readiness of professionals as the extent to which addiction care professionals possess the competencies, attitudes, and FC required to embrace, adopt, and effectively and sustainably use technology in their professional practice. For each construct, mean scores and SDs can be calculated to gain insight into technology competencies, attitude, and FC. Scores range from 1 to 5 and the higher the score, the more positively the given construct is rated. Further research is required to establish normative values and to determine how score differences relate to meaningful outcomes.

For the first factor, technology competencies, we did not observe the hypothesized differentiation between basic and advanced technology competencies. This implies that, psychometrically, they tap into the same dimension. A likely explanation is that participants who score highly on advanced competencies also score highly on basic competencies and similarly for low scores. This indicates that basic and advanced technology competencies may be perceived as a continuum rather than as distinct categories. Interestingly, not all initial items of technology competencies were retained in this construct after analysis; instead, they predominantly loaded on the construct of attitude. For instance, the technology competency item being confident (in using technology; COF) was not retained. Based on individual factor loadings, this construct appeared more closely related to AT instead of competencies. This is consistent with the conceptual overlap between the SE item, which includes the term “confident” and loaded on the attitude factor. Furthermore, the competencies “changing” and “replacing” were not included in any of the 3 identified factors. Both competencies were derived through expert consultation rather than being grounded in theoretical frameworks. Previous studies have shown that theory-based items often demonstrate stronger psychometric properties [34]. As such, expert-derived items may be more susceptible to revision or exclusion. In addition, they do not appear to have a unique contribution to technology competencies but seem to be broader concepts. They appear to be rather multidimensional, including knowledge, influence, communication, and reflective and societal insights.

The second factor was labeled attitude toward the use of technology. This label seems more suitable than the rationally derived construct of willingness to adopt in the original item set because there is a substantive connection in the content of the items that represent attitude: the items include beliefs, feelings of competence, willingness to take action, and appreciation for technological developments. This partly corresponds to the definition of attitude in the theory of planned behavior, which entails the extent to which an individual has a positive or negative assessment or opinion of the target behavior (using technology) [35]. In the theory of planned behavior, attitude is seen as one of the main determinants of BI, besides subjective norm and perceived behavioral control. The original construct (willingness to adopt) and many of the items were based on or derived from the field of technology adoption and acceptance, including models as TAM [13] and UTAUT [14]. In TAM, attitude is

seen as a mediator of perceived usefulness and perceived ease of use that leads to BI. However, in later TAMs, attitude is no longer modeled as a construct that influences BI and the actual use of technology. This is illustrated in the UTAUT [14], which shows that attitude has a spurious relationship with BI once PE and EE were added as important predictors of BI. Psychometrically, the second factor measures a single construct. Theoretically, considering the content of the items in the second factor, there are 3 other underlying constructs that could be distinguished, in accordance with those defined in UTAUT: PE (items COF01, AT06, AT13, AT12, AT04, AT14, AT05, AT01, and EI01; Multimedia Appendix 1), BI (items BI02, BI03, BI04, BI06, AE03, AE05, AE08, and AE07), and EE (items SE02 and COF02). Empirically, however, these 3 constructs appear to be strongly interrelated and may therefore represent manifestations of a single underlying construct. Future research in new samples is needed to confirm or refute the hypothesis that there might be 3 underlying constructs, for example, by performing confirmatory factor analysis in a new sample completing this newly developed TRIP questionnaire.

The third factor measures the FC needed to use technology. This factor consists of several items from the constructs, FC and EI of the original item set, which in the initial conceptualization were hypothesized to belong to the broad construct of willingness to adopt. Items of FC are derived from extended UTAUT [19] and predict BIs, in addition to EE and PE [14,36]. Items of EI are derived from UTAUT [14], Dinamo 6.0 [26] (a questionnaire measuring willingness to change among professionals within an organization), and expert consultation, and they appear to correspond with the construct of SI in UTAUT. The existence or absence of these underlying constructs in this factor (FC and EI) should be scrutinized in future research. If the existence of these underlying constructs is confirmed, factors 2 and 3 may represent the constructs of PE, EE, SI, and FC, which are predictors of BI in UTAUT. If that is the case, both factors might be different representations of technology acceptance as defined in the UTAUT model. However, future research is needed to confirm the subscales underlying the TRIP and their reliability and convergent, discriminant, and criterion validity [37].

Practical Implications

Although normative values for the interpretation of TRIP scores have yet to be established through future research, the current questionnaire already provides insight into the technology readiness of addiction care workers within the participating institution. The scores on the Likert-scale questionnaire range from 1 (“totally disagree”) to 5 (“totally agree”). A higher average score (eg, >3) on a construct (competencies, attitude, and FC) could, for instance, be used to identify high technological potentials or early adopters of technological innovations within teams, whereas low scores could signal the need for tailored interventions.

For instance, in the current sample, ATs were rated more positively (mean 3.66, SD 0.53) than technology competencies (mean 2.87, SD 0.64) and FC (mean 2.95, SD 0.63). The implementation strategies from the Expert Recommendations for Implementing Change [38] might help overcome barriers within these constructs, for example, by identifying and preparing champions to support implementation within their multidisciplinary treatment teams, distributing educational materials, or improving facilitation by the institution. Strategies could also be tailored to context-specific needs based on the outcomes of the questionnaire. Importantly, at this stage, the scores should be interpreted with caution, pending further cross-validation and refinement of their interpretation.

Limitations

The relatively low response rate (33.47%) is one of the limitations of the current study. A possible reason for this might be the length of the original item set, which made completing the survey burdensome for participants. Other reasons might be the high workload of the target group and their prioritization of client work. Although data on nonrespondents were lacking, and the sample might not have been representative of the entire population, the sample size appeared adequate for examining the psychometric properties of the item set.

Second, our sample consisted mostly of social workers, nurses, and psychologists. This is unsurprising, as they constitute the largest professional groups in our population. Other professional groups (eg, psychiatrists, psychomotor therapists, and physicians) were underrepresented in our sample, because they constitute relatively small professional groups within the participating institution. Overrepresentation or underrepresentation may introduce sampling bias [39]. However, for examining the psychometric properties of the item set, representativeness was considered less relevant than sample size, because we had no theoretical reasons to expect these psychometric properties to differ substantially across professional groups.

Third, our preliminary structural validation study used a convenience sample within one addiction care institution. This limits the generalizability of our findings [39]. We encourage the further assessment of the validity, reliability, and generalizability of our questionnaire in different health care and well-being contexts, professional groups, and cultural settings.

Fourth, the sample size of 334 participants resulted in a participant-to-item ratio below the often-cited 10:1 guideline [40]. However, such recommendations represent a general heuristic rather than an absolute requirement and depend on characteristics of the data, including communalities, factor loadings, and the strength of the factor solution [41]. For the current study, the sample size appeared sufficient, given the excellent KMO values, an adequate average communality value, and a consistent, balanced, and well-interpretable underlying 3-factor structure with items that loaded uniquely and highly on each factor. Nonetheless, replication of the structural validity of the questionnaire in sufficiently large, independent samples remains warranted. It remains a challenge to recruit addiction care professionals for noncare-

related tasks in the current context of staff shortages and high workloads.

Finally, because our questions did not specify a particular type of technology, participants may have had different technologies in mind, which may have influenced their answers. One reason for not specifying a particular type of technology was that TRIP aims to capture insights into technology-related competencies, attitudes, and FC across a range of technologies. Therefore, this wider focus was intentionally chosen to measure these constructs from a broader perspective, given that different types of technology are already available within the addiction care context.

Future Research

In this study, we field-tested the TRIP questionnaire, aligning with step 7 of the AMEE Guide for developing questionnaires, which emphasizes the importance of preliminary testing to evaluate item quality and refine the instrument [18]. However, more research is needed to gain insight into the feasibility of the questionnaire and how it can be applied in addiction care practice.

Scrutiny is needed to determine whether TRIP can indeed measure diverse patterns and nuances in technology readiness and whether it can be effectively applied across various health care contexts. Consequently, a confirmatory factor analysis or similar analyses, in a new sample and in different health care contexts, is recommended to examine whether there might be other underlying constructs or subconstructs, to further reduce items, and to test for dimensionality, reliability, and convergent, criterion, and discriminant validity. Furthermore, it is worthwhile to investigate the potential of TRIP to help mitigate barriers to technology adoption, thereby enhancing uptake. Finally, it is important to examine whether the TRIP questionnaire is suitable for measuring organizational change over time, enabling longitudinal monitoring.

Conclusion

In this study, a first step has been taken toward developing a psychometrically sound and feasible questionnaire (TRIP) for assessing technology readiness for professionals, comprising technology competencies, AT, and FC for use by professionals working in an addiction care setting. Since this was a preliminary validation of a new questionnaire in a single setting, more validation steps in different contexts are warranted.

Generative AI Use

Copilot, a generative AI program, was used solely for proofreading and editing, including minor rephrasing of author-written sentences to improve clarity and readability. No new content, interpretations, analyses, or conclusions were generated by AI.

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Data Availability

The dataset generated or analyzed during this study is available from the corresponding author (RV) upon reasonable request.

Authors' Contributions

Conceptualization: RV
Data curation: RV
Formal analysis: RV, PMTK
Investigation: RV
Methodology: RV, JELV, MGP, SMK, PMTK, MEMDO
Project administration: RV
Resources: RV
Supervision: JELV, MGP, SMK
Validation: RV, JELV, MGP, SMK, MEMDO
Visualization: RV
Writing – original draft: RV
Writing – review & editing: JELV, MGP, SMK, PMTK, MEMDO
All authors approved the final version of the manuscript.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Original item set, their sources, and reason for removal if applicable.
[DOCX File (Microsoft Word File), 57 KB-Multimedia Appendix 1]

Multimedia Appendix 2

Description of technology competencies of health care professionals.
[DOCX File (Microsoft Word File), 23 KB-Multimedia Appendix 2]

Multimedia Appendix 3

Factor loadings on 3-factor solution containing 49 items (n=334).
[DOCX File (Microsoft Word File), 26 KB-Multimedia Appendix 3]

References

1. Keij B, Versluis A, Alblas EE, Keuper JJ, van Tuyl LHD, van der Vaart R. E-healthmonitor 2023: Stand van zaken digitale zorg [Report in Dutch]. Rijksinstituut voor Volksgezondheid en Milieu (RIVM); 2024. URL: https://www.nivel.nl/sites/default/files/bestanden/1004571.pdf [Accessed 2026-10-30]
2. Kooij L, van Harten WH. Healthcare and digital transformation. In: Kip H, Beerlage-De Jong N, van Gemert-Pijnen L, Sanderman R, Kelders SM, editors. eHealth Research, Theory and Development: A Multidisciplinary Approach. 2nd ed. Routledge; 2024:53-70. [doi: 10.4324/9781003302049-5]
3. Gemert-Pijnen L, Kip H, Kelders SM, Sanderman R, Beerlage-de Jong N. Introducing ehealth. In: Kip H, Beerlage-De Jong N, van Gemert-Pijnen L, Sanderman R, Kelders SM, editors. eHealth Research, Theory and Development: A Multidisciplinary Approach. 2nd ed. Routledge; 2024:3-19. [doi: 10.4324/9781003302049-2]
4. Greenhalgh T, Abimbola S. The NASSS framework—a synthesis of multiple theories of technology implementation. Stud Health Technol Inform. Jul 30, 2019;263:193-204. [doi: 10.3233/SHTI190123] [Medline: 31411163]
5. Plsek PE, Greenhalgh T. Complexity science: the challenge of complexity in health care. BMJ. Sep 15, 2001;323(7313):625-628. [doi: 10.1136/bmj.323.7313.625] [Medline: 11557716]
6. Schreiweis B, Pobiruchin M, Strotbaum V, Suleder J, Wiesner M, Bergh B. Barriers and facilitators to the implementation of eHealth services: systematic literature analysis. J Med Internet Res. Nov 22, 2019;21(11):e14197. [doi: 10.2196/14197] [Medline: 31755869]
7. Alotaibi N, Wilson CB, Traynor M. Enhancing digital readiness and capability in healthcare: a systematic review of interventions, barriers, and facilitators. BMC Health Serv Res. Apr 4, 2025;25(1):500. [doi: 10.1186/s12913-025-12663-3] [Medline: 40186200]
8. Parasuraman A. Technology Readiness Index (TRI): a multiple-item scale to measure readiness to embrace new technologies. J Serv Res. 2000;2(4):307-320. [doi: 10.1177/109467050024001]
9. Kelders SM, Perski O. Engagement. In: Kip H, Beerlage-De Jong N, van Gemert-Pijnen L, Sanderman R, Kelders SM, editors. eHealth Research, Theory and Development: A Multidisciplinary Approach. 2nd ed. Routledge; 2024:251-268. [doi: 10.4324/9781003302049-17]
10. Postel M, Jaschinski C, Van Til J, Wentzel J, De Vries S, Den Ouden M. Willen en kunnen?! technologiecompetenties van opleiders en docenten in zorg en welzijn [Article in Dutch]. Onderwijs En Gezondheidszorg. 2024;48(2):22-25. URL: https://onderwijsengezondheidszorg.nl/artikelen/2024/april/2024-2/willen-en-kunnen-technologie-competentiescan-voor-opleiders-in-zorg-en-welzijn [Accessed 2026-11-02]
11. Cannavacciuolo L, Capaldo G, Ponsiglione C. Digital innovation and organizational changes in the healthcare sector: multiple case studies of telemedicine project implementation. Technovation. Feb 2023;120:102550. [doi: 10.1016/j.technovation.2022.102550]
12. Rogers EM. Diffusion of Innovations. 4th ed. Free Press; 2010. ISBN: 9781451602470
13. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Q. Sep 1, 1989;13(3):319-340. [doi: 10.2307/249008]
14. Venkatesh V, Morris MG, Davis GB, Davis FD. User acceptance of information technology: toward a unified view. MIS Q. 2003;27(3):425-478. [doi: 10.2307/30036540]
15. Lee AT, Ramasamy RK, Subbarao A. Understanding psychosocial barriers to healthcare technology adoption: a review of TAM technology acceptance model and unified theory of acceptance and use of technology and UTAUT frameworks. Healthcare (Basel). Jan 27, 2025;13(3):250. [doi: 10.3390/healthcare13030250] [Medline: 39942440]
16. Carrera A, Lettieri E, Lietti G, Martignoni S, Sgarbossa C, Cafazzo J. Therapies go digital. What drives physicians' acceptance? PLoS One. 2024;19(5):e0303302. [doi: 10.1371/journal.pone.0303302] [Medline: 38728346]
17. Ferreira JP, Magalhães T. Instruments to assess the digital health competencies of healthcare professionals: a scoping review. Front Public Health. 2025;13:1726452. [doi: 10.3389/fpubh.2025.1726452] [Medline: 41561857]
18. Artino AR Jr, La Rochelle JS, Dezee KJ, Gehlbach H. Developing questionnaires for educational research: AMEE Guide No. 87. Med Teach. Jun 2014;36(6):463-474. [doi: 10.3109/0142159X.2014.889814] [Medline: 24661014]
19. Venkatesh V, Thong JYL, Xu X. Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. MIS Q. 2012;36(1):157-178. [doi: 10.2307/41410412]
20. Buyle R, Van Compernolle M, Vlassenroot E, Vanlishout Z, Mechant P, Mannens E. "Technology readiness and acceptance model" as a predictor for the use intention of data standards in smart cities. Media Commun. Dec 21, 2018;6(4):127-139. [doi: 10.17645/mac.v6i4.1679]

21. Lin C, Shih H, Sher PJ. Integrating technology readiness into technology acceptance: the TRAM model. Psychol Mark. Jul 2007;24(7):641-657. [doi: 10.1002/mar.20177]
22. Bayrakcı S, Narmanlıoğlu H. Digital literacy as whole of digital competences: scale development study. Düşünce ve Toplum Sosyal Bilimler Dergisi. Jun 29, 2021;3(4):1-30. URL: https://dergipark.org.tr/en/download/article-file/1797036 [Accessed 2026-11-02]
23. Tzafilkou K, Perifanou M, Economides AA. Development and validation of Students' Digital Competence Scale (SDiCoS). Int J Educ Technol High Educ. 2022;19(1):30. [doi: 10.1186/s41239-022-00330-0] [Medline: 35602658]
24. den Ouden M, Stokkers-Scholten J, Jaschinski C, et al. Technologiecompetenties van zorg- en welzijnsprofessionals van nu én de toekomst [Article in Dutch]. Onderwijs En Gezondheidszorg. 2023;47(4):22-25. URL: https://tinyurl.com/4dmnmutd [Accessed 2026-11-02]
25. Tactus 125 jaar [Article in Dutch]. Tactus Verslavingszorg. URL: https://www.tactus.nl/tactus-125-jaar/ [Accessed 2025-08-29]
26. Metselaar C. Assessing the willingness to change: construction and validation of the DINAMO. Vrije Universiteit Amsterdam; 1997. URL: https://research.vu.nl/ws/portalfiles/portal/42170160/complete%20dissertation.pdf [Accessed 2026-11-02]
27. IBM SPSS Statistics. IBM. URL: https://www.ibm.com/products/spss-statistics [Accessed 2026-06-12]
28. Artino AR, Gehlbach H, Durning SJ. AM last page: avoiding five common pitfalls of survey design. Acad Med. Oct 2011;86(10):1327. [doi: 10.1097/ACM.0b013e31822f77cc] [Medline: 21955721]
29. DiStefano C, Motl RW. Further investigating method effects associated with negatively worded items on self-report surveys. Struct Equ Modeling. 2006;13(3):440-464. [doi: 10.1207/s15328007sem1303_6]
30. Marjanovic Z, Maidens AL. A clarified examination of the item wording effect: item valence (good vs. bad) versus semantic framing (I am vs. I am not). Psychol Rep. Oct 2026;129(5):4153-4168. [doi: 10.1177/00332941241301353] [Medline: 39541592]
31. Kaiser HF, Rice J. Little Jiffy, Mark IV. Educ Psychol Meas. Apr 1974;34(1):111-117. [doi: 10.1177/001316447403400115]
32. Cattell RB. The scree test for the number of factors. Multivariate Behav Res. Apr 1, 1966;1(2):245-276. [doi: 10.1207/s15327906mbr0102_10] [Medline: 26828106]
33. Terwee CB, Bot SDM, de Boer MR, et al. Quality criteria were proposed for measurement properties of health status questionnaires. J Clin Epidemiol. Jan 2007;60(1):34-42. [doi: 10.1016/j.jclinepi.2006.03.012] [Medline: 17161752]
34. Kyriazos TA, Stalikas A. Applied psychometrics: the steps of scale development and standardization process. Psychology. 2018;09(11):2531-2560. [doi: 10.4236/psych.2018.911145]
35. Ajzen I. The theory of planned behavior. Organ Behav Hum Decis Process. Dec 1991;50(2):179-211. [doi: 10.1016/0749-5978(91)90020-T]
36. van der Vaart R, Atema V, Evers AWM. Guided online self-management interventions in primary care: a survey on use, facilitators, and barriers. BMC Fam Pract. Mar 9, 2016;17(1):27. [doi: 10.1186/s12875-016-0424-0] [Medline: 26961547]
37. Boateng GO, Neilands TB, Frongillo EA, Melgar-Quiñonez HR, Young SL. Best practices for developing and validating scales for health, social, and behavioral research: a primer. Front Public Health. 2018;6:149. [doi: 10.3389/fpubh.2018.00149] [Medline: 29942800]
38. Powell BJ, Waltz TJ, Chinman MJ, et al. A refined compilation of implementation strategies: results from the Expert Recommendations for Implementing Change (ERIC) project. Implement Sci. Feb 12, 2015;10(1):21. [doi: 10.1186/s13012-015-0209-1] [Medline: 25889199]
39. Bryman A. Social Research Methods. 5th ed. Oxford University Press; 2015. ISBN: 9780199689453
40. Nunnally JC. Psychometric Theory. 2nd ed. McGraw-Hill; 1978. ISBN: 9780070474659
41. MacCallum RC, Widaman KF, Zhang S, Hong S. Sample size in factor analysis. Psychol Methods. 1999;4(1):84-99. [doi: 10.1037/1082-989X.4.1.84]

Abbreviations

AE: attitude toward educating colleagues (in applying technology)
AMEE: Association for Medical Education in Europe
AT: attitude toward technology
BI: behavioral intention
CHA: changing
COF: confident
CON: connecting
DEE: deepening

EE: effort expectancy
EFA: exploratory factor analysis
EI: external influence
ER: ethical reflection
FC: facilitating condition
FIN: finding
INF: informing
INS: instructing
IP: improving
KET: knowledge of and experience with technology
KMO: Kaiser-Meyer-Olkin measure
LEA: leading
PE: performance expectancy
REP: replacing
SE: self-efficacy
SI: social influence
SU: skillfully using technology
TAM: technology acceptance model
TRIP: Technology Readiness Inventory for Professionals
UTAUT: unified theory of acceptance and use of technology

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