

KEY DIMENSIONS OF CLIENT SATISFACTION WITH ASSISTIVE TECHNOLOGY: A CROSS-VALIDATION OF A CANADIAN MEASURE IN THE NETHERLANDS

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The purpose of this study was to conduct a cross-validation of the bidimensional structure of a satisfaction measure with assistive technology. Data were drawn from a follow-up study of 243 subjects who had been administered the Dutch version of the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST). Ratings related to 12 satisfaction items were analysed. Factor analysis results showed that the underlying structure of satisfaction with assistive technology consists of two dimensions related to assistive technology, Device (eight items) and Services (four items), accounting for 40% of the common variance. This finding was consistent with a previous Canadian study and was interpreted as supporting the adequacy and stability of the QUEST measure of satisfaction. Although the structure is delineated, further studies are recommended to support its use in European countries.

Key words: assistive technology, user satisfaction, validation, factor analysis, outcome assessment, QUEST.

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INTRODUCTION

In this new era of evidence-based practice, satisfaction information is conferred considerable importance as a patient outcome and, as a result, measurement of the concept is gaining status (1–3). It is common belief that satisfaction data can help clinicians, researchers, managers, and payers improve what they do, for example, by enabling services monitoring and creating positive attitudes among patients or clients (4). According to Keith (1), satisfaction can be defined as an attitude about a service, a product, a service provider or a person's health status. This definition emphasizes the diversity of purposes satisfaction outcomes may address.

In the field of assistive technology, user satisfaction is identified as one of five main outcomes categories, together with clinical results, functional status, quality of life, and costs

(5). Although the use of these outcomes is strongly advocated, satisfaction assessment tools are scarce, due in part, to a vacuum in the theoretical knowledge concerning the phenomenon under study. Indeed, satisfaction determinants are vague and indefinite and this situation is prejudicial for the measurement of the concept, frequently making it totally arbitrary.

Despite important conceptual limitations, it is useful in the context of this study to represent the relations between the variables involved in the experience of assistive technology within a general frame of reference. The linear satisfaction theoretical model depicted in Fig. 1 was inspired by Simon & Patrick's work (6) in rehabilitation. Expressed satisfaction, which appears in the corner box, may be conceived as a reaction to assistive technology provision and, therefore, as a dependent variable. Satisfaction can also trigger a subsequent action or behaviour, whereby it is approached as an independent variable. According to this model, the core concept under study can be broken down into several dimensions, all of which contribute to the user perception. This multidimensional approach is strongly supported by empirical work in the field of rehabilitation (7, 8) as well as in other health domains (9, 10). To date however, there is little agreement about the conceptual structure of satisfaction measures with assistive technology.

A first step in the definition of key satisfaction dimensions with assistive technology was recently taken in the context of the development of the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST) tool (11). This outcome measurement instrument was designed to measure satisfaction with assistive technology devices in a structured and standardised way. Although its experimental version consisted of 24 variables, an item analysis subsequently reduced this number by half (12). As part of the same methodological study, the 12 selected items were submitted to factor analysis. Results suggested that the underlying structure of satisfaction consists of two key dimensions respectively related to assistive technology, Device and Services. As shown in Fig. 2, the Device dimension embraced 8 items related to salient characteristics of the assistive technology whereas the Services dimension encompassed four intercorrelated items. The fit of the proposed measurement model was judged as reasonably good, with an acceptable amount of explained total item variance totalling 48.4% (12). Several studies (13–15) have been published which support the bidimensional approach of assistive technology, thus strengthening its validity.

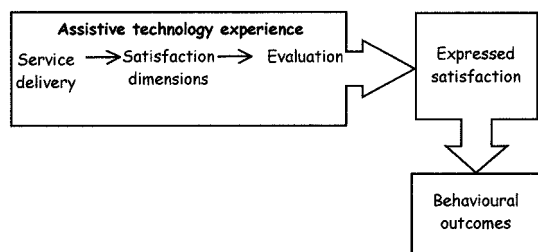


Fig. 1. Satisfaction with assistive technology model. Inspired from Simon & Patrick (6).

From a methodological perspective however, there are two issues that challenge the stability of this conceptual structure. Both stem from the fact that the data used were obtained from a single sample of subjects. The first criticism is that all satisfaction ratings were drawn from seating and mobility aids as well as lower limb prostheses (12). Logically, it can be argued that different patterns of inter-correlated items might have emerged with other types of devices. The second criticism concerns the cross-cultural application of the satisfaction structure proposed, since it was based on a single North American setting, that of Montreal. Provision of assistive technology is likely to vary substantially across countries, not to mention continents. Both limitations need to be addressed in order to give credibility to the proposed structure and support its adequacy. The goal of the present study was to conduct a cross-validation of the bidimensional structure of satisfaction with assistive technology, using a sample of subjects that differed from the original research with respect to cultural setting and types of devices.

METHODS

Subjects

Data were obtained from a previous Dutch follow-up study involving 375 subjects (16). The devices used by these people included toilet adaptations, shower seats and chairs, wheelchairs, adapted beds, stair-lifts, home adaptations and adapted beds. A large proportion of this sample (82%) was recruited from the TNO-PG, a Dutch organization for applied scientific research located in Leiden. These subjects had been provided with an assistive technology device in the past and were taking part in a larger questionnaire survey. The remaining 18% of the sample were selected from the Institute for Rehabilitation Research (iRv) in Hoensbroek, which houses an assistive technology service delivery centre. A follow-up evaluation was implemented 3 months after the clients had received a new device. In both of these regions, subjects were visited in their home. No formal training of the evaluators was provided and a large number of them (total of $n = 31$) were involved in the data collection. Prior to conducting the analysis, the dataset was inspected to ensure it was suitable for the intended purpose. Data were screened with regards to age of subjects (children were excluded from sample), aberrant data (zero variability), missing data and non-applicable responses (individuals who responded to less than 50% of the questions were excluded).

Items

All subjects were administered the Dutch version of the experimental QUEST, the D-QUEST (17). The translation was based on a set of standardized procedures as discussed in two articles (16,18). The consistency of viewpoints between the authors of the tool, the

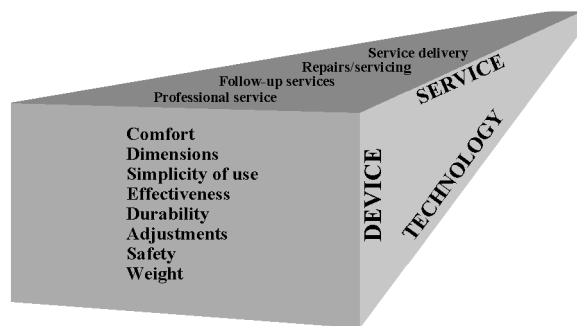


Fig. 2. Key dimensions of satisfaction with assistive technology.

researchers from the iRv and several Dutch occupational therapists was a strong contributing factor for obtaining conceptual equivalence between the English and Dutch versions. It also permitted the adaptation of the instrument to the specific context of assistive technology provision and use in the Netherlands.

The D-QUEST was administered in full. However in this study, satisfaction ratings with 12 items selected from the previous item analysis of the QUEST (12) were included in the analysis. These target items are listed in Table I, together with their definition. Each item was scored with a 5-point satisfaction scale, with a score of 1 denoting "not satisfied at all", 2 "not very satisfied", 3 "more or less satisfied", 4 "quite satisfied", and 5 indicating "very satisfied". In terms of psychometric properties, they were found to be reliable with respect to test-retest stability and inter-rater reproducibility, with weighted kappa values respectively ranging from 0.51 to 0.74, and from 0.35 to 0.72 (19). With respect to content validity, all 12 items were considered of primary importance for assessing satisfaction according to 50% and more assistive technology experts ($n = 12$) recruited in the United States, the Netherlands and Canada (18). Moreover, these items were rated as highly important (mean scores of 4.00 to 4.85 on a 5-point importance scale) by 158 Canadian users of assistive technology (12).

Procedures

Factor analysis is an analytical technique that permits the reduction of a certain number of inter-related variables to a smaller number of latent hidden dimensions (20). In test development and cross-validation, it reveals the pattern of shared variation within a set of items. Principal Axis Factoring (PAF) is the most widely used method of factor extraction for explaining common variance (20) and it was used in this study. Principal Components Analysis (PCA) which is designed to extract total (not common) variance, is automatically produced as a preliminary step to PAF. The statistic pertaining to total variance was examined.

Because the QUEST provided subjects with the option of scoring items as non-applicable, there was a large proportion of missing data (24%). The percentage of missing responses per item is given in Table I. Therefore, in order to avoid a significant reduction of the sample size, a pairwise strategy was used to compute the matrix of inter-item correlation coefficients. Accordingly, all valid responses were analysed. To obtain a simple structure, items loading (correlating) high on one factor and low on the remaining factors were needed. Loading values may vary from 0.000 to 1.000. Meaningful item loadings for each factor were examined after both orthogonal (varimax) and oblique (oblimin) rotations. In one case, the factors are independent, whereas in the second case, they are allowed to correlate. The results were similar, but orthogonal rotation was retained because it was easier to interpret.

RESULTS

Factor analysis was performed on a matrix of correlations between item scores obtained from 243 subjects (67.5% of the original sample). This sample size exceeded the recommenda-

Table I. QUEST items, definitions and percentage of missing data

No.	Item	Definition	% of missing data
1.	Comfort	Physical and psychological well-being associated with use of ATD	5.8
2.	Dimensions	Convenience of the device's size (height, width, length)	6.2
3.	Professional services	Quality of information on ATD provided, accessibility and competence of professionals	18.1
4.	Follow-up services	Ongoing support services for ATD	42.0
5.	Simplicity of use	Ease in using the ATD	2.5
6.	Effectiveness	Goal achievement with the ATD	7.4
7.	Repairs and servicing	Ease in having the ATD repaired and serviced	48.6
8.	Durability	Robustness and sturdiness of the ATD	9.9
9.	Adjustments	Simplicity in setting/fixing the components of ATD	42.4
10.	Safety	Degree to which the ATD is safe, secure and harmless	6.6
11.	Service delivery	Ease in acquiring the ATD including length of time	14.8
12.	Weight	Ease in lifting and/or moving the ATD	62.1

ATD, Assistive Technology Device.

tion of having at least 10 times as many subjects as variables (21). Both the Bartlett Test of Sphericity ($p < 0.000$) and the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) (0.76) demonstrated that the data were appropriate for the planned analysis. The results yielded two factors accounting for 40% of the total common variance among the 12 items. Based on PCA, the total item variance explained by this solution attained 49%. Consistent with common practice, each factor was interpreted according to the variables (QUEST items) that 'loaded' or were mostly highly correlated.

The factor structure matrix shown in Table II represents the loadings of the 12 items with the factors. The communalities, or the proportion of variance that is accounted for by this solution, are reported in the right-hand column. Small portions of *durability* (no. 8), and *service delivery* (no. 11) variances were explained (0.271 and 0.108, respectively). For this analysis, a conservative threshold for meaningful loadings at 0.30 was employed (20). Results revealed that most items are high on one factor and low on the other, thus contributing positively to a simple resulting structure. Three items, however, performed slightly differently. Items *effectiveness* (no. 6) and *weight* (no. 12) loaded on both factors but more substantially with Factor 1. Item *durability* (no. 8) loaded moderately on the two factors, however, somewhat more with Factor 2.

The largest factor was consistent with a Device dimension and accounted for 24.6% of the explained common item variance. It was characterized by high loadings of all technical and 'user-interface' features of the assistive technology. Indeed, *comfort* (no. 1), *dimensions* (no. 2), *simplicity of use* (no. 5), *effectiveness* (no. 6), *adjustments* (no. 9), *safety* (no. 10), and *weight* (no. 12) all loaded high on this factor. Despite its dual allegiance, it was reasonable to also assign *durability* (no. 8) to Factor 1 because it is usually considered as a technical characteristic of a device.

The second factor, Services, accounted for 15.1% of the explained common variance. It was defined by high loadings of consumer service aspects of assistive technology. The items involved included *professional services* (no. 3), *follow-up services* (no. 4), *repairs/servicing* (no. 7) and *service delivery*

(no. 11). As noted previously, items *effectiveness* (no. 6), *durability* (no. 8), and *weight* (no. 12) also moderately correlated with Factor 2, despite their stronger affiliation with Factor 1. Table II also reproduces the Canadian factor analysis in order to make comparison of results.

DISCUSSION

To gain confidence in outcome assessments and increase knowledge of user perception and satisfaction, it is essential to build theoretical backgrounds that support the proposed approaches. Based on a previous study of the QUEST tool, it was hypothesized that satisfaction with assistive technology should be considered as a bidimensional construct, encompassing satisfaction with the Device and Services. To test the validity of this proposition, we used a different sample of subjects from that on which the items were originally selected. By conducting the same analyses as in the original study, we are quite confident that the results of this replication study were not due to some methodological scheme.

The existence of the Device and Services components for the assessment of satisfaction with assistive technology was confirmed by the fact that the same factorial structure emerged from this study data. Indeed, the first factor embraced 8 items: *comfort*, *dimensions*, *simplicity of use*, *effectiveness*, *durability*, *adjustments*, *safety*, and *weight*. On the basis of content validity, it is reasonable to include *durability* in the device dimension. However, because of its allegiance to both factors, the position of this item is rather weak and should be considered in future studies. It is important to note that, despite some minor differences in loadings and communalities values, the same pooling of items had been obtained in the previous study from Demers et al. (12). From a theoretical perspective, this finding is consistent with those who view technology quality as a top priority in device selection (15), use (22), and evaluation (13, 14, 23). Similarly, the second factor regrouped the four items most closely associated with Services aspects of assistive technology provision: *professional services*, *follow-up services*,

Table II. Dutch and Canadian results of factor analysis (after orthogonal rotation) of 12 QUEST satisfaction items

Item	Factor 1 Device	Factor 2 Services	Communalities
<i>Dutch (n = 253)</i>			
1. Comfort	0.764		0.611
2. Dimensions	0.611		0.399
5. Simplicity of use	0.766		0.609
6. Effectiveness	0.585	0.377	0.484
8. Durability	0.339	0.395	0.271
9. Adjustments	0.629		0.402
10. Safety	0.467		0.305
12. Weight	0.474	0.316	0.325
3. Professional service		0.503	0.333
4. Follow-up services		0.651	0.434
7. Repairs/servicing		0.685	0.475
11. Service delivery		0.312	0.108
<i>Canadian (n = 150)</i>			
1. Comfort	0.420		0.193
2. Dimensions	0.608		0.381
5. Simplicity of use	0.661		0.485
6. Effectiveness	0.589	0.346	0.466
8. Durability	0.361	0.419	0.306
9. Adjustments	0.658		0.449
10. Safety	0.396		0.224
12. Weight	0.577		0.338
3. Professional service		0.689	0.509
4. Follow-up services		0.823	0.696
7. Repairs/servicing		0.689	0.487
11. Service delivery		0.394	0.180

repairs/servicing, and service delivery, with loadings and communality values very close to those published originally (12).

Based on the literature reviewed, defining these two key dimensions of satisfaction with assistive technology appears sound. Although it is the first time that such a conceptual structure is empirically supported for satisfaction, theoretical reflections of authors concerned with use, delivery and evaluation of assistive technology distinguish the same dimensions and view the concept in a similar way. This has been highlighted by Bain (13) who, in her systematic evaluative approach, suggested that assistive technology is comprised of devices and service delivery. Similarly, Kohn et al. (14) explicitly referred to two areas of practice: the provision of services, and the devices themselves. Vanderheiden (15) also emphasized that the proper choice of advanced technology and effective delivery were the essential conditions for successful assistive technology provision.

The data set used for this study was diametrically different from the original study. Indeed, subjects were assessed in the context of a clinical follow-up, with few standardised procedures. Compared with the strict management of a research protocol, it is not surprising to see more interviewers involved, varying degrees of training and a variety in the types of devices. In addition, although Canada and the Netherlands' health and social services systems may, due to common western values, resemble each other in some ways, delivery of assistive technology in the two countries is clearly distinct. Examples of differences include private/public funding, training, follow-

up, and availability of devices, all of which may influence the users' perception. By revealing an identical factorial solution, this study provides a strong support for the adequacy and stability of the measure of satisfaction.

One benefit of this study is to confirm that measurement of satisfaction with assistive technology should be divided in two components, related to the device and the services characteristics of assistive technology. In conclusion, future studies will need to be conducted to support the applicability of the QUEST tool in the European countries.

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