EVALUATING POWER WHEELCHAIR USERS' DESIRED FUTURE UTILITY AS A FUNCTION OF CURRENT UTILITY

John K. Layer*, University of Evansville;* Robert M. Levy, *Criterion Health, Inc.; and* Richard Nelson*, Criterion Health, Inc. & Easter Seals Rehabilitation Center*

INTRODUCTION

The purpose of the present paper is to introduce a methodology, using structural equation modeling, that we believe has the potential to improve the design of assistive technology products. In addition, a large-scale evaluation of the methodology is currently underway (to be completed in early 2011) that focuses on power wheelchair use and users. The methodology attempts to determine the future utility of design properties based on end-users' current use patterns and demographics.

Current literature concerning the evaluation or assessment of power wheelchair technology, and assistive technology in general, takes on a client-centered perspective[1] that is predominantly driven by self-reported reflection of the technology users' current level of satisfaction in the use of an assistive device and/or service. The client's satisfaction[1, 2, 3, 4] has been reported to be determined or influenced substantially by their personal values[2, 3, 5] and their perceived quality of life[1] associated with the use of the assistive device. The users' satisfaction has been shown to predict the abandonment of assistive devices[5], which brings practicality to the current consideration, since the continued use of the device (non-abandonment) is extremely important. While this consideration consists of practicality of the current assistive technology, it does not necessarily provide direction towards a user's future or desired utility, only the current level of satisfaction or dissatisfaction associated with the current utility.

Other assistive device evaluation outcomes are ease of use[4, 6], safety[6], comfort[6, 7], function[3], cost[3, 4, 8], maneuverability[9], and independence[4]. In these outcome studies, users of assistive technology were evaluated in regards to their current situation and the continued use of the same technology. It has been shown that a user's current sense of independence[10] is associated with one's health related quality of life which in turn affects the user's psychological well-being which could be constructed to impact future utility considerations, as indicated by Driver[11] who developed an affective model that utilizes psychosocial attributes in the evaluation of future physical activity. The present methodology and study evaluate the associations between the users' current power wheelchair utility and their desired future utility, which, in turn, can lead to more effective designs.

This approach answers a call from literature for more evaluation that goes beyond the self-reporting level of consumer satisfaction as indicated with current utility instruments that some researchers have stated may have experienced a "ceiling effect"[8] characterized by consistently indicated highly satisfied users. Additional issues associated with the consumer satisfaction model include the relatively small number of instruments described as "a handful of self-reported instruments"[2, 12]. Second, is that there exists a degree of subject, or user variance[6] and cultural or societal variances[13, 14]. A third issue with the consumer satisfaction model is the natural "change in life"[15] aspect where a user's perception of satisfaction changes with age or their particular station in life.

Therefore, there is a need for a methodology that goes beyond current consumer satisfaction models and searches for a future intended state of power wheelchair utility that strives to understand the future utility state in association with the users' current utility state, lifestyle considerations, and demographics. The need for this conceptual model has been identified in the literature as the basic consideration of being "not aware of any studies comparing different wheelchairs"[9], the description of a "lack of predictive tools"[4], and the need for "greater attention to future goals"[15].

BACKGROUND

Initial Focus Group Trial

A Power Wheelchair Users' Focus Group was facilitated by Criterion Health, Inc. There were ten Focus Group participants, of whom seven were power wheelchair users and three were caregivers or family. Independent observation notes concerning the proceedings were recorded. Since this evaluation reflects a sample size of only seven, there is no possibility of gaining statistically significant model results from the Focus Group trial; rather, the feasibility of such a modeling exercise was evaluated.

Structural Equation Modeling

Structural equation modeling provides a strong process for the simultaneous assessment of hypothesized cause-effect relationships between variables (observed or latent) that are contained in a hypothesized composite model designed to evaluate patterns of statistical dependencies. The software for this analysis is AMOS V17, which is designed to evaluate structural equation models by using an iterative process to minimize the difference between the model and sample data covariance matrices. The fitting criterion takes the mathematical form of a maximum likelihood function.

The overall model null hypothesis is that the estimated model covariance matrix equals the observed sample covariance matrix. This evaluation involves the assessment of several goodness of fit indices.

Focus Group Hypothesized Structural Equation Model

The planned Focus Group discussion was not designed to gather structural equation modeling data, but the notes were evaluated and transcribed to best discern applicable data. Because structural equation modeling does not facilitate missing or incomplete data, coding needed to be developed for the Focus Group discussion that was general enough to provide 100% data entry for all samples, all variables. A more specific and reliable questionnaire with specifically designed items that support the structural equation model is discussed in the next section.

The base hypothesized structural equation model chosen revolved around three independent latent variables (Demographics, Current Utility, and Lifestyle Considerations) that are modeled as to bring effect to a single dependent latent variable (Future Desired Utility) as depicted in Figure 1.

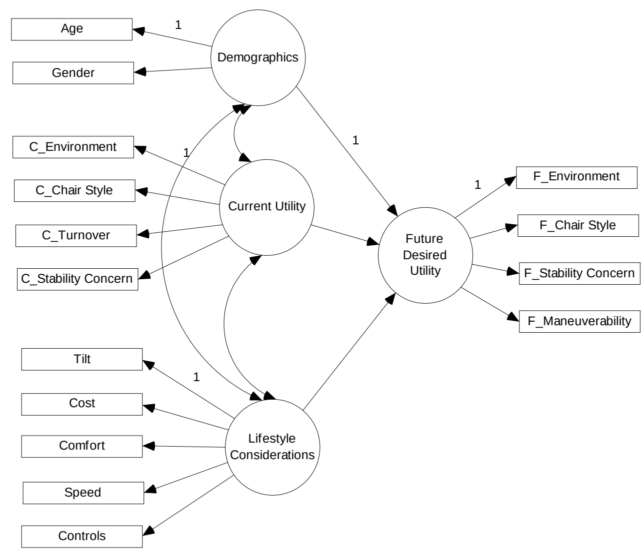

Figure 1. Base Focus Group Structural Equation Model

The model hypothesized that one's Demographics, Current Utility, and Lifestyle Considerations affect their Future Desired Utility concerning a powered wheel chair. The latent variables cannot be observed directly, but must be measured using a measurement model consisting of the observed variables attached to each latent variable. An example is that the latent variable of Current Utility is measured by one's current environment, current chair style, current turnover accidents encountered, and current stability concern.

The standardized path coefficients, or straight arrows of this model are considered a validity measurement, the larger the value the stronger the association between the associated variables. The curved arrows of this model indicate a modeled correlation between the associated variables which aid the development of the model and the determination of variables.

Sufficient trial data was evident from the Focus Group structural equation modeling trial study to indicate data could be collected in regards to Demographic, Current Utility, and Lifestyle Considerations so that specific attributes associated with a user's Future Desired Power Wheelchair Utility could be assessed in a larger study.

CURRENT STUDY

Purpose and Procedures

The purpose of the current large-scale study is to build upon the Focus Group results and evaluate how power wheelchair users' desired future utility may be evaluated by virtue of the users' attributes associated with their current wheelchair utility, lifestyle considerations, and demographics.

A 28-item questionnaire has been developed and is currently being administered to approximately 200 power wheelchair users who are at least 18 years old. Where possible, questionnaire items have been derived from previously validated items, included in the identified referenced literature.[1, 2, 5, 6, 7, 12, 16, 17]. The questionnaire items generally follow a 5-point Likert-type scale format.

Since users may have varying ability to answer the questions unassisted, the actual administration, and associated data collection of the questionnaire consists of an internet questionnaire service, hardcopy questionnaire mailing, assisted hardcopy questionnaire, and/or phone survey/ questionnaire techniques using the identical questionnaire items. The importance of anonymous data collection is highlighted in which no subjects are to include their name or any identifying comments other than the questionnaire item responses.

The data collected from the questionnaires are combined into a single SPSS database. The causal relationships between the observed and latent variables are evaluated with the AMOS structural equation modeling software, utilizing the SPSS database.

Hypothesized Structural Equation Model

It is anticipated that the power wheelchair users' desired future utility of assisted mobility is contingent upon the causal nature and extent of their current power wheelchair utility, lifestyle considerations, and demographics as depicted in the Figure 2 power wheelchair utility structural equation model.

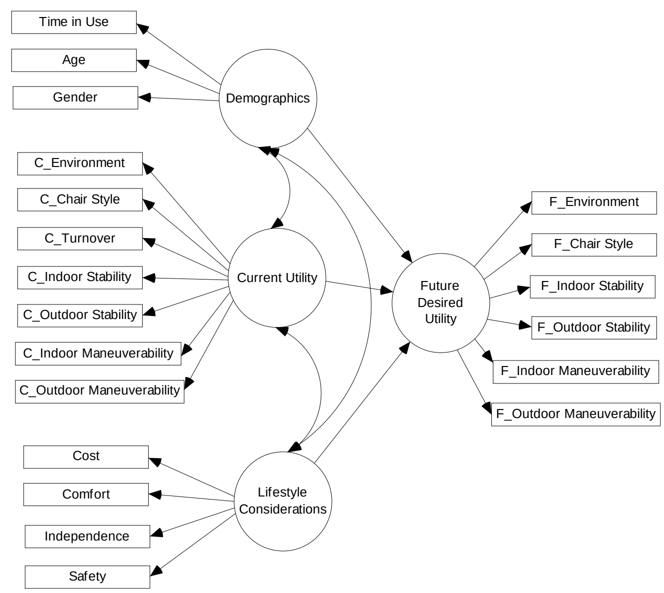

Figure 2. Hypothesized Study Structural Equation Model

Figure 2 incorporates the learned points from the initial Focus Group session. The observed variables of Tilt, Speed, and Controls were deleted from the Figure 1 model since they did result in a relevant response during the Focus Group session. In addition, the observed variables of Time In Use, Independence and Safety were added to the Figure 2 model. The Focus Group session also indicated the need to distinguish between indoor and outdoor variants when assessing stability and maneuverability attributes.

Future Work

Data collection is currently in process, with the primary collection technique anticipated as being the use of the internet questionnaire service.

Structural Equation Model testing/validation will commence once a sufficient questionnaire sample size is acquired. At that time it will be possible to determine 1) the potential value of the methodology per se, 2) the actual results for power wheelchair users in particular and 3) understand more fully the potential value of the methodology for assistive technology development in general.

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REFERENCES

[1] L. Demers, M. Monette, Y. Lapierre, D.L. Arnold, & C. Wolfson, "Reliability, validity, and applicability of the Quebec user evaluation of satisfaction with assistive technology (QUEST 2.0) for adults with multiple sclerosis," *Disability and Rehabilitation*, Vol. 24, No. 1/2/3, 21-30, 2002.

[2] L. Demers, R. Weiss-Lambrou, & B. Ska, "The Quebec user evaluation of satisfaction with assistive technology (QUEST 2.0): An overview and recent progress," *Technology and Disability*, 14, 101-105, 2002.

[3] S. Chan, & A. Chan, "The validity and applicability of the Chinese version of the Quebec user evaluation of satisfaction with assistive technology for people with spinal cord injury," *Assistive Technology*, 18(1), 25-33, 2006.

[4] N. Schreuer, "Accommodation outcomes and the ICF framework," *Assistive Technology*, 21, 94-104, 2009.

[5] H-F. Mao, W-Y. Chen, G. Yao, S-L. Huang, C-C. Lin, & W-N. Huang, "Cross-cultural adaptation and validation of the Quebec user evaluation of satisfaction with assistive technology (QUEST 2.0): The development of the Taiwanese version," *Clinical Rehabilitation*, 24, 412-421, 2010.

[6] K. Samuelsson, & E. Wressle, "User satisfaction with mobility assistive devices: An important element in the rehabilitation process", *Disability and Rehabilitation*, 30(7), 551-558, 2008.

[7] B. Crane, M. Holm, D. Hobson, R. Cooper, M. Reed, & S. Stadelmeier, "Test-retest reliability, internal item consistency, and concurrent validity of the wheelchair seating discomfort assessment tool," *Assistive Technology*, 17(2), 98-107, 2005.

[8] M. Stickel, S. Ryan, P.J. Rigby, & J.W. Jutai, "Toward a comprehensive evaluation of the impact of electronic aids to daily living: evaluation of consumer satisfaction", *Disability and Rehabilitation,* Vol. 24, No. 1/2/3, 115-125, 2002.

[9] N. Pellegrini, S. Bouche, F. Barbot, M. Figere, B. Guillon, & F. Lofaso, "Comparative Evaluation of electric wheelchair maneuverability," *Journal of Rehabilitation Medicine*, 42, 605-607, 2010.

[10] D. Hawthorne, J. Richardson, & R. Osborne, "The assessment of quality of life (AQoL) instrument: A psychometric measure of health-related quality of life," *Quality of Life Research,* 8, 209-224, 1999.

[11] S. Driver, "Development of a conceptual model to predict physical activity participation in adults with brain injuries," *Adapted Physical Activity Quarterly*, 25, 289-307, 2008.

[12] T. Mills, M. Holm, & M. Schmeler, "Test-retest reliability and cross validation of the functioning every day with a wheelchair instrument," *Assistive Technology,* 19(2), 61-77, 2007.

[13] S. Chan, & A. Chan, "User satisfaction, community participation, and quality of life among Chinese wheelchair users with spinal cord injury: A preliminary study," *Occupational Therapy International*, 14(3), 123-143, 2007.

[14] R. Wessels, & L. De Witte, "Reliability and validity of the Dutch version of QUEST 2.0 with users of various types of assistive devices," *Disability and Rehabilitation*, Vol 25, No. 6, 267-272, 2003.

[15] L. Demers, M. Fuhrer, J. Jutai, M. Scherer, I. Pervieux, & F. DeRuyter, "Tracking mobility-related assistive technology in an outcomes study," *Assistive Technology,* 20(2), 73-83, 2008.

[16] A. Koontz, Y. Yang, D. Boninger, J. Kanaly, R. Cooper, M. Boninger, K. Dieruf, & L. Ewer, "Investigation of the performance of an ergonomic handrim as a pain-relieving intervention for manual wheelchair users," *Assistive Technology.* 18(2), 123-143, 2006.

[17] K. Pesudovs, E. Garamendi, & D. Elliott, "The quality of life impact of refractive correction (QIRC) questionnaire: Development and validation," *Optometry and Vision Science,* Vol. 81, No. 10, 2004.