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SYSTEMATIC DEVELOPMENT AND TEST-RETEST RELIABILITY OF THE ELECTRONIC INSTRUMENTAL ACTIVITIES OF DAILY LIVING SATISFACTION ASSESSMENT (EISA) OUTCOME MEASURE

by

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University of Pittsburgh, 2018

Assessment of the level of satisfaction with completing Instrumental Activities of Daily Living (IADLs) using accessible Information Communication Technology (ICT) or Electronic Assistive Devices (EAD) is critical for enabling high quality of life and community participation for people with disabilities (PWD). Currently there are no reliable and valid outcome measures that have been specifically designed for assessing level of satisfaction with completing IADLs using EAD. In this dissertation study, the Electronic Instrumental activities of daily living Satisfaction Assessment (EISA) self-report outcome measure was developed to fill this void. The EISA research study had the following specific aims: (1) identify common functional tasks that all people use ICT to complete; (2) review the literature to identify any existing outcome measures for EAD; (3) develop and establish content validity at acceptable levels; and (4) establish test-retest reliability and internal consistency at acceptable levels. The EISA research study was sub-divided into 4 studies. Study 1, reviewed the literature, to assess, common functional tasks, that all people, with or without disabilities, use ICT to complete. Study 2, reviewed the literature, to identify any existing outcome measures for EAD. This study had three phases: phase 1 reviewed relevant databases to identify any self-report outcome measures for EAD; phase 2 reviewed the National Institutes of Health (NIH) Patient Reported Outcome (PRO) measures; and phase 3 reviewed the literature to identify any self-report IADL measures. Study 3 involved content validation using expert clinicians and EAD users, as domain experts. Study 4 covered establishment of test-retest reliability and internal consistency at acceptable levels. Using the

Scale Content Validity Index (SCVI) Average method, the content validity of the EISA, was SCVI = 0.91. Reliability was assessed by conducting a repeated-measures cohort study (n = 84) using the Qualtrics on-line research platform. Both test-retest reliability (Rs = .81) and internal consistency (Cronbach's alpha = 0.88) of EISA were found to be acceptable. The study results indicate that the EISA-Version 1.0 is a reliable and stable tool for assessing the functional performance of individuals who use or need EAD interventions.

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1.0 INTRODUCTION

This chapter provides an introduction to the proposed development of an outcome measure, specifically designed and validated, for assessing satisfaction of everyday functional needs using contemporary technology.

1.1 PROJECT IMPETUS

This section discusses the problem or root cause, which provided the impetus for developing the Electronic Instrumental Activities of Daily Living Satisfaction Assessment (EISA), a self-report outcome measure for assessing satisfaction of Information Communication Technology (ICT) related to everyday functional needs for People with Disabilities (PWD), or veterans.

1.1.1 Problem

With the onset of the new millennium, in the wake of the post 9/11 Operation Enduring Freedom and Operation Iraqi freedom (OEF/OIF) and Operation Afghani Freedom (OAF), the Veteran's Administration (VA) was faced with a new generation of veterans with disabilities. This led to the VA providing funding for establishment and development of five Polytrauma Rehabilitation Assistive Technology (PRAT) clinics. During the development of these AT clinics, the VA

stipulated a need for making outcome measures a key component of clinical practice, in order to develop a practical outcomes management system, which would enable assessment of patient satisfaction as part of clinical effectiveness. This initiative led to the discovery that there are three commonly used outcome measures used for measuring Assistive Technology (AT) outcomes: (1) the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST); (2) the Psychosocial Impact of Assistive Devices Scale (PIADS); and (3) the Functional Mobility Assessment (FMA).

1.1.1.1 Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST)

The QUEST 2.0 is a 12 item self-report outcome measure designed to measure satisfaction with a wide range of ATDs using the domains of devices and services (Demers, Monette, Lapierre, Arnold, & Wolfson, 2002; Demers, Ska, & Weiss-Lambrou, 2000). The instrument enables the clinicians to: (1) gage the effectiveness of AT devices and services; and (2) understand the user's priorities and value systems (Demers, Weiss-Lambrou, & Ska, 1996). The scale has predominantly been validated on adults, however, it can be administered to adolescents and elderly users of AT device and services (Demers et al., 2002). The QUEST is available in both the self-administered and interview formats and allows the consumer to prioritize three components they consider most important, as well as provide comments for items the consumer is not very satisfied with. It takes between 10 to 15 minutes to administer the instrument. No specific equipment, or particular training and experience, is required for taking or administering the scale (Demers, Weiss-Lambrou, & Ska, 2016). The instrument provides two sub-scales (devices and services) scores and one composite (total) score. Scoring is done manually by taking averages of valid responses on a 5 points scale, ranging from not satisfied at all to very satisfied (Demers et al., 1996; Demers et al., 2016). The instrument's psychometric properties

have been evaluated for: (a) test-retest stability (ICC = 0.82, 0.82, and 0.91 for the devices, services, and total QUEST score, respectively); (b) alternate form reliability (ICC = 0.89, 0.76, and 0.91 for the devices, services, and total QUEST score, respectively); and (c) construct validity (fair to moderate correlation, r = 0.27 to 0.45, with the QUEST (experimental version) devices, services, and total score) (Demers et al., 2002; Demers, Weiss-Lambrou, & Ska, 2002). The QUEST is short, easy to administer and applicable to all kinds of ATDs; however, it has a few shortcomings: (1) no role for expectations in satisfaction; (2) assesses satisfaction with device and services, but not necessarily with functional needs; (3) can assess satisfaction with one ATD at a time and not a combination of devices; (4) only accounts for users of ATDs as stake holders in the process; and (5) in terms of service delivery, the QUEST can only be used after the user has used the ATD for some time which does not allow assessment of effectiveness (Wessels, de Witte, & van den Heuvel, 2004).

1.1.1.2 Psychosocial Impact of Assistive Devices Scale (PIADS)

The PIADS is a self-report outcome measure that evaluates the psychosocial impact of ATDs on a user's functional independence, quality of life (QOL) and well-being. It is a responsive measure able to detect change in important attributes like the user's clinical condition, device stigma, and functionality of the device. The PIADS is a generic measure applicable to all major categories of ATDs and can provide information related to device use and abandonment (Day & Jutai, 1996). The instrument is composed of a 26-item questionnaire, and it takes between 5 to 10 minutes to administer the instrument under normal circumstances. No specific equipment, or particular training and experience, is required for taking or administering the scale (Day & Jutai, 2003). The instrument generates 3 sub-scales (competence, adaptability, and self-esteem) scores and 1 composite (total) score. Each item on the measure is rated on a 7-point scale to indicate the

extent to which a user is effected by wearing or using an assistive device. Higher scores indicate increased effect and lower scores reflect decreased effect. Scoring is done manually by adding responses to calculate the sub-scale and/or total score (Day & Jutai, 1996). With regard to psychometric properties, the instrument has demonstrated (a) convergent validity by showing fair to moderate correlations (n = 81, r = 0.27-0.45) with the QUEST devices, services, and total score (Demers et al., 2002); (b) discriminant validity (positive relationship of the total PIADS score with only the pleasure (rp .46 to .59) and dominance (rp .21 to .34) subscales, and not with the arousal (rp .06 to .17) subscale, of the pleasure, arousal, and dominance outcome measure, an environmental impact instrument; (c) high reliability (r = 0.92, 0.88, and 0.87 for the competence, adaptability, and self-esteem subscales, respectively); (d) high internal consistency (Cronbach's alpha = 0.95) (Day, Jutai, & Campbell, 2002; Day, Jutai, Woolrich, & Strong, 2001; Jutai, Rigby, Ryan, & Stickel, 2000). The PIADS enables assessment of psychosocial benefits of all major categories of ATDs. It can also be used to assess expected or anticipated impact of ATDs. However, it has a few shortcomings: (1) assesses psychosocial impact of ATDs and not satisfaction with functional needs being met; and (2) in terms of service delivery, the PIADS can only be used after the user has used the ATD for some time which does not allow assessment of effectiveness (Day & Jutai, 1996; Jutai & Day, 2002).

1.1.1.3 Functional Mobility Assessment (FMA)

The FMA (add reference) is a 10 item self-report questionnaire that measures a person's satisfaction in performing common Mobility Related Activities of Daily Living (MRADLs) independent of type of mobility device or no device. However, it can be used as an outcome measure to assess the effectiveness of wheeled mobility and seating (WMS) and non-WMS interventions for PWD. It provides a reliable and valid measurement of consumer satisfaction

and functional changes for PWD who are in the process of being evaluated for a mobility assistive device. The advantage offered by the tool, is its ability to focus on performance of MRADLs for both wheeled and non-wheeled mobility interventions including manual wheelchairs, power wheelchairs, scooters, canes, crutches, walkers, prosthetics, and orthotics. The FMA can be used to assess types and features of mobility devices that enable PWD to meet their functional mobility needs in their natural environment in as independent, safe and efficient manner as possible. All items on the tool are scored on a 6 point Likert scale ranging from completely agree (6) to completely disagree (1). On average, it takes 10 minutes to administer the instrument. No specific equipment, or particular training and experience, is required for taking or administering the scale. Scoring is done manually by summing responses to generate a total or composite score (Kumar et al., 2013). In terms of psychometric properties, the FMA is a derivative of the Functioning Every day with a Wheelchair (FEW) scale which has demonstrated good content validity and test-retest reliability (ICC = 0.86, $p < 0.001$) (Kumar et al., 2013; Mills, Holm, & Schmeler, 2007). The FMA, based on test-retest evaluations has demonstrated excellent reliability (ICC = 0.87) and is a stable tool for assessing functional performance (Kumar et al., 2013). Furthermore, because of its practical utility, the FMA is widely accepted by clinicians nationally (including the VA) and internationally. In terms of service delivery, the FMA can be used by both non-WMS users who are in the process of being evaluated for a mobility assistive device, as well as PWD who are existing WMS users therefore lends itself well as an outcome measure.

1.1.2 Discovery of Growing Need

Regular use of the QUEST, PIADS, and FMA, in the VA PRAT clinics led clinicians to discover that, even though the QUEST and the PIADS are generic across ATDs; (1) they assess satisfaction with device, and not necessarily with function; and (2) they do not lend themselves well to ICT related ATDs. Furthermore, the only way, to have a practical outcomes management system, is to have both time 1 (baseline) and time 2 (follow up) scores. Both the QUEST and the PIADS, are unable to provide time 1 (baseline) scores, as both of these outcome measures, can only be administered to respondents, who have used the ATD/s being evaluated, for some time. This is particularly important, as many of the veterans referred to the VA PRAT clinics, are not users of ATDs at the time of initial evaluation (time 1), and therefore, it is not possible to secure baseline data from such users.

The FMA, on the other hand, has become a very well accepted tool in the PRAT clinics, as it: (1) provides time 1 (baseline) information; and (2) compliments the clinical routine by providing meaningful information about functional needs. However, the FMA assesses satisfaction with function, but only as it relates to MRADLs. Therefore, if a veteran with non-mobility related issues, for instance, individuals with Traumatic Brain Injury (TBI), Post-Traumatic Stress Disorder (PTSD), upper extremity amputation, or sensory impairment comes to a PRAT clinic, the clinicians are unable to use the FMA. The QUEST and the PIADS are the only available tools with the VA PRAT clinicians for such clients. Moreover, what was discovered from clinical feedback was that the QUEST and the PIADS do not measure satisfaction with Instrumental Activities of Daily Living (IADLs) like the FMA does for MRADLs. Therefore, it became clear that what clinicians are really aiming to measure is not satisfaction with AT, but rather, satisfaction with self/patient reported function using ATDs. In

addition, the advantage self-reported function measures offer is the ability to secure time 2 (follow up) data that can be compared to baseline data. Furthermore, this is especially critical in relation to IT related ATDs as with the fast-paced development in the field of IT, existing technologies and devices, soon become obsolete or redundant with emergence of newer technologies and devices, however, the function related needs remain the same.

The VA PRAT clinicians have now for some time been expressing a continually growing need for developing an outcomes management tool that: (1) targets a population of adult PWD who want to be able to effectively complete IADLs in a contemporary fashion, that includes access to information technology (IT); (2) is valid at time 1 (baseline) even if the referred PWD has not been using IT related ATDs at the time of initial evaluation; and (3) is similar in design to the FMA, in terms of specifically performing IADLs using IT related ATDs. Examples of IT related ATDs could range from, computer access hardware/software and Electronic Aids to Daily Living (EADL) to smart phones and tablets.

This is particularly important as the VA is spending a large amount of money and resources on IT related ATDs, however, it is unable to assess their effectiveness. Development of such an outcome measure shall not only fill an unmet need in outcomes assessment, but also, help advance rehabilitation science; in better understanding the mechanisms underlying the new era of IT enabled IADLs. Furthermore, such an outcome measure shall help open doors for PWD; to optimally utilize IT related ATDs for effective completion of IADLs.

1.2 DISABILITY STATISTICS AND IMPORTANCE OF AT

Disability is a complex, multi-faceted phenomenon that poses significant challenges in the lives of PWD who experience it, as well as, clinicians and researchers who assess and work with it in rehabilitation (World Health Organization & World Bank, 2011).

Based on the 2015 Disability Status Report - United States (US) The prevalence of disability in the US in 2014 was: 12.6 percent (Kraus, 2015). Furthermore, in 2011 the World Health Organization (WHO) and the World Bank jointly produced the first of its kind, world report on disability. According to this report, over a billion people, about 15% of the world's population, have some form of disability and consequently have poorer health and education, fewer economic opportunities and choices. A key reason for this is the lack of services including the provision and use of ATDs (Assistive Technology Devices) (reference?).

ATDs like mobility assistive devices, hearing aids, visual aids and specialized Information Communication Technology (ICT) hardware and software are critical for PWD as they help restore or improve functional capacities, for instance, mobility, communication, hearing, vision and cognition (World Health Organization & World Bank, 2011). Apart from compensating a functional limitation, ATDs also promote and enhance choice and control of the environment (Samuelsson & Wressle, 2008; World Health Organization & World Bank, 2011). ATDs thus help facilitate a high QOL for PWD by enabling independence and participation in key life activities like education, employment and community life (World Health Organization & World Bank, 2011).

1.3 OCCUPATIONS-ACTIVITIES OF DAILY LIVING (ADLS) AND INSTRUMENTAL ACTIVITIES OF DAILY LIVING (IADLS)

In the endeavors for achieving enhanced and clinically meaningful outcomes in rehabilitation, it is key to recognize the mind-body-spirit connection as the client participates in everyday functional activities. It is equally key to appreciate that this relationship is transactional, and signifies the importance of incorporating a holistic approach, along with meaningful and productive occupations in enabling high quality of life (Hildenbrand & Lamb, 2013; Trombly, 1995).

1.3.1 Occupations

According to the Occupational Therapy Practice Framework-Domain and Process 3rd edition (American Occupational Therapy Association, 2014), occupations are different kinds of life activities in which individuals, groups and populations engage. This includes occupations like ADLs, IADLs, education, leisure and social participation.

1.3.2 Activities of Daily Living (ADLs)

ADLs are also referred to as Basic Activities of Daily Living (BADLs) or Personal Activities of Daily Living (PADLs). They enable basic survival and well-being, and are fundamental to living in a real social world context (Christiansen & Hammecker, 2001). These activities are geared toward taking care of one's own body (Rogers & Holm, 1994). Examples of ADLs include

bathing, dressing, toileting, grooming, hygiene, transferring, sexual activity and personal device care ranging from orthotics and prosthetics to contact lenses and ATDs.

1.3.3 Instrumental Activities of Daily Living (IADLs)

IADLs are activities that support everyday functioning within the home and community, that generally entail more complex interactions than those used in ADLs. IADL domains generally include: (1) financial management; (2) handling transportation; (3) shopping; (4) health management; (5) meal preparation; (6) communication management; (7) safety and emergency management; (8) education; (9) employment; and (10) leisure (American Occupational Therapy Association, 2014). The degree of independence of an individual, in safely and successfully completing IADLs, provides a measure of the individual's ability, to live independently in the community. ATDs play a crucial role in enabling PWD to complete IADLs independently. However, achieving an optimal person-ATD environment fit depends on several contextually relevant and continually changing factors.

Different kinds of outcome measure formats, ranging from self-report, informant report and performance-based report are generally used by clinicians to grade the level of independence or amount of assistance required by an individual in completing IADLs. The level of independence of an individual in completing IADLs is inversely related to the level of assistance required by them in completing IADLs. In other words, as the level of independence of an individual in safely and successfully completing IADLs increases, the level of assistance required by them decreases.

The ability of an outcome measure to accurately assess this capacity of completing IADLs is crucial for tailoring key rehabilitation attributes like intervention protocols, discharge

planning and deciding the level and type of support services required by a PWD (American Occupational Therapy Association, 2014; Schmitter-Edgecombe, Parsey, & Lamb, 2014).

In sum, it is clear that several inter-related factors underpin (unsupported, what factors?) an optimal person-device-environment fit. Furthermore, each of these factors are under constant flux. Therefore, in the measurement of outcomes related to ADLs and IADLs for PWD, it is prudent to not only utilize a holistic approach, but also, an approach that is in sync with the contemporary trends in everyday functioning.

1.4 IMPACT OF ICT ON MAINSTREAM SOCIETY AND ITS FUTURE

ICT had its modern genesis in the 1960s, with the development of the ARPANET, regarded as the predecessor of the internet, by the department of defense of the United States of America (USA). From that point on, the growth and development in ICT, has been exponential, to the extent that IT now has become an integral part of our every sphere of life (Deb, 2014; Dicianno et al., 2015). ICT, according to the World Bank, is defined as the set of activities, that enable the capture, storage, processing, transmission and display of information using electronic means (Lee, Liu, & Lio, 2016). The range of ICT is staggering from simple telephones and word processing software to internet of things and self-driving cars. In the current digitalized and globalized environment, the key components of ICT are internet; mobile technology; cloud computing; and social media platforms e.g. Facebook, Twitter etc. (Esposito et al., 2015; Lee et al., 2016; Sujatha, Satheesh, Kumar, & Manjula, 2014).

1.4.1 MOBILE TECHNOLOGY

Mobile technology is a key component of the ICT industry, and in the last few decades, the mobile industry has seen phenomenal and groundbreaking growth. Mobile technology devices have been widely adopted and ubiquitously used (Atkinson, 2013; Lee, 2014), to the extent that both in high and low income countries, the mobile phone is the most quickly adopted technology in the history of the world (Anglada-Martinez et al., 2015). Furthermore, mobile devices are the most commonly carried devices for PWD (Dicianno et al., 2015). The mobile industry includes smartphones; tablets; innovative mobile networks; interfaces; and specialized applications called Apps. Mobile devices offer several unique advantages like: 1) personalization; 2) interactivity; 3) intuitiveness; 4) timeliness; 5) powerful computational ability; and 6) context specificity by connecting with internal sensors and external devices, in order to assist the user throughout different ADLs (Azevedo, Sousa, Monteiro, & Lima, 2015; Dicianno et al., 2015). Most functions on mobile devices are managed by specialized applications called apps, which are often available for low or no cost, are easily downloadable and assist the user in performing a variety of functions (Dayer, Heldenbrand, Anderson, Gubbins, & Martin, 2013). Table 1 provides a representation of the ubiquity and accessibility of mobile technology in contemporary society.

Table 1: Mobile Technology Ubiquity and Accessibility Statistics

Demographic/Parameter	Application/Usage	Remark	Source
Internet usage in the United States of America (USA) in 2015	84% of all adults used the internet	Usage is lower in individuals who are: older, have lower socio-economic status, are African Americans or Hispanic	(Perrin & Duggan, 2015)
Mobile technology usage in the USA in 2014	More than 80% of adults have mobile phones; more than 40% of adults have smartphones. Smartphone ownership expected to double in 10 years	Recent statistics show 83% of smartphones are always turned on and with the user	(Dicianno et al., 2015)
Global smartphone usage in 2015	More than 1.08 billion smartphones of a total of 5 billion mobile phones globally	Greater penetrance between the ages of 25-34, and women taking the lead with 56% of women owning smartphones	(Azevedo et al., 2015; GO-Gulf, 2012; Mosa, Yoo, & Sheets, 2012; Stebbing & OgilvyAction, 2012)
Health and wellness apps usage in 2013	More than 17,000 mobile medical apps in the USA. Vast majority free.	Food & Drug Administration predicts that by 2016 more than 500 million smartphone users worldwide will use mobile medical apps	(Dicianno et al., 2015)
Penetration of smart phones in Europe 2012	49% of all Europeans own smartphones	Penetration amongst the highest in the world. Penetration rate growing continually.	Groups Special Mobile Association (GSMA, 2013)

1.4.2 PARADIGM SHIFT: REDEFINING IADLS IN THE CONTEXT OF ICT

The impact of ICT, on every sphere of mainstream society, has been so pervasive, that it has forced a change in the traditional way of daily functioning, by providing a new way or ability for doing day-to-day activities (Tsai, Leu, & You, 2016). Indeed, the ability of an individual, to be able to use ICT devices and software, is increasingly becoming essential for autonomous functioning in the society (Munoz-Neira et al., 2012). The impact of ICT has led to the development of a "new normal" that promotes an environment of independence, personal preferences and choice. The impact has been so profound that it has also led to changes in infrastructure, policies and practices (Longe, Ouahada, Ferreira, & Rimer, 2014). As the new era of ICT evolves so, must practices and concepts used to guide rehabilitation. The ensuing section discusses the impact of ICT on IADLs, in order to investigate the need for an ICT enabled IADLs paradigm shift. The section looks at each domain of IADLs in two parts: 1) traditional IADL domain; and 2) ICT enabled IADL domain.

1.4.2.1 Traditional Transportation Management

This is generally done by accessing travel information and making reservations through information/reservation counters and public display signs at transportation portals and printed brochures. The advantages include face-to-face communication and reduced risk of fraudulent reservations. The disadvantages include: unreliability or lack of information about on-time performance; long waiting cues; limited hours of operation and access points; cumbersome for complex travel itineraries; access issues for PWD; and increased perceived wait times (Watkins, Ferris, Borning, Rutherford, & Layton, 2011).

1.4.2.2 ICT Enabled Transportation Management

This is generally done by using the internet on personal computers and mobile devices using apps and voice calls to access travel information; and using Global Positioning Systems (GPS). The advantages include: anytime anywhere access to travel reservations and information like GPS directions, digital maps, transportation routes, traffic updates (Chun & Lee, 2015; Ma, Zheng, & Wolfson, 2015), fares; user friendly; real-time transit information; inexpensive; enhanced control over trip and time spent waiting; multiple modes of information access including websites, text messaging, smartphone apps, standard telephones with automated information (Watkins et al., 2011); more productive use of travel time (Lyons & Urry, 2005); promotion of mode-shift to public transportation (Multisystems Inc, Transit Cooperative Research Program, Transportation Research Board, & U.S. Federal Transit Administration, 2003); real-time taxi sharing; lower traffic congestion and fares; and enhanced commuting and employment capacity (Cannon & Summers, 2014; Ma et al., 2015). The disadvantages include: concerns over regulation of sharing economy businesses and user safety (Cannon & Summers, 2014); and dependence on user being tech savvy.

1.4.2.3 Traditional Financial Management

This is generally done by relying on memory, mathematical ability and to do lists for counting, paying and tracking money, bankbooks, utility bills; and physically accessing the bank. It offers the advantage of possibly more security from fraudulent transactions. The disadvantages include prone to error and recall bias; cumbersome for complex calculations; long waiting cues; limited hours of operation and points of access; and access issues for PWD.

1.4.2.4 ICT Enabled Financial Management

This is generally done by using the internet on personal computers and mobile devices using apps; and accessing Automated Teller Machines (ATMs). The advantages include: anytime anywhere access to wide range of bank information and transactions ranging from money transfer services to real-time and automatic payments (Yoon & Occeña, 2014); faster transaction speed; little or no cost for transactions; increased transparency of information (Lee, 2009; Xue, Hitt, & Chen, 2011; Yiu, Grant, & Edgar, 2007); ease of use (Landman, 2010); increased banking activity and autonomy; Conveniences like digital wallet, website customization, and digital currency (Yusuf Dauda & Lee, 2015). The disadvantages include security concerns and perceived risk of fraudulent transactions or account hacking (AlGhamdi, Drew, & Al-Ghaith, 2011; Lee, 2009); and dependence on tech savviness of user (Yusuf Dauda & Lee, 2015).

1.4.2.5 Traditional Shopping

This is generally carried out by physically accessing the retail shop or mall. It offers the advantage of physically experiencing the product/service prior to purchase. There can be several limitations like limited range of products defined by geographical location; limited hours of operation; access issues for PWD; higher cost; long travel times; long waiting cues at supermarket checkouts and possible poor service by sales staff (Deb, 2014).

1.4.2.6 ICT Enabled Shopping/Online Shopping

This is generally carried out using internet-based resources on a computer or mobile device with Apps. It offers several advantages including: very wide range; anytime and anywhere access; lower cost; no travel time; instantaneous real-time financial transactions. The disadvantages

include: limited to experiencing a product or service through viewing a video or picture of the product; and reading product reviews by other buyers (Lee, 2002).

1.4.2.7 Traditional Health Management

This is generally done by: patient relying on memory; packaged calendars; pill counts or weekly pillboxes; and biological monitoring. The advantages of these methods are that they are relatively more tested and shown to work across several medications. The disadvantages of these methods include: prone to error and recall bias; unreliable; invasive; cumbersome for complex regimens; provide minimal involvement and access to adherence data for patients and are only passive reminders (Dayer et al., 2013).

1.4.2.8 ICT Enabled Health Management

This is generally done using internet-based resources on mobile devices using apps, smart home and assistant robotic technologies. The advantages include: anytime, anywhere access (Sekar, Ma, & Dong, 2015); involvement and education of patient; availability as a repository for both patient health and medication specific information; low or no cost; ease of use; optimal for complex medication and health management regimens and use by family members and care givers; real-time health status and pharmacological monitoring (Antonopoulos et al., 2015; Berrewaerts, Delbecque, Orban, & Desseilles, 2016; Dayer et al., 2013; Nawaz et al., 2014); promotion of physical activity (Plischke, Marschollek, Wolf, Haux, & Tegtbur, 2008); monitoring of real world functioning, cognitive decline, mental health, and heart conditions (Demiris et al., 2004; Demiris & Thompson, 2012; Korman, Weiss, & Kizony, 2016; Liu, Stroulia, Nikolaidis, Miguel-Cruz, & Rios Rincon, 2016) ; and provision of customized information like notifications, alerts and tagging of input data (Augusto, Nugent, Martin, &

Olphert, 2005; El-Gayar, Timsina, Nawar, & Eid, 2013; Nikou, 2015). The disadvantage is that the main users of mobile devices are the young-middle age individuals, with the elderly population trailing behind increasingly with age (Nikou, 2015).

1.4.2.9 Traditional Meal Preparation

This is generally done by using resources like: own cooking experience and creativity; family and friends; cookbooks; grocery store handouts; and coupon book recipes. The advantages include tried and tested mechanism due to personal connection and reliance on self. The disadvantages include a finite set of recipes which are likely to be accessed at home (Doub, Small, Levin, LeVangie, & Brick, 2016) and reliability and access issues for PWD.

1.4.2.10 ICT Enabled Meal Preparation

This is generally done using internet based resources like company-branded websites; food blogs; food community websites; special nutrition interest websites; social networking sites (Facebook, Pinterest, etc.); and mobile apps (Doub, Small, & Birch, 2016; Doub, Small, Levin, LeVangie, & Brick, 2016; Schneider, McGovern, Lynch, & Brown, 2013). The advantages include, anytime, anywhere access; user friendliness; very wide range of recipe options; availability of specialized nutrition diets to suit dietary plan (Doub et al., 2016); and skill building through visual instructional tutorials (Hartmann, Dohle, & Siegrist, 2013; Winkler & Turrell, 2010). The disadvantages include information overload and dependence on tech savviness of user.

1.4.2.11 Traditional Communication Management

Generally, used modes of communication include face-to-face and written. The advantages include tried and tested mechanism; reinforcement of personal connections; and relatively lower concerns about loss of privacy of information. The disadvantages include limited availability in terms of time and geographical location; time delay; access issues for PWD; and limited number of work and social contacts.

1.4.2.12 ICT Enabled Communication Management

This is generally carried out by using internet-based resources on a computer or mobile device using apps. Commonly used communication modes include: Voice Over Internet Protocol (VOIP) phone; video conferencing; email; Social Networking platforms (Facebook, Twitter etc.); and instant messaging (Deb, 2014). The advantages offered include: user-friendliness and quick synchronous and asynchronous communication; increased flexibility; lowered cost (Deb, 2014); and global exposure (Ciaran, 2010). The disadvantages include concerns over privacy; reliability and overload of information (Lee, 2002); addictive use; safety concerns; psychological impact and musculoskeletal problems (Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011; Gustafsson, 2009; Lee et al., 2016).

1.4.2.13 Traditional Household Activities Management

This is generally achieved by physically initiating, controlling and completing the household tasks, like vacuuming, dish washing, laundry, repair, environmental control (lighting, air conditioning) etc. The advantages include self-reliance and tried and tested mechanisms. The disadvantages include limited by health status; access issues for PWD; and limited availability of time.

1.4.2.14 ICT Enabled Household Activities Management

This is generally achieved by using internet and mobile app resources and applications like Internet of Things (IoT), for information, real-time control and reminders; using automated devices like environmental control units (ECUs) or Electronic Aids to Daily Living (EADLs); and automated household equipment like vacuum cleaners, washing machines, and dishwashers. The IoT is a global network of interconnected objects that are uniquely addressable and controllable with a mobile technology device, both from inside and outside the house. Smart Homes is one of the applications of the internet of things in the networking industry (Sujatha et al., 2014). In a smart home, household devices and appliances like refrigerators, washing machines, air conditioners, lights, fans, electricity meters and computers are interconnected, so they can communicate with each other and with the residents (Bregman & Korman, 2009). The advantages include: energy and cost effectiveness (Barbieri & Palma, 2016; Terry & Palmer, 2016; Tsai et al., 2016), anytime anywhere access, automated reminders, ability to customize activities, wide range of options (Sujatha et al., 2014); automated task cueing (Gentry, 2009); relieved work load for family care givers (Ding, Cooper, Pasquina, & Fici-Pasquina, 2011); and enabled access for PWD (Jeet, Dhillon, & Bhatia, 2015; Salatino et al., 2016) and senior citizens (Singh, Bajpai, & Sweta, 2016). The disadvantages include dependence on tech savviness of user, inaccessibility for some PWD.

1.4.2.15 Traditional Safety and Security/Emergency Management

This is generally done by: patient relying on memory; seeking assistance from emergency call line services; relying on locally available support of neighbors, friends, and relatives; stocking up emergency medical and household supplies. The advantages of these methods are that they have been known to work reasonably from experience. The disadvantages of these methods include:

prone to error and recall bias; unreliable; cumbersome for complex scenarios; provide minimal involvement and access to relevant data and are only passive reminders.

1.4.2.16 ICT Enabled Safety and Security/Emergency Management

This is generally done through use of specialized software, apps and internet-based resources on mobile devices; IoT; and GPS. The advantages include: (1) smart homes with security control mechanisms (Gentry, 2009; Tsai et al., 2016); (2) using GPS secure and discrete tracking to provide remote orientation assistance and dispatch support services to tend to an emergency; (3) 24 hour remote monitoring enabling prompt detection, confidential decision making and provision of immediate and most appropriate response for emergencies (Park, Yang, Oh, Jeon, & Choi, 2014; Sekar et al., 2015); (4) tailoring mobile devices for enabling PWD with varying mental and physical limitations to be able to independently control communication and environmental control equipment, e.g. tailored mobile devices that enable an individual with cerebral palsy to wave to answer the phone; (5) enabling aged individuals and PWD to live longer independently, and significantly delaying the move to costly residential care services; (6) remote service delivery for under-served populations in rural and hitherto inaccessible areas (Baker & National Disability Services, 2016).

It is clear from the above discussion, the advantages offered by ICT far outweigh the few and far between disadvantages. It is also very evident that because of the unprecedented impact of ICT the global community is not only becoming increasingly more dependent on the ICT infrastructure, but also, the whole philosophy of social attitudes and daily functioning are continually changing to conform to an IT based lifestyle. (Deb, 2014). In the future, the society in the developed world is expected to be divided into the technophile (technology embracing) people constituting 75% of the population, and technophobic (technology apposing) people

constituting 25% of the population. However, the technology opposition is expected to be temporary, and the traditional societal values will be replaced by new, radically different, societal values of personal preference and interest (Masutti, 2001).

As a result of the quantum impact of IT on changing lifestyle and infrastructure there has been for some time the emergence of concepts like Electronic Health (EHealth), Electronic Commerce (Ecommerce) etc. It therefore would be prudent to recognize this impending change in the field of rehabilitation and take pre-emptive steps to enable enhanced outcomes and promote optimal potential. Creation of the concept of Electronic Instrumental Activities of Daily Living (EIADLs) would be a first step in marking this paradigm shift, and would foster further advances for understanding the mechanisms underlying IT related outcome measurement in rehabilitation science.

1.5 WHY OUTCOME MEASURES ARE A NECESSARY PART OF CLINICAL PRACTICE NOW

The key focus of AT clinical practice is to achieve the best person-device-environment fit to enable optimal functioning for the user (Scherer, Jutai, Fuhrer, Demers, & Deruyter, 2007). Assistive Technology (AT) interventions are made up of two parts: 1) the ATDs and 2) the practitioner services associated with ATDs acquisition and usage. For evidence based clinical practice and research, delineating intervention attributes lies at the core of understanding treatment effectiveness (Lenker et al., 2012). AT outcome measures, reflect changes in the lived experiences of users and their environments produced by ATDs (Lenker, Harris, Taugher, & Smith, 2013).

AT outcome measures are critical for establishing the effectiveness of ATDs and services involved with their usage. In particular, clinicians who prescribe ATDs can use outcome measures to identify features of device and services associated with positive outcomes, enable repeatable predictions about users who would benefit from specific devices as well as provide insightful clues about potential new devices (Lenker et al., 2012; Scherer et al., 2007). Furthermore, evidence based use of outcome measures can markedly increase the confidence of service providers in their AT intervention plans (Jutai, Fuhrer, Demers, Scherer, & DeRuyter, 2005). Without the incorporation of outcome measures in clinical practice, clinicians would be forced to rely on case studies and anecdotal appeals in order to advocate for funding for ATDs and related services. The need for using reliable and valid outcome measures has become even more pronounced, given the current funding challenges. Furthermore, in relation to outcomes research, both the measurement and description of AT interventions is crucial for establishing causal relationships between the independent and dependent variables, identification of confounding factors and translating positive clinical research into everyday clinical practice (Lenker et al., 2012). Historically, use of outcome measures in AT clinical practice and related outcomes research has been scant. AT outcomes research is still limited, primarily in the domains of measuring the impact of ATDs on participation or involvement in real life situations; and AT services related to device acquisition. The limited research has thwarted establishment of causal relationships between ATDs and services as the cause; and AT outcomes as the effect, especially related to participation outcomes. As a consequence, ATD and service funding decisions are often limited or delayed (Lenker et al., 2013). Use of outcome measures in clinical practice can help mitigate these gaps. Furthermore, use of reliable and valid outcome measures would promote development of evidence based AT practices for establishing AT effectiveness.

1.6 PATIENT CENTERED CARE

From a historical viewpoint, the influence of the biomedical model has been very prominent on the rehabilitation process, the role a client has in it, and the assessment of rehabilitation outcomes, wherein the focus has primarily been on regaining of function. However, overtime there has been increased pressure on therapists in terms of accountability and use of evidence based practice, which requires using relevant and valid evaluation tools and use of a patient centered approach for measuring outcomes. Prescription of ATDs is a skilled process, requiring the prescribing therapist to not only be aware of the range of ATDs available in the market, but also, contextual factors like the physical, psychological and environmental characteristics, as well as the individualized needs and priorities of the client (Aminzadeh & Edwards, 2000; Roelands, Van Oost, Buysse, & Depoorter, 2002; Samuelsson & Wressle, 2008; Ward, 1994). It is crucial to involve the consumer or patient in a collaborative fashion in the AT selection process (Martin, Martin, Stumbo, & Morrill, 2011). This would have a range of positive outcomes including the consumer feeling empowered; high likelihood of consumer being satisfied with the AT which matches their needs; higher QOL with the prospect of tapping their optimal potential; much reduced chances of device abandonment (Martin et al., 2011; Riemer-Reiss & Wacker, 2000). Moreover, participation of the client in the prescribing process is crucial to promote self-reliance, enhanced outcomes and foster commitment on the part of the client to successfully complete the rehabilitation program (Samuelsson & Wressle, 2008; Yeomans, 2000). Furthermore, consumers who are informed about the AT during the selection process are likely to be more satisfied with it (Martin et al., 2011). The AT abandonment rates according to Peterson (2008) range from 30% to 90%. The primary reason for this rate of abandonment is the consumer not having any say in the development and marketing of ATDs (reference?). The

Center for Medicare and Medicaid Services (CMS), the largest health insurer in the United States of America has launched a special effort to make health care patient centered. Patient-centered is defined as being more respectful and responsive to individual patient preferences, needs and values, along with using patient values to guide all clinic decisions (Reuben & Tinetti, 2012). Historically, the technology centered model focused on performance of the ATDs in standardized or ideal environments like laboratories, however, the patient centered model has a real world focus on evaluation of ATDs in the client's natural environment, enabling them to meet daily functional needs (Martin et al., 2011; Wielandt & Scherer, 2004). It is clear the end users of ATDs are the most important stakeholders in AT outcome measurement and research. Furthermore, the importance of patient centered outcomes for evaluating treatment benefits has not only been codified by the US Food and Drug Administration, but also, incorporated by the National Institutes of Health (NIH), Patient Reported Outcome Measurement Information System (PROMIS) (Andresen, Fried-Oken, Peters, & Patrick, 2016; Lenker et al., 2013). This transition was in recognition of the fact that AT interventions would be unable to meet therapeutic goals without taking into consideration what patients themselves want and value (Andresen et al., 2016). The patient centered approach aims to find the best match for the person-task-environment relationship, however, the approach is relatively new and thus requires more research to explore the myriad implications and factors affecting it (Eggers et al., 2009; Lenker & Paquet, 2003; Martin et al., 2011).

As elucidated earlier, currently patient centered outcome measures like QUEST and PIADS exist for assessing user satisfaction with, and psychosocial impact of, ATDs respectively; there are no outcome measures for assessing satisfaction of everyday functional needs related to

ICT. Therefore, this study developed and validated the EISA, a self-report outcome measure for assessing satisfaction of everyday functional needs related to ICT.

2.0 COMMON FUNCTIONAL TASKS USING INFORMATION COMMUNICATION TECHNOLOGY (ICT)

Prior to commencing development of EISA, it was crucial to assess the common functional tasks that all people use ICT to complete. This would serve as a solid theoretical foundation for developing an outcome measure that is both valid and coordinated with state of the art technology and infrastructure.

2.1 PHASE 1- SEARCH FOR COMMON FUNCTIONAL TASKS USING ICT

The initial development of EISA involved several phases of literature review. In phase 1, a literature review was carried out to ascertain common functional tasks that all people, with or without disabilities, use ICT to complete.

2.1.1 Methodology

The results of this review were collected by searching the Engineering Compendex, Inspec, Embase, PubMed/MEDLINE and Scopus databases. Studies were identified that were: (a) written in English, (b) peer-reviewed articles, conference proceedings, or book chapters with full text available for review, (c) relevant to ICT and/or EADs. Common functional tasks or needs of

ICT, were researched using the following free-text search words: information and communication technology, purposes, daily functions, functional needs. In the iterative search process, subsequent to the search with an undefined population, refined searches included additional key words along the domains of cognitive disabilities, learning disabilities, sensory disabilities and physical disabilities. The search for common functional tasks or functional needs associated with various disabilities enabled comparison to that of the able-bodied population in terms of ICT needs. An item bank, consisting of 111 items, was derived based on the literature review data. Subsequently, two reviewers, the first author and a student intern, incorporated a functional need, shared characteristics and item-fit iterative approach, to sort the 111 items in the item bank, into 8 categories of common functional tasks with ICT. Table 1 represents the list of common functional tasks with ICT categories, providing examples of activities for better understanding of the corresponding goal, and examples of electronic devices, which may aid in completing the activity.

For the purpose of this review, an Electronic Assistive Device (EAD) is defined as, "Any ICT/electronic device or software that assists with promoting, maintaining, and/or enhancing the ability of a PWD to live independently in society". An EAD would thus enable a PWD to independently complete IADLs, as well as, promote community participation. As defined earlier in Chapter 1, Information Communication Technology (ICT) refers to, the set of activities, that enable the capture, storage, processing, transmission and display of information using electronic means (Lee et al., 2016). ICT includes: (1) ICT used by able-bodied individuals, that may not be accessible for PWD; and (2) ICT specifically designed/modified to be accessible for PWD. From this point on, ICT accessible to PWD shall be referred to as "EAD."

This literature review was carried out for analyzing existing ICT literature to establish common reasons for its use. The method also helped to validate that both able-bodied people and PWD share common goals for ICT use, though the process for accomplishing the same task may differ for the two populations.

The common functional tasks with ICT have been categorized into the following eight categories:

2.1.1.1 Communication

Communication is defined as the sender conveying information electronically, including audible and visual forms of messaging. Common devices such a Smartphones, Tablets, PDAs, and computers allow for forms of communication such as calling, text messaging, email, instant messaging, voice mail, and video conferencing (Bouwman, van den Hooff, van de Wijngaert, & van Dijk, 2005). Specialized devices such as a modified keyboard, mouse, or activation methods have been developed to allow a PWD to accomplish the same functional goals as the typical able-bodied user population. To utilize these common devices, a person with a disability may use various speech adaption systems for verbal communication such as text-to-speech or digital speech synthesis (Greene, 2011), as well as computer access software like screen readers for internet communication such as for email or social media purposes (Muncert et al., 2011).

2.1.1.2 Memory Aids

Memory aids serve the goal of retaining information in a device rather than relying on memory alone, which can be unreliable and prone to error. Electronic alert or alarm systems, which remind the user of a time-sensitive task or event, fall under this category. Common electronic devices may serve as a memory notebook or be used for external cuing for an individual

requiring a reminder, regardless of disability status (Helmick, 2010). For users of any functional level, electronic devices such as voice recorders, pocket-sized digital calendars, alerting software, and cell phone alarm apps are commercially available as memory aids (LoPresti, Mihailidis, & Kirsch, 2004). More specialized EADs are designed for people with disabilities such as a cognitive impairment: enlarged calendars and clocks, talking clock/wrist watches, voice-activated phone dialers, smartphone memory-aid apps, automated pill dispensers with message machine and timer, and a Find-It beeping device to keep track of small items such as car keys and glasses (Family Caregiver Alliance, 2011).

2.1.1.3 Health and Safety

The goal of health and safety includes the use of an EAD to promote a safe environment, healthy lifestyle, or care of the body and mind. Technology may be used to prevent potential danger with the use of systems such as home monitoring or identification notification. A fitness app, digital pedometer, medicine dispensers, and nutrition app are examples of common EAD applications that promote the wellbeing of an individual regardless of disability status, fulfilling the goal of physical health (Bouwman et al., 2005). An ECU may allow a PWD to safely control appliances, adapt surroundings, and meet daily self-care needs (Wendt, Quist, & Lloyd, 2011).

2.1.1.4 Accessing Information

Accessing information from an EAD is the task of electronically obtaining data or material of any subject, in print or digitalized, video, or audio form, typically through Internet access via a Smartphone, Tablet, PDA, or computer (through standard or modified accessed). The types of data available through internet access may include currencies, prices, stock exchange information, electronic records, and file sharing software. General news may be generated from

online news apps, the internet browser, or various online editorial boards (Bouwman et al., 2005). Storage on common EADs for the purpose of eventually accessing the information may include pictures, contact information, appointments, shopping-list, and various expense tracking (Hart, Buchhofer, & Vaccaro, 2004).

2.1.1.5 Entertainment

Entertainment is the goal of holding the attention of the EAD user by offering an activity of enjoyment. Common activities for entertainment include films, music, pictures, reading, and gaming. The nature of the activity is based on the user's leisure preference or desired hobbies and the access to the EAD is selected based on the user's functional abilities. For example, the able-bodied individual may choose to pleasure read electronically on the nook tablet, kindle, or personal computer, while a PWD may require screen reader software on the same EAD to perform the same activity (Bouwman et al., 2005; LoPresti et al., 2004).

2.1.1.6 Education

Education is meant in the broad sense of an EAD aiding in the learning process. This commonly involves learning information from bibliographical databases, scientific articles, and online or digitalized textbooks, which is possible through common EADs with modified access for a person with a disability (Bouwman et al., 2005). The informative experience is not limited to devices used in a formal schooling environment, but includes curriculums with computer assisted learning software for promoting motivation, skills training, or cognitive development (Roselli & Gulick, 2013). Educational games are designed for students to explore future work skills on common EADs (Sawyer, Griffiths, Light, Lincoln, & Ashton, 2011) or for a person with a

disability to further develop rehabilitation skills such as cognitive fitness on interactive gaming systems like the Wii (Muncert et al., 2011).

2.1.1.7 Online Shopping

Online shopping or e-shopping allows the consumer to purchase goods and services directly. An EAD user accesses a virtual store via internet access using an EAD to place an order, indicate delivery address, and method of payment to buy a product (Family Caregiver Alliance, 2011). Electronic money transfers are possible through online checking apps and banking websites, through typical or modified use of common EADs (Collins, 2012). It offers several advantages including: very wide range; anytime and anywhere access; lower cost; no travel time; instantaneous real-time financial transactions. The disadvantages include: limited to experiencing a product or service through viewing a video or picture of the product; and reading product reviews by other buyers (Lee, 2002).

2.1.1.8 Travel

Travel is a category referring to an EAD providing information, which aids in the user getting to a desired destination, rather than being a literal vehicle means of transportation. The travel information includes functions such as GPS directions with a garner device or digital mapping app, access to public transportation routes via Smartphone apps, or traffic updates through any EAD with internet access (Bouwman et al., 2005; Roselli & Gulick, 2013).

Table 2 summarizes examples of activities that are included within the established common functional tasks with ICT categories. The common functional tasks with ICT categories have been shown with the corresponding electronic device examples, which able-bodied individuals may use to complete these activities. Furthermore, the table also lines up these

categories with an alternative method of completing the same activity for PWD. The visual representation in Table 2 enables comparison between both the able-bodied individuals and PWD, with regard to completing the same common functional tasks using alternative methods and/or ICT devices.

Table 2: Common Functional Tasks with ICT Categories

ICT Category of Functional Tasks	Able-bodied Individuals - Functional Need Examples	Able-bodied Individuals - Device Examples	PWD - Functional Need Examples	PWD - Device Examples
Communication	Call, text message, email, social media, video conference, voice mail	Mobile or smart phone, desktop or laptop computer, tablet	Speech, call, text message, email, social media, video conference, voice mail	Modified keyboard, mouse, or activation method of mobile device, computer, Computer access software like screen readers (for electronic communication such as email), speech adaption systems (text-to-speech, digital speech synthesizer)
Memory Aid	Notes, alert notification, calendar	Alarm clock, alarm app, calendar app	Notes, alert notifications, calendar	Verbal recorder, scheduled alert systems, wristwatch alarm, talking or enlarged clocks, memory notebook, accessible smartphones with apps
Health and Safety	Physical health, mental health, home security, privacy	Fitness app, home monitoring app, pedometer, nutrition app, medicine dispenser, identification and privacy notification systems	Physical health, mental health, home security, privacy	Environmental control unit, biomedical vital monitors, nutrition medicine dispenser, voice recognition identification privacy systems
Accessing and Storing Information	Internet, news, weather, pictures, contact information, electronic records	Camera app, cell phone, computer tablet, expense tracking app	Internet, news, weather, pictures, contact information, electronic record	Internet via Dynavox (Windows), modified computer access (keyboard, mouse, or activation)

Table 2. (Continued)

Entertainment	Digital games, music, videos, movies, reading, pictures, social media	Books on iPad, Nook, kindle, game apps, game systems, cell phone, computer, tablet	Digital games, music, videos, movies, reading, pictures, social media	Remote for music and movie players, screen-reader
Education	Study, research, calculation, educational games	Online textbook, study apps, online flash cards, university app, calculation software, internet database via computer/phone	Study, take notes, rehabilitation	Learning disability devices, study aids, SmartPen, rehabilitation videogames, educational software programs
Online Shopping	Website purchases, budgeting	Budgeting and banking apps, tip calculator, retail website via smart phone, computer, tablet	Website purchases, budgeting	retail website via smart phone, computer, tablet (modified mouse, keyboard, voice control activation)
Travel	Maps, public transportation routes, traffic updates	Cell phone, GPS, maps app, public transit app	Information on wheelchair accessibility, travel packages, public transportation routes	Internet via cell phone, computer, tablet (modified mouse, keyboard, voice control activation), public transit app

Key: ICT = Information Communication Technology; and PWD = People with Disabilities

Thus, the common functional tasks all people, with or without disabilities use ICT for can be broadly condensed into a few categories. In this study, the common functional tasks were categorized into eight categories. This categorization was validated further through the EISA content validation and item development by focus groups of clinicians and EAD users. Furthermore, this study also validates the assumption that even though able-bodied individuals and PWD may use different electronic devices and/or methods to meet their ICT related functional needs, the common functional tasks or needs with ICT are the same for both able-bodied individuals and PWD.

3.0 REVIEW OF TOOLS TO ASSESS PERFORMANCE OF INSTRUMENTAL ACTIVITIES OF DAILY LIVING USING CONTEMPORARY ELECTRONIC ASSISTIVE DEVICES (EADS)

In order to achieve the specific aims of this study, literature reviews were conducted in four phases. Phase 1, as elucidated in chapter 2, common functional tasks using ICT, analyzed the literature to ascertain common functional tasks that all people, with or without disabilities, use ICT to complete. Phase 2 gauged the literature to identify any outcome measures, specifically designed and validated, for assessing satisfaction of functional needs related to EADs. Phase 3 reviewed prominent self-report outcome measures in the field of ATDs use and evaluation that may also relate to EADs. Phase 4 reviewed existing self-report IADL outcome measures, to identify any IADL instruments specifically designed and validated, for assessing satisfaction of functional needs, related to EADs.

3.1 PHASE 2-SEARCH FOR OUTCOME MEASURES FOR ASSESSING SATISFACTION OF FUNCTIONAL NEEDS WITH EADS

Outcome measurement involves the evaluation of the results of completing established functional tasks and their comparison with intended results (Jutai et al., 2005; Scherer et al., 2011). This phase of the study was undertaken to validate the assumption that in the current

literature, there is no outcome measure that has been specifically designed and validated for assessing satisfaction of functional needs with EADs.

3.1.1 Methodology

To ensure that the search of the literature is thorough and valid, this phase of the study was carried out in conjunction with a librarian specializing in systematic reviews of the literature. The results of this review were collected by searching the PubMed/Medline, Engineering Compendex, Inspec and Embase databases. Studies were identified that were: (a) written in English, (b) peer-reviewed articles, conference proceedings, or book chapters with full text available for review, (c) relevant to outcome measurement for ICT devices for the able-bodied population and/or PWD. Table 3 presents the combination of search terms used for searching for Outcome Measures for EADs. The table categorizes the terms into: (1) general search terms; (2) Medical Subject Headings (MeSH) terms; (3) engineering compendix terms; (4) Population, Intervention, Comparator and Outcome, segments of research question, to help guide the search; (5) types of disabilities; and (6) major categories of EADs.

Table 3: Search Terms Used For EAD Outcome Measures Search

Search term	Mesh term	Engineering Compendix term	PICO question	Types of Disabilities	Major Categories of Electronic Assistive Devices
outcome measure	outcome assessment, outcome and process assessment, treatment outcome	no term	Population: for adults with physical and/or cognitive and/or sensory disabilities	Physical: spinal cord injury, cerebral palsy, muscular dystrophy, Spina Bifida, amyotrophic lateral sclerosis, multiple sclerosis, Parkinson disease, amputation.	Communication - smart phone, tablet, laptop, Computer access, speech adaption systems e.g. Text-To-Speech, digital speech synthesizer
assistive technology	self-help devices	no term	Intervention: is there any outcome measure specifically for electronic assistive devices	Cognitive: Traumatic brain injury, acquired brain injury, post-traumatic stress disorder, learning disability, stroke, autism spectrum disorder	Memory aid - Verbal recorder, scheduled alert systems, memory notebook, cognitive aids, cognitive assistive devices, cognitive prosthetic devices, electronic cognitive devices
electronic devices	no term	no term	Comparator: compared to global AT outcome measures like the QUEST & PIADS	Sensory: visual impairment, hearing impairment	Health and safety - home automation systems, smartphone app, mobile health, mHealth, biomedical vital monitors, nutrition medicine dispenser, voice recognition identification privacy systems

Table 3. **(Continued)**

cognitive aids	no term	no term	Outcome: for measuring satisfaction of functional needs related to electronic assistive devices	Same as above	Accessing and storing information- modified computer access, iPad, iPhone
instrumental activities of daily living	no term	no term	Same as above	Same as above	Entertainment - Remote control
Environmental Control Unit	no term	no term	Same as above	Same as above	Education - adapted keyboards, alternative mouse options, screen readers, screen magnification, voice recognition, software support for learning disability, digital recorders, dictation software, modified computer activation, smartPen, and rehabilitation videogames
Electronic Aids to Daily Living	no term	no term	Same as above	Same as above	On-line shopping - voice control activation)
cognitive assistive devices	no term	no term	Same as above	Same as above	Travel- public transit app
Information Communication Technology	no term	no term	Same as above	Same as above	Same as above

Table 3. **(Continued)**

Information Technology (IT)	medical informatics, health IT	information science, information systems, information retrieval systems	Same as above	Same as above	Same as above
cognitive prosthetic devices	no term	no term	Same as above	Same as above	Same as above
electronic cognitive device	no term	no term	Same as above	Same as above	Same as above
disability	no term	no term	Same as above	Same as above	Same as above
rehabilitation	no term	no term	Same as above	Same as above	Same as above
purposes	no term	no term	Same as above	Same as above	Same as above
daily function	no term	no term	Same as above	Same as above	Same as above
functional need	no term	no term	Same as above	Same as above	Same as above
speech generating devices	no term	no term	Same as above	Same as above	Same as above
people with disabilities	disabled persons	no term	Same as above	Same as above	Same as above
patient satisfaction	patient satisfaction & preference	no term	Same as above	Same as above	Same as above

Key: QUEST = Quebec User Evaluation of Satisfaction with Assistive Technology; PIADS = Psychosocial Impact of Assistive devices Scale; AT = Assistive Technology; and PICO = Problem/Patient/Population, Intervention/Indicator, Comparison, Outcome

In the iterative search process, articles retrieved were screened based on their titles having a combination of the following key elements: (1) population - people with a disability; (2) intervention – information communication technology related device; and (3) outcome - questionnaire or survey or some type of outcome measure for assessing satisfaction of functional needs related to EADs. The total number of articles retained after removing duplicate articles were 264. A total of 76 articles were selected from the initial search based on the content of their titles. The total number of articles screened for further evaluation after reading abstracts were 22. After further evaluation of the shortlisted 22 articles, no articles were found that dealt with outcome measures, specifically designed and validated, for assessment of satisfaction of functional needs, related to EADs. The following flow diagram in Figure 1 elucidates the phase 2 search process.

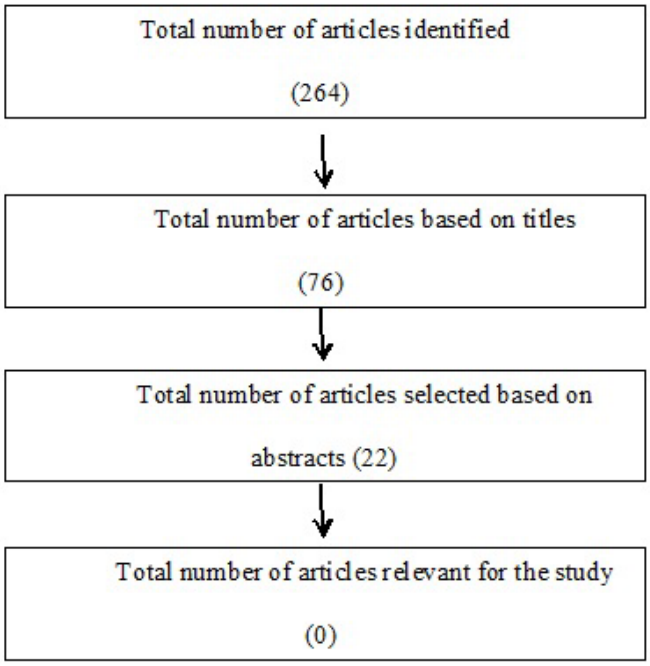

Figure 1: Phase 2 Search for EAD Outcome Measure

The results of phase 2 of this study met the second main objective of this review by providing evidence-based research to prove that at the time of Phase 2 there were no existing outcome measures for assessing satisfaction of functional needs related to EADs. Furthermore, the results of this literature review served the purpose of justifying the development of an adequate outcome measure for the same. This means an instrument that accounts for user satisfaction, in order to promote optimization of the functional needs met by PWD with the use of EADs.

3.2 PHASE 3-REVIEW OF PROMINENT EXISTING OUTCOME MEASURES

This section presents a review of additional prominent outcome measures in the field of ATD use and evaluation that may also relate to EAD. The primary purpose of the review was assessment of the selected outcome measures, in order to gage their applicability and effectiveness for assessing satisfaction of functional needs related to EADs.

3.3 NATIONAL INSTITUTES OF HEALTH (NIH) HEALTH RELATED PATIENT-REPORTED OUTCOME (PRO) PROGRAMS

In 2004, The NIH invested $50 million in PROs research aiming to have a substantial impact on the use of patient information to assist both clinicians and patients in making informed decisions about treatments for different medical conditions. The NIH developed 3 major programs in this field: the Patient-Reported Outcomes Measurement Information System (PROMIS), NIH

Toolbox for assessing neurological and behavioral functioning, and Neuro-QOL, a quality of life assessment for neurological disorders in health care. The approach behind these measures has been that rehabilitation takes place in a wide range of environments, having different levels of specialized personnel and equipment, however, PROs would be able to provide consistent measures in the end that bridge disease type, and this would benefit the field of rehabilitation (Quatrano & Cruz, 2011).

3.3.1 NIH PROMIS

PROMIS is a system of patient reported health status measures for physical, mental and social health that are highly reliable and precise. These measures are generated from item banks and can be used for clinical practice and research. The PROMIS instruments can be used to measure outcomes by asking questions about what patients are able to do and how they feel (PROMIS, 2014b). Within this framework, adult, parent proxy and pediatric item banks are available, for each of the mental, physical and social health classifications. Furthermore, the PROMIS instruments are created using modern measurement theory and their formats consist of a short form (4 - 10 items per concept) or a computerized adaptive testing format (3 - 7 items per concept). All PROMIS items use a 5 point scale for responses from 1 = Not at all, to 5 = Very much, except the pain items. Most PROMIS items incorporate a 7 day recall format, with questions beginning with…"in the past 7 days…," except items like sexual function having a longer recall of 30 days and physical function having a present focus or daily recall. There were 66 instruments available at the time of this research to measure the following domains: Anxiety, Anger, Depression, Fatigue, Pain Behavior, Pain Interference, Satisfaction with Discretionary

Social Activities, Satisfaction with Social Roles, Sexual Function, Global Health, and Physical function (see Figure 2).

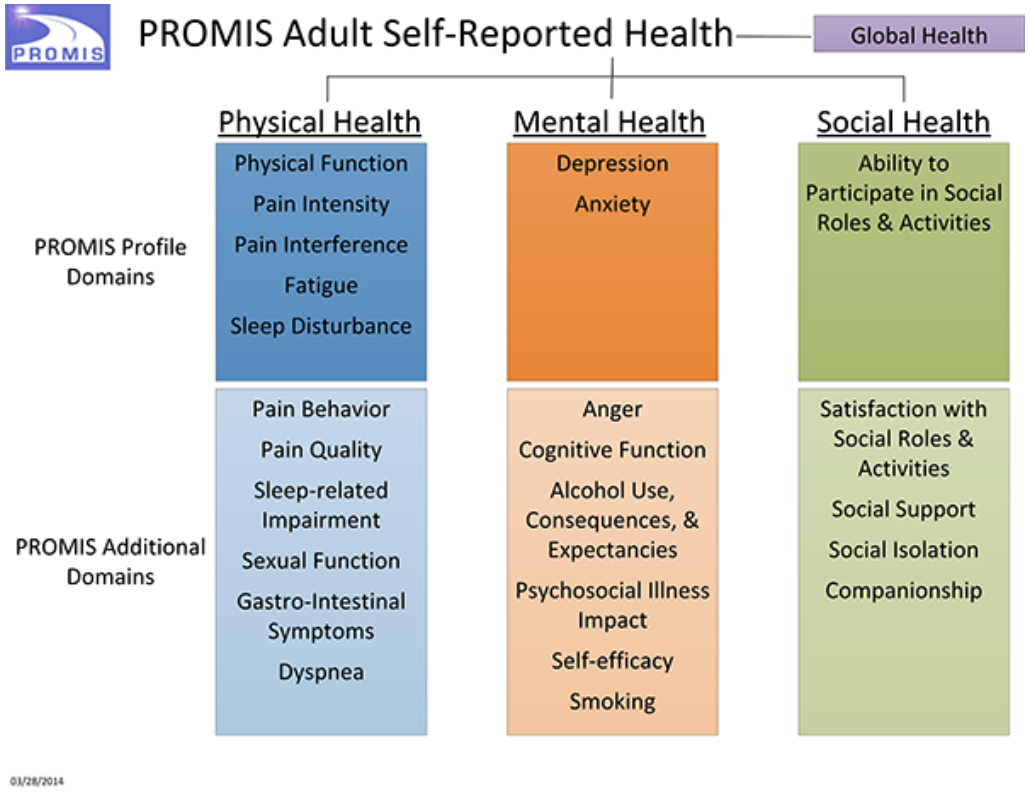

Figure 2: PROMIS Adult Self-Reported Health

3.3.1.1 PROMIS Mental Health Adult Item Bank

The PROMIS mental health adult item bank was made up of the following sub-domains: 1) anxiety; 2) depression; 3) alcohol use; 4) anger; 5) cognitive function; and 6) psychosocial illness impact. All items in each of the sub-domains dealt with limitations or characteristics that were specific to that particular sub-domain. The sub-domain, PROMIS Bank v1.0 - Applied Cognitive Abilities, was the only sub-domain, within the mental health adult item bank, that contained items that broadly identified with IADLs related to EAD. However, the items in this sub-domain lacked the sensitivity and specificity for IADLs related to EAD. Nevertheless, they did provide

validation for IADLs related to EAD, and more importantly, establish the need to develop measures or instruments that are specific to EAD. Table 4 below, lists the items in the mental health adult item bank domain that relate to IADLs for EAD. The table also classifies the related items, from the perspective of common functional tasks with ICT categorization, discussed earlier in the literature review section.

Table 4: PROMIS Mental Health Adult Items Relevant to IADLs for EAD

Domain	Sub-domain	Item number	Item	Functional tasks with ICT classification
Adult Item Bank-Mental Health	PROMIS Bank v1.0 - Applied Cog Abilities	PC27	I have been able to remember to do things, like take medicine or buy something I needed	Health and safety, memory aid, and online shopping
Adult Item Bank-Mental Health	PROMIS Bank v1.0 - Applied Cog Abilities	PC-CaPS10	I have been able to remember telephone numbers	Memory aid and communication
Adult Item Bank-Mental Health	PROMIS Bank v1.0 - Applied Cog Abilities	PC-CaPS12	I have been able to remember the name of a familiar object	Memory aid
Adult Item Bank-Mental Health	PROMIS Bank v1.0 - Applied Cog Abilities	PC-CaPS16	My ability to remember important dates has been as good as usual	Memory aid
Adult Item Bank-Mental Health	PROMIS Bank v1.0 - Applied Cog Abilities	PC-CaPS19	My ability to keep track of lists has been as good as usual	Memory aid
Adult Item Bank-Mental Health	PROMIS Bank v1.0 - Applied Cog Abilities	PC-CaPS21	My ability to follow driving directions has been as good as usual	Travel

Table 4. (**Continued)**

Adult Item Bank-Mental Health	PROMIS Bank v1.0 - Applied Cog Abilities	PC-CaPS23	My ability to remember things that I need to do has been as good as usual	Memory aid
Adult Item Bank-Mental Health	PROMIS Bank v1.0 - Applied Cog Abilities	PC-CaPS9	I have been able to learn new things easily, like telephone numbers or instructions	Memory aid, health and safety, and education
Adult Item Bank-Mental Health	PROMIS Bank v1.0 - Applied Cog Abilities	PC-CaPS20	My ability to count money has been as good as usual	Financial management

3.3.1.2 PROMIS Social Health Adult Item Bank

The PROMIS social health adult item bank was made up of the following sub-domains: 1) satisfaction with participation in discretionary social activities; 2) satisfaction with participation in social roles; 3) ability to participate in social roles and activities; 4) emotional support; 5) informational support; 6) instrumental support; 7) satisfaction with social roles and activities; and 8) social isolation. All items in each of the sub-domains dealt with limitations or characteristics that were specific to that particular sub-domain. Within the social health adult item bank domain, the sub-domains, PROMIS bank v1.0 – social satisfaction Discretionary Social Activities (DSA); PROMIS bank v1.0 – social satisfaction role; and PROMIS bank v2.0 – satisfaction with social roles and activities, contained items that broadly identified with IADLs related to EAD. However, the items in these sub-domains lacked the sensitivity and specificity for IADLs related to EAD. Nevertheless, they did provide validation for IADLs related to EAD, and more importantly, establish the need to develop measures or instruments that were specific to EAD. Table 5 lists the items in the social health adult item bank domain that relate to IADLs

for EAD. In addition, it also classifies the related items from the perspective of common functional tasks with ICT categorization discussed earlier in the literature review section.

Table 5: PROMIS Social Health Adult Items Relevant to IADLs for EAD

Domain	Sub-domain	Item number	Item	Functional tasks with ICT classification
Adult Item Bank-Social Health	PROMIS Bank v1.0 - Social Sat DSA	SRPSAT19	I am satisfied with my ability to do all of the community activities that are really important to me	Communication, entertainment
Adult Item Bank-Social Health	PROMIS Bank v1.0 - Social Sat DSA	SRPSAT23	I am satisfied with my ability to do leisure activities	Communication, entertainment
Adult Item Bank-Social Health	PROMIS Bank v1.0 - Social Sat DSA	SRPSAT48	I am satisfied with my ability to do things for fun at home (like reading, listening to music, etc.)	Entertainment
Adult Item Bank-Social Health	PROMIS Bank v1.0 - Social Sat DSA	SRPSAT52	I am satisfied with my ability to do all of the leisure activities that are really important	Entertainment
Adult Item Bank-Social Health	PROMIS Bank v1.0 - Social Sat Role	SRPSAT07	I am satisfied with how much work I can do (include work at-home	Education
Adult Item Bank-Social Health	PROMIS Bank v1.0 - Social Sat Role	SRPSAT09	I am satisfied with my ability to do the work that is really important to me (include work at home)	Education

Table 5. **(Continued)**

Adult Item Bank-Social Health	PROMIS Bank v1.0 - Social Sat Role	SRPSAT35	The quality of my work is as good as I want it to be (include work at home)	Education
Adult Item Bank-Social Health	PROMIS Bank v1.0 - Social Sat Role	SRPSAT47	I am satisfied with my ability to do regular personal and household responsibilities	Education, online shopping, financial management, health and safety
Adult Item Bank-Social Health	PROMIS Bank v2.0 - Satisfaction with Social Roles and Activities	SRPSAT43	I am satisfied with my ability to keep in touch with others	Communication, travel

3.3.1.3 PROMIS Physical Health Adult Item Bank

The PROMIS physical health adult item bank was made up of the following sub-domains: 1) fatigue; 2) pain intensity; 3) pain interference; 4) physical function; 5) sleep disturbance; 6) pain behavior; 7) sexual function; and 8) sleep-related impairment. All items in each of the sub-domains dealt with limitations or characteristics that were specific to that particular sub-domain. The sub-domain, PROMIS Bank v1.0 – physical function samples with mobility aid, was the only sub-domain, within the physical health adult item bank, that contained items that broadly identified with IADLs related to EAD. However, the items in this sub-domain lacked the sensitivity and specificity for IADLs related to EAD. Nevertheless, they did provide validation for IADLs related to EAD, and more importantly, establish the need to develop measures or instruments that were specific to EAD. Table 6 lists the items in this sub-domain that relate to

IADLs for EAD. The table also classifies the items, from the perspective of, common functional tasks with ICT categorization, discussed earlier in the literature review section.

Table 6: PROMIS Physical Health Adult Items Relevant to IADLs for EAD

Domain	Sub-domain	Item number	Item	Functional Tasks with ICT Classification
Adult Item Bank-Physical Health	PROMIS Bank v1.0 - Phys Func Samples w Mobility Aid	PF_10	Are you able to dial a number on a phone with large buttons?	Communication
Adult Item Bank-Physical Health	PROMIS Bank v1.0 - Phys Func Samples w Mobility Aid	PF_13	Are you able to dial a number on the keypad of a cell phone?	Communication
Adult Item Bank-Physical Health	PROMIS Bank v1.0 - Phys Func Samples w Mobility Aid	PF_37	Are you able to push the buttons on a television remote control?	Entertainment
Adult Item Bank-Physical Health	PROMIS Bank v1.0 - Phys Func Samples w Mobility Aid	PF_41	Are you able to type a few sentences on a computer keyboard?	Accessing and storing information
Adult Item Bank-Physical Health	PROMIS Bank v1.0 - Phys Func Samples w Mobility Aid	PF_43	Are you able to use a regular computer mouse?	Accessing and storing information
Adult Item Bank-Physical Health	PROMIS Bank v1.0 - Phys Func Samples w Mobility Aid	PF_9	Are you able to receive a call on a cellphone?	Communication

3.3.2 NIH Toolbox

The NIH toolbox was a brief set of multi-dimensional measures that assess cognitive, emotional, motor and sensory function, between the ages of 3 to 85. These standard measures could be used across a range of study designs and settings. Furthermore, the toolbox helped facilitate the study of neurological and behavioral function changes across the life span, including evaluating treatment and intervention effectiveness.

The toolbox provided the following domains for assessment:

3.3.2.1 Cognition Domain

The NIH toolbox cognition domain was designed to measure the sub-domains of: 1) executive function; 2) attention; 3) episodic memory; 4) language; 5) processing speed; and 6) working memory. None of the cognition sub-domains along with the tests used to measure them, had any items covering IADLs related to EAD.

3.3.2.2 Emotion Domain

The NIH toolbox emotion domain was designed to measure the sub-domains of: 1) psychological well-being; 2) social relationships; 3) stress and self-efficacy; and 4) negative effect. None of the emotion sub-domains along with the instruments used to measure them had any items that covered IADLs related to EAD.

3.3.2.3 Motor Domain

The NIH toolbox motor Domain was designed to measure the sub-domains of: 1) balance; 2) dexterity; 3) endurance; 4) locomotion; and 5) strength. None of the motor sub-domains along with the tests used to measure them had any items that covered IADLs related to EAD.

3.3.2.4 Sensation Domain

The NIH toolbox sensation domain was designed to measure the sub-domains of: 1) audition; 2) olfaction; 3) pain; 4) taste; 5) vestibular; and 6) vision. None of the sensation sub-domains along with the tests used to measure them had any items that covered IADLs related to EAD.

3.3.3 NIH Neuro-QOL Adult Scales

The NIH neuro-QOL adult scales were a set of self-report measures that assessed the Health Related Quality Of Life (HRQOL) in adults with neurological disorders. These measures assessed symptoms, concerns and issues that were relevant across disorders. Furthermore, these measures assessed areas that were most relevant to specific patient populations. The neuro-QOL adult scales assessed the sub-domains of: 1) ability to participate in social roles and activities; 2) anxiety; 3) depression; 4) emotional and behavioral decontrol; 5) fatigue; 6) lower extremity function; 7) positive affect and well-being; 8) upper extremity function; 9) stigma; 10) satisfaction with social roles and activities; and 11) cognitive function. All items in each of the sub-domains dealt with limitations or characteristics that were specific to the particular sub-domain. The sub-domains: Neuro-QOL item bank v1.0 – ability to participate in social roles and activities; Neuro-QOL item bank v1.0 – upper extremity function-fine motor ADL; Neuro-QOL item bank v1.1 – satisfaction with social roles and activities; Neuro-QOL item bank v2.0 –

cognitive function; and Neuro-QOL item bank v1.0 – communication social function; contained items that broadly identified with IADLs related to EAD. However, the items lacked the sensitivity and specificity for IADLs related to EAD. Nevertheless, they did provide validation for IADLs related to EAD, and more importantly, establish the need to develop measures or instruments that were specific to EAD. Table 7 lists the items in these sub-domains that relate to IADLs for EAD. The table also classifies the items, from the perspective of, common functional tasks with ICT categorization, discussed earlier in the literature review section.

Table 7: Neuro-QOL Adult Scale Items Relevant to IADLs for EAD

Domain	Sub-domain	Item Number	Item	Functional tasks with ICT classification
Adult Banks	Neuro-QOL Item Bank v1.0 - Ability to Participate in Social Roles and Activities_03-04-2014	NQPRF26	I am able to participate in leisure activities	Entertainment, communication
Adult Banks	Neuro-QOL Item Bank v1.0 - Ability to Participate in Social Roles and Activities_03-04-2014	NQPRF34	I can keep up with my work responsibilities (include work at home)	Employment, education
Adult Banks	Neuro-QOL Item Bank v1.0 - Ability to Participate in Social Roles and Activities_03-04-2014	NQPRF20	I am able to do my hobbies or leisure activities	Entertainment, communication, accessing and storing information, travel
Adult Banks	Neuro-QOL Item Bank v1.0 - Ability to Participate in Social Roles and Activities_03-04-2014	NQPRF37	I am accomplishing as much as usual at work for me (include work at home)	Employment, education

Table 7. **(Continued)**

Adult Banks	Neuro-QOL Item Bank v1.0 - Ability to Participate in Social Roles and Activities_03-04-2014	NQPRF38	My ability to do my work is as good as it can be (include work at home)	Employment, education
Adult Banks	Neuro-QOL Item Bank v1.0 - Ability to Participate in Social Roles and Activities_03-04-2014	NQPRF16	I have to limit the things I do for fun at home (like reading, listening to music, etc.)	Entertainment, accessing and storing information
Adult Banks	Neuro-QOL Item Bank v1.0 - Ability to Participate in Social Roles and Activities_03-04-2014	NQPRF25	I have trouble keeping in touch with others	Communication
Adult Banks	Neuro-QOL Item Bank v1.0 - Upper Extremity Function - Fine Motor, ADL_03-04-2014	NQUEX44	Are you able to make a phone call using a touch-tone key-pad?	Communication
Adult Banks	Neuro-QOL Item Bank v1.1 - Satisfaction with Social Roles and Activities_07-09-2014	NQSAT39	I am disappointed in my ability to take care of personal and household responsibilities	Employment, education, health and safety

Table 7. **(Continued)**

Adult Banks	Neuro-QOL Item Bank v1.1 - Satisfaction with Social Roles and Activities_07-09-2014	NQSAT30	I am satisfied with my ability to do all of the leisure activities that are really important to me	Entertainment, communication
Adult Banks	Neuro-QOL Item Bank v1.1 - Satisfaction with Social Roles and Activities_07-09-2014	NQSAT43	I am satisfied with my ability to work (include work at home)	Employment, education
Adult Banks	Neuro-QOL Item Bank v2.0 - Cognitive Function_09-8-2014	NQCOG15r1	keeping track of time (e.g., using a clock)?	Time management
Adult Banks	Neuro-QOL Item Bank v2.0 - Cognitive Function_09-8-2014	NQCOG16r1	checking the accuracy of financial documents, (e.g., bills, checkbook, or bank statements)?	Financial management
Adult Banks	Neuro-QOL Item Bank v2.0 - Cognitive Function_09-8-2014	NQCOG22r1	reading and following complex instructions (e.g., directions for a new medication)?	Memory aid, health and safety, education, employment
Adult Banks	Neuro-QOL Item Bank v2.0 - Cognitive Function_09-8-2014	NQCOG24r1	planning for and keeping appointments that are not part of your weekly routine, (e.g., a therapy or doctor appointment, or a social gathering with friends and family)?	Time management

Table 7. **(Continued)**

Adult Banks	Neuro-QOL Item Bank v2.0 - Cognitive Function_09-8-2014	NQCOG25r1	managing your time to do most of your daily activities?	Time management
Adult Banks	Neuro-QOL Item Bank v2.0 - Cognitive Function_09-8-2014	NQCOG26r1	planning an activity several days in advance (e.g., a meal, trip, or visit to friends)?	Time management, memory aid
Adult Banks	Neuro-QOL Item Bank v2.0 - Cognitive Function_09-8-2014	NQCOG40r1	learning new tasks or instructions?	Memory aid, education, employment
Adult Banks	Neuro-QOL Scale v1.0 - Communication SF_03-14-2014	NQCOG01	writing notes to yourself, such as appointments or 'to do' lists?	Communication, memory aid, accessing and storing information
Adult Banks	Neuro-QOL Scale v1.0 - Communication SF_03-14-2014	NQCOG04	understanding family and friends on the phone?	Communication

3.4 PHASE 4-SEARCH FOR SELF-REPORT IADL OUTCOME MEASURE FOR ASSESSING SATISFACTION OF EVERYDAY FUNCTIONAL NEEDS WITH EADS

Phase 2 and 3 of preliminary research confirmed that at the time of this study there were no outcome measures specifically designed and validated for assessing satisfaction of functional needs related to EADs.

Furthermore, EISA was designed to assess satisfaction of IADL based everyday functional needs with EADs. Therefore, phase 4 of the study was undertaken to validate the assumption that in the existing literature there was no self-report IADL outcome measure that had been specifically designed and validated for assessing satisfaction of everyday functional needs with EADs.

3.4.1 Methodology

To ensure that the search of the literature was thorough and valid, this phase of the study was carried out in conjunction with a librarian specializing in systematic reviews of the literature. The results of this review were collected by searching the PubMed/Medline, Engineering Compendex, Inspec and Embase databases. Studies were identified that were: (a) written in English; (b) peer-reviewed articles, conference proceedings, or book chapters/administration manuals with full text available for review; (c) relevant to self-report IADL functional assessment related to ICT devices for the able bodied population and/or PWD.

The combination of search terms used for probing for self-report IADL outcome measures for EADs included Instrumental Activities of Daily Living, IADL, self-report, patient-report, outcome measure, IT, Information Communication Technology, electronic devices and

everyday functioning. In the iterative search process articles retrieved were screened based on their titles having a combination of the following key elements: (1) population -Adults with a decline in everyday functioning; (2) intervention – self-reported IADL functional assessment; and (3) outcome - questionnaire or survey or some type of self-report IADL outcome measure for assessing satisfaction of everyday functioning needs with EADs. Comprehensiveness of the search was further ensured by retrieving systematic reviews on IADL functional assessment.

The search was carried out on June 23, 2016, and was limited to the years 1996-2016. Further studies were identified by pursuing the references of relevant articles. Finally, the authors of studies were contacted for a copy of the tool, through email/phone, for which the IADL tool questions were not available in the respective peer reviewed article/s, and/or details could not be retrieved from a website for the tool. The total number of articles retained after removing duplicate articles was 101. A total of 44 articles were selected from the initial search based on the content of their titles. The total number of articles screened for further evaluation after reading abstracts were 16.

A total of 32 self-report IADL outcome measures were identified for investigation. After initial screening, 26 IADL tools did not meet further investigation criteria. After further evaluation of the shortlisted 6 self-report IADL instruments, no IADL outcome measures were found that were specifically designed and validated, for assessment of satisfaction of everyday functional needs, related to EADs. The following flow diagram elucidates the phase 4 search process (see Figure 3).

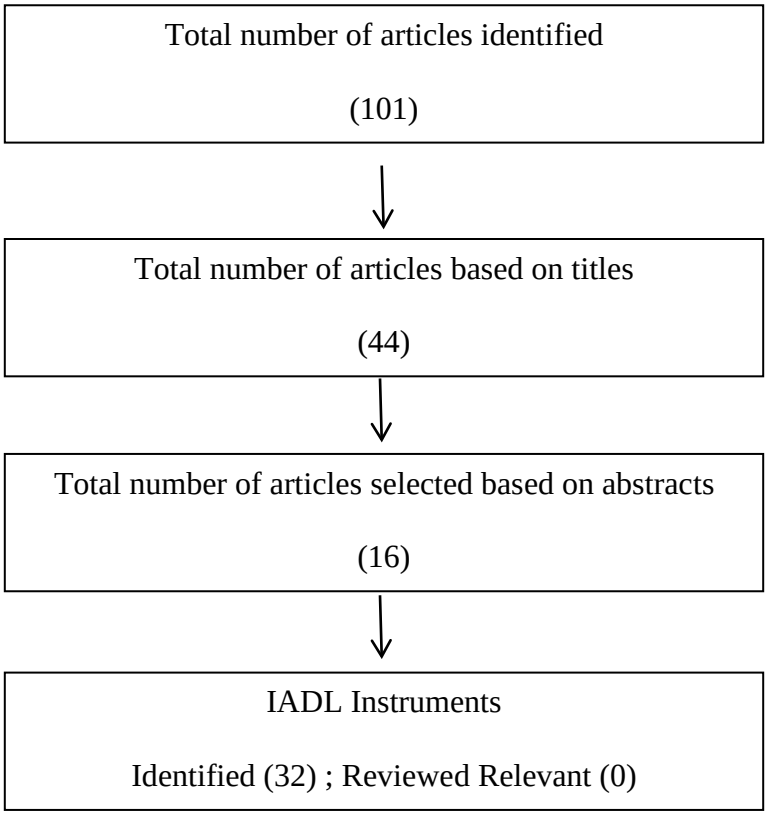

Figure 3: Phase 4 Search for EAD Outcome Measure

The results of phase 4 of this study met the second main objective of this review by providing evidence-based research that at the time of this review there were no existing self-report IADL outcome measures for assessing satisfaction of everyday functional needs related to EADs. Furthermore, the results of this literature review serve the purpose of justifying the development of an adequate outcome measure for the same. This means a self-report outcome measure that assesses user satisfaction of everyday functional needs with EADs. This outcome

measure would enable an optimal person-EAD-environment match and promote high quality independent living for PWD.

3.4.2 Review of self- report IADL measures

When selecting an outcome measure for clinical use four major considerations can serve as a guide: (1) appropriateness to the target population- this refers to the measure having been designed and tested on individuals similar to the target population; (2) practicality- the factors to consider here are time required for administering the test, experience and/or training required by individual administering the test or outcome measure, equipment needed, format of test (self-report/informant report/performance based), method of scoring (manual or computerized) and format of resulting measurement data (composite/subscale scores); (3) clinical utility- Degree of fit into clinical routine and usefulness of information for measuring outcomes (Ability to reflect change over time); and (4) psychometric properties of the measure (Donnelly & Carswell, 2002; Hallin, Sullivan, & Kreuter, 2000; VanSwearingen & Brach, 2001).

3.4.2.1 Activities of Daily Living-Prevention Instrument (ADL-PI) Scale

The Alzheimer's Disease Cooperative Society ADL-PI scale was developed by a team of neurologists and neuropsychologists (Galasko et al., 2006), and is designed to help discriminate elderly subjects with normal cognitive function from those elder subjects that may have MCI, by verifying if subjects have normal or impaired ADLs (Ferris et al., 2006). The instrument has been validated on community dwelling elderly individuals. The format of the test is self/informant report (Jekel et al., 2015; Lindbergh, Dishman, & Miller, 2016). Both versions require minimal staff involvement or training, and can be administered via mail (Ferris et al.,

2006), with no special equipment needed. Participants are asked a series of 15 questions relating to ADL performance, and must make single, best response for each question that delineates how much difficulty he or she feels when performing the ADLs over the past 3 months. Answer choices include “as well as usual, with no difficulty”, “with some difficulty”, “with a lot of difficulty”, or does “not do this activity at all” (Ferris et al., 2006). No information regarding time required to administer the scale was available. The IADL categories in this scale were selected based on likelihood to be performed by most elderly individuals, and include money management, shopping, transportation, communication, and household management (Galasko et al., 2006). In addition to the IADL questions, the ADL-PI also includes five yes-no questions to ascertain disorders affecting physical function and the senses. Scoring is done manually by summing responses to generate a composite score that can be used to detect potential change in cognitive function.

Retest reliability for the ADL-PI was reported from r = 0.69 to r = 0.74 internal (Jekel et al., 2015). The ADL-PI scale did not specifically address the usage of EAD devices in its assessment of IADLs, and as such, did not lend itself well to assess such usage.

3.4.2.2 EASY-Care Standard 2010

The EASY-Care Standard 2010, which is an updated version of the European Assessment System, was designed to assess the health status and healthcare needs of elderly individuals, so that they and their care providers may plan appropriate levels and types of support (Lindbergh et al., 2016; Talarska, Pacholska, Strugala, & Wieczorowska-Tobis, 2016). It consists of a number of items that were derived from other scales and tests used to assess physical health, mental health, and overall level of functioning, like the Barthel Index and the OARS (Philp, Lowles, Armstrong, & Whitehead, 2002). The testing format of the scale is self/informant report. The

instrument has been tested on older people (50+ years) based in community or primary care settings, including cognitively healthy adults and adults with mild MCI. No specific equipment or special training is required for administration, although it has been suggested that the test is best administered by nurses for their interpersonal skills (Craig, Chadborn, Sands, Tuomainen, & Gladman, 2015).

Participants fill in background and medical information and check off responses on a questionnaire that includes 49 items across seven different domains, including "seeing, hearing and communicating", "looking after yourself", "getting around", "your safety", "staying healthy", and "your mental health and well-being". In reference to IADLs, items on the questionnaire address the domains of meal preparation, medication management, shopping, travel, communication/telephone usage, and financial management, allowing participants to choose that they may do these activities "without help", "with some help", or that they are unable to perform the task. Once administered, the test gives results on three scales, including an "independence score" out of 100 that determines independence in ADLs and IADLs, a "risk of break down in care" subscale out of 12 that determines the likelihood the subject will need hospitalization, and a "risk of falls" scale out of 8, with higher scores representing poorer outcomes (Talarska et al., 2016). No information regarding the time required to administer the test was available. The test can be administered and scored both manually and via a computer. Scoring is done by summing responses, leading to 3 subscale scores and a composite score. As the EASY-Care Standard 2010 is largely based on other tools, it has been suggested that more studies need to be performed to establish concurrent and convergent validity; however, compared to other gold standard health measurements, Cohen's kappa values ranged from 0.39 to 1, and the disability score gave good evidence of criterion validity. Additionally, 63 of the 75 questions

can be linked to the ICF, establishing content validity, as does the cross-cultural usage of the test internationally (Craig et al., 2015). The repeatability of most EASY care items is moderate to good (kappa statistics between 0.41 to 0.80), except for items pertaining to speech, cognitive impairment, feeding, and telephone ability, which ranged from fair to no better than chance. The reliability of the total disability score was "good to excellent" with a kappa of 0.87 (Philp et al., 2002).

The EASY-Care Standard 2010 questionnaire did not specifically address the usage of EAD devices in its assessment of IADLs, and as such, did not lend itself well to assess such usage.

3.4.2.3 Everyday Technology Use Questionnaire (ETUQ)

The ETUQ, a self/informant report outcome measure (Jekel et al., 2015; Lindbergh et al., 2016), was designed to detect the perceptions of individuals or groups of older adults, with regard to: (1) the relevance of everyday technology to their life situation; (2) extent of their own ability/difficulty in using daily technology objects and services, and (3) degree to which they do not use technologies relevant to them. The instrument primarily serves as a screening tool for indicating a "respondent's perception" of their possibilities and limitations in everyday technology use. The scale incorporates an extensive array of mechanical, electronic and digital everyday technology artifacts and services, ranging from radios and coffee makers to smartphones and internet banking, that are commonly used by the elderly in ADLs (Jekel et al., 2015; Lindbergh et al., 2016; Rosenberg, Nygård, & Kottorp, 2009). The ETUQ has been validated on older adults with or without Mild Cognitive Impairment (MCI); adults with mental retardation, Acquired Brain Injury (ABI), and Chronic Obstructive Pulmonary Disease (COPD).

The ETUQ is administered in a structured interview format with the respondent providing answers to the interview questions. Administering the full ETUQ, having 86 items, takes between 40-60 minutes, however, administering the shortened version, Short ETUQ (SETUQ) having 33 items, takes between 20-40 minutes. It is preferred to conduct the interview in the respondent's home or natural environment. The ETUQ is divided into 7 topic areas: (1) home maintenance, (2) information and communication, (3) self-care, (4) maintenance and repair, (5) accessibility, (6) finances and purchasing, and (7) travel. Additional topic areas that have been created are: (8) e-health, (9) vocational life, (10) management of illness. The respondent's perception of encountering difficulty in using a technology is only registered for technologies that are relevant to them (Rosenberg et al., 2009). A technology is considered relevant if: (1) it is available to the user and (2) the technology-(a) has earlier been used by the user; (b) is currently used by the user; (c) is intended to be used by the user. The ETUQ grades a user's difficulty in using an everyday technology on a 4 point scale, from a response of 1 indicating the technology is used with no uncertainty/difficulties at all, through to 4, indicating the technology is only used together with another person. The ETUQ allows for additional technologies that are relevant to the user, but not included in the questionnaire, to be added in the "other item" category. The final section enquires about technologies used by the respondent based on personal interest and are most valued by them.

The instrument has demonstrated acceptable levels of internal scale validity, as 95% of the 86 items demonstrate acceptable goodness-of-fit to the Rasch rating scale model. The ETUQ also demonstrates acceptable Person Response Validity; in a sample of 157 participants, 97% demonstrated goodness-of-fit according to the Rasch rating scale model. The ETUQ demonstrates acceptable levels of unidimensionality, as the first component, competence in

technology use, accounted for 62% of the variance in the data set (Jekel et al., 2015; Rosenberg et al., 2009).

In sum, the time and effort required for, recollecting 86 different artifacts and services, and rating the perceived level of difficulty in using them, can be challenging, in particular for individuals with cognitive impairments. Furthermore, considering the relatively complicated administration and scoring, training is recommended for individuals administering the ETUQ, in order to accurately rate the user's relevance and perceived level of difficulty in using everyday technologies (Rosenberg, Kottorp, Winblad, & Nygard, 2009). Finally, since ETUQ is predominantly dependent on specific technologies listed in the questionnaire, therefore, it is subject to the need for periodic modifications, to keep up with emergence of newer, and redundancy of older, technologies.

3.4.2.4 Instrumental Activities of Daily Living-Compensation (IADL-C) Scale

The IADL-C scale was designed to detect early functional difficulties in the ageing population, and quantify the compensatory strategies (to-do lists, alarms, and GPS) (Jekel et al., 2015; Lindbergh et al., 2016; Schmitter-Edgecombe et al., 2014; Robin L. West, 1989; Robin Lea West, 1995) used by them, that may mitigate decline in physical and cognitive function. The unique feature of this scale is the identification of compensatory strategy ("aid"), use to enable functional independence at home, as cognitive changes occur. An aid is defined as any item that is used to assist the user with the completion of an activity or remind the user to complete an activity. For instance, grocery lists, Personal Digital Assistants (PDAs) etc. (Schmitter-Edgecombe et al., 2014). The testing format of the scale is self/informant report (Lindbergh et al., 2016; Schmitter-Edgecombe et al., 2014). The instrument has been tested on a sample of cognitively healthy older adults, subjects with Mild Cognitive Impairment (MCI), and dementia.

The IADL-C scale consists of 27 items, which are divided into four functional domain subscales: (1) money and self-management, (2) home daily living, (3) travel and event memory, (4) social skills. The items on the scale cover the IADL domains of shopping, travel/driving, financial management, meal preparation, medication management, phone use, conversation, organization, household activities, and social activities. Information on the amount of time required to administer the test was not available. Each item on the scale is answered using an 8-point Likert scale, having 4 options for independent functioning, as well as, options indicating the use of an aid and level of assistance required. The 8-point Likert scale can come across as, difficult to use, for some users. Scoring is done manually by adding all the Likert scale responses to get a total or composite IADL-C score and summing the responses in each functional domain to get subscale scores. Lower scores indicate higher level of functioning. No specific equipment, or particular training and experience, is required for taking or administering the scale. With regard to psychometrics, apart from the travel and event memory subscale (Cronbach's alpha = 0.65), overall, the IADL-C total and subscale scores have demonstrated good internal consistency: IADL-C total (Cronbach's alpha =0.95); money and self-management (Cronbach's alpha =0.93); home daily living (Cronbach's alpha = 0.85); social skills (Cronbach's alpha = 0.87). The self-report IADL-C scores have proved low to moderate correlation with the informant IADL-C scores, with IADL-C total of rest = 0.41. Furthermore, the scale has demonstrated convergent validity with measures of everyday functioning (Lawton and Brody IADL n = 172 R_s = 0.35; ADL PI n = 41 R_s = 0.74) and discriminant validity with psychosocial measures (geriatric depression scale-15 n = 236 R_s = 0.48; elders life satisfaction inventory n = 171 R_s = 0.31). (Schmitter-Edgecombe et al., 2014). In summary, the IADL-C scale lacked clinical utility, as it

did not specifically address the usage of EAD devices in its assessment of IADLs, and as such, did not lend itself well to assess such usage.

3.4.2.5 Lawton IADL Scale

The Lawton IADL scale is a self/informant report measure designed for assessing everyday functional competence (Jekel et al., 2015; Lawton & Brody, 1969; Lindbergh et al., 2016). The scale has been designed for and tested in a variety of institutions and facilities serving community-dwelling older people. The instrument classes IADLs into representative activities, with the performance of tasks like shopping, cooking and doing laundry for women; and using transportation and managing finances for men, as possibly the best means of assessing general competence (Lawton & Brody, 1969). The instrument can be administered through a written questionnaire or by interview through self or informant report of IADLs. The scale is comprised of 11 questions and assesses the activity domains of telephone use; use of transportation; shopping; meal preparation; housekeeping; laundering; medication management; and handling finances (Lawton & Brody, 1969; Roedl, Wilson, & Fine, 2016). However, the items in this scale did not lend themselves well to IADLs related to EAD. It takes between 10 to 15 minutes to administer the instrument. No specific equipment, or particular training and experience, is required for taking or administering the scale. The instrument uses an 8-point IADL scale for women, and a 5-point IADL scale for men. Scoring for each IADL domain is done using a 3 point system, with 3 points received by the client for completing the activity independently, 2 points received for the client needing some help from others to complete the activity, and 1 point for the client being completely unable to do the activity on their own. The interpretation of scores is based on each individual client scenario, with declining scores over time indicating deteriorating function and higher scores classifying higher function (Roedl et al., 2016). Scoring

is done manually, by summing the responses to obtain a composite score. With respect to psychometric properties, not much information was available. The only information found in a systematic review by (Jekel et al., 2015) was that interrater reliability correlation: r=0.85.

3.4.2.6 Older American Resources and Services (OARS) Scale

The Older Americans' Resources and Services (OARS) Multidimensional Functional Assessment Questionnaire is a self-report tool used to assess an individual's overall function in a comprehensive fashion, and includes coverage in physical and mental health, ADLs, and economic and social resources (Fillenbaum & Smyer, 1981; Jekel et al., 2015; Lindbergh et al., 2016). It has two parts: Part A assesses a person's overall level of functioning; Part B assesses the community provided services utilized, like transportation, social and recreational services, administrative, legal, and protective services (Fillenbaum, 1985; Fillenbaum & Smyer, 1981).

The ADL scale of the OARS consists of 14 questions and takes approximately 15 minutes to administer. An interviewer, who is ideally but not necessarily a trained clinician, verifies if participants can do specified activities "without help", "with some help", or "not at all" (Fillenbaum, 1988). It includes questions pertaining to the IADL domains of telephone usage, travel, shopping, meal preparation, housework, medication management, and handling money. It requires no special equipment other than the testing materials themselves.

Once all questions are completed, the interviewer manually rates the abilities of the evaluated person to perform activities of daily living on a single six-point scale, with "1" representing ADL performance "without assistance" and "with ease". Each subsequent point on the scale represents the need for either more assistance or more effort in the performance of ADLs (Fillenbaum & Smyer, 1981).

Validity of the OARS is highly correlated with patient self-care ratings by physical therapists, as well as with total disability scores as measured by the Functional Autonomy Measurement system (SMAF) ($r = 0.79 - 0.89$ and inter-rater reliability high at $ICC = 0.87$ (Fillenbaum & Smyer, 1981). The OARS does not specifically address the usage of IT or EAD devices in its assessment of IADLs, and as such, does not lend itself well to assess such usage.

Table 8 presents a summary of the key attributes of the 6 IADL measures reviewed above.

Table 8: Self-Report IADL Measures Summary Table

Measure	Appropriateness	Practicality	Clinical Utility	Psychometrics
ADL-PI	Validated on community dwelling elderly subjects	15 items; no specific equipment and particular training/experience required; test format self/informant report; scoring-manual; generates composite score	Lacks clinical utility as scale does not lend itself well to IADLS related to EAD	Test-retest reliability: from r = 0.69 to r = 0.74
EASY-Care Standard 2010	Validated on community dwelling elderly subjects and subjects with Mild Cognitive Impairment	49 items; no specific equipment and particular training/experience required; format-self/informant report; scoring-manual or computerized; generates 3 subscale scores and a composite score	Lacks clinical utility as scale does not lend itself well to IADLS related to EAD	Concurrent and convergent validity; Cohen's kappa values ranged from 0.39 - 1.00. Good evidence of criterion validity. Repeatability of most items = kappa statistics (0.41 to 0.80). Reliability of total disability score = kappa of 0.87.
ETUQ	Validated on elderly subjects-with/without Mild Cognitive Impairment, Mental Retardation, and Chronic obstructive pulmonary disease	86 items, 40 to 60 minutes to complete; no specific equipment; training in administration & scoring recommended; self/informant report; 7 subscale scores and a composite score	Lacks clinical utility as too long, requires training and is dependent on technology items	Acceptable internal scale and person response validity

Table 8. **(Continued)**

IADL-C	Validated on cognitively healthy older adults, subjects with Mild Cognitive Impairment and dementia	27 items; no specific equipment and particular training/experience required; test format-self/informant report; scoring-manual; generates composite and 4 subscale scores	Lacks clinical utility as scale does not lend itself well to IADLs related to EAD	Internal consistency: Cronbach's alpha = 0.95; Convergent validity on IADL-C: Rs = 0.41;
Lawton IADL scale	Validated on community-dwelling older people	11 items, takes 10 to 15 minutes to complete; no specific equipment and particular training/experience required; format-self/informant report; scoring-manual; generates composite score	Lacks clinical utility as scale does not lend itself well to IADLs related to EAD	Interrater correlation, r=0.85
OARS	Validated on community dwelling elderly adults	14 questions, takes 15 minutes to complete; no specific equipment; trained clinician preferred but not necessary; format-self report; scoring-manual	Lacks clinical utility as scale does not lend itself well to IADLs related to EAD	Validity highly correlated with patient self-care ratings by physical therapists, as well as with total disability scores as measured by the Functional Autonomy Measurement system (r=0-79-0.89) and inter-rater reliability high at ICC = 0.87

Key: ADL-PI = Activities of Daily Living-Prevention Instrument; ETUQ = Everyday Technology Use Questionnaire; IADL-C = Instrumental Activities of Daily Living-Compensation Scale; OARS = Older American Resources and Services Scale; IADL = Instrumental Activities of Daily Living; and ICC = Intraclass Correlation Coefficient

3.5 LIMITATIONS

Precautions were taken in using the key phrase of “electronic assistive device” to identify studies because it was new terminology, so authors may have chosen to use alternative words to describe the same topic. To ensure the search identified all relevant articles, the search was extended to synonymous key words including: ICT, electronic assistive technology, electronic device, or electronic cognitive device. The search was limited to articles in English only, precluding the chance of retrieving articles in other languages dealing with EAD outcome measures. In addition, the search was limited to databases predominantly acknowledged for housing articles related to the goals of this study. Therefore, there was a possibility of missing an article on EAD outcome measurement, in a database, not generally recognized for having articles related to ICT and EAD outcome measurement. As a limitation in the method of broad categorization for Table 1, it is considered that some individual functional needs of ICT users may not specifically fit under a single goal category. The reader should be cautioned that the search was not all-inclusive, because all possible daily tasks of any individual could not realistically be identified. The method adequately addressed the most common tasks and offered general examples to serve the purpose of showing how the two populations shared the same functional needs.

3.6 IMPLICATIONS OF DISRUPTIVE INNOVATIONS AND BUSINESS MODELS

Another key issue worthy of attention in recent ICT developments are disruptive digital innovations and business models. The two fundamental areas in the disability sector facing challenges from disruptive digital innovations and business models are disability access and

quality of disability support services. This is particularly so, as on the one hand IT has become a mainstay of modern society, and on the other hand, the pace of growth in ICT innovation and usage is staggering. This has led to innovations like new products, software and apps, coming out every few months or so, which are very often not accessible to PWD. This is in spite of the fact that there generally are regulations globally for ensuring access for PWD, however, with the fast pace of development in ICT, regulations struggle to keep up to date. Furthermore, with E-markets and services becoming the norm, it is crucial to ensure that PWD are having equal and timely access, and are not deprived of essential services due to inaccessibility (Baker & National Disability Services, 2016).

The speed of a new piece of ICT's development for able-bodied individuals generally does substantially exceed the speed at which accessible versions of the technology develop. Consequently, the time by which a PWD generally has access to an accessible version of a new piece of ICT device and/or software and/or app is much longer than the time it takes for an able-bodied individual to access such a product. As a result, IT presents both a source of opportunity, as well as, threat for PWD. Opportunities may result from accessible ICT solutions, for example, using screen readers for sending emails, using accessible apps for monitoring calorie intake. Similarly, unless adequate pre-emptive steps are taken to minimize delay, threats may result from the delay in accessible versions of ICT being available to PWD. This is so, because, the delay prevents PWD from having the same opportunity, as able-bodied individuals, to use technology to complete IADLs. Furthermore, such threats can lead to low user satisfaction, poor QOL and possible ATD abandonment, resulting from use of older or incompatible versions of ICT e.g. inaccessible apps for using the car hire service Uber, inaccessible telehealth or telecare apps.

Disruptive innovation business models like Uber have the potential for providing increased worker flexibility. However, another already observed challenge resulting from such models is the shift to a casual work force. This disjointed and insecure approach to employment may lead to a work force that is unsafe, under insured, and lacks in the required standard of training for providing high quality service, especially with regard to disability support. Furthermore, this style of work does not generally support traditional employment relationships, but rather, makes it hard to attract employees looking for full time work and a career in disability services (Baker & National Disability Services, 2016; Rogers, 2015). In addition, other challenges resulting for PWD from disruptive IT innovations include: (1) concerns about privacy of personal information; (2) threats of theft, fraud and bullying; and (3) social isolation resulting from increased dependence on technology and resulting reduced human interaction (Baker & National Disability Services, 2016).

3.7 NEED FOR AN EAD OUTCOME MEASURE

Currently of IT, it is crucial for PWD to have access to EAD that match their individualized needs and enable them to achieve their optimal potential. Nevertheless, as can be gleaned from the aforementioned analysis, currently there is no good outcome tool for the assessment of user-satisfaction in performing functional needs with EADs. Furthermore, related to the previously mentioned analysis, it needs to be highlighted that an exhaustive literature review (see phases one, two and four of preliminary research) revealed a dearth of research articles on the impact of ICT on IADLs for PWD. The only studies that remotely resembled this aspect of analysis, are the studies mentioned in table 1-mobile technology ubiquity and accessibility statistics. Even so, all

of these studies either analyze the impact of ICT on particular aspects of functional limitations for specific populations with disabilities or investigate the impact of ICT broadly on society and its future. Nevertheless, it is hard to miss the apparent paucity of research articles assessing the impact of ICT on IADLs for PWD.

It cannot be stressed enough that for both able-bodied individuals and PWD, having access to ICT is no longer a luxury, but rather, a necessity, to cope with the current technology-based life style. Furthermore, having equal and timely access to IT for PWD is imperative to enable them to live independently and have a high Quality of Life. Moreover, this equal and timely access not only provides increased life options for PWD, but also, wider economic benefits for the society at large. However, currently several factors are impeding this equal and timely access to ICT for PWD. These factors include: (1) lack of an outcome measure specifically designed and validated to assess satisfaction of everyday functional needs related to EAD; (2) inappropriateness, impracticality, apart from lack of clinical utility and psychometric validation of existing outcome measures to assess satisfaction of everyday functional needs of PWD, related to EADs; (3) continual and fast paced, disruptive innovations very often rendering essential services inaccessible for PWD. Therefore, to fill this unmet need, as well as, to enable PWD to have equal opportunity with able-bodied individuals to tap their optimal potential, this study developed and validated the self-report outcome measure, EISA, specifically designed to assess satisfaction of everyday functional needs of PWD, related to EADs.

4.0 DEVELOPMENT AND CONTENT VALIDITY INDEX (CVI) OF THE ELECTRONIC INSTRUMENTAL ACTIVITIES OF DAILY LIVING SATISFACTION ASSESSMENT (EISA) INSTRUMENT

4.1 INTRODUCTION

The purpose of this study was the development and validation of EISA, a Self-report outcome measurement tool, for assessing satisfaction of everyday functional needs, for consumers using EADs as the primary means to complete IADLs. The EISA outcome measure was designed as a questionnaire that could be self or interview-administered to users of EADs. Development of EISA was modeled along the lines of development of the self-report outcome measure, FMA (Kumar et al., 2013). EISA serves as a dynamic gauge for assessing perceived user function, related to using EADs for completing IADLs. The instrument underwent systematic development in three phases. In phase 1, an initial pool of potential EISA items was generated, based on literature review data. In phase 2, content experts (clinician and EADs user) review panels, assessed the initial pool of potential EISA items for further content validity.

Content validity refers to the extent to which, a sample of items, taken together, represent an adequate operational definition of a construct (Polit & Beck, 2006). Furthermore, according to the methodological literature, content validity is mainly a matter of judgement, that is made up of two distinct phases: (1) a priori efforts by the scale developer to strengthen content validity

through cautious conceptualization of the construct being assessed, and domain analysis, prior to item generation; and (2) a posteriori efforts by individuals who are experts in the field, to evaluate the relevance of the content of the scale (Beck & Gable, 2001; Lynn, 1986; Mastaglia, Toye, & Kristjanson, 2003; Polit & Beck, 2006). The following section elucidates the a priori phase of content validation in the development of EISA.

4.2 PHASE 1: GENERATING AN INITIAL POOL OF POTENTIAL EISA ITEMS

The first step in development of the EISA outcome measure, was to generate an item bank, housing a pool of items, that serve as candidates for eventual inclusion in the scale (DeVellis, 2012). This pool of items was assessed for content validity in phase 2 of the study, by clinicians and EADs users, in order to constitute the final list of items on the EISA Self-report outcome measure. This initial pool of items would on average have 3 to 4 times more items, than the targeted final list of items on the EISA measure. However, empirical data from: (1) preliminary review of the literature (chapter 2); and (2) development of the FMA, the outcome measure (Kumar et al., 2013) which served as a guide for the development of the EISA; demonstrated that generating numerous items was not necessary to get good internal consistency for the EISA scale. Therefore, an item bank that was twice as large as the targeted number of items on the final scale, was considered appropriate (DeVellis, 2012). The inflated bank of items, was compiled in order to ensure content validity through: (1) provision of an adequate sample of items covering the construct; and (2), availability of ample material covering the content for the clinician and EADs user review panels to choose from (DeVellis, 2012; Polit & Beck, 2006). Since the final list of items on the EISA instrument was targeted to have approximately 10 items,

therefore, an item bank of 20 statements was generated by the Principal Investigator (PI). This initial pool of potential EISA items, was generated by the PI from the: (1) 9 primary IADLs domains identified in Chapter 1 section “redefining IADLs in the context of ICT, a paradigm shift;” and (2) the 8 “common functional tasks with ICT categories” (Table 2), identified in chapter 2, preliminary review of literature, section “phase 1 common functional tasks with ICT.” The pool of items was developed with the aim of covering the entire domain of EIADLs that might be used by a PWD.

4.3 PHASE 2: EISA ITEM VALIDATION

Following the compilation of a large pool of potential EISA items derived from the literature review, validation of the compiled items by review panels of experts (clinicians and EADs users), constituted phase 2 of content validation. Phase 2 of content validation, refers to the a posteriori efforts undertaken by clinicians and EADs user review panels for assessing content validity of the EISA scale items (Polit & Beck, 2006).

4.3.1 Content Validity Computation

Adopting scale development procedures in the development of a new scale are vital for developing reliable and valid outcome measures. Scale developers generally provide information about criterion and construct validity for newly developed outcome measures, however, very often; information about the content validity of the scale is not available. It needs to be stressed that information about the content validity of a newly developed scale is essential for drawing

conclusions about the quality of the scale. Furthermore, it is equally important for scale developers to provide information, about the procedure adopted for estimating the content validity of the scale. This has a twofold advantage as: (1) it adds more rigor to the quality of the scale, by providing interpretable content validity information; and (2) it does not leave the user guessing, how the content validity was estimated, and whether it meets criterions for acceptable standards.

A method commonly used to provide evidence of content validity is computation of a Content Validity Index (CVI). This method determines the level of content validity by using ratings of item relevance to the construct by individuals who are knowledgeable or experts in the content domain.

CVI computation can be done at two levels: (1) item level called Item-Content Validity Index (I-CVI); and (2) scale level called Scale-Content Validity Index (S-CVI) (Polit & Beck, 2006). For the computation of CVI, content experts are required to rate the relevance of each item on a four-point ordinal scale where: 1 = not relevant; 2 = somewhat relevant; 3 = quite relevant; and 4 = highly relevant (Davis, 1992). The use of a four point ordinal scale is recommended in order to avoid a neutral and ambivalent point (Lynn, 1986). I-CVI for each scale item is calculated by dividing the number of experts (clinicians/users) giving a rating of 3 or 4 along the domain of relevance, divided by the total number of experts (clinicians/users). S-CVI for the whole scale can be calculated by averaging the I-CVI's for each item on the scale. This method of calculating S-CVI is known as the S-CVI/Ave method.

To sum up, for a scale to be judged as having excellent content validity, it is recommended that the scale adhere to the following criteria: (1) is made up of items having a minimum I-CVI of 0.78 based on item relevance ratings from a review panel of 6 or more

experts; (2) has an S-CVI/ Ave of 0.90 or higher. It needs to be pointed out that having less than 6 expert raters requires universal agreement between raters for an item to be judged relevant. This standard can become difficult to achieve. Furthermore, having more than 10 raters is regarded as unnecessary. Therefore, it is recommended to have no less than 6 and no more than 10 raters for I-CVI computation (Lynn, 1986; Polit & Beck, 2006). For a scale to be able to demonstrate the aforementioned I-CVI and S-CVI criterions for acceptability it requires: (1) well defined research construct of interest; (2) well written items that are relevant, clear and concise; (3) cautiously selected review panel experts (Davis, 1992; DeVellis, 2012; Polit & Beck, 2006); and (4) clear instructions to the review panel experts (Lynn, 1986).

4.3.2 Expert Clinician Participants

The item bank of potential EISA statements was evaluated for content validity, by a review panel consisting of 8 clinicians. The review panel of 8 clinicians enabled S-CVI computation using the S-CVI/ Ave method (Polit & Beck, 2006). Recruitment of clinicians was carried out in a targeted manner, through invitation of clinician colleagues from: (1) University of Pittsburgh Medical Center (UPMC) Center for Assistive Technology (CAT); (2) Hiram G. Andrews Center (HGAC) Center for Assistive and Rehabilitative Technology (CART); (3) The Ohio State University (OSU) Assistive Technology Clinic; and (4) the Veterans Administration Assistive Technology Labs. To facilitate recruitment, solicitation emails were sent to specific groups of clinicians who we knew from experience, were known experts in the field of EADs. The solicitation emails contained a brief abstract providing an explanation of the study. The interested potential participants were required to use the link provided in the solicitation email, to complete an on-line survey using the Qualtrics research platform.

The inclusion criteria for study clinician participants were:

1. Possession of relevant certification to practice in Rehabilitation and/or Assistive Technology (e.g. occupational therapy, physical therapy, speech language pathology, rehabilitation counselling, psychology, rehabilitation engineering, and assistive technology professional).
2. No less than 2-years work experience in the field of assessment and provision of EADs for PWD.

The clinician participant review panel consisted of 8 rehabilitation professionals including: 2 Occupational Therapists ; 2 Speech Language Pathologists ; 1 Physical Therapist; and 3 Rehabilitation Engineers. Two of the professionals also had the Rehabilitation Engineering and Assistive Technology Society of North America Assistive Technology Professional (ATP) certification. The number of years of professional experience for the clinician participants had a mean of 20.13 years (range 12-30 years).

4.3.3 EADs User Participants

The target population for the EISA outcome measure was PWDs who use EADs as their primary means for completing IADLs. Although recruiting more than 10 domain experts was considered unnecessary, since we were not sure how many EADs users would finally agree to be on the review panel, solicitation emails were sent out to more than 10 EADs users. Thirteen EADs users ended up completing the on-line survey for content validation. Therefore, a sample of 13 EADs Users (Polit & Beck, 2006) comprised the EADs user review panel, for S-CVI/Ave computation. Recruitment of EADs users was carried out in a targeted manner, through invitation of PWD

colleagues from: (1) non-governmental organizations for PWD; (2) disability advocacy and peer support groups; and (3) University of Pittsburgh, Carnegie Mellon University, University of Texas Medical Branch. To facilitate recruitment, solicitation emails were sent to specific groups of PWD, at aforementioned sites, who we knew from experience, were known experts in the field of EADs. The solicitation emails contained a brief abstract providing explanation of the study. The interested potential participants were required to use the link provided in the solicitation email, to complete an on-line survey using the Qualtrics research platform.

The inclusion criteria for EAD user participants were:

1. Should be an existing EADs user for at least 3 months, using EADs on a daily basis.
2. 18 years of age or older.
3. Should be capable of cognitively reading instructions and answering questions within Qualtrics.

The EAD user participant review panel consisted of 13 PWDs. The mean age of the EAD user participant review panel was 43-years. The majority EAD user participants were male (61.54%) and White/Caucasian (76.92%). The diagnoses/disabilities ranged from congenital disorder and sensory impairments (hearing/ vision) to Spinal Cord Injury (SCI) and Traumatic Brain Injury (TBI). Most users were highly confident with their ability to use internet-connected devices. Furthermore, majority users were graduates and employed. Table 9 shows the demographic details of the EADs user review panel.

Table 9: EAD User Participant Demographics (n=13)

Demographic Characteristics	Parameters
Age (mean, SD)	43.3 ± 11.5
Gender	
Male (%)	61.53
Female (%)	38.46
Ethnic Group	
White/Caucasian (%)	76.92
Asian (%)	15.38
Mixed Ethnicity (%)	7.69
Disability	
Users with Visual Impairment (%)	38.46
Spinal Cord Injury (%)	23.08
Progressive Neuromuscular Disorder (%)	15.38
Traumatic Brain Injury (%)	15.38
Congenital Disorder (%)	7.69
Hearing Impairment (%)	7.69
Musculoskeletal Disorder (%)	7.69
Postural Orthostatic Tachycardia Syndrome (%)	7.69
Confidence with using internet	
Highly Confident (%)	69.23
Mostly Confident (%)	30.77
Education	
Graduate Degree or Higher (%)	84.62
Other (%)	15.38
Employment Status	
Employed/Student/Homemaker/Volunteer (%)	92.30
Not Employed/Not a Student (%)	7.69

Key: SD = Standard Deviation

4.3.4 Instrument

For the EISA scale a Likert response format was used. Likert response formats are generally used for measuring latent constructs (DeVellis, 2012). Most commonly used number of Likert scale response options range from 5 to 7 (Dawes, 2008). Using more number of response

options, may not necessarily be better (Jones & Loe, 2013). Indeed choosing to use more than 7 response options, can actually, depress the total mean score (Dawes, 2008). Choosing the number of response options depends on what the scale has been designed to measure. There is no one response format that would suit all scales. Different response formats, like odd or even numbered response formats, are best suited for different purposes (Preston & Colman, 2000). Using an odd number of response options can lead to responders using the neutral midpoint: (1) as a dumping ground for lack of knowledge or awareness about the research topic; (2) sit the fence; and (3) indicate general disinterest. However, use of an odd numbered scale, might be suitable for purposes, such as educational surveys, where it is appropriate, to provide the responder a mid-point, to indicate equal agreement and disagreement (Tsang, 2012). Even numbered response scales, on the other hand, facilitate responders to take an active stance for scale items. This kind of a format is key for clinical purposes, where active decisions need to be made by the responder about ATDs, which are going to have a substantial impact on their QOL and optimal potential. Therefore, an even numbered Likert scale was used for the EISA scale to: (1) avoid a neutral or ambivalent point; and (2) facilitate the user to take an active stance in determining their satisfaction with their ability to complete IADLs using EADs (DeVellis, 2012). Furthermore, use of an even number of options for EISA would enhance clinical utility, in terms of being able to provide an ATD that helps promote an optimal device-user-environment fit.

Each item on the EISA instrument was scored using a 6-point Likert scale with: 1 = completely disagree; 2 = somewhat disagree; 3 = slightly disagree; 4 = slightly agree; 5 = somewhat agree; and 6 = completely agree.

4.4 STUDY PROCEDURE

Content validity of the generated EISA item pool, was assessed simultaneously by two review panels of experts consisting of: (1) clinicians and (2) EADs users. The review panels of clinicians (n = 8) and EADs users (n = 13) assessed content validity of the generated pool of items by completing an on-line survey on the Qualtrics research platform. The Qualtrics on-line research platform is a web-based service that the University of Pittsburgh has a license to use. The web-based platform enables users to collect and analyze qualitative and quantitative data, for a variety of research purposes. None of the participating review panel members, required accommodations because of a disability to independently access the Qualtrics on-line survey.

Prior to initiation of the survey, the Qualtrics platform required the participants to complete a demographics' questionnaire. In the on-line survey, the clinicians and EADs users were asked to rate the 20 potential EISA item bank statements, along the domains of: (1) relevance; (2) clarity; and (3) conciseness. Each item, within each domain, was rated on a 4-point ordinal scale where: 1 = not agree; 2 = somewhat agree; 3 = quite agree; and 4 = highly agree (Davis, 1992). A four point ordinal scale was used, in order to avoid a neutral and ambivalent point (Lynn, 1986). Furthermore, to ensure content validity and facilitate consolidation of the total number of EISA items to 10, the participants were provided open-ended response options for each item, to solicit feedback including: (1) what needs to be modified; (2) what needs to be added; and (3) what needs to be deleted. The open-ended response options were optional for items receiving a rating of 3 or 4, however, open-ended response options were required for any item receiving a rating of 2 or 1. Instructions regarding optional or required open-ended feedback options were provided on the Qualtrics platform. Additionally, at the end of the survey, the participants were provided with a separate open-ended

comments section, to enable participants to provide any additional comments, including but not limited to, feedback about aspects of EADs that were important in their view, however, were not included in the EISA.

4.5 RESULTS

4.5.1 Sample Characteristics

The PI in consultation with the Co-PI, generated an initial pool of 20 items, to serve as an item bank for the final scale. This item bank covered the following IADL domains: (1) transportation management; (2) financial management; (3) shopping; (4) health management; (5) meal preparation; (6) communication; (7) household activities management; (8) safety and security/emergency management; (9) memory needs; (10) information access and storage needs; (11) leisure needs; (12) school needs; and (13) work needs. The generated pool of items covered the entire domain of EIADLs that a PWD might use EADs for. Furthermore, the item pool provided redundancy to evaluate different item stems and activity examples, in the context of clarity and conciseness.

As part of the a posteriori phase of content validation, the initial pool of 20 EISA items, were assessed simultaneously for content validity, by two groups of domain experts: (1) clinicians; and (2) EADs users (see Table 10). The review panels of clinicians and EADs users assessed content validity of the generated pool of items, by completing an on-line survey, on the Qualtrics research platform. Prior to initiation of the survey, the Qualtrics platform required the review panel participants to complete a demographics' questionnaire.

Table 10: Original EISA Items Compared to EISA Version 1.0 Items

Original EISA Items	EISA Version 1.0 Items
1. I am currently able to meet my transportation needs. 2. My current means of everyday functioning enables me to meet my transportation management needs.	1. I can meet my transportation needs.
3. My current means of everyday functioning enables me to meet my financial management needs.	2. I can meet my banking needs.
4. My current means of everyday functioning enables me to meet my shopping needs. 5. I am currently able to meet my shopping needs.	3. I can meet my shopping needs
6. My current means of everyday functioning enables me to meet my health management needs. 7. I am currently able to manage my health needs.	4. I can meet my health and wellness needs.
8. I am currently able to meet my nutritional needs. 9. My current means of everyday functioning enables me to meet my meal preparation needs.	5. I can meet my nutritional needs
10. My current means of everyday functioning enables me to meet my communication needs. 11. I am currently able to meet my communication needs.	6. I can meet my communication needs.
12. I am currently able to meet my household management needs. 13. My current means of everyday functioning enables me to meet my household activities management needs.	7. I can meet my household and security needs
14. I am currently able to meet my safety and security needs. 15. My current means of everyday functioning enables me to meet my safety and security/emergency management needs.	
16. My current means of everyday functioning enables me to meet my memory needs.	8. I can manage my memory needs.
17. I am currently able to meet my information access and storage needs.	
18. My current means of everyday functioning enables me to meet my leisure needs.	9. I can meet my leisure needs
19. I am currently able to meet my school needs.	10. I can manage my work, school, or volunteering needs.
20. My current means of everyday functioning enables me to meet my work needs.	

Table 11 shows the software/applications used by the EADs users. As can be seen, the items used most regularly are calendars and scheduling tools, communication apps, and the World Wide Web. Eleven out of 13 EADs users did not have a therapist included in the selection of the internet-connected devices/software they routinely used.

Table 11: EAD User Content Frequency of Software/Application Items

Software/Application Item	Never	Rarely	Sometimes	Regularly
Calendar, Schedules, & Reminders	0.00%	0.00%	0.00%	100.00%
Communication	0.00%	0.00%	7.69%	92.31%
Worldwide Web Access	0.00%	0.00%	0.00%	100.00%
Social Media	23.08%	7.69%	15.38%	53.85%
Transportation & Navigation	0.00%	0.00%	38.46%	61.54%
Travel	7.69%	30.77%	53.85%	7.69%
Financial Management	7.69%	0.00%	23.08%	69.23%
Shopping	0.00%	0.00%	46.15%	53.85%
Health & Wellness	15.38%	61.54%	15.38%	7.69%
Meal Preparation	15.38%	38.46%	38.46%	7.69%
Household Management	46.15%	15.38%	23.08%	15.38%
Safety & Security/Emergency Management	69.23%	7.69%	15.38%	7.69%
Leisure Activities	0.00%	7.69%	23.08%	69.23%
Voice assistants/ conversational agents	0.00%	30.77%	7.69%	61.54%
Document & File Storage/Sharing	7.69%	0.00%	7.69%	84.62%
Visual Accommodation	38.46%	15.38%	7.69%	38.46%
Typing/Navigation Accommodation	30.77%	23.08%	0.00%	46.15%

4.5.2 CVI Results

Content validity determination of EISA, was done by computing a CVI at both the item level (I-CVI) and scale level (S-CVI). I-CVI computations for each item were done along the domains of (1) relevance; (2) clarity; and (3) conciseness.

The table below provides the I-CVI computations, along the domain of relevance. Furthermore, the table provides I-CVI and S-CVI computations, at two levels: (1) overall level, which was the entire group of experts (N = 21), including both clinicians and EADs users; and (2) individual review panel level, which was the clinician review panel (n = 8) and EADs user review panel (n = 13) separately. As can be seen in the table below, out of the initial pool of 20 EISA items, the overall I-CVI values for 2 items, were less than 0.78. Therefore, those 2 items were dropped from the pool, and I-CVI and S-CVI computations for the EISA were done with the 18-item pool. As can be seen in the Table 12, the S-CVI value was 0.95 for clinicians, 0.91 for users, and 0.90 for overall.

Table 12: Content Validity Index (CVI) Computation

IADL Domain	Clinicians (n=8)	EAD Users (n=13)	I-CVI (N= 21)
Transportation (1)	1.00	1.00	1.00
Transportation (2)	0.63	0.85	0.76
Financial Management	1.00	0.92	0.95
Shopping (1)	1.00	0.92	0.95
Shopping (2)	0.75	1.00	0.9
Health Management (1)	0.75	0.92	0.86
Health Management (2)	0.88	1.00	0.95
Meal Preparation (1)	1.00	0.92	0.95
Meal Preparation (2)	0.88	0.77	0.81
Communication (1)	1.00	0.92	0.95
Communication (2)	0.88	0.85	0.86
Household Management (1)	0.88	0.77	0.81
Household Management (2)	0.88	0.69	0.76
Safety and Security (1)	1.00	0.85	0.90
Safety and Security (2)	1.00	0.77	0.86
Memory Needs	1.00	0.85	0.90
Information Access and Storage Needs	0.88	0.92	0.90
Leisure Needs	1.00	0.85	0.90
School Needs	0.88	0.77	0.81
Work Needs	1.00	0.85	0.90
S-CVI	**0.95**	**0.91**	**0.90**

Key: I-CVI = Item Level-Content Validity Index; S-CVI = Scale-Content Validity Index; and IADL = Instrumental Activity of Daily Living

Several primary IADL domains had 2 items for each domain. These IADL domains were: (1) transportation management; (2) shopping; (3) health management; (4) meal preparation; (5) communication; (6) household activities management; and (7) safety and security/emergency management. For IADL domains having 2 different items representing the same domain, only the item having the higher of the 2 I-CVI values was retained. Further to elimination of redundant items, the EISA item pool was reduced to 13 items. Table 13 below provides S-CVI computations for EISA, based on the top 13-item pool. As can be seen, the S-CVI is 0.96 for clinicians, 0.89 for users, and 0.91 for overall.

Table 13: Content Validity Index - Top 13 Categories

Category	Clinicians (n=8)	Users (n=13)	I-CVI (N=21)
Transportation Management	1.00	1.00	1.00
Financial Management	1.00	0.92	0.95
Shopping	1.00	0.92	0.95
Health Management	0.88	1.00	0.95
Meal Preparation	1.00	0.92	0.95
Communication	1.00	0.92	0.95
Household Activities Management	0.88	0.77	0.81
Safety and Security/Emergency Management	1.00	0.85	0.90
Memory Needs	1.00	0.85	0.90
Information Access and Storage Needs	0.88	0.92	0.90
Leisure Needs	1.00	0.85	0.90
School Needs	0.88	0.77	0.81
Work Needs	1.00	0.85	0.90
S-CVI	**0.96**	**0.89**	**0.91**

Key: I-CVI = Item Level-Content Validity Index; and S-CVI = Scale-Content Validity Index

4.6 GENERATION OF EISA PROTOTYPE VERSION 1.0

Further to conducting a round of content validation, by the review panels of clinicians and EADs users, a prototype/version 1.0 of the EISA, was developed. In order to do this, the PI compiled the survey data from the clinician and EADs user review panels. This entailed compiling: (1) quantitative data, in terms of I-CVI values along the domains of relevance, clarity and conciseness; and (2) qualitative data from optional open-ended comment sections. Content validity determination of the EISA, was done by computing a CVI at both the item level (I-CVI) and scale level (S-CVI), as elucidated in the content validity computation section earlier. Furthermore, I-CVI and S-CVI computations were done at two levels: (1) overall level, which

was the entire group of experts (n=21), including both clinicians and EADs users; and (2) individual review panel level, which was the clinician review panel (n=8) and EADs user review panel (n=13) separately. This enabled identification and comparison of any significant differences in the EISA S-CVI levels, between the clinician and EADs user review panels.

Each item on the EISA instrument was scored using a 6-point Likert scale with: 1 = completely disagree; 2 = somewhat disagree; 3 = slightly disagree; 4 = slightly agree; 5 = somewhat agree; and 6 = completely agree.

For the computation of I-CVI, any EISA item, having an overall I-CVI (both clinicians and EADs users) value of less than 0.78, along the domain of relevance, was dropped from the initial pool of items. Out of the initial pool of 20 EISA items, the overall I-CVI values for 2 items were less than 0.78. Therefore, those 2 items were dropped from the pool, and I-CVI and S-CVI computations for the EISA were done with the 18-item pool.

Furthermore, several primary IADL domains each had two items. These IADL domains were: (1) transportation management; (2) shopping; (3) health management; (4) meal preparation; (5) communication; (6) household activities management; and (7) safety and security/emergency management. This approach of having 2 different items, representing the same IADL domain, was incorporated in the EISA tool development to: (1) build redundancy, which is a key requirement in new scale development; and (2) test the feasibility of different item stems and structure (DeVellis, 2012). For example, the IADL domain of transportation management had the following 2 items representing the same domain: (1) I am currently able to meet my transportation needs. (Example: use personal or public transportation, get directions, navigate, traffic updates, make travel arrangements); and (2) my current means of everyday functioning enables me to meet my transportation management needs. (Example: getting

directions, using navigation/GPS, traffic alerts, public transportation schedules, travel reservations, tracking real-time traffic or bus location, GPS maps).

For IADL domains having 2 different items representing the same domain, only the item having the higher of the 2 I-CVI values was retained. Further to elimination of redundant items, the EISA item pool was reduced to 13 items. S-CVI computations for the EISA, based on the 13-item pool/domains were carried out to ensure the EISA S-CVI value meets the minimum acceptable standard of 0.90 or higher.

Subsequently, the PI, Co-PI and one other dissertation committee member, by consensus, used a shared characteristic and an item-fit approach, to reduce the 13 EISA item domains to 10 domains. Using this approach, the following domains were grouped together or collapsed: (1) household activities management, and safety and security/emergency management were collapsed into the single domain of household and security needs; and (2) work needs, school needs and information access and storage needs, were collapsed into the single domain of work, school or volunteering needs.

The number of EISA domains was reduced for purpose of creating a new outcome measure that was: (1) practical, with regard to, being able to be administered in a reasonable timeframe in a typical clinical environment, being able to be scored manually with ease to generate a composite score; and (2) possess a high degree of clinical utility, in terms of ease of fit into the clinical routine and usefulness of information for measuring outcomes (Donnelly & Carswell, 2002; Hallin et al, 2000; VanSwearingen & Brach, 2001).

I-CVI computations along the domains of clarity and conciseness were done the same as I-CVI computations along the domain of relevance. Items receiving an I-CVI of less than 0.78 along the domains of clarity and/or conciseness were reworded or modified. EISA item

improvement/modification was done by incorporating both the quantitative and qualitative feedback from review panel members. Compilation of feedback was done using a team approach consisting of the PI and co-PI. In the event of disagreement between the PI and Co-PI, on a content validation issue, one other dissertation committee member and one other clinical expert were consulted. Even though the initial S-CVI (average estimation method) value met the minimum standard of acceptability (scale items having a minimum I-CVI of 0.78 and scale S-CVI/ Ave having a minimum value of 0.90 or higher), a second round of expert review, was conducted. Generally, this need for a second round of expert review, results from: (1) I-CVI feedback requiring substantial item improvement; (2) feedback from experts suggesting aspects of research construct of interest, not adequately covered by the initial pool of EISA items (Lynn, 1986; Polit & Beck, 2006). However, for the EISA development and validation study, the second round of expert review was conducted to further bolster the methodological rigor and clinical fit of the tool. For this second round, a smaller set of experts is generally considered acceptable (Polit & Beck, 2006). Therefore, a second round of expert review was scheduled with two clinicians from the initial pool. These were clinicians who had provided the most articulate and insightful open-ended comments in the first round of expert review. This round of expert review was to be conducted via a conference call. Unfortunately, one of the clinicians, scheduled to participate in the conference call, was unable to join in, due to a scheduling conflict. Nevertheless, the PI still conducted the conference call with the one review panel clinician and one other expert rehabilitation professional team member. This second round of expert review enabled the participating clinician who was a speech language pathologist, to assess the relevance, clarity, and conciseness, of the 10-item EISA outcome measure. The clinician found all 10 items highly relevant. Apart from minor re-wording suggestions for two items, the

reviewing clinician was very satisfied with the 10-item EISA outcome measure. The clinician also perceived immediate applicability of the EISA in their clinic.

Further to the second round of expert review, the PI in consultation with the Co-PI, compiled the item improvement feedback and generated the EISA prototype (version 1.0) (see Appendix A). The EISA prototype, further to content expert's feedback, had 10 items. However, the final number of EISA items were determined by evaluating item level performance information, within internal consistency analysis. This is because there could have been flawed items on the instrument and it would have been advisable to reduce the number of items further to the quantitative analysis data for internal consistency (See Chapter 5).

4.7 DISCUSSION

The EISA Self-report outcome measurement tool was specifically designed for assessing satisfaction of everyday functional needs for consumers using EADs as the primary means to complete IADLs. The development and content validation of EISA took place systematically in two phases. In phase 1, an initial pool of potential EISA items was generated based on literature review data. This phase constituted the a priori efforts by the PI to strengthen content validity through cautious conceptualization of the construct being assessed, and domain analysis prior to item generation. Empirical data from: (1) preliminary review of the literature; and (2) development of the FMA, the outcome measure, which served as a guide for the development of the EISA; demonstrated that generating an item bank that was twice as large (20 items) as the targeted number of items on the final scale (10 items) was sufficient. The inflated bank of items was compiled in order to ensure content validity through: (1) provision of an adequate sample of

items covering the construct being assessed; and (2), availability of ample material covering the content for the clinician and EADs user review panels, to choose from. To achieve the minimum acceptable standards of the CVI, the PI ensured, the initial pool of EISA items were well written, in terms of relevance, clarity and conciseness.

In phase 2, content experts (clinician and EADs user) review panels, assessed the initial pool of potential EISA items for further content validity. This phase comprised the a posteriori efforts by individuals who are experts in the field, to evaluate the relevance of the content of the scale items. As part of the a posteriori content validation efforts, a Content Validity Index (CVI) was computed. This method computed the level of content validity by using ratings of item relevance to the construct by individuals who were knowledgeable or experts in the content domain. To ensure acceptable standards of CVI, the domain experts were chosen judiciously and particular care was taken to provide clear set of instructions to the domain experts. The recommended number of experts was no less than 6 and no more than 10. This is because fewer than 6 experts creates the requirement of universal agreement, which is difficult to achieve. Additionally, having more than 10 experts is unnecessary. However, when recruiting experts, it could not be told in advance how many experts would finally participate in each review panel. Therefore, solicitation emails were sent to more than 10 experts, for each review panel. As a result, the clinician review panel had 8 members, and the EADs user review panel, had 13 members. A limitation of the review panel was that majority of domain experts were male and white Caucasian. This had implications in terms of limited gender and cultural sensitivity for EISA

The review panels of domain experts, clinicians (n = 8) and EADs users (n = 13), assessed content validity of the generated pool of items, by completing an on-line survey, on the

Qualtrics research platform. Although the domain experts were chosen judiciously, however, some of the domain experts did not give adequate thought to individual items in terms of providing insightful feedback with regard to: (1) what needs to be added; (2) what needs to be modified; and (3) what needs to be deleted. This brings into question the feasibility of on-line platforms for collecting feedback from domain experts

The S-CVI for EISA at the overall level for the 20-item pool was 0.90. There was slight difference in the S-CVI ratings between the clinician (0.95) and EADs user review panels (0.91). Further to elimination of redundant items, the EISA item pool was reduced to 13 items. S-CVI for the EISA at the overall level was (0.91). The difference between the S-CVI levels between the clinician (0.96) and EADs user (0.89) was wider. This possibly could be a reflection of the level of understanding of concept between the clinicians and EADs user review panels.

Incorporation of a shared characteristic and an item-fit approach by consensus, between the PI, Co-PI and one other dissertation committee member, led to the reduction of the 13 EISA item domains to 10 domains. Using this approach, the following domains were grouped together or collapsed: (1) household activities management, and safety and security/emergency management were collapsed into the single domain of household and security needs; and (2) work needs, school needs and information access and storage needs, were collapsed into the single domain of work, school or volunteering needs.

The number of EISA domains was reduced for purpose of creating a new outcome measure that was: (1) practical, with regard to, being able to be administered in a reasonable timeframe in a typical clinical environment, being able to be scored manually with ease to generate a composite score; and (2) possess a high degree of clinical utility, in terms of ease of fit into the clinical routine and usefulness of information for measuring outcomes

Even though the S-CVI values for the EISA were acceptable with one round of domain expert validation. However, an additional round was conducted to bolster EISA's rigor. For this second round, a smaller number of experts, from the original pool is generally considered acceptable. Since the feedback from the clinician review panel, was much more articulate and precise, than the EADs user review panel, therefore, the second round was planned with 2 members from the clinician panel. These were the 2 clinicians, who provided the most detailed and relevant feedback. Unfortunately, due to a scheduling conflict, only one of the clinicians was able to participate, in the second round of content validation. However, the feedback from the second round was extremely beneficial, as apart from the clinician, and the PI, the second round was attended by an expert rehabilitation professional. Moreover, this round was conducted over a telephone conference call, therefore, feedback, was live and very valuable.

4.8 CONCLUSION

The EISA was developed, following rigorous scale development procedures, to ensure a reliable and valid outcome measure, that is: (1) appropriate to the target population; (2) practical; (3) clinically fit; and (4) psychometrically sound. Using the CVI procedure, EISA has demonstrated acceptable item level (I-CVI greater than 0.78) and scale level (S-CVI/Ave of 0.90 or higher) content validity. In summary, EISA serves as a dynamic gage, for assessing perceived user function, related to using EADs for completing IADLs.

5.0 TEST-RETEST RELIABILITY AND INTERNAL CONSISTENCY ANALYSIS OF THE ELECTRONIC INSTRUMENTAL ACTIVITIES OF DAILY LIVING SATISFACTION ASSESSMENT (EISA) INSTRUMENT

5.1 INTRODUCTION TO RELIABILITY

An integral component of outcome measure development is establishing psychometric validation. The first step in the validation, of a newly developed outcome measure, is to establish reliability (DeVellis, 2012). The objective of phase 3 of the EISA study was validation of the first iteration of the EISA, by establishing reliability for test-retest administration and internal consistency, at acceptable levels, by no less than 25 and no more than 100 EADs users.

The reliability study focused on two objectives:

a) Establish test-retest reliability Spearman's rho at ≥ 0.80; and
b) Establish internal consistency of EISA using Cronbach's alpha with an acceptable range of 0.70 – 0.90.

The Institutional Review Board (IRB) at the University of Pittsburgh, after reviewing the EISA study design, granted the study an "exempt" status. The determination was based on the grounds: (1) the EISA study was conducted on-line, with no direct interaction with human subjects; and (2) the risk posed to any human subject completing an on-line survey would be low to none. Further, to IRB approval the study was initiated.

5.2 STUDY PARTICIPANTS

The target population for the self-report EISA outcome measure were PWD who used, or intended to use, EADs as their primary means for completing IADLs. The initial contact with potential participants for recruitment into the study was made by targeted clinicians at: (1) Veterans Administration Assistive Technology labs; and (2) specific group of clinicians, outside of the VA, who we knew from experience, were known experts in the field of EADs. Targeted clinicians helped facilitate recruitment of participants by informing potential participants about the study at the following sites: (1) University of Pittsburgh Medical Center (UPMC) Center for Assistive Technology (CAT); (2) Hiram G. Andrews Center (HGAC) Center for Assistive and Rehabilitative Technology (CART); (3) The Ohio State University (OSU) Assistive Technology Clinic; and (4) the Veterans Administration Assistive Technology Labs. Additionally, the initial contact with potential participants for recruitment into the study was made by the PI through invitation of PWD from: (1) non-governmental organizations for PWD; (2) disability advocacy and peer support groups; and (3) higher education institutions (community colleges, universities) across the USA. Flyers and solicitation emails (see Appendix B) giving details about the EISA outcome measure reliability study were provided to clinicians/PWD at these sites, in digital/electronic formats, to aid with recruitment. A sample of no less than 25 and no more than 100 participants, was targeted as that would be an adequate number of subjects for: (1) constituting a representative sample, that is appropriate to the target population of PWD, who use EADs for completing IADLs; (2) conducting a test-retest stability analysis, based on the distribution of data; (3) carrying out an internal consistency analysis. The interested potential participants were required to use the link provided in the solicitation email, to complete an on-line survey using the Qualtrics research platform.

The inclusion criteria for EISA test-retest administration were:

1. Subject is 18 years of age or older and has a disability / functional limitation that could be accommodated with an EAD.
2. Subject has used an existing EAD device for at least one month or is not using an EAD device and not planning to receive a new EAD intervention during the test-retest timeframe.
3. Adequate cognitive and linguistic (oral) status at a 5^{th} to 7^{th} grade reading level (DeVellis, 2012) to be able to respond to questions posed in the EISA version 1.0.
4. Subject has access to and can use email to receive Documents or can be reached by telephone to have forms read to have and have discussions.

5.3 STUDY PARTICIPANTS PROCEDURE

The study sample of EADs users, Administered and re-administered, EISA version 1.0 on the Qualtrics research platform, no less than 7 days and no more than 21 days (Portney & Watkins, 2000) apart to determine stability/reliability of the tool. The Qualtrics on-line research platform is a web-based service that the University of Pittsburgh has licensed access to. The web-based research and experience platform enables users to collect and analyze qualitative and quantitative data, for a variety of research purposes. Furthermore, Qualtrics offers users the ability to customize, their on-line research, to suit their needs. Study participants who completed, both time 1 and 2 administrations, within the specified period on the Qualtrics platform, received a $25 WePay card as compensation.

5.3.1 Time 1 EISA Administration

The study participants administered EISA version 1.0, on the Qualtrics research platform, using the hyperlink provided to them, in the research study solicitation email by the PI (see Appendix B). Prior to time 1 administration of EISA version 1.0, the Qualtrics platform required the participants to: (1) read the EISA exempt introductory script (see Appendix C); (2) complete a demographics questionnaire; and (3) complete a health status questionnaire. The demographics questionnaire included one question, regarding the participant's confidence level with using internet-connected devices. Another related question asked participants to check all the EADs that they used at the time of time 1 administration, including an option for no device.

In addition, the demographics questionnaire included one question, regarding the participant's primary diagnosis. The question asked participants to check all the disabilities/functional limitations that applied to them. Answering this question was a requirement, to proceed further. Furthermore, the health status questionnaire required the participants to rate their health and how they were feeling while performing IADLs, on the day of the study, and in the past 3 months. The participants were required to complete the health status questionnaire, in order to rule out, change in health status, as the cause for change in level of satisfaction with the ability to complete IADLs using EADs.

The Time 1 EISA administration was automatically scored to participants over the Qualtrics research platform.

Any participants, who because of their disability were unable to independently access the Qualtrics survey platform, had the option of being assisted by a study investigator, to complete both the time 1 and 2 administrations. The study investigator spoke with the participant who

required assistance, over the phone, and completed the on-line Qualtrics survey, on behalf of the participant.

5.3.2 Time 2 EISA Administration

Seven days after completion of time 1 administration, the Qualtrics platform was programmed to automatically send an email reminder to the study participants, inviting them to complete time 2 administration. Unfortunately, due to a programming error, the first batch of the email reminders did not go out automatically, and had to be sent out manually. However, in co-ordination with Qualtrics trouble shooting staff, the programming issue was resolved and subsequent participants received reminders automatically through Qualtrics. Furthermore, due to a design limitation with the Qualtrics research platform, email reminders go out to all study participants, regardless of whether or not they have already completed time 2 administration. Therefore, all study participants received an initial email reminder on day 7 from time 1; friendly reminder on day 14 from time 1; and a final reminder on day 21 from time 1. Consequently, 28 study participants completed time 2 administration, more than once (twice). These 28 erroneous time 2 administrations were not included in the final analysis.

Prior to time 2 administration of EISA version 1.0, the Qualtrics platform required the participants to recomplete the health status questionnaire. The health status questionnaire required the participants to rate their health and how they were feeling while performing IADLs, on the day of the study, and in the past 3 months. The participants were required to complete the health status questionnaire, in order to rule out, change in health status, as the cause for change in level of satisfaction with the ability to complete IADLs using EADs. Furthermore, prior to time 2

administration, qualtrics also required participants, to answer an open-ended question, regarding any change in their EADs, within the test-retest time frame.

5.4 DATA ANALYSIS

The SPSS package was used to perform analyses. Descriptive statistics like frequency counts and range, were used for collecting data on study subjects. For example, demographics like gender, ethnicity, primary diagnosis/disability, confidence with using internet connected devices, number of hours of use of internet connected devices/day, level of education, employment status, frequency of using internet connected devices/software/Apps, involvement of clinician/health professional in selection of routinely used internet connected device/software.

Health status was scored on a vertical Visual Analogue Scale (VAS), having values from 0 to 100, where 0 represented the worst the participants had felt in the past 3 months, and 100 represented the best the participants had felt in the past 3 months. The VAS used in the study, was an adapted version of the "EQ-5D-5L VAS", a standardized health-related quality of life instrument, developed by the EuroQol group. Furthermore, the health status questionnaire required the participants to rate their health and how they were feeling while performing IADLs, on the day of the study, and in the past 3 months. The participants were required to complete the health status questionnaire, in order to rule out, change in health status, as the cause for change in level of satisfaction with the ability to complete IADLs using EADs.

Owing to the data not being normally distributed, non-parametric analysis was used to evaluate the correlation between time 1 and time 2 scores. Spearman's Rho correlation coefficient was used to calculate the test-retest reliability for each item and the total score of

EISA. The Spearman's rank correlation coefficient or Spearman's Rho is a measure of ranked correlation between two variables. Spearman's Rho is used when the variables being assessed for correlation are continuous/discrete and the data is skewed or not normally distributed. The value of a Spearman's Rho can range from -1 to +1, where +1 is a perfect positive correlation, and -1 is a perfect negative or inverse correlation (Portney & Watkins, 2000).

Cronbach's Alpha was used for computing internal consistency with an acceptable target range of 0.70 – 0.90. Cronbach's Alpha or Coefficient Alpha is a measure of internal consistency. It is a measure of how well the items in a scale are correlated to each other, and to the construct they are assessing. The values of Cronbach's Alpha can range from 0 to 1. The higher the value, the higher the internal consistency (DeVellis, 2012; Portney & Watkins, 2000).

Since EISA had been designed as a unidimensional tool, therefore, inter-item correlation matrix data, in the internal consistency analysis was used to verify unidimensionality of EISA. The inter-item correlation matrix data was used to make sure that the scale items were at least somewhat correlated, and there was not an item that is totally uncorrelated. Additionally, the inter-item correlation matrix data was used to identify redundant items. For any item, a correlation of 0.80 or higher, was likely regarded as redundant.

The internal consistency analysis was used to provide corrected item to total correlation data, as part of the SPSS coefficient alpha analysis. The item to total correlation, for any item, was required to be fairly reasonable, at 0.30 or higher. If the item to total correlation, for any item, was under or less than 0.30, then a case was likely made for potentially removing that item from the scale, as that particular item was not as correlated with the total score, as the other items. This enabled determination of which items were best to keep for the next version of the draft.

5.5 RESULTS

5.5.1 Participants

Of the 129 participants who completed time 1, 85 subjects completed both time 1 and time 2 EISA administrations. However, the data of one participant, who completed time 2 EISA administration more than 21 days from time 1, was not included in data analysis. Therefore, test-retest reliability and internal consistency analysis was conducted with data from 84 participants.

The demographic data (see Table 14) showed that the EISA study sample consisted of adults with an average age of 41 years. With respect to the split between males and females, the study sample was composed of 57% females and 43% males. Furthermore, the sample was predominantly composed of white Caucasians (85%). There was a good sampling of different primary diagnoses/disabilities. However, the 2 most frequently occurring primary diagnoses/disabilities were: (1) congenital disorder (21%); and (2) progressive neuro muscular disorder (28%). Furthermore, the sample had only one veteran.

Table 14: EISA Study Sample Demographics

Demographic Characteristics (n=84)	Parameters
Age (mean, SD)	43.3 ± 11.5 (range from 19-75)
Gender	
Male (%)	42.86
Female (%)	57.14
Ethnic Group	
White/Caucasian (%)	85.71
Asian (%)	18.33
Black/African American (%)	4.76
American Indian or Alaska Native (%)	1.19
Primary Diagnosis	
Progressive Neuromuscular Disorder (%)	27.62
Congenital Disorder (%)	20.95
Vision Impairment (%)	11.43
Musculoskeletal Disorder (%)	6.67
Learning Disability (%)	5.71
Amputation (%)	3.81
Hearing Impairment (%)	3.81
Post-Traumatic Stress Disorder	3.81
Spinal Cord Injury (%)	3.81
Anxiety (%)	1.90
Autism (%)	1.90
Traumatic Brain Injury (%)	1.90
Cancer (%)	0.95
Cirrhosis/Encephalopathy (%)	0.95
Depression (%)	0.95
Lyme Disease (%)	0.95
Myalgic Encephalomyelitis (%)	0.95
Spinal Curve (%)	0.95
Stroke (%)	0.95
Veteran Status	
Yes (%)	1.59
No (%)	98.41

Key: SD = Standard Deviation

It is clear the sample consists of participants who are highly confident with their ability to use internet-connected devices. As can be seen in the Figures 4 and 5, majority of users (63%) were

highly confident in their ability to use internet-connected devices and 72.62% spend anywhere from 5-12 hours using their internet-connected devices

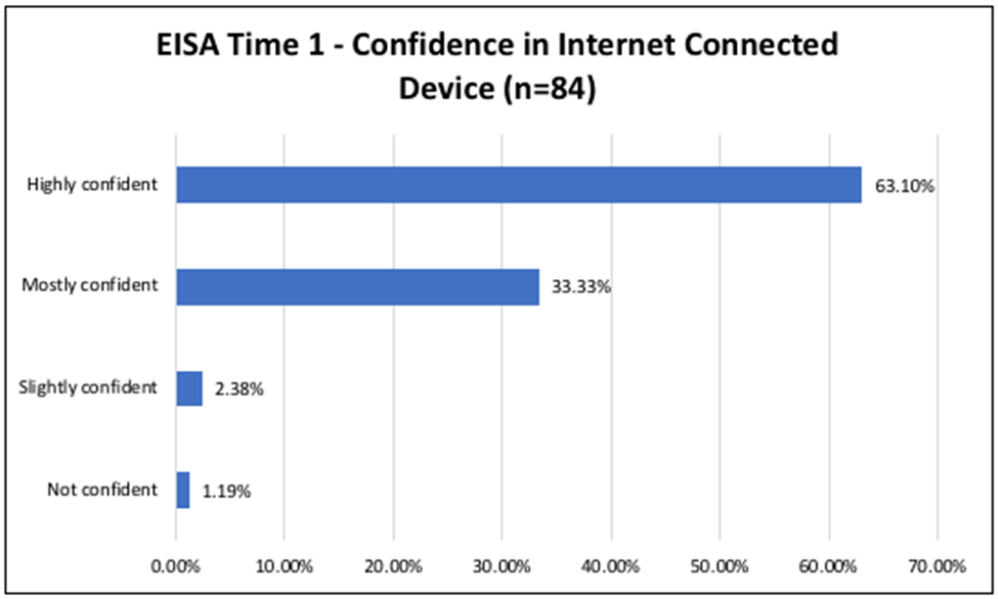

Figure 4: Confidence in Using Internet Connected Devices

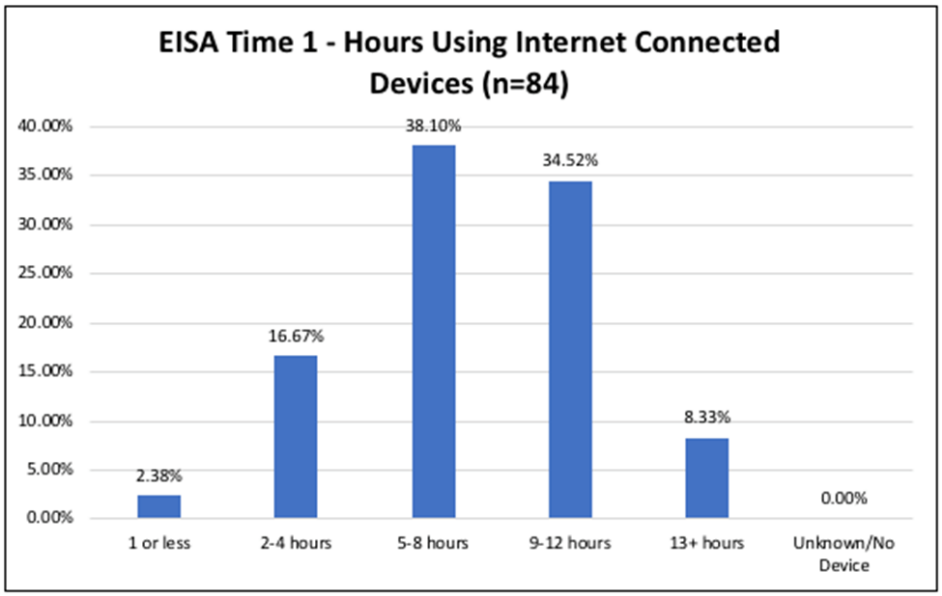

Figure 5: Hours Using Internet Connected Devices

Table 15 shows that the EISA study sample was also highly educated. 38.1% had completed an undergraduate degree. Furthermore, 26.19% had received a graduate degree. The data also showed that 67.86% of participants were employed. Additionally, 76.19% of participants did not involve a clinician or health professional, such as a therapist, in the selection of their routinely used internet-connected device/software.

Table 15: EISA Participant Responses to Demographic Qualtric Survey

Demographic Questionnaire (n=84)	Parameters
Highest Education Level	
Undergraduate Degree (%)	38.10
Graduate Degree or Higher	26.19
High School (%)	19.05
Community College (%)	9.52
Some College (%)	4.76
General Education Development (%)	1.19
Trade School (%)	1.19
Employment Status	
Employed/Student/Homemaker/Volunteer (%)	67.86
Not Employed/Not a Student (%)	17.86
Retired (%)	14.29
Healthcare Professional Involvement with Device	
Yes (%)	20.24
No (%)	76.19
Unsure (%)	3.57

The data in Table 16 below shows that, the study sample was a high EADs use population. Most participants used a smart phone, laptop, and desktop regularly. A majority of users also regularly used laptop computers at 64.29%. Calendar, scheduling, and reminder apps were frequently used at 63.1%. Almost all participants used communication devices regularly. Social Media apps and software were used slightly less regularly (76.19%), and 10.71% of users never used them. Transportation apps were regularly used 45.24% of participants. Travel apps

were used less frequently; 32.14% of users rarely use them, and 27.38% reported that they are never used. Financial apps were also quite varied. A majority (51.19%) of users used them regularly, but 16.67% did not use them at all. A majority of users (55.59%) regularly used shopping apps. Meal preparation apps were only regularly used by 10.71% of users. A majority of users (53.57%) rarely used home management apps, while the majority of users (53.57%) rarely used safety and security apps. Leisure apps were commonly used, with 63.10% of users using them regularly. Voice assistant use was quite varied with 34.52% using them regularly and 23.81% never. Most users used document or file storage apps sometimes or regularly, at 37.30% and 38.10%, respectively. Typing/navigation app use was quite varied.

Table 16: EISA Participants Test-Retest App and Device Use (n=84)

Question Item	Never	Rarely	Sometimes	Regularly
App Based				
Calendar, Schedules, & Reminders	5.95%	10.71%	20.24%	63.10%
Communication	1.19%	1.19%	2.38%	95.24%
Worldwide Web Access	3.57%	0.00%	5.95%	90.48%
Social Media	10.71%	5.95%	7.14%	76.19%
Transportation & Navigation	4.76%	15.48%	34.52%	45.24%
Travel	27.38%	32.14%	30.95%	9.52%
Financial Management	16.67%	7.14%	25.00%	51.19%
Shopping	5.95%	8.33%	29.76%	55.95%
Health & Wellness	20.24%	34.52%	26.19%	19.05%
Meal Preparation	30.95%	27.38%	30.95%	10.71%
Household Management	53.57%	10.71%	20.24%	15.48%
Safety & Security/Emergency Management	54.76%	19.05%	11.90%	14.29%
Leisure Activities	4.76%	8.33%	23.81%	63.10%
Voice assistants/ conversational agents	23.81%	16.67%	25.00%	34.52%
Document & File Storage/Sharing	16.67%	11.90%	37.30%	38.10%
Visual Accommodation	46.43%	17.46%	12.70%	22.22%
Typing/Navigation Accommodation	35.71%	14.29%	26.19%	23.81%
Device Based				
Smartphone	9.52%	1.19%	3.57%	85.71%
Tablet	30.95%	20.24%	20.24%	28.57%
Laptop	9.52%	13.10%	13.10%	64.29%
Desktop	25.00%	17.86%	14.29%	42.86%

5.5.2 Health Status

This section analyzed the perceived health status at the time of EISA administration (today), and the health status in the past 3 months at both time 1 and time 2. The table below presents the mean values at time 1 and time 2. It can be seen that the sample was healthy, and the health scores were relatively stable at time 1 and time 2. At time 1, the mean health was 74.30 today and 72.94 in the past 3 months. At time 2, the mean health was 75.10 today and 75.14 in the past 3 months. The normality of data for health status today and health status in the past 3 months, at both time 1 and time 2 was not normally distributed (see Table 17).

Table 17: Perceived Health Status at EISA Time 1 and Time 2

Perceived Health Status	EISA Time 1 Mean ±SD (range)	EISA Time 2 Mean ±SD (range)	P
Health Status Today	74.30 ± 19.59 (5-100)	75.10 ± 21.46 (4-100)	< 0.001
Health Status Past 3-Months	72.94 ± 21.65 (0-100)	75.14 ± 20.37 (6-100)	< 0.001

Key: EISA = Electronic Instrumental Activities of Daily Living Satisfaction Assessment; and SD = Standard Deviation

Since the data was not normally distributed, a Wilcoxon test was used (see Table 18) to see if, there is a statistically significant difference in the health status scores, at time 1 and time 2. The results indicated that: (1) for health status today, there was no statistically significant difference, between time 1 and time 2; and (2) for health status in the past 3 months, there was a statistically significant difference between time 1 and time 2. However, health status in the past 3-months can be subject to a stronger recall bias. Overall, since there was no statistically significant difference in the health status scores today, therefore, the health status of participants,

between time 1 and time 2, was stable, and is not likely to have affected the participant's satisfaction scores with their EADs.

Table 18: Wilcoxon Signed-Rank Test for Perceived Health Status (n=84)

Perceived Health Status	Z-Score	P
Health Status Today	-1.074	0.283
Health Status Past 3-Months	-2.297	0.022

5.5.3 New Device

All participants had the same EAD at time 2, that they had at time 1. This further indicates that the participants were evaluating the same EAD at time 1 and 2, and therefore, there should not have been any change in their satisfaction scores with their EADs. It also confirms that what was being analyzed, was just retest, and not change, that could be attributed, to a change in EAD.

5.5.4 Test-Retest

It can be seen in Figure 6 that at time 1, the means for all EISA items were slightly lower, than the means at time 2.

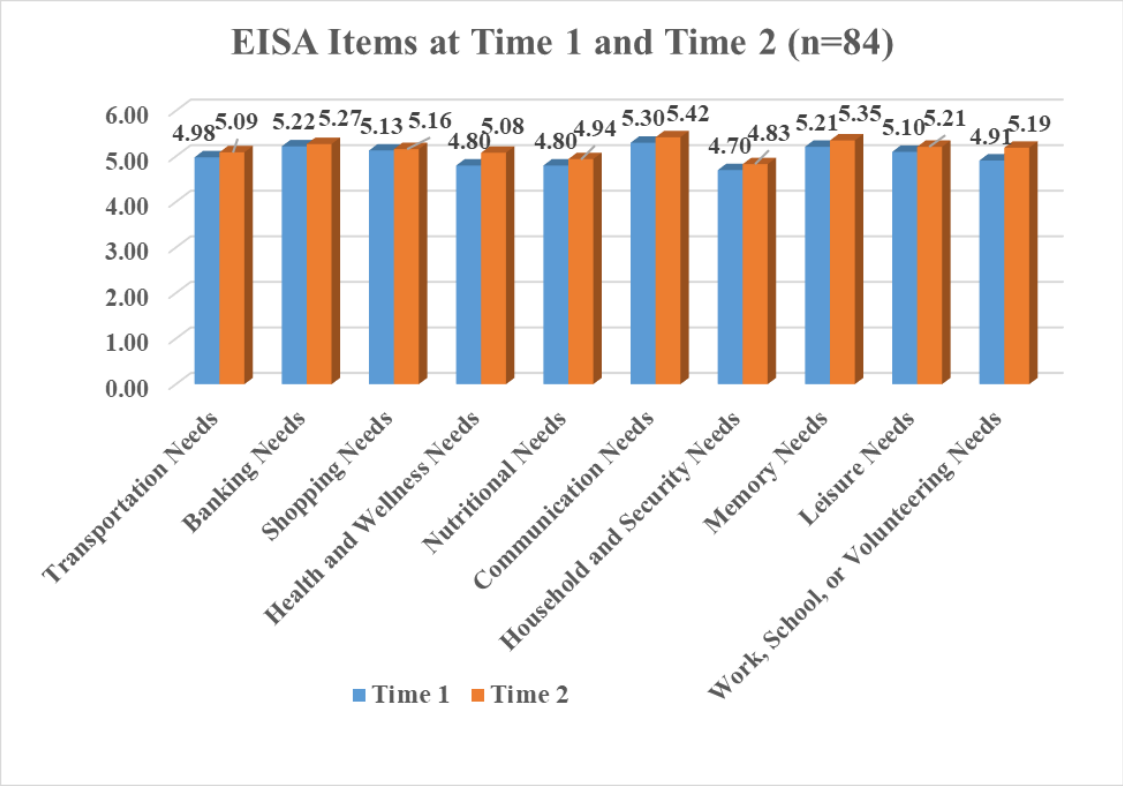

Figure 6: EISA Items at Time 1 and Time 2

Table 19 compares the EISA total scores at time 1 and time 2, using the raw scores, having a maximum of 60. As can be seen, the means and the medians are very close to each other. These scores reflect the high degree of agreement between the time 1 and time 2 scores.

Table 19: EISA Total Scores at Time 1 and Time 2

Interval	Mean ±SD	Median (IQR)	Range
Time 1	51.4 ±7.5	53.0 (8)	20-60
Time 2	52.8 ±6.7	54.0 (9)	34-60

Key: EISA = Electronic Instrumental Activities of Daily Living Satisfaction Assessment; SD = Standard Deviation; and IQR = Interquartile Range

Table 20 shows the normality test for the total sample (n = 84), for each of the 10 EISA items, as well as, the total EISA score, at both time 1 and time 2. The normality distribution for the entire sample shows that all subjects scored at the higher end of the response scale. It can be seen that all of them were not normally distributed, as P-value was less than 0.05.

Table 20: Kolmogorov-Smirnov Test for EISA Items at Time 1 and Time 2 (n=84)

EISA Items	Time 1 Statistic	df	P	Time 2 Statistic	df	P
Transportation needs	0.29	84	< 0.001	0.29	84	< 0.001
Banking needs	0.33	84	< 0.001	0.36	84	< 0.001
Shopping needs	0.28	84	< 0.001	0.27	84	< 0.001
Health and wellness needs	0.23	84	< 0.001	0.29	84	< 0.001
Nutritional needs	0.27	84	< 0.001	0.24	84	< 0.001
Communication needs	0.37	84	< 0.001	0.39	84	< 0.001
Household and security needs	0.24	84	< 0.001	0.25	84	< 0.001
Memory needs	0.31	84	< 0.001	0.36	84	< 0.001
Leisure needs	0.28	84	< 0.001	0.34	84	< 0.001
Work, school, or volunteering needs	0.30	84	< 0.001	0.33	84	< 0.001
EISA Total Score	0.15	84	< 0.001	0.15	84	< 0.001

Key: EISA = Electronic Instrumental Activities of Daily Living Satisfaction Assessment

Table 21 shows the results of the normality test for EISA total scores for the sub-group without cognitive impairment (n = 73), and for the sub-group with cognitive impairment (n = 11). For the group without cognitive impairment, the data was not normally distributed. For the group with cognitive impairment the data was normally distributed. However, the sub-group without cognitive impairment, was a larger group, and had outliers. Whereas, the sub-group with cognitive impairment was smaller, and did not have outliers. Moreover, the cognitive impairment group data, due to its small size, was not reliable and precise, and could at best, only be

considered, preliminary data. Thus, overall, for the EISA study, the data was not normally distributed.

Table 21: Normality Test for Respondents with and without Cognitive Impairment at Time 1

EISA Group (N=84)	P
Respondents with no Cognitive Impairment (n=73)	< 0.001
Respondents with Cognitive Impairment (n=11)	0.200

Key: EISA = Electronic Instrumental Activities of Daily Living Satisfaction Assessment

Since the EISA data was not normally distributed, therefore, non-parametric analysis of the data was carried out. The first analysis was a Scatter Plot (see Figure 7), that plots time 1 on the X-axis, and time 2 on the Y-axis, in order to show the association between the raw scores. As can be seen in the scatter plot, most of the points are at the higher end. There was some variability in the data where scores ranged from 30 to 60; however, most subjects scored in the 45 to 60 range. However, generally there was agreement between time 1 and time 2 scores. Although there was some scatter, the scores were generally consistent. There was also an outlier, which indicated a low score at time 1, and a high score at time 2. Means are generally affected a lot by outliers, and this outlier could have very well been dragging the time 1 means down slightly. This could be the reason for the time 1 means, being systematically lower, than the time 2 means, as was observed earlier in the group 2 means being higher.

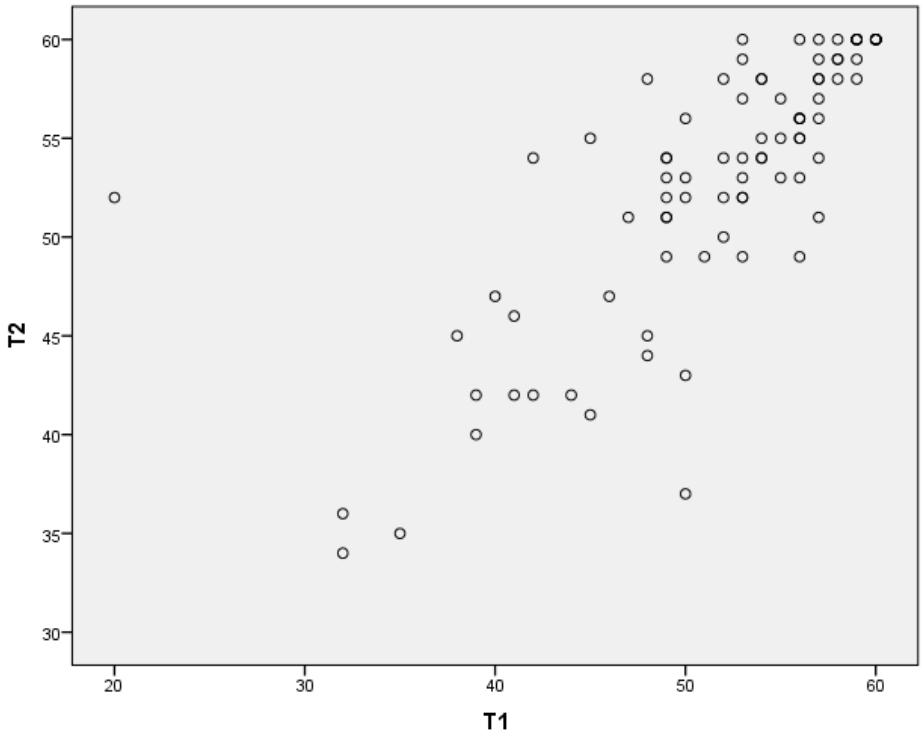

Figure 7: Scatterplot of Total EISA Scores at Time 1 (x-axis) and Time 2 (y-axis).

Table 22 shows the Spearman's Rho reliability for the total sample (n = 84). The analysis presents the correlation for each item, as well as the total score, between time 1 and time 2. All correlations were positive, and above 0.40. The reliability for the total sample was $R_s = 0.81$. The analysis indicated, that there was agreement between time 1 and time 2 scores. The most reliable item was Leisure needs ($R_s = 0.74$) and the least reliable was Communication needs ($R_s = 0.49$).

Table 22: Spearman's rho Correlations for all Participants (N=84)

EISA Items	N	R_s
Transportation Needs	84	0.69**
Banking Needs	84	0.63**
Shopping Needs	84	0.69**
Health and Wellness Needs	84	0.50**
Nutritional Needs	84	0.62**
Communication Needs	84	0.49**
Household and Security Needs	84	0.56**
Memory Needs	84	0.61**
Leisure Needs	84	0.74**
Work, School, or Volunteering Needs	84	0.64**
Total Score	84	0.81**

Key: EISA = Electronic Instrumental Activities of Daily Living Satisfaction Assessment; R_s = Spearman's rho; and **Correlation is significant at the 0.01 level

Table 23 shows the Spearman's Rho reliability for the sub-group without cognitive impairments (n = 73). The analysis presents the correlation for each item and the total score between time 1 and time 2. All correlations for the items were positive and large. The reliability for the sub-group without cognitive impairments was $R_s = 0.83$. The analysis indicated, that there was agreement between time 1 and time 2 scores. The results of this sub-group were very similar to the total sample. This is because the sample sizes of the 2 groups were very similar.

Table 23: Spearman's rho Correlations for Participants without Cognitive Impairment (n=73)

EISA Items	N	R_s
Transportation Needs	73	0.72**
Banking Needs	73	0.62**
Shopping Needs	73	0.71**
Health and Wellness Needs	73	0.53**
Nutritional Needs	73	0.63**
Communication Needs	73	0.47**
Household and Security Needs	73	0.55**
Memory Needs	73	0.63**
Leisure Needs	73	0.75**
Work, School, or Volunteering Needs	73	0.68**
Total Score	73	0.83**

Key: EISA = Electronic Instrumental Activities of Daily Living Satisfaction Assessment; Rs = Spearman's rho; and **Correlation is significant at the 0.01 level

Table 24 shows the Spearman's Rho reliability for the sub-group with cognitive impairments (n = 11). The analysis presents the correlation for each item, as well as, the total score, between time 1 and time 2. Between time 1 and time 2, a few of the correlations for individual items were bizarre and not significant. For example, shopping needs had an estimated Spearman's correlation of R_s = -0.22, which was not significant, with a P-value of 0.51. However, when you looked at the actual responses, of subjects who had answered the EISA survey, the differences were only scores of 5 (mostly agree) and 6 (strongly agree). This was because the sample size of the sub-group was not big enough, to get a good estimate of the population correlation. Furthermore, due to the small sample size of this sub-group, this was considered preliminary data. As opposed to the individual items, the correlation of the total score R_s = 0.72, was statistically significant. There was a positive correlation for the total score, between time 1 and time 2.

Table 24: Spearman's rho Correlations for Participants with Cognitive Impairment (n=11)

EISA Items	N	R_s
Transportation Needs	11	0.26
Banking Needs	11	0.75**
Shopping Needs	11	-0.22
Health and Wellness Needs	11	0.12
Nutritional Needs	11	0.63*
Communication Needs	11	0.70*
Household and Security Needs	11	0.73*
Memory Needs	11	0.39
Leisure Needs	11	0.68*
Work, School, or Volunteering Needs	11	0.04
Total Score	11	0.72*

Key: EISA = Electronic Instrumental Activities of Daily Living Satisfaction Assessment; R_s = Spearman's rho; *Correlation significant at the 0.05 level; and **Correlation significant at the 0.01 level

Table 25 shows the comparison of medians, between the sub-group having a cognitive impairment (median = 49), and the sub-group not having a cognitive impairment (median = 53), using a Mann-Whitney U test. There was no difference in scores between groups, although this analysis is limited by the small frequency of participants with cognitive impairment.

Table 25: Mann-Whitney U Test for EISA Total Scores with and without Cognitive Impairment

Group	N	Mean (SD)	Median (IQR)	P
Respondents with cognitive impairment	11	49 (7.0)	49 (10)	0.146
Respondents without cognitive impairment	73	52 (7.6)	53 (8)	

Key: SD = Standard Deviation; and IQR = Interquartile Range

5.5.5 Internal Consistency

The internal consistency analysis using Cronbach's Alpha for the total set of 10 items was 0.88. Although the internal consistency for some of the items was low, the overall internal consistency was good. The inter-item correlation matrix and corrected item to total correlation analyses were conducted to identify poorly performing items. However, all items performed within the acceptable range. No items needed to be dropped, to improve the reliability of EISA. In the inter item correlation matrix sub-analysis, the correlation of all items was acceptable (less than 0.80) ranging from 0.16 to 0.64 (see Table 26).

Table 26: Inter-item Correlation Matrix of EISA

EISA Item	TRAN	BAN	SHO	HW	NUT	COM	HS	MEM	LEI	WSV
Transportation	1.000	0.39	0.50	0.30	0.41	0.32	0.36	0.35	0.16	0.46
Banking		1.000	0.39	0.51	0.51	0.47	0.37	0.43	0.16	0.44
Shopping			1.000	0.53	0.53	0.45	0.28	0.59	0.52	0.39
Health & Wellness				1.000	0.54	0.47	0.29	0.57	0.39	0.41
Nutritional					1.000	0.40	0.64	0.38	0.24	0.48
Communication						1.000	0.28	0.58	0.28	0.47
Household & Security							1.000	0.34	0.19	0.61
Memory								1.000	0.53	0.52
Leisure									1.000	0.36
Work, School, or Volunteering										1.000
Overall Internal Consistency										**0.88**

Key: TRAN = Transportation; BAN = Banking; SHO = Shopping; HW = Health & Wellness; NUT = Nutrition; COM = Communication; HS = Household & Security; MEM = Memory; LEI = Leisure; WSV = Work, School, or Volunteering; and EISA = Electronic Instrumental Activities of Daily Living Satisfaction Assessment

5.5.6 Corrected Item Total Correlation

For the corrected item to total correlation analysis, all items performed well. The corrected item to total correlation of all items was acceptable at > 0.30. None of the items corrected item to total correlation was below 0.43 and importantly, the alpha level was very stable, ranging from 0.86 to 0.88 (see Table 27). This indicated that the EISA instrument was very consistent.

Table 27: Corrected Item Total Correlation

EISA Items	Corrected Item Total Correlation	Cronbach's Alpha, if Item is Deleted
Transportation	0.52	0.87
Banking	0.59	0.86
Shopping	0.66	0.86
Health & Wellness	0.64	0.86
Nutritional	0.68	0.86
Communication	0.59	0.87
Household & Security	0.55	0.87
Memory	0.68	0.86
Leisure	0.43	0.88
Work, School, or Volunteering	0.68	0.86

Key: EISA = Electronic Instrumental Activities of Daily Living Satisfaction Assessment

5.6 DISCUSSION

The results of the EISA test-retest reliability study, provided good support, for EISA to be used in an AT clinical setting. The data showed that, test-retest reliability scores were satisfactory, and

the items had good internal consistency. The study provides good pilot data, for a self-report outcome measure, that is reliable and valid.

The EISA test retest reliability study is one of the first of its kind research studies, which was designed and conducted on-line, using the Qualtrics on-line research platform. There was no direct interaction with the study participants. On-line platforms may have advantages and disadvantages. The key advantages included: (1) very wide reach for recruiting subjects; (2) increased sample size; (3) drastically reduced recruitment time; (4) high degree of flexibility for subjects to complete the study anytime, anywhere, based on their individualized needs; (5) reduced study coordinator time and cost; (6) increased accessibility for PWDs; (7) availability of customizable on-line research platform tools to collect and analyze study data.

The on-line nature of the study also presented several problems. Firstly, due to a programming error, automatic reminders were not sent out to the first batch of participants to complete time 2 administration, seven days after time 1. The error was promptly detected and corrected on the 7th day itself, by sending out reminders manually, to the first batch of participants. All subsequent participants did get reminders automatically. However, this brought up an issue, about the nature of programming on-line platforms. Such programming could come across as complicated for average users and as a result could be prone to errors. Furthermore, it could be deduced that, using on-line research platforms like Qualtrics generally requires a good handle with technology to function appropriately. Secondly, due to a design limitation with Qualtrics, time 2 automatic reminders at the 7th, 14th, and 21st days went to all participants, regardless of whether or not they had already completed time 2 administration. This was frustrating for some of the participants and consequently 28 participants erroneously completed time 2 administration, more than once. This was in spite of the fact that the reminder emails

indicated that if the participant had already completed time 2 administration they should ignore the reminders. Moreover, design limitations with Qualtrics can lead to participants misinterpreting electronic communication apart from incorrectly altering the study sample size. Nevertheless, these 28-erroneous time 2 administrations were removed from the final analysis.

Additionally, when analyzing the data a ceiling effect was observed for most of the sample (80 to 90%) who scored 5 (mostly agree) and 6 (completely agree). The data reflected highly skewed responses. For each item, the distribution was negatively skewed. In terms of normality distribution for the entire sample, most subjects scored at the higher end and only a few subjects answered at the lower end. The participant's responses indicated that for most subjects their IADL needs were met with their existing EADs.

Subjects scored high on the individual items but they also scored high on the total score. This could have been a facet of doing the study on-line that subjects who were already quite comfortable with EAD were the people who were actually doing the study. Furthermore, this could have been a result of the sample having the education and the financial means to be able to get the EAD that enabled them to complete IADLs. The study demographic data validated this assumption as the study sample was made of subjects that were: (1) highly confident with their ability to use internet connected devices; (2) highly educated, and (3) mostly employed. The participant's satisfaction scores might have looked very different if the sample was comprised of subjects, which were more at risk in terms of being less educated and had lower rates of employment. Thus, the major limitation of the EISA reliability study was that the sample was so homogeneous with most subjects being well-educated, very proficient with technology, and high users of technology.

The impetus for the EISA project came from the VA being faced with a new set of Veterans with disabilities, ranging from cognitive impairments like TBI, PTSD, to sensory and physical disabilities. This was a younger veteran population wanting to use contemporary technology like EAD to complete IADLs. A substantial section of this new set of Veterans with disabilities were Veterans with cognitive impairments. However, the continually growing need with the VA clinicians was for a self-report outcome measure that: (1) was specifically designed for EAD; (2) assessed satisfaction with functional need; and (3) could be used at initial assessment, like the FMA, when a user may not have a device. Therefore, the EISA was designed as a self-report outcome measure that could be used with users having physical/ sensory/cognitive disabilities. Consequently, the study population comprised of individuals, having physical/sensory/cognitive impairments.

In order to assess the feasibility of using on-line platform like Qualtrics for assessing satisfaction of functional need for users with cognitive impairments, the total sample was split into two groups: (1) sub-group without cognitive impairments (n = 73); and (2) sub-group with cognitive impairments (n = 11). However, with the very small sample size of the group with cognitive impairments, the data could not be regarded as conclusive. This prevented drawing valid inferences regarding the feasibility of using on-line research platforms for conducting research with subjects with cognitive impairments. In particular, for the sub-group with cognitive impairment the analysis was limited in 3 ways: (1) small sample size (n = 11); (2) restriction in range of responses with all subjects scoring at the high end (scores of 5 mostly agree or 6 strongly agree) which resulted in the correlation being artificially lowered; and (3) limited variability in each item scores. Moreover, these 3 factors made the analysis for this group less than ideal.

The only conclusions that could be drawn were that it would be important to do future research where you have more subjects with cognitive impairments, including in particular, subjects with varying levels of cognition.

EISA is a promising tool with acceptable content validity, reliability and internal consistency. It would have future application both in research and in clinical environments. The focus of clinical research would generally be on the overall satisfaction scores and how they impact the daily functioning, and QOL of the user. The emphasis of research environments on the other hand could likely be on individual item domains within EISA. The research focus could be on controlled application of a specific EAD or set of EAD in longitudinal pre-post studies in order to assess the impact of a particular EAD or set of EAD on functional need satisfaction scores. Additionally, over time with the building up of a large enough Uniform Data Set (UDS), it would be possible to use the UDS in a predictive manner. This could enable predictions like what EAD for what user population would be most effective in what particular user environment.

Furthermore, in order to provide further validation to EISA, it would be important to conduct further studies that have a varied sample in terms of the level of satisfaction of users with their EADs as well as users in different stages of the clinic from initial assessment to discharge. For future studies, it would be important to ensure that the study sample includes participants who are not comfortable with EADs or are not able to use EADs. Such participants would probably be at-risk individuals where if they have EADs, their capabilities are not matching their needs. Including such subjects would be crucial, as this was the purpose of designing EISA to be able to identify PWDs whose needs are not being met by their EADs. This would provide good variability in the study sample as well as provide a true reflection of the target population for which EISA was designed. Furthermore, since EISA has been designed to

assess user satisfaction with functional needs related to EADs, therefore, it would be desirable to conduct longitudinal studies. Longitudinal studies from initial assessment to follow-up, would enable assessment of change in user satisfaction with their EADs. Such longitudinal studies could be designed to have two cohorts with one being administered EISA face-to-face in the clinic, and the other being administered EISA on-line. Conducting such studies would enable comparative effectiveness analysis between using patient reported outcome measures face-to-face in the clinical settings versus on-line platform settings.

Currently ICT is pervading every sphere of mainstream society where conducting studies to explore the feasibility of using on-line research platforms in rehabilitation research would offer a plethora of advantages. First, it would enable understanding of the mechanisms underlying on-line research. Secondly, it would help tap the immense potential of on-line research in addressing the barriers of access, cost and quality. Thirdly, it would enable assessment of use of EAD like Smartphones in less resourced environments to facilitate a more level playing field in terms of equal opportunities for PWD. Finally, it would help advance the application of on-line outcomes measurement in rehabilitation. It would only be prudent to embrace this impending change and conduct such studies in order to accommodate to the new normal provided by an internet based mobile lifestyles.

5.7 CONCLUSION

In sum, the results of the EISA test-retest reliability and internal consistency analyses provided good support, for the EISA to be used in the clinical settings, for assessing user satisfaction with completing IADLs using EADs. The data showed that in this specific sample of reasonably well

educated adults who were highly proficient with technology, test-retest reliability scores were satisfactory ($R_s \geq$ than 0.80), and the items had good internal consistency (Cronbach's Alpha between 0.70 to 0.90).

6.0 SUMMARY

The purpose of this study was the development and validation of the Electronic Instrumental activities of daily living Satisfaction Assessment (EISA), a self-report outcome measurement tool for assessing satisfaction of everyday functional needs for consumers using Electronic Assistive Device (EADs) as the primary means to complete Instrumental Activities of Daily Living (IADLs). The EISA outcome measure was designed as a questionnaire that could be self or interview-administered to users of EADs. Development of EISA was modeled along the lines of development of the self-report outcome measure, Functional Mobility Assessment (FMA).

The specific aims of the EISA study were:

1. Develop EISA with content validation through feedback from two groups of domain experts: (1) clinicians; and (2) EADs Users ;
2. Establish acceptable test-retest reliability ; and
3. Establish acceptable internal consistency

Using the Content Validity Index (CVI) procedure, the EISA demonstrated acceptable: (1) item level content validity, with each EISA item having an Item level Content Validity Index (I-CVI) = 0.78 or higher; and (2) scale level content validity, with an overall Scale level Content Validity Index/ Average method (S-CVI/Ave) = 0.90. This provided a twofold advantage as: (1) it added more rigor to the quality of the scale, by providing interpretable content validity

information; and (2) it did not leave the user guessing, how the content validity was estimated, and whether it met criterions for acceptable standards.

EISA version 1.0 demonstrated good test-retest reliability, with a Spearman's Rho correlation coefficient Rs = 0.81. Moreover, the EISA reliability was above the minimum acceptable limit of 0.80 or higher. This established that EISA has good reliability for assessing user satisfaction with completing IADLs using EADs. It further indicated that EISA was a reliable tool for assessing change in user satisfaction over time with their EADs. The EISA further demonstrated excellent internal consistency with a Cronbach's Alpha = 0.88. This showed that firstly, the EISA internal consistency value using Cronbach's Alpha, was within the acceptable standard of 0.70 to 0.90; and secondly, EISA was a unidimensional outcome measure, consisting of items that correlated well with each other as well as, the latent construct the tool was designed to assess (satisfaction with functional need using EADs). Moreover, the excellent internal consistency of EISA, provided further validation, to items generated through content validation.

In summary, EISA was a highly reliable and valid self-report outcome measure that was: (1) appropriate to its target population, as it had been designed and tested on adult PWDs with physical, cognitive and sensory impairments, who used EADs for completing IADLs; (2) practical, with regard to, being able to be administered in a reasonable timeframe in a typical clinical environment, not requiring any particular training or specific equipment for administration, being able to be administered both in self-report or interview format, being able to be scored manually with ease to generate a composite score; (3) clinically fit, in terms of ease of fit into the clinical routine and usefulness of information for stake holders, for measuring

outcomes (Ability to reflect change over time); and (4) psychometrically sound, with regard to having demonstrated acceptable levels of content validity, reliability and internal consistency.

APPENDIX A: ELECTRONIC INSTRUMENTAL ACTIVITIES OF DAILY LIVING SATISFACTION ASSESSMENT (EISA) VERSION 1.0

Electronic Instrumental Activities of Daily Living Satisfaction Assessment (EISA) Version 1.0

DIRECTIONS:

Please answer the following questions by selecting the appropriate response (Example: completely agree; mostly agree; slightly agree etc.) that best matches your ability to complete common daily activities to your satisfaction on your own, or with the help of someone else. All examples may not apply to you, and there may be activities you perform that are not listed. However, make every attempt to answer these questions. Select only one response for each question.

1. I can meet my transportation needs. (*Example: use personal or public transportation; get directions; traffic updates; arrange travel*)	**Completely Agree**	**Mostly Agree**	**Slightly Agree**	**Slightly Disagree**	**Mostly Disagree**	**Completely Disagree**
2. I can meet my banking needs. *(Example: online banking; bill payments; account information; money Transfers)*	**Completely Agree**	**Mostly Agree**	**Slightly Agree**	**Slightly Disagree**	**Mostly Disagree**	**Completely Disagree**
3. I can meet my shopping needs. *(Example: shop online or in-person; browse and compare products/Services; make payments*)	**Completely Agree**	**Mostly Agree**	**Slightly Agree**	**Slightly Disagree**	**Mostly Disagree**	**Completely Disagree**
4. I can meet my health and wellness needs. *(Example: monitor health; access personal health information; manage medication; communicate with health providers)*	**Completely Agree**	**Mostly Agree**	**Slightly Agree**	**Slightly Disagree**	**Mostly Disagree**	**Completely Disagree**

5. I can meet my nutritional needs. *(Example: order or prepare meals; follow online recipes; comply with diets)*	**Completely Agree**	**Mostly Agree**	**Slightly Agree**	**Slightly Disagree**	**Mostly Disagree**	**Completely Disagree**
6. I can meet my communication needs. *(Example: use a phone; email/text; social media; videoconferencing)*	**Completely Agree**	**Mostly Agree**	**Slightly Agree**	**Slightly Disagree**	**Mostly Disagree**	**Completely Disagree**
7. I can meet my household and security needs. *(Example: control temperature; lighting; appliances; home security and monitoring system; emergency alerts)*	**Completely Agree**	**Mostly Agree**	**Slightly Agree**	**Slightly Disagree**	**Mostly Disagree**	**Completely Disagree**
8. I can manage my memory needs. *(Example: calendars; keeping appointments; customized reminders; to-do lists)*	**Completely Agree**	**Mostly Agree**	**Slightly Agree**	**Slightly Disagree**	**Mostly Disagree**	**Completely Disagree**
9. I can meet my leisure needs. *(ExaMple: music; movies; reading; games; sports and recreation)*	**Completely Agree**	**Mostly Agree**	**Slightly Agree**	**Slightly Disagree**	**Mostly Disagree**	**Completely Disagree**
10. I can manage my work, school, or volunteering needs. *(Example: accessing and storing information; taking notes; generating reports; participating in discussions)*	**Completely Agree**	**Mostly Agree**	**Slightly Agree**	**Slightly Disagree**	**Mostly Disagree**	**Completely Disagree**

APPENDIX B: PARTICIPANT RECRUITMENT SOLICITATION EMAIL

Dear Potential Study Participant,

Our University of Pittsburgh research team is developing the first of its kind, survey to determine how people with disabilities complete common daily activities to their satisfaction (on their own, with the help of someone else, or by using assistive technology devices), such as communicating with others, getting around, work/school tasks, banking, buying things, entertainment, etc.

What is different about this tool is that it considers common daily activities in a more contemporary manner, through the use of internet-enabled devices such as smartphones, tablets, and computers with associated software/Apps and hardware peripherals.

To ensure the survey is consistent and useful, we shall be recruiting a sample of people with disabilities, who would like to be among the lucky few, who helped validate this first of its kind survey. To be part of the study, participants would be required to complete two 15 to 20 minute online surveys within a 7-21 day time frame.

Participants will receive a $25 gift card for completing the study.

Anyone can participate who:

- Has a disability, is 18 years of age or older, and lives in the United States,
- Has been using any kind of Internet-connected device/software for at least 1 month and is not planning to change or modify their device during the 7 to 21 day time frame of the test-retest research study period, or
- Has never used such a device/software before and is not planning to get one during the 7 to 21 day time frame of the test-retest research study period,
- Can complete an on-line survey on their own, or complete the survey over the phone (see contact information below).

To complete the survey go to: www.rstce2.pitt.edu/EISA

We appreciate your assistance with the development of this much needed tool. Please feel free to share this email broadly both with colleagues and potential participants. Also feel free to contact any of us involved in the study at the information provided below should you have any questions or comments.

Regards,

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APPENDIX C: EXEMPT INTRODUCTORY SCRIPT

The purpose of this research study is to develop the first of its kind survey to determine how Internet connected devices such as Smartphones, Tablets, Computers, and associated apps/software help people with disabilities perform common daily activities such as communicating with others, getting around, work/school tasks, financial management, buying things, entertainment, etc. For that reason, we shall be surveying people with disabilities, and asking them to complete 2 rounds of a brief, approximately 15 to 20 minute, on-line survey.

Anyone can participate who:
1) Has a disability, and is 18 years of age or older

2a) Has been using any kind of internet-connected device/software for at least 1 month and is not planning to change or modify their device during the 7 to 21 day time frame of the test-retest research study period, or

2b) Has never used such a device/software before and is not planning to get one during the 7 to 21 day time frame of the test-retest research study period

3) Can complete an on-line survey on their own, or complete the survey over the phone

If you are willing to participate, the survey shall ask and collect background information including zip code, age, gender, race, disability/diagnosis, level of education, employment status, and involvement of health professionals in the selection of your assistive technology device. The questionnaire shall also enquire about your confidence level, daily use and satisfaction with your ability to use internet connected devices and associated apps/software that help you perform common daily activities that allow you to participate in society.

There are no foreseeable risks associated with this project, nor are there any direct benefits to you. Each participant who completes both rounds of the on-line survey shall receive a $25 WePay gift card as a token of appreciation. This is an anonymous questionnaire, so your responses shall not be identifiable in anyway. All responses are confidential, and shall be kept under lock and key, or in password-protected files. Your participation is voluntary, and you may stop completing the survey at any time.

This study is being conducted by Abbas Bobby Quamar (principal investigator), who can be reached at:

Email: ahq1@pitt.edu
Cell: 412 512 5277

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