1st International Conference on High Performance Energy Efficient Buildings and Homes (HPEEBH 2018)

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What is the Energy Price of Independent Living?

A Review of Energy Consumption of AT Products in Inclusive Smart Homes

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Overview
of presentation

Abstract
The overview of the paper will be provided through summary

Introduction
Various terms used in paper will be described

Research Question
Following the introduction, the RQ will provides clarification of concerned issues to be discussed in the paper

Literature Review
The broader areas from which literature is reviewed will be defined

Research Gap
Based on the literature review the research question will be formulated

Research Method
The method adapted for this research will be described and data collected will be discussed in the result section.

Abstract

Assistive Technology products + Smart Homes + Energy Consumption

Need of Research

Maintaining good health and independence for as long as possible is essential for a globally aging population and people with disabilities. Assistive Technology (AT) products are intended to enhance the functional capabilities and increase independence for elderly and individuals living with disabilities. Some of AT products are relatively low-tech devices such as glasses, grips, and crutches. The application of safety-critical products that consume comparatively large amounts of domestic energy may require additional consideration in regions where reliability of energy delivery may be an issue.

Purpose of Research

A mainstream 'smart home' offers the owner the convenience of monitoring and controlling their domestic environment. These proprietary environmental controllers are now affordable through commercial systems such as monitoring and controlling environment controllers for instance Hive, Amazon Alexa, Echo and Siri etc. These systems are often low-voltage and do not appear to add significantly to domestic energy consumption. Individuals and families living with a cognitive or physical disability often require motorized systems that draw much more energy than monitoring systems.

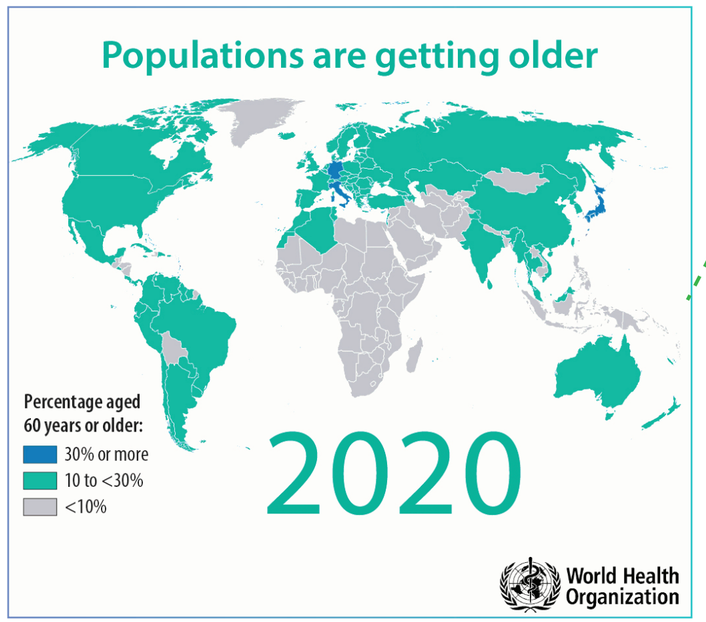
Introduction

- What is Significance of project?
- What is Assistive Technology (AT) products?
- What is Independent Living?
- What is Smart Home?
- Why AT products and Smart Home?

STATISTICS

over a billion (10% of world population)
approximately 1 in 10 persons

World Health Organization (WHO)



Between 2015 and 2050, the proportion of the world's population over 60 years will nearly DOUBLE from 12% to 22%

What is Assistive Technology (AT) product?

Any item, piece of equipment or product system whether acquired commercially off the shelf, modified, or customized that is used to increase, maintain or improve functional capabilities of individuals with disabilities (Scherer and Glueckauf, 2005, p. 133; Cook, 2009, p. 128; Shinohara and Wobbrock, 2011, p. 705; Cook and Polgar, 2015, p. 17).

Examples of AT Product

Low Technology AT Products_Low-tech devices are simple to operate and construct

Eye-glasses,
manual wheelchair,
adapted utensils,
computer key- guards etc.

HIgh Technology AT products_complex to use; frequently are electrically powered or feature electronics,

Augmentative and Alternative Communication (AAC),
Powerd Wheelchairs etc.

Wheelchair and Marketsize

It is estimated that about 1% of a total global population or 10% of a disabled population need wheelchairs, which is about 65 million people worldwide (WHO, 2008).
Like other AT products the global wheelchair market is predicted to reach an estimated $6.1 Billion by 2022 (Lucintel, 2017, Market research reports Inc., 2017)

What is smart house?

Smart home' refers to a term describing the residence equipped with technology that enables monitoring and controlling for residents and/or promotes independent living and increase inhabitant's QOL (Demiris and Hensel, 2008)

Primarily, smart homes were being considered as a design development for home for rich, however, with internet-based smart technological devices it is accessible for other individuals. This is often termed 'the Internet of Things'. The automation of domestic appliance with smart controls (such as mobile phones) has not been considered as an application for care sector.

Research Question

For elderly and disabled individuals, energy-consumption of AT devices remains an important element of AT product acceptance, contributing to the use or subsequent abonnement of devices (Boucher, 2018). The problem of energy deprivation in dwellings are commonly described by an expression known as 'energy poverty'. This notion has been widely discussed to address the deficient access to energy, specifically for disabled and elderly occupants, indicating their health concern (Bouzarovski and Petrova, 2015).

In a domestic environment advanced mobility AT devices, such as hoists, lifts or powered wheelchairs, consume relatively more energy for their operation compared to other mainstream devices, (Boucher, 2018). **Whilst energy consumption relating to mainstream smart homes is well documented, energy use in daily activities among those with physical disability is less well defined.**

Research Problem

Whilst energy consumption relating to mainstream smart homes is well documented, energy use in daily activities among those with physical disability is less well defined. This leads to the question: "what is energy consumption and associated cost for independent living for the people with disabilities within a smart home?"

Method, Results

To explore this question further, a literature review of smart home and specific high-energy requirement equipment was completed. Databases were chosen that provide a wide range of literature that has a focus on smart homes and AT products associated with tasks that aid manual handling and moving. A number of personas were created from information gathered from the literature review to provide an indication of the amount of energy consumed, with an indication of when spikes in demand may occur.

Conclusion

The study concludes with the comparison of an AT smart home with a mainstream equivalent, savings in care costs and consequences of power outage for the AT homes. Areas for further research are also suggested.

Objectives of Research

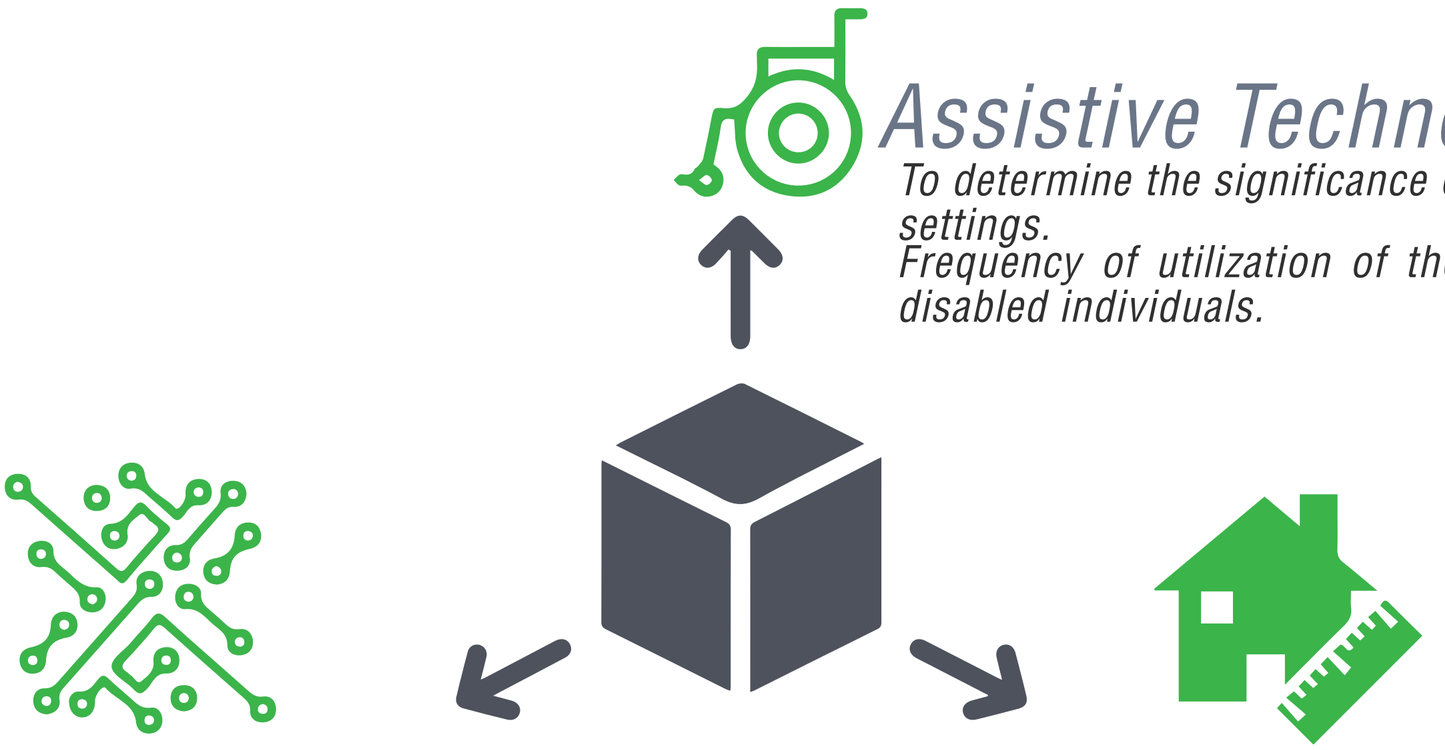
The aim of this paper is to identify the energy consumption in mobility AT devices and associated cost for independent living within smart home. Specific objectives are:

- *To identify the factors impacting the energy consumption for elderly and people with disabilities*
- *To analyze and compare energy consumption in mobility assistive technology in smart home settings with a mainstream equivalent*

Literature Review

Housing design must support independent living for all people- irrespective of disability or circumstance (Dewsbury and Edge, 2001, p. 2)

Lietrature from interdisciplinary fields was reviewed which provides with evidences that the require RQ needs to be addressed. Those fields from which literature was revied includes



Assistive Technology Products

To determine the significance of those devices in domestice settings.
Frequency of utilization of those products fro elderly and disabled individuals.

Electronics

To measure energy consumption of domestic products
Comparision energy consumption in AT products with mainstream products.

Architecture

To identify smart home importance and consideration of individuals with disabilities in smart homes.

AT products in Domestic Settings

For this research Assistive Technology products are chosen that have frequent application in domestic settings. Some of those AT devices are as following:

Ceiling Hoist

Automatic door opener

Stair-lifts

Powered Wheelchair

Measurement of Energy Consumption

Different tools for measuring energy consumptions of appliances within domestics settings were explored. Some of those equippments are:

Smart Meters

Home Monitoring Systems

Smart Plugs

Smart Energy Apps

Methodology

Methodology Adapted:

For preliminary study, an initail calculation for energy consumption was performed on aforementioned AT devices.
The energy consumption in operating an appliance is generally labelled by the 'Wattage (W)' or 'Power rating' for that specific device (Saidur et al., 2007).

For many appliances, product label shows the details of specific appliance, also, outlines the maximum energy consumption of devices in the form of Wattage (W). The amount of energy (electrical) consumed [P(W)] by an appliance can be determined through their information such as Voltage [v] and Current [I] by utilizing following formula:

Appliance operating on Direct Current (DC)

$$P(w) = V(V) \times I(A)$$

Appliance operating on Alternative Current (AC)

$$P(w) = V(V) \times I(A) \times PF$$

Findings:

Table (1) presents the estimation of energy consumption in mobility assistive devices which has application in smart home.

Activities of Daily Life *(ADL)*	***Description, Frequency***	***At Product***	***Product Model***	***Energy Consumption in Watts*** *(W)*	***Energy consumed per day*** *(kwh/day)*	***Energy consumed per month*** *(kWh/month)*	***Energy consumed per year*** *(kWh/year)*
Entrance	Provide access in the home, One (01) hour a day	Automated swing door	Model 4300	317	0.317	9.51	115.705
		Automated sliding door	Bi-Parting automatic	360	0.36	10.80	131.40
Walking	Mobility around the home, One (01) hour a day	Batteries operated powered wheelchair	-	1500/hr	1.5	45	547.5
Climbing Stairs	Increase access in different floors of home, One (01) hour a day	AC Stair Lifts	-	288	0.288	3.64	105.12
		DC Stair Lifts	-	168	0.168	5.04	61.32
Upright	Mobility in the home, One (01) hour a day	AC Electric Hoist	OT200	240	0.24	7.20	87.60
		DC Electric Hoist	OT200	120	0.12	3.60	43.80

Table 1: Estimation of energy consumption in Assistive Technology products

Findings:

Table (2) presents the comparative analysis of energy consumption in assistive technology products against the mainstream household appliances.

	Appliance	AC	DC	Qty	"*"	Wattage (V x A)	"*"	Hours per Day	"*"	Days per week	Divide By 7	"="	Avg. Watt Hrs. per Day
Energy Consumption by Mainstream appliances	Fridge	✓	×	1	x	-	x	24	x	-	-	=	1411
	Microwave	✓	×	1	x	1000	x	0.5	x	6	3000/7	=	428
	Ceiling fan	✓	×	2	x	120	x	3	x	7	5040/7	=	720
	Desktop Computer	✓	×	1	x	200	x	2	x	7	2800/7	=	400
	TV-LCD	✓	×	1	x	150	x	2	x	7	2100/7	=	300
	Dehumidifier	✓	×	1	x	280	x	2	x	7	3820/7	=	560
	Blender	✓	×	1	x	500	x	0.5	x	7	1750/7	=	250
	Toaster	✓	×	1	x	850	x	0.5	x	7	2975/7	=	425
	Iron	✓	×	1	x	1200	x	0.5	x	7	4200/7	=	600
	Incandescent Light	✓	×	1	x	100	x	5	x	7	3500/7	=	500
	Printer	✓	×	1	x	100	x	1	x	7	700/7	=	100
	Smart phone charger	✓	×	1	x	6	x	2	x	7	84/7	=	12
	Tablet Charger	✓	×	1	x	8	x	2	x	7	112/7	=	16
Energy Consumption by AT Devices	Automatic Door	✓	×	2	x	317	x	1	x	7	4438/7	=	634
	Powered W/chair	×	✓	1	x	1500	x	2	x	7	21000/7	=	3000
	Stair Lifts	×	✓	1	x	288	x	1.5	x	7	3024/7	=	432
	Electric Hoist	×	✓	2	x	120	x	2	x	7	1680/7	=	240
	Other Devices	×	✓	-	-	500	-	-	-	7			

Table 2: Estimation of Load Evaluation Chart for domestics appliances (source: (*wholesalesolar.com*, 2017))

Conclusion:

The demographic changes and technological advances has increased the health cost, that leads to the decentralization of healthcare form hospital to house. Therefore, the interaction between assistive technology devices and elderly/disabled individual, in a smart home setting to enhance the Quality of Life (QOL) is quite important. But, the needs of elderly and individuals with disabilities living in smart homes, have rarely been featured in academics or policy debates (Imrie, 2004). For instance, the amount of energy consumed by Assistive Technology (AT) appliances and their consequent impact on overall energy consumption of smart home has not been considered. This preliminary research suggests more effective recording of power consumption of AT device equipped homes is required. This may be achieved by smart meters, smart plugs/outlets and displayed through 'smart energy' apps.

Future Direction:

The suggestion that power supplies may require a heightened level of reliability and potential increased consumption could have implications for accessible and semi-independent sheltered accommodation. This type of accommodation may be defined as having on-site staff support. Multiple flats or houses in a building complex that are considered accessible for independent living, which are equipped with these additional devices, may require more robust and reliable power access and distribution. This is an important aspect to consider within town planning, architectural design and electrical supply distribution.