Use of Internet of Things(IoT) to overcome differently abled community issues

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Abstract— *Since the 15 percent of global population lives with some type of disability, it is critical for the Information technology industry to design and develop specific software that can help the disabled community to enjoy the full benefits of modern digital society. Human with different form of disabilities and in specifically people who are working with the impairment are not having equal opportunities to accessing Information technology and Internet access compare to the non-disabled population in the world and it is common for Sri Lankan disabled community . Comparative with other countries Disability among young generation is high in Sri Lanka. The main reason for this cause is until the year 2009 Sri Lanka had 30 years of humanitarian operations in the country. Most of them were permanently disabled while working in the National security forces in the country. The authorized governing body of the Information Communication Technology (ICT) in the country which is, Information Communication Technology Agency (ICTA), develops infrastructure and facilities increases the country digital literacy rate but according to the preliminary research study statistically prove that still disabled community experiences difficulties in use of ICT. This issue is known as the disability digital divide. To bridge this issue will improve the quality of life of disabled community in Sri Lanka This study proposes a framework to develop technology focused educational model to bridge the disability digital divide in the country and align them in the e-government strategy. The study is basically consisting with two phases. In the first phase of the study examined the current technology adaption among the differently abled community in Sri Lanka. The second phase examines how the modern new technologies such as Internet of things (IoT) successfully solving the issues in globally and develop a framework to overcome the Sri Lankan disability digital divide. First phase of these study two set of samples were interviewed to identify the current disability digital divide in the country. Initially 314 participants were interviewed and in the second phase of this study another set of 180 disabled participants were interviewed to identify the real problems and issues faced by the differently abled community. Sample selected from different communities, different disabled categories and different geographical locations. Findings indicated that basic level ICT technologies used by the differently abled community are statistically low. Therefore In the second phase of the study focuses on how could Internet of things (IoT) concept could successfully apply to overcome the disabled digital divide in the country. By bridging the gap through IoT concept, this community also could be an effective contributor for the national development process. There- fore, the purpose of this paper is to analyze how people with visual, hearing and physical impairments can interact with and benefit from the IoT. Initial phase 01 of this study publish in the Kotelawala Defence University (KDU) IRC 2014.*

Keywords— **Disability Digital Divide, Internet of Things, Disability, Digital Divide**

I. INTRODUCTION

A. Background to the study

In the IoT and disability is a pertinent topic discussed in the modern globalised world. In Sri Lanka many people disabled due to the civil war during the three decades. This makes a huge disadvantage for the Nation. Due to their disability many of them are having difficulties of using technologies into their day today activities. It makes deviation among the social life of disabled and non-disabled civilian in the country. Most technologies are daily added into the Sri Lanka due to the smart Nation concept implemented by the government. But the main problem is adoption on those tools and technologies are low among the community.

The lack of support services can make disabled people dependent on their assistants, which causes them from being economically, socially, politically and technologically isolated from the rest of the world.

With a concept of every object connected to internet is being created, generating an entirely new viewpoint of assistive technologies. The Internet of thing (IoT) enables new means of communication between people, things and the environment. By using this technology differently abled people can also improve their life style to some extend as other people do. .As a result the Internet of Things can offer people with disabilities the assistance and support they need to achieve a good quality of life and allows them to participate in the society.

B. Research Objectives

The Overall objective of this study is to IoT based framework to overcome the disability digital divide in Sri Lanka.

C. Research Questions

This research firstly identifies the influencing factors which causes for Sri Lankan disability digital divide. Then it critically evaluate the existing IoT could be effectively use to overcome the disability digital divide in the world. Finally formulate a framework to overcome the disability digital divide

D. Purpose of the Research

Outcome of the research propose a framework to overcome the disability digital divide which could be consider in the Sri Lankan government transformation process.

II. LITERATURE REVIEW

A. Definitions

According to the Charloton(1998) and Driedger(1989) study disability is complex, dynamic, multidimensional, and contested. Over recent decades, the disabled people's movement together with World report on disability numerous researchers from the social and health sciences (Barnes,1991) have identified the role of social and physical barriers in disability.

According to the Roger et.al(anon) Digital divide is the latest evocative term that refers to differences in access to and uses of information technology that are correlated with income, race and ethnicity, gender, age, place of residence, and other measures of socioeconomic status. According to them some people have the most powerful computers, the best telephone service and fastest Internet service, as well as a wealth of content and training relevant to their lives. Another group of people don't have access to the newest and best computers, the most reliable telephone service or the fastest or most convenient Internet services. The difference between these two groups calls as Digital Divide.

B. Internet of Things (IoT)

The Internet of Things (IoT) is a technological revolution in computing and communications. It depicts a world of networked smart devices, where everything is interconnected (ITU Internet Reports, 2005) and has a digital entity (Pascual et al., 2011). Everyday objects transform into smart objects able to sense, interpret and react to the environment thanks to the combination of the Internet and emerging technologies such as Radio-frequency Identification (RFID) (Amaral et al., 2011), real-time localization and embedded sensors.

According to the Domingo(2012) studies he proposed a IoT Architecture with analysing the three layers Perception, Network and Application Layer. Solutions for three different types of disabled people, such as visually, hearing and physically impaired categories were discussed.

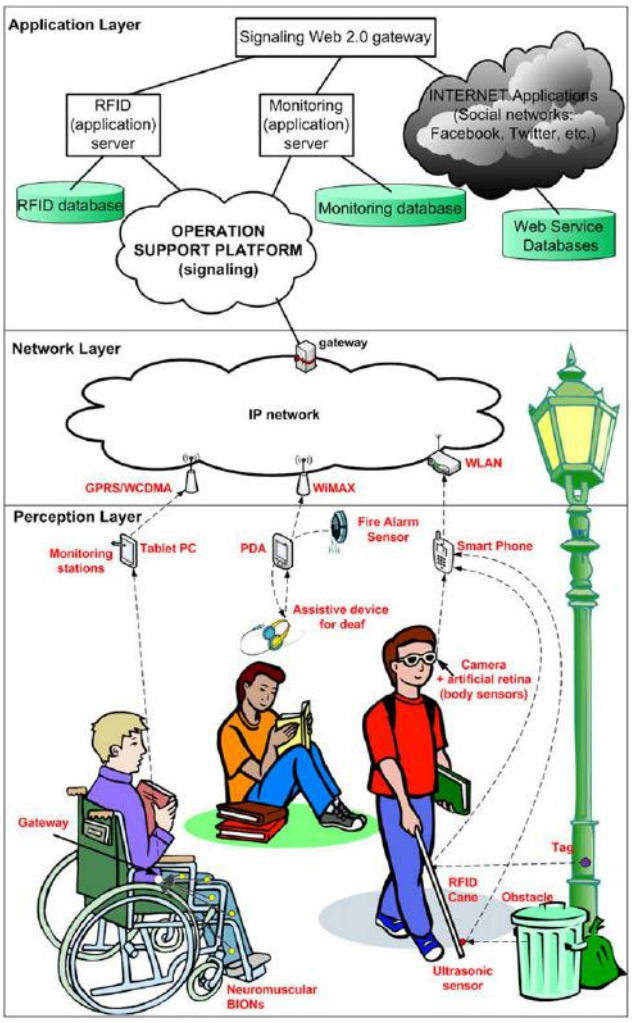

Figure 1:Domingo's three layer architecture

The components designed for the visually impaired are:(1) body micro-and nano-sensors and (2) RFID-based assistive devices.

RFID Cane - The RFID cane (see Figure 1) has a tag reader with an antenna that emits radio waves; the tags respond by sending back their stored data, hence identifying the location of the blind person. The tag reader (RFID cane) transmits via Bluetooth or ZigBee the data read from the RFID tag, which includes the tag ID string (D'Atri et al., 2007). This data is sent from the monitoring station through the network layer to the RFID server of the application layer. The blind person can record the destination's name as a voice message using the monitoring station. Directions are received by the monitoring station and played as voice messages (Shiizu et al., 2007).

Hearing impaired- (Assistive devices and sensors.)

People who are hearing impaired can benefit from external or internal (implanted in the ear) assistive devices that improve hearing. Different types of sensors (such as doorbell or smoke detectors (see Fig. 1)) detect events or

malfunctions that give rise to alarm conditions. Consequently, an alarm signal is sent from the sensors to the monitoring station, which forward sit to the assistive device as an amplified alarm signal. The deaf person can also be notified with visual (flashing light) or vibrio tactile signals(vibration motor)(Renetal.,2006).
An obstacle detection system based on an ultrasonic sensor can also be added.(Martin et al.,2009)The sensor is attached to the RFID cane to extend its coverage to detect the obstacles.

Body sensors and RFID technology.
Some paralysed patients must wear a diaper when they are in bed. A wetness sensor can immediately alert nurses and caregivers to replace the diaper as soon as it becomes wet (Yang etal.,2008). The detected design a listen to wards is adder using an RFID reader.

Assistive devices and sensors
People who are having hearing impairment can have external or internal assistive devices which could detect doorbell or smoke detectors. The alarm signals station send from the sensors to the monitoring station, which forwards it to the assistive devise as an amplified alarm signal. (Ren et al.,2006)

Body sensors, actuators and neuro chips
Body sensors and actuators could use to perform functional reanimation of paralysed limbs. Sensors attached to the nerves can detect the user's intention to move certain muscles and actuators can stimulate these muscles to restore the ability to move.

III. METHODOLOGY AND EXPERIMENTAL DESIGN

The empirical model used to examine the relationship between the level of adoption of ICT in a disabled community, associated factors and the methods used to collect and analyse data are discussed below.

A. Research Strategy

This study has been conducted using an empirical investigation. This research consists of two phases. In the first phase the study on Technology adoption in Sri Lankan for differently abled community is found using a survey. Second phase proposed some IOT related technologies to solve differently abled community issues using different technologies

B. Data Collection

Data is collected for first phase of this study based on two approaches. The primary data is collected through observation and interviews done at Sri Lanka Army CLI, unit Panagoda. Around 40 Information Technology undergraduate students participated to interview the participants. Structured interviews were conducted. This study interviewed 314 differently abled people using a non-probability sampling method such as convenience sampling. Age group of the participants was between 20 to 50. Participants for this study were selected from different communities, disabled categories and various geographical locations. Data is collected under different themes.

In the second phase of this study conducted by interview 180 disabled employees at the Ranaviru Apprel Yakala Branch. Structured interviews were conducted. Participants for this study were selected from different Age, Type of Work, Gender, Leaving arrangement, Employment status, Management Level and Income.

C. Data Analysis Framework

Table 1: Type of Variable Used for the Empirical Model in Phase 01

Variable Name	Type of Accessibility	Variable Description
B1	Basic	Telephone Use
B2	Basic	Web Access – Information Search and Email use
B3	Basic	Computer Use
I1	Intermediate	Office application Use
I2	Intermediate	Multimedia use
I3	Intermediate	Screen reader Software use
I4	Intermediate	Social media use
A1	Advance	IT Administration
A2	Advance	S/W Design Development related
A3	Advance	High-tech S/W Use (Eg. CAD/ CAM Operations)

Table 2: Dependent Variables Used in the Empirical Model

Type of Users	Dependent Variable	Range of the Digital Divide Index
1. ICT Innovators	DDI1	0.8 < DDI >1.0
2. Early ICT	DDI2	0.6 < DDI >0.8
3. Early Majority ICT Adopters	DDI3	DDI3 0.4 < DDI>0.6
4. Late Adopters Majority ICT Adopters	DDI4	DDI4 0.2 < DDI> 0.4
5. Laggards in Adopting ICT	DDI5	DDI5 0.0 < DDI >0.2

Level of Adoption of Basic ICT (B Basic ICT Facilities ICT) = Basic ICT Facilities/ 3 (i)

Level of Adoption of Intermediate ICT (I Intermediate ICT Facilities ICT) = Intermediate ICT Facilities/ 4 (ii)

Level of Adoption of Advanced ICT (A Advanced ICT Facilities ICT) =Advance ICT Facilities/ 3 (iii)

In the first sample set differently abled community adopts 2 out of 3 ICT facilities listed under the Basic category, its BICT would be 2 = 0.66. Similarly, if the same set adopts 2 Intermediate and 1 Advanced ICT facility, its IICT and AICT would be 2/4 = ½ = 0.5 and 1/3 = 0.33, respectively.

Table 3: The Sampling Framework Phase 02

Level of Disability	**No of Participants**
Eyes	53
Ears	05
Upper Limbs	06
Lower Limbs	06
Other-Simple disabilities	107
Reject	3
Total	180

IV. RESULT AND DISCUSSION

Descriptive statistics of the sample, the general information of differently abled community (age, experience in technology), and the other details arereported in Table 4.

According to the descriptive statistics three main areas were taken into consideration such as current ICT knowledge, Relevance of IT for job related activities and Interest of ICT for future needs. Result of the study indicated that the level of Current ICT Knowledge is high among the age between 25 to 28.Reason for this could be that younger generation is using more smart phones and they are likes to incorporate new technologies. Adaption level is high among this community.

English language issues among this community can be considered as a significant issue. It is indicated that majority are having language barriers to use technology. 90 precent of the participant had English language issues and they are working in Sinhala language. Most of them are in the medium level .Most of the computer users are using office package in day today life at the same time some participants in young age like to use new innovative technology. But employees who are closer to retirement age do not like to learn new technologies. Their ambition is to have their pension and stay at home. But they are interested in giving IT education to their children rather than learning themselves.

On the other hand according the findings social media usage is 0% among the community. Restriction of social media with in the office hours and office computer are cause for this result. Most of them do not have a computer at home and as a result less usage of social media among the community.

Table 4: Use of Technology

Variable	**Description**	**Respondent**	**Percentage**
B1	Telephone Use	252	98 %
B2	Web Access	150	58 %
B3	Computer Use	155	60 %
I1	Office application Use	131	51 %
I2	Multimedia use	28	11 %
I3	Screen reader Software use	4	0 %
I4	Social media use	10	0 %
A1	IT Administration	2	0 %
A2	S/W Design Development related	1	0 %
A3	High-tech S/W Use	0	0 %

A. Level of Adoption

According to the Rodgers adoption theory discussed above following calculations were done to identify the level of adoption.

Level of Adoption of Basic ICT (B Basic ICT Facilities ICT) = Basic ICT Facilities/ 3

According to the formula values for adoption in basic ICT is 72 % .Therefore this study conclude that level of adoption among the use of basic ICT Facilities are between 0.8 to 0.6.Terefore it is proved that this community are early users for basic level of ICT facilities. This is shown in the figure 3.

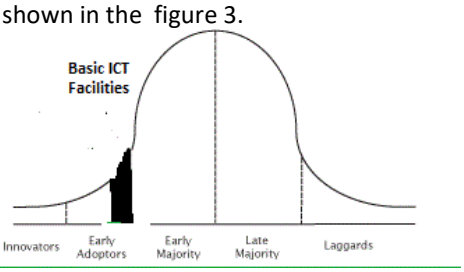

Figure 2: Adoption on Basic ICT Facilities

Level of Adoption of Intermediate ICT (I Intermediate ICT Facilities ICT) = Intermediate ICT Facilities/ 4

According to the formula, values for adoption in Intermediate ICT is 15.5 % .Therefore this study concludes that level of adoption among the users of basic ICT Facilities are between 0.2 to 0.0.Therefore it proves that this community are Laggards in Adopting ICT for

Intermediate level of ICT facilities.This is shown in the 4.

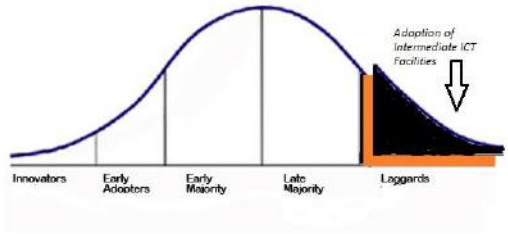

Figure 3: Adoption of Intermediate ICT Facilities

Level of Adoption of Advanced ICT (A Advanced ICT Facilities ICT) =Advance ICT Facilities/ 3

According to the formula values for adoption in advance ICT is 0 % .Therefore this study concludes that level of adoption among the use of basic ICT Facilities is between 0.2 to 0.0.Terefore, it is clear that this community are Laggards in Adopting for advance ICT facilities. This is shown in the figure 5.

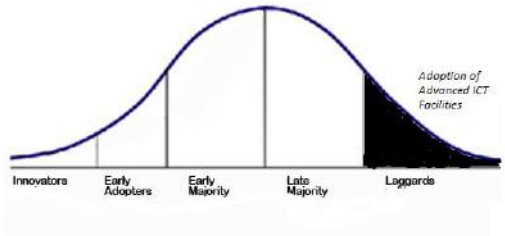

Figure 4: Adoption on Advance ICT Facilities

According to the analysis, 58 % are using web services including E-mail system, but it is noticeable that the usage of Social media is 0%. Reason for this deviation is that this community does not have social relationships with the use of high technology.

v. Proposed Model

According to the above phase 1 finding indicated that technology adoption on different technologies and different facilities are diversifying in the spectrum. Therefore overcome the digital divide issues among the disabled community need to consider in multiple perspectives.

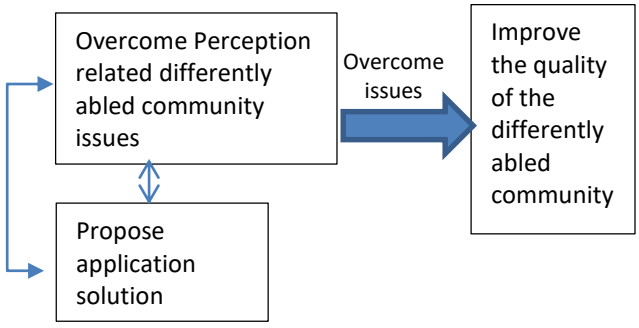

Figure 5: Improve the Quality Standards of life via Technology

To overcome the disability digital divide propose some IOT related architectural solutions for visually, hearing and physically impaired people.

To overcome the issues identified solutions were recommended through this framework.

RFID Devises

The internet of things requires a few necessary components to enable communication between devises and objects. Objects need to be augmented with an Auto-ID technology. RFID Tag. Therefore objects need to be uniquely identifiable. In addition to that objects need to wirelessly communicate certain types of information and ability to monitor data.

A. Perception layer

This layer concern about the information concerning on the environment of disabled community according to the different disabled types. Three different types of disabled are discussed below. Such as visually impaired, hearing impaired and physically impaired.

Visually impaired – There are many internet embedded assistive devices could be develop for visually impaired people. For example the cane can use a mini camera and image processing system to detect if a nearby object is stored in its database. This cane can also be including sensors for detecting distances and obstacles.

Equip walky with ultrasonic sensors could be select. Reasons for selecting this is readily commercially and compliance for walky. In addition to that with the support of it ultrasonic sensors waly can keep track of distance for the obstacle. In order to measure the distance can propose distance measuring ultrasonic systems. Most of them are using time-of-flight method.

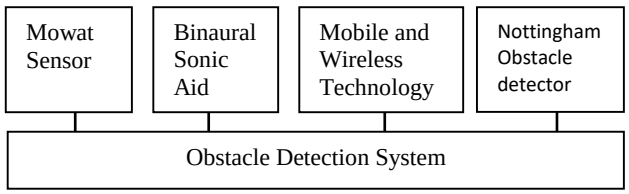

Figure 6: Proposed model for visually impaired [Obstacle detection]

According to the Sahardande(2012) et. Al the Mowat Sensor is a pulsed ultrasound which is ordained with an analogue vibratory feedback operating over two ranges of distance. This is range between one to four meters.

The Binatural Sonic Aid (Sonic guide) is a device which furnishes much information about aspects of the person's social environment .It detects the immediate path of the user. This device is incorporated in the pair of spectacle with two receivers mounted on left and right side, while,

the transmitter faces straight piercing the environment via pulsed ultrasound. An obstacle detected on the left side receiver signal will be send to left ear and similarly for right ear. Then easily blind person can identify the obstacle.

In order to detect the person and the obstacle mobile and wireless technologies could be use. This could be used to realize navigation systems in an intelligent environment. For the Deaf people the mobility system can detect obstacle that surrounds the deaf People by using malty sonar system and sending appropriate vibro-tactile acknowledgement which, serves as an aid by permitting a person to feel the vibrations of sounds.
The Nottingham obstacle detector is a hand held device sunburned with ultrasound. The device provides feedback as a unique note on the musical scale which is audible, and depicts the distance of the obstacle.

Hearing impaired – Vibe ring and hand talk are the new technologies could use for deaf people to communicate with their day today life. Vibe ring system comes in the form of a wrist watch and a pair of rings which have to be worn on both hands. The ring are designed to act as the persons ears as they listen for sounds coming from behind the individual. The wristwatch identifies the sound captured by the rings and presents the information to the person wearing it in an easy to read display manner.
Hand talk is another method to solve the problems with disabled people. According to the shrote(2014) A setup date glove is equipped with five flex sensors, each of the flex sensor is meant to be fixed on each of the finger of the hand glove for the monitoring and static movements of the fingers of the hand. Hand gesture or keypad in the device could be used. The input is text is processed using a microcontroller. The output from the LCD can be read by the dumb people and speaker can be heard by the deaf people.

Physically impaired - This people mainly having issues of mobility of their Hands specially for the Wheels chairs movement. They are basically need someone else need to push their wheel chair. As a solution with the IOT solution wheelchairs that developed could include sensors with shortest path an emergency wheelchair could detect and inform to the doctor. Boins sensors that help physically disabled people. They are wireless, injectable micro devices that are versatile, robust and relatively inexpensive to implant.

VI Conclusion

Internet of things is a new start of the art technology which could be used for differently abled community in Sri Lanka. According the initial phase of this study indicated is proved that there is a digital divide in this country. Therefore this research subjected to implemented different IOT related solutions to the different type of disabled people in the country. This solutions are basically concern with economical and user friendly since initial studies indicated that Sri Lankan have some technology adoption issues as well as income issues to adopted these new technologies.

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