

ORIGINAL RESEARCH

Assistive Devices for Persons with Visual Impairment and Low Vision: Preferences and Expectations of Users in the Southern States of India

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ABSTRACT

Purpose: *Persons with visual disabilities use various assistive devices to support, uphold or progress in their functional abilities. Under the ADIP scheme of the Government of India, persons with any form of disability are provided with assistive devices to suit their needs. This study focused on finding out the preferences of persons with visual impairment in selecting and using their assistive devices. It also aimed to understand their expectations and measures for assessing the utility of assistive devices.*

Method: *Data was collected by using semi-structured interview schedules from 227 respondents in the Southern States of India and the Union Territory of Puducherry (Pondicherry). The expectations and suggestions made by the study sample are discussed in detail.*

Results: *Assistive devices of any sort are considered in terms of durability, availability and suitability. The study findings revealed that 90% of the users preferred assistive devices such as Braille Slate-Interpoint A4, Taylor Frame, Daisy Player, JAWS Screen Reading Software, NVDA Screen Reading Software, Chessboard and Audible Cricket Ball, which were extremely helpful for their independent living. They had used most of these assistive devices in the optimal way.*

Conclusion: *Assistive devices distributed to persons with visual impairment under various schemes are beneficial in enhancing their progress in education, employment, social participation and recreational aspects of life. The expectation of the respondents/users was that assistive device services be made easily accessible.*

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INTRODUCTION

As per Census 2011, it has been estimated that the population of persons with disabilities in India is 2.68 crore, or 2.21% of the total population of the country. The total number of people with visual disabilities constitutes 19% of the population with disabilities (NSSO, 2016). Assistive devices play a pivotal role in fostering independence with or without minimal assistance, thereby paving the way for all-round rehabilitation and social inclusion. Assistive devices provide the means to access and participate in educational, vocational, social, and recreational opportunities, empower greater physical and mental function, improve self-esteem, and reduce costs for educational services and individual support (Alquraini & Gut, 2012). The use of assistive devices enhances the functional abilities of persons with disabilities and improves community participation. Active participation of these individuals in the community contributes to their own well-being as well as the development of an inclusive society for all.

Even though the use of assistive devices has its developmental dimension, many people with disabilities and their families are unaware of assistive products and services (Kamaleri & Eide, 2011). The development of assistive technology does not always follow user needs and expectations, thereby affecting its usability and effectiveness (Paredes, Fernandes, Martins & Barroso, 2013). The high costs of specialised devices acts as a deterrent to using assistive technology (Brady, Thies & Cutrell, 2014). Furthermore, assistive technology services are often scarce and located far from the homes of people with disabilities (WHO, 2011).

These statements express the various concerns related to the use of assistive devices. The present study focused on filling in a few of the abovementioned gaps by gathering multidimensional data about the usefulness of assistive devices and users' expectations of the products. This information reflects the practical usability of assistive devices and how effectively they manage to fulfil the functional needs of people with disabilities.

International mandates issued by statutory bodies such as the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD), the Incheon Strategy, and legislation like "The Rights of Persons with Disabilities Act, 2016", emphasise the role of assistive devices in providing accessibility and developing independence for people with disabilities. The government of India

has taken many steps to implement these mandates. The National Institute for the Empowerment of Persons with Visual Disabilities (Divyangjan) (NIEPVD), located in Dehradun, is an apex organisation working under the Ministry of Social Justice and Empowerment to produce assistive devices for persons with visual impairment and distribute them at an affordable cost (NIEPVD, 2022). Additionally, the Artificial Limbs Manufacturing Corporation of India (ALIMCO) has been set up to manufacture and supply quality aids and appliances at an affordable cost.

Assistive devices which are commonly used by persons with visual impairment are manufactured by ALIMCO, NIEPVD and other organisations within and outside the country; these are procured and distributed under the scheme of “Assistance to Disabled Persons for Purchase/Fitting of Aids/Appliances” (ADIP). Since the ADIP scheme is sponsored by the government, the costs of the devices are low, and the population with low economic status in the country is mainly targeted through this scheme. This scheme also creates awareness about assistive devices among people with disabilities and their organisations. In addition, the Government of India runs ADIP camps and gives assistive devices to people with all kinds of disabilities in all parts of the country (DEPwD, 2022).

With this background, the current research study was undertaken to identify the usefulness of aids and appliances used by people with visual disabilities. The study considered the software commonly used by persons with visual impairment and the assistive devices that are distributed through the ADIP scheme.

The users’ feedback about usefulness, preferences and drawbacks/difficulties of using the devices was consolidated, and their suggestions were elicited for enhancing the use of assistive devices.

Description and Functional Importance of Assistive Devices selected for the Study

Assistive devices that are universally used were selected for this study. The basic structure and function of the majority of these devices are the same globally and there are minimal adaptations depending on the manufacturers.

Devices for Independent Living

The three types of canes listed below ensure that people with visual impairments have reliable mobility, allowing them to develop self-confidence in their pursuit

of education, employment, and social inclusion.

- *Rigid White Cane (Long Cane)*: Non-foldable stick.
- *Folding White Cane*: A stick with four or five segments that are joined and foldable with the help of an elastic band.
- *Smart Cane*: A small sensor attached to the stick which detects obstacles up to a distance of 3 metres in front.

The devices listed below are used to identify the time independently:

- *Talking Wristwatch*: This is a watch that has audio features.
- *Braille Wristwatch*: Embossed dots present in the watch help to indicate the time.

Devices for Education and Employment

a) Software

Screen reading software converts the text that appears on the computer screen into speech, which enables people with visual impairments to access the content. This software facilitates their education and provides various employment opportunities in computer-oriented jobs. JAWS (Job Access with Speech), NVDA (Non Visual Desktop Access), Orca and Narrator are universally used screen reading software. Apart from these, screen reading software such as Talks, eSpeak, Google text-to-speech, Shine Plus, VoiceOver and TalkBack are used on mobile-based platforms.

Screen magnification software assists in magnifying the contents on the computer screen, thereby enabling people with low vision to access the content. This software enhances the education and employment of people with low vision. MAGic, Dolphine SuperNova, Microsoft Magnifier, Orca and ZoomText Magnifier are some of the most popularly used computer-based screen magnification software. Software like Talks&Zooms and Mobile Speak are used to make the screen bigger on mobile-based apps.

b) Reading and Writing Devices

The following devices are used universally for the education of persons with visual impairment and low vision. These modified devices make the teaching

and learning process easier. Small variations are present in the devices that come from different manufacturers.

i) Braille reading and writing devices

Braille is a system of tactile reading and writing for people with visual impairments, in which raised dots represent the letters of the alphabet, numbers, punctuation, etc. Documents in Braille format are accessible to people with visual impairments.

For Braille writing, Braille Slate-Interline (small and large), Braille Slate-Interpoint A4 and a Pocket Writing Frame are used. A Round Head Stylus and a Concave Head Stylus are used to make the embossment on the Braille paper. Embossed dots present in the Braille Scale are used to identify the measurement markings. A Brailler is a typewriter used to type Braille letters. A Braille shorthand machine is used to take down shorthand instructions in Braille, just like in other languages. The Signature Guide assists people with visual impairments to sign the correct place in the document.

ii) Mathematical devices

A Taylor Frame is a device used by people with visual impairment to do mathematical calculations. The abacus (Cranmer) is a simple instrument for performing rapid arithmetic calculations. People with visual impairment can use the Modified Geometric Mathematical Kit to access geometry content. Tactile markings on the measuring tape help to identify measurements. A set of embossed diagrams in the mathematics and science content helps people with visual impairments to understand the concepts easily. A tactile Drawing Board assists in creating embossed diagrams.

A Radio-cum-CD player plays the content in audio format. The Daisy Player is a mobile phone-like device that has the features of reading books in DAISY format (Digital Accessible Information System), audio books, text documents and supporting MP3 music files. These devices are used by people with visual impairments to listen to audio-formatted content.

Low Vision Devices

Low vision devices are used to magnify the contents for people with low vision. Spectacles enable people with low vision to see objects magnified through

aspheric lenses. The Illuminated Handheld Magnifier provides magnification facilities along with illumination features. The handy Tabletop Magnifier is ideal for magnifying printed matter, artworks, maps, etc., by moving the Stand Magnifier over the content of the material placed on the table.

Recreational Devices

Simple changes made to regular playing materials allow people with visual impairments and low vision to actively participate in sports and games. The Audible Cricket Ball enables the player to locate the ball by tracking the sound. Devices like the adapted chessboard and playing cards provide an inclusive playing environment in which people with visual impairments and sighted people can play together.

Objectives

The study had the following objectives:

- To find out the usefulness of already existing assistive devices for persons with visual impairment and low vision.
- To identify the preferences for selecting the existing assistive devices.
- To find out the reasons for the non-use of the devices.
- To find out the expectations of the users.
- To suggest measures to improve the usability of assistive devices for persons with visual impairment and low vision.

METHOD

Study Design

The study is descriptive in nature. It has two components. The quantitative part describes the percentage of sample responses, which indicate the usefulness and preference for the devices. The qualitative part describes the useful features of the individual device, reasons for preferring the device, shortcomings of the device, expectations and suggestions from the end-user.

Sampling

Organisations working for persons with visual impairment and low vision in the Southern States of India (Tamil Nadu, Kerala, Andhra Pradesh, Telangana, Karnataka and the Union Territory of Puducherry) were selected for this study through a stratified random sampling technique. The samples from the individual organisations were selected through a simple random sampling technique. They consisted of 227 persons with visual disabilities who use any kind of assistive device.

Study Instruments

A semi-structured interview schedule was prepared and pilot tested. Content validity was obtained from professional experts. The semi-structured interview schedule consisted of four components. The first part covers personal information; the second part has a 5-point rating scale to assess the usefulness of the assistive devices; the third part consists of questions related to ranking the preferred devices and new devices to be designed; and the fourth part gathers information regarding the useful features of the device, reasons for preferring the device, its drawbacks, reasons for discarding it, the user's expectations about the device and suggestions to improve its usability.

Data Collection

Data was collected from 26 organisations situated in the southern parts of India. The interview schedule was administered to 227 persons with visual impairment, to collect details about the devices. The duration of the interviews ranged from 1 - 1½ hours. The interviews were conducted on a one-to-one basis with 101 persons with visual impairment. Data was also collected from 24 small groups (each group consisting of 3-6 persons with visual impairment) in places such as special schools. Since many students were available at the same location and the interview questions were the same for each person, this mode was chosen for data collection. The interviews were recorded with the consent of the individuals.

Data Analysis

The percentile representations and mode were used to describe the sample responses. The responses were described qualitatively in the report and were consolidated. A single technical committee was formed to analyse the consolidated responses to all the devices and the suggestions received. The committee

examined the different dimensions of the responses, like technical aspects, service delivery, manpower availability, etc., and checked the authenticity of the feedback; for example, whether the problems stated by the respondent due to a lack of awareness. The committee also checked the feasibility of the suggestions made by the users.

Ethical Considerations

In the present study, there was no risk to the physical and mental well-being of the respondents. The purpose and outcomes of the research were intimated to the respondents and a consent letter was obtained from each individual prior to the interview.

RESULTS and DISCUSSION

Respondents' Background Characteristics

The sample population consisted of 227 people, of whom 145 (63.88%) were people with visual impairment and 82 (36.12%) were people with low vision. There were 84 (37%) female respondents and 143 (63%) male respondents. Among them, 180 (79.30%) had the onset of disability before the age of 3 years and 47 (20.70%) acquired the disability after the age of 3 years. The respondents' age range was from 9 to 57 years, and the average age was 23.33 years (SD = 11 years). Table 1 gives insight into the categories of the respondents for this study sample.

Table 1: Categories of Respondents for the Study

Sl. No.	The Category of the Respondent	No. of Samples	Percentage (%)
1	School student	68	29.96
2	College student	91	40.09
3	Vocational trainee	13	5.73
4	Unemployed	2	0.88
5	Govt. employed	19	8.37
6	Self-employed	2	0.88
7	Private employed	32	14.10
	Total	227	100.00

Since most of the devices under consideration were relevant to the field of education, more students with visual impairment took part in this study.

The Usefulness of Assistive Devices for People with Visual Impairment or Low Vision

The usefulness of assistive devices has been measured by two different methods.

1. The users were asked to express the level of usefulness of each device on a 5-point Likert scale. The scores were coded as: '1-Not at all useful', '2- Slightly useful', '3-Somewhat useful', '4-Very useful', and '5-Extremely useful'.
2. The users were asked to describe the useful features of their individual assistive devices.

Tables 2 to 6 summarize the usefulness of various assistive devices for various life domains .

Table 2: Level of usefulness of 5 different Assistive Devices for Independent Living of People with Visual Impairment

Sl. No.	Type of Assistive Device	1		2		3		4		5		Total No. of Users
		N	%	N	%	N	%	N	%	N	%	
1	Rigid White Cane (Long Cane)	0	0.00	12	19.05	26	41.27	17	26.98	8	12.70	63
2	Folding White Cane	0	0.00	3	1.95	24	15.58	56	36.36	71	46.10	154
3	Smart Cane	1	1.23	13	16.05	18	22.22	18	22.22	31	38.27	81
4	Talking Wristwatch	1	0.65	2	1.30	26	16.88	44	28.57	81	52.60	154
5	Braille Wristwatch	0	0.00	3	3.19	15	15.96	24	25.53	52	55.32	94

Table 3: Level of usefulness of Educational Software for People with Visual Impairment

Sl. No.	Type of Assistive Device	1		2		3		4		5		Total No. of Users
		N	%	N	%	N	%	N	%	N	%	
Screen Reading Software – Computer												
1	JAWS(Job Access with Speech)	0	0	0	0	4	2.06	43	22.16	147	75.77	194

2	NVDA(Non Visual Desktop Access)	1	0.69	4	2.78	7	4.86	59	40.97	73	50.69	144
3	Inbuilt Screen Reading options in Computer (ORCA)	0	0	1	3.33	1	3.33	11	36.67	17	56.67	30
Screen Reading Software - Mobile Phone												
4	eSpeak	0	0	0	0	4	10.81	9	24.32	24	64.86	37
5	Talks	0	0	0	0	0	0	8	32	17	68	25
6	Shine Plus	0	0	0	0	0	0	0	0	4	100	4
Inbuilt Screen Reading option in Mobile Phones												
7	TalkBack	0		0		15	14.56	31	30.09	57	55.33	103
Screen Magnification Software												
8	Computer-based Screen Magnification Software (MAGic)	1	6.67	0	0	4	26.67	8	53.33	2	13.33	15
9	Inbuilt Screen Magnification options in a Computer	3	8.57	0	0	5	14.29	18	51.43	9	25.71	35
10	Screen Magnification Software – Mobile Phones	0	0	0	0	3	6.00	14	28.00	33	66.00	50
11	Inbuilt Screen Magnification options in Mobile Phones	0	0	0	0	7	10.45	19	28.35	41	61.19	67

Table 4: Level of usefulness of Educational Devices other than Software for People with Visual Impairment

Sl. No.	Type of Assistive Device	1		2		3		4		5		Total No. of Users
		N	%	N	%	N	%	N	%	N	%	
Reading, Writing and Mathematical Devices												

1	Braille Slate-Interline (Small and Large)	10	9.35	19	17.8	15	14.02	22	20.56	41	38.32	107
2	Braille Slate-Interpoint A4	0	0	2	0.93	3	1.39	39	18.06	172	79.63	216
3	Round Head Stylus	18	8.78	17	8.29	32	15.61	70	34.15	68	33.17	205
4	Concave Head Stylus	3	1.62	6	3.24	21	11.35	34	18.38	121	65.41	185
5	Pocket Writing Frame	1	0.88	5	4.42	27	23.89	38	33.63	42	37.17	113
6	Signature Guide	2	3.64	2	3.64	22	40	12	21.82	17	30.91	55
7	Taylor Frame	3	1.6	0	0	9	4.81	36	19.25	139	74.33	187
8	Abacus	2	1.54	5	3.85	30	23.08	32	24.62	61	46.92	130
9	Geometric Kit	1	0.9	6	5.41	33	29.73	38	34.23	33	29.73	111
10	Measuring Tactile Tape	0	0	2	2.89	12	17.39	29	42.02	26	37.68	69
11	Braille Scale	0	0	4	3.28	31	25.41	45	36.89	42	34.43	122
12	Tactile Diagram Set	0	0	1	1.54	11	16.92	30	46.15	23	35.38	65
13	Braille Shorthand Machine	0	0	1	7.14	5	35.71	1	7.14	7	50	14
14	Braille	0	0	5	2.98	15	8.93	44	26.19	104	61.9	168
15	Tactile Drawing Board	0	0	0	0	17	38.64	12	27.27	15	34.09	44
16	Radio- cum-CD Player	2	1.18	1	0.59	27	15.88	61	35.88	79	46.47	170
17	Daisy Player	0	0	1	0.73	10	7.25	27	19.56	100	72.46	138

Table 5: Level of usefulness of Low Vision Devices

Sl. No.	Type of Assistive Device	1		2		3		4		5		Total No. of Users
		N	%	N	%	N	%	N	%	N	%	
1	Spectacle	0	0.00	0	0.00	5	26.32	3	15.79	11	57.89	19
2	Illuminated Handheld Magnifier	1	7.69	2	15.38	2	15.38	6	46.15	2	15.38	13
3	Stand Magnifier	3	42.86	0	0.00	1	14.29	2	28.57	1	14.29	7

Table 6: Level of usefulness of Recreational Devices for People with Visual Impairment

Sl. No.	Type of Assistive Device	1		2		3		4		5		Total No. of Users
		N	%	N	%	N	%	N	%	N	%	
1	Chessboard	0	0.00	2	1.05	6	3.14	32	16.75	151	79.06	191
2	Braille Playing Cards	6	6.52	7	7.61	14	15.22	23	25.00	42	45.65	92
3	Audible Cricket Ball	0	0.00	0	0.00	10	5.71	24	13.71	141	80.57	175

The description and functional importance of each of the devices mentioned above are described in the earlier section.

The respondents stated that they found devices like JAWS Screen Reading Software, Braille Slate-Interpoint A4, Chessboard, Audible Cricket Ball, Mobile Screen Magnification Software, Taylor Frame, Orca Screen Reading Software, Daisy Player, NVDA Screen Reading Software and Talks Screen Reading Software extremely useful. This is clearly reflected in the score of more than 90%, which is the combination of scores for extremely useful (rating 4) and very useful (rating 5).

At the next level, devices like Inbuilt Screen Magnification options in Mobile Phones, eSpeak Screen Reading Software, Brailier, TalkBack Screen Reading Software, Concave Head Stylus, Folding White Cane, Radio-cum-CD Players, Tactile Diagram Set, Talking Wristwatch and Braille Wristwatch got scores ranging from 81% to 90% (rating 4 and rating 5) from the users. Except for the Stand Magnifier and Rigid White Cane, all the devices had a score of 50% (rating 4 and rating 5) or higher from the users. Assistive devices are being distributed at present under the ADIP Scheme for persons with visual disabilities, either manufactured by NIEPVD or other agencies, and the software considered in the present study is extremely useful for the end-users.

Independent mobility is one of the most important requirements for persons with visual impairment in order to attend school, work, and other social gatherings. Advancements in mobility devices and mobility training enable them to move independently and actively participate in community life. Devices like Braille wristwatches and talking watches reduce their dependence on others for assistance in time management.

Inaccessible educational materials and inappropriate teaching strategies act as impediments to the educational advancement of people with disabilities. Adaptations in educational materials and teaching methodologies make education accessible to people with visual impairment. The aforementioned educational tools and software play an important role in ensuring that students with visual impairments receive the education they require.

The majority of workplace content is only available in print and consequently inaccessible to people with visual impairment. This situation restricts their ability to perform particular jobs. Screen reading software, screen magnification software, and other assistive devices make it easier for them by converting printed materials to audio format or by magnifying the content. This creates lots of employment opportunities for people with visual impairments in computer-oriented jobs.

Recreational and leisure activities are important elements in every person's life. Due to a lack of adapted playing materials, people with visual impairments stay away from most games. Recreational devices like adapted chessboards, audible cricket balls and playing cards provide the opportunity for people with visual impairments to actively participate in sports and games.

According to users, the most useful features of the specific devices are as follows:

- The alarm facility in the talking wristwatch is useful (24.67%, n=38).
- The Braille wristwatch has better durability than the talking wristwatch (11.70%, n=11).
- eSpeak screen reading software for mobile phones supports regional languages like Tamil, Malayalam, etc., (27.03%, n=10). It also has different voices and options for modifying the voice (8.10%, n=3). It automatically converts the speech output as per the language of the text (5.40%, n=2).
- JAWS Screen Reading Software has good audio clarity (7.73%, n = 15) and good English pronunciation (4.12%, n = 8).
- NVDA Screen Reading Software supports regional languages like Tamil, Malayalam, Telugu, Kannada, etc., (23.61%, n = 34).
- Folding White Cane is portable in nature (27.92%, n = 43).
- Users can easily identify obstacles when using the Smart Cane (6.17%, n = 5).

- Braille Slate-Interpoint A4 helps to take notes easily in the classroom (3.70%, n = 8).
- The Concave Head Stylus does provide a good grip while writing, as it has been equipped with a good grasping handle. Therefore, writing is not only easier but also faster (18.92%, n = 35).
- The Pocket Writing Frame is handy in size and therefore can be carried and handled with ease (13.27%, n = 15).
- The Tactile Diagram Set is effective for teaching science and mathematics concepts through embossed pictorial presentations (6.15%, n = 4).
- Recording clarity is good in DAISY Player (16.67%, n = 23).

Preferences in Selecting the Existing Assistive Devices

Two distinct methods were used to collect data on user preferences for assistive devices.

1. The users were asked to rank the various assistive devices in order of preference.
2. The respondents were asked to describe their reasons for preferring a particular device.

As per the results obtained, the users prefer Daisy Player (68.84%, n = 95), Braille Slate-Interpoint A4 (68.52%, n = 148), Folding White Cane (51.30%, n = 79), JAWS Screen Reading Software (50.52%, n = 98), Taylor Frame (42.78%, n = 80), Chessboard (40.84%, n = 78), Audible Cricket Ball (36.00%, n = 63), Smart Cane (28.40%, n = 23), NVDA Screen Reading Software (27.08%, n = 39), Braille (26.19%, n = 44), Talking Wristwatch (25.97%, n = 40), TalkBack Screen Reading Software (23.30%, n = 24) and Braille Wristwatch (22.34%, n = 21). The respondents from Kerala preferred Orca Screen Reading Software (53.33%, n = 16).

The major reasons stated by the users, for preferring a particular assistive device, are as follows:

- By using the Rigid White Cane, as compared to other types of canes, the users can identify obstacles clearly (12.69%, n = 8).
- The Folding Cane is preferred over the Smart Cane because the Smart Cane vibrates constantly when there are objects and confuses the user finding the right path (4.54%, n = 7).

- The Talking Wristwatch can be used by people with visual impairment who do not know Braille (5.84%, n = 9).
- While using the JAWS, language proficiency skills are improved (1.03%, n = 2).
- In comparison to the Round Head Stylus, the Concave Head Stylus is more comfortable. (3.78%, n = 7).

Reasons for Non-use of Assistive Devices

The users were asked about the minimal use or non-use of their devices. They were asked to give their reasons for not using any particular device.

- There were hardly any minimally used or non-used devices. However, it was pointed out that the Talking Wristwatch becomes unusable due to a lack of repair facilities, so users prefer to purchase a new watch instead of repairing it (42.85%, n = 66).
- Due to the limited/remote possibility of repair facilities, the Daisy Player (29.71%, n = 41) and Brailier (6.55%, n = 11) are not in use.
- Due to a lack of training (16.21%, n = 18), the Geometric Kit is not used.

Users' Expectations regarding Assistive Devices

The users' expectations have been elicited in two different ways.

They were asked to respond to the following questions:

1. Mention the assistive devices needed but not available on the market or yet to be designed.
2. Describe their expectations of individual assistive devices.

The participants expressed their desire to use new assistive devices compatible with their growing needs. Assistive devices like bus number identifiers (n = 22) and Optical Character Recognition Software in the Regional Languages (n = 11) are much anticipated devices by the majority of users, and also devices (n = 4) and Audible Power Bank (n = 1).

Major findings about the expectations of the specific devices, as stated by the users, are:

- A standard - size Talking wristwatch is desired instead of a large - sized watch (9.74%, n = 15).
- JAWS Software could support more Indian regional languages (11.86%, n = 23).
- The accent and pronunciation in NVDA software can be changed to sound more like a human voice (8.33%, n = 12).
- Large size Taylor Frame may be introduced again to facilitate bigger calculations (6.95%, n = 13)
- Training is needed for using the Geometric Kit (14.41%, n = 16).
- Audio output in regional languages is needed in DAISY Player (Plectalk) (4.35%, n = 6).
- People with visual impairments need a bigger chessboard so that they can play with their sighted friends (8.38%, n = 16).

Suggestions from Users regarding Assistive Devices

The users were asked for device-specific suggestions to improve the utility of the device.

Some suggestions were:

Rigid White Cane

- The present height of the cane is suitable for adults but not for children. Since children start orientation and mobility training with the rigid white cane, the length of the cane may be in two or three sizes, suitable to the child's height (4.76%, n = 3).

Smart Cane

- Using the Smart Cane during the rainy season may damage the sensor and the speaker as rainwater gets into the device. In order to prevent this, a waterproof sensor can be fitted to the Smart Cane (14.81%, n = 12).

Braille wristwatch

- The dial of the Braille watch is white in colour and it becomes dusty due to regular use; this makes the display dull. To overcome this, a coloured dial may be used in the watch (1.06%, n = 1).

eSpeak

- Instead of reading the numbers separately, it reads the entire digits. For example, while reading the mobile number, instead of reading ten numbers separately, it reads the whole ten digits in words. An individual number reading option is suggested (8.11%, n = 3).

Taylor Frame

- The embossed dots/surfaces presented in the Algebra and Arithmetic pegs become rounded and flattened due to regular use. To overcome this, it is desirable to have pegs made out of thick plastic material (3.21%, n = 6).
- The storage container of the pegs may be fixed at the bottom of the Taylor Frame with bifurcation to hold/store Algebra and Arithmetic Types separately in order to facilitate easy handling at the time of the examinations (7.49%, n = 14).

Braille Scale

- The sharp edges of the scale sometimes cause injuries. To prevent injuries, the sharp edges could be blunted and rounded (4.92%, n = 6).

Chessboard

- A folding type of chessboard is suggested (6.81%, n = 13).
- The coins containers on both ends of the chessboard could be provided with sliding doors for storing the coins while not in use (4.19%, n = 8).
- At present, one set of chessboard coins is sold with the chessboard. In the case of coins getting lost, provision may be made for buying only a new set of coins (0.52%, n = 1).
- Braille markings on the sides of the cells, indicating the position of the square in sequential numbers, will facilitate easy identification of the exact square while playing (0.52%, n = 1).

Audible Cricket Ball

- Bright-coloured balls are preferred instead of the white ones being used at present, to suit people with low vision (2.29%, n = 4).

Recommendations

- According to the research findings, the devices considered for this study that are being distributed at present under the ADIP Scheme for persons with visual disabilities are extremely useful for the end-users. The same devices that are manufactured by NIEPVD and other agencies should continue to be distributed under the ADIP Scheme.
- The sales counters for assistive devices for people with visual impairment are located in different parts of the country. These sales counters could make provision for selling spare parts for various assistive devices, such as chessboard coins, elastic bands and tips for the folding cane, guider for the Braille slate, etc. The sales counters could also be upgraded into workshops for servicing assistive devices, as very few facilities are available right now to undertake after-sales service.
- The users expressed their desire to have some new assistive devices that are designed to meet their specific needs. For example, a device to identify/ announce the bus numbers at bus stops, OCR software in the regional languages and a few more assistive devices can be considered for future research and development. The needs may be communicated to the manufacturers with assistive devices to design and promote new products.
- Very few technical people are available to service faulty assistive devices. It may be a good move to start short-term and long-term training programmes, which will certainly lead to an increase in qualified manpower.
- The scarcity of adapted sports equipment prevents people with visual impairments from participating in sports activities. Therefore, it is desirable to develop more adapted games for them.
- An accessible format of the user guide for assistive devices will be of great help to users in understanding how best to use these devices.

Limitations

This study did not include technologically advanced devices used in organisations, such as refreshable Braille displays, Braille printers and other devices. The study focused only on the devices commonly used by individuals, rather than on the ones used in organisations.

CONCLUSION

The users expressed device-specific expectations concerning its usefulness and provided useful feedback to improve the utility of most of the devices. The suggestions are consolidated and presented in this research report and may offer useful feedback to the manufacturers of each of the devices for further refinement on quality, durability and to fulfil the users' expectations of the devices.

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