

Article Info

Received: 20 Dec 2020 | Revised Submission: 28 Feb 2021 | Accepted: 05 Mar 2021 | Available Online: 15 Mar 2021

Study of Work Effectiveness of Physically Disabled Workforce through Applied Ergonomics

Prashant Ahlawat, Tausif Alam**, Vijender Singh*** and Roop Lal*****

ABSTRACT

There is a large population of disabled working people. These people constitute at least 2.21% of the total population of India as per 2011 census data. Out of the total population of persons with disabilities, approximately 1.50 crore are men and 1.18 crore, are women. These include persons with visual, hearing, speech and loco-motor disabilities, mental illness, mental retardation (intellectual disabilities), multiple disabilities and other disabilities. Among the workers with disabilities, 31% constitute agricultural labourers. Fifty percent of the PwD population in the age group of 15-59 years is working whereas 4% of children with disabilities in the age group below 14 years are working. They need special ergonomic attention, but a great deal of information is missing or incomplete about their work efficiency. Work is said to be one of the basic factors of human life. It is well known that appropriate workplace and tools preferable to disabled workers can contribute to the healthy and satisfied worker and this fact is even more important when we talk about workers with disabilities. Disability inclusion in the workplace is the manifestation of recognition that employees are human. Employees do not and cannot shed the complexities of their physical and mental selves while they are at work. Worker centric tools and furniture need to be developed by industrial designers at a cost-effective price. This study shows how the efficiency of the disabled workers can be increased by making changes in the workplace design for a "regular adult" population in the age range of about 15 to 60 years. Anthropometry, biomechanics, physiology, attitudes and behaviour of this population and the tools which they use during work provides necessary stimulation to workplace designers, owners of the establishment for making changes in the workplace preferable to the disabled workforce. We conducted testing to compare pre-test and post-test results using preferred products to evaluate the work effectiveness of the people with physical disabilities using statistical analysis (paired t-tests). The results after using worker preferred products showed a higher average post-test score than pre-test. This analysis indicated a statistically higher work effectiveness ($\alpha = 0.05$) and supports the research hypothesis.

Keywords: *Analysing Work Effectiveness; Disabled Workforce; Efficiency, Ergonomics; Kolmogorov-Smirnov Test; Physically Disabled Workforce; Shapiro-Wilk Test; Statistical Package.*

1.0 Introduction

Disabled population in India as per Census 2011 is 2.68 crore out of 120 crore population, Indian businesses have a long road to travel when it comes to inclusion of people with disabilities.

Loss of locomotor skills like vision, hearing difficulty and little bit of mental retardedness are the primary categories of disabilities associated with growing age included while calculating these statistics. World Bank has placed this figure at 8% loss in terms of productive work hours and employable workforce that we are losing due to

marginalised workforce which has been neglected by the working establishment resulting in loss in GDP. Most owners are usually in little bit of ambiguity as they are not sure about how the disabled person should be treated with and how they will work, they are also unsure about their working efficiency. All these happened due to lack of knowledge and their chronic mentality which is being passed from one generation to other as disability is often regarded as some form of abnormality. Most of the India's disabled people cannot support themselves and are considered a burden to society [1]. We have done analysis on physically disabled people who are

*Corresponding author; Department of Mechanical Engineering, Delhi Technological University, Delhi, India
(E-mail: prashantahlawat40640@gmail.com)

** , *** , **** Department of Mechanical Engineering, Delhi Technological University, Delhi, India

employed and we have tried to summarise their problems. These are related to education, work environment and is of workplace accessibility. There is a need to pay attention on these issues because these things cannot be neglected as the disabled will have greater difficulties due to this. There is a need to pay emphasis on fundamental issues that are important to the disabled and although the Indian government has taken a more inclusive approach of attempting to promote occupational training for the disabled workforce, though its efforts were not correctly focused and have not produced the desired results due to lack of conclusive data which could have act as a catalyst for the government [3]. Cooperation from many stakeholders including members of society, private concerns and public participants is absolutely necessary to concurrently develop in various areas for the upliftment of the working disabled workforce. According to a study[4] Disability rehabilitation system can be classified into four categories occupational, education, medical and societal. Creation of support tool is must for rehabilitation, it includes workplace facilities and work environment benefit provision. Education is important to change the attitude of the disabled and the society and also in the removal of obstacles. According to Ministry of Human Resources & Development [1]there is a need for integration of disabled into society by granting equal entitlement, there must not be any discrimination against disabled workforce and good environment should be created, also equal access to technology and information for the disabled workforce should be provided. There are some studies which says that solution to this problem is to be supported by legislation to enable access in society for the disabled workforce by the Department of Disability Affairs Ministry of Social Justice and Empowerment[1]. Additionally the ministry should organise educational program initiative among various agencies to develop occupational training skills development for the disabled workforce. Occupational development of disabled people in India seems to be failing and is seen as problematic in spite the efforts and sufficient budget provided by the public and private sectors, the desired results not been produced. As a result we are keen in finding guidelines to create workplace facilities preferable to disabled. In the current study we have examined working people with disabilities in various wholesale shops and small industries. The aim was to collect

the results of the study and make improvements in workplace facilities for the disabled. Focus has been given on having disabled people self-reliant so that they can live freely in society. Realisation of this term can only happen if their work effectiveness increases so that they can generate more income and thus enhance the quality of life for themselves and their families.[5]

1.2. Research objectives

The current study has two objectives:

- To study the issues of workplace facilities environments in existing facilities and to use the resulting information in developing guidelines for small industries and wholesale shops.
- To test the effectiveness of the workers preferred workplace facilities and environment for people with disabilities in wholesale shops and small industries using statistical principles and summarise the find of the products that were used in making the workplace suitable for the disabled for various types of office furniture and the tools which the we used to aid the disabled.

2.0 Literature Review

Disability is present in every race, ethnicity, gender, sexual orientation, age, and religion. More than a billion people, or 15 percent of the world's population, have some category of disability. Disability in India is a very complex issue as it overlaps with other difficult challenges such as low literacy and employment rates, widespread social stigma, and poverty. Consequently, the elderly are at risk of developing disabilities and the frequency of disabled persons will rapidly increase. The researchers analyzed the employment of people with physical disabilities and summarized their greatest problems. These are education, work environment, and ease of workplace accessibility, as well as encouragement of the disabled. According to one study [5], there are four fundamental disability rehabilitation systems, occupational, education, medical, and societal. Additionally, support tools for rehabilitation must be created. These include workplace facilities and work environments, provision for benefits, education to improve the attitudes of the disabled and society, and removal of obstacles.[1] As per Census, 2011, about 36% of the persons with disabilities in India are working (male-

47% and female-23%). [1] According to Department of Empowerment of Persons with Disabilities, Ministry of Social Justice and empowerment. Bringing an attitudinal change in perception of general public towards Divyangjan remains the biggest challenge of the Department. Awareness generation is therefore key to change the mindset not only of the general public but also of persons with disabilities to increase their self-confidence. There is a greater need for the Governments and the local bodies to imbibe the culture of accessibility standards at the designing, planning and execution stage for creating barrier free environment for persons with disabilities.

Similar studies have been conducted in Thailand, Korea and China and it is found that common problems exist in inclusion of disabled people in workforce. Like discrimination and employment opportunities in Thailand [2], while the problem is same in Korea, it is more serious as although Korea [3] has a public procurement policy to purchase products made by workers with disabilities the procurement programme in Korea is not mandatory, but only recommended. Thus, many public institutions in Korea do not observe it.

This research paper focuses on increasing the efficiency of disabled people in workforce. The research aims to gather data to study the work effectiveness of people with physical disabilities [6] in small industries. The following conceptual framework is used in this paper:

a) Theory of creative equality of career and society: An important aim of society is to integrate persons with disabilities so that they actively participate in the opportunities afforded to them and are able to lead normal lives. Giving equal opportunities to people with disabilities will make them a part of the social mainstream. It is a shift in societal attitudes from the traditional perspective of seeing the disabled as a burden to becoming social assets. Having a disability does not mean being a burden. [4] Social enterprises for people with disabilities help us learn about their capacities and values. It is a tool that empowers the disabled, providing training and occupational guidance. Therefore, people with physical disabilities can proudly rely on themselves, become empowered to live independently, have access to various services, and become equal members of society. This will

eliminate discrimination, promote acceptance, and lead to a happier society [10].

b) The theory of universal design is the design and composition of an environment so that it can be accessed, understood and used to the greatest extent possible by all people regardless of their age, size, ability or disability. An environment (or any building, product, or service in that environment) should be designed to meet the needs of all people who wish to use it. It has seven principles: (1) Equitability, (2) Flexibility, (3) Simple and Intuitive, (4) Perceptible Information, (5) Tolerance for Error, (6) Low Physical Effort, (7) Size and Space.

3.0 Methodology

The research process was divided into three phases. Mixed research method was used [9]. Each phase is as follows:

3.1 Phase 1

Data was gathered from wholesale shop retailers and small industries. We consulted people with different kinds of disability. Information was collected about problems and needs of the disabled. Data was collected using questionnaires and interviews, the sample consisted of 15 participants who worked in various wholesale shops and small industries [6]. The aim was to identify problems and obstacles. Then solutions to problems were identified. We tried to use their given information to provide them with the preferred tools and furniture [7]. These changes were based on the information and needs of the disabled people.

3.2 Phase 2

Discussion were held to summarise the information and to brainstorm ideas on design and development of a draft summarising the results of phase. The results of this phase were used to find the research products.

3.3 Phase 3

The products were brought and given to disabled workforce in wholesale shops in small industries and the test was administered before and after the use of the available furniture and tools designed in the current study. This was primarily done to evaluate the effectiveness of the design with

a sample of 15 disabled people and analysis using a paired sample T-test[8].

3.4 Survey Form 1 Link

<https://forms.gle/CaXANXUDMNwZGyAU8>

Is the disability a barrier to work? *

Yes

No

Name the areas that is barrier to work? *

Office Area

Dinning Area

Store Area

Center Area

None

IWD

Will the improvement of workplace facilities for the disabled create work effectiveness? *

Yes

No

Submit

Never submit passwords through Google Forms.

This content is neither created nor endorsed by Google. [Report Abuse](#) - [Terms of Service](#) - [Privacy Policy](#)

Google Forms

Basis in universal design *

5

4

3

2

1

Submit

This content is neither created nor endorsed by Google. [Report Abuse](#) - [Terms of Service](#) - [Privacy Policy](#)

Google Forms

Table1: Pre-Test response

	A	B	C	D
1	Safety	Basis in universal desig	Usability	Suitability
2		4	3	2
3		3	2	2
4		3	3	3
5		4	4	3
6		3	3	4
7		3	3	5
8		5	4	4
9		5	3	4
10		4	4	3
11		3	4	3
12		4	2	4
13		2	4	3
14		4	2	3
15		3	2	4
16		2	2	3
17				

Table 2: Response for Post-Test

	A	B	C	D	E
1	Person	Safety	Usability	Suitability	Basis in universal design
2	1	3	3	4	4
3	2	2	4	3	3
4	3	4	3	4	3
5	4	3	5	4	3
6	5	4	3	3	5
7	6	3	4	4	4
8	7	3	4	4	5
9	8	5	3	4	4
10	9	3	3	5	4
11	10	3	4	5	3
12	11	3	5	4	4
13	12	5	4	3	3
14	13	3	4	4	3
15	14	2	3	4	3
16	15	3	4	3	3
17					

3.5 Survey Form 2 Link

<https://forms.gle/385phXv2AJmBDwQh8>

SURVEY FORM 2

*Required

Safety *

- 5
- 4
- 3
- 2

Fig 1: Safety-15 Response

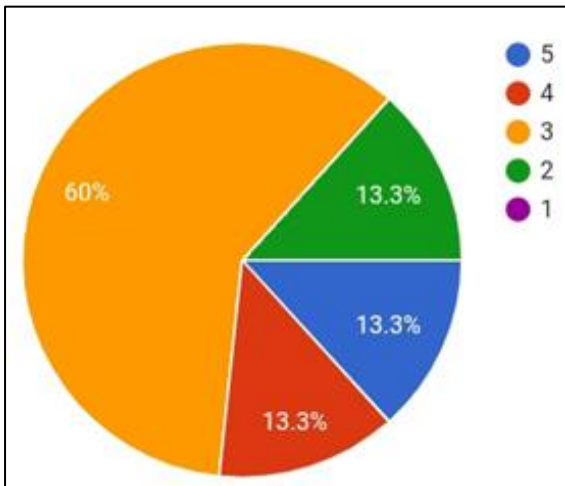


Fig 4: Bases in Universssal Design-15 Response

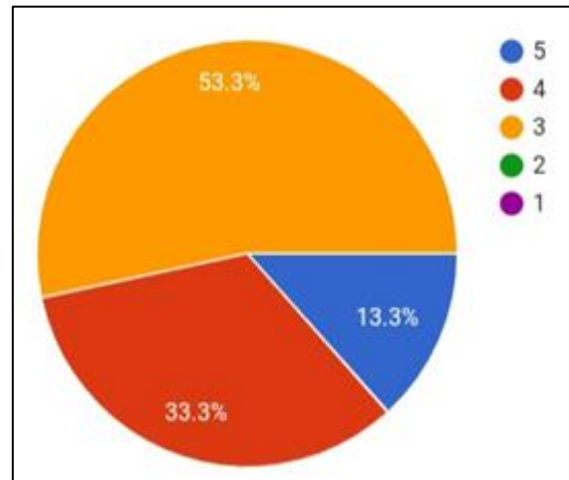


Fig 2: Usability-15 Response

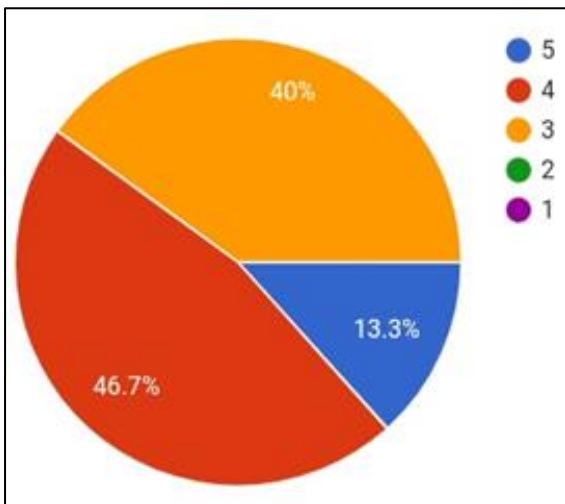
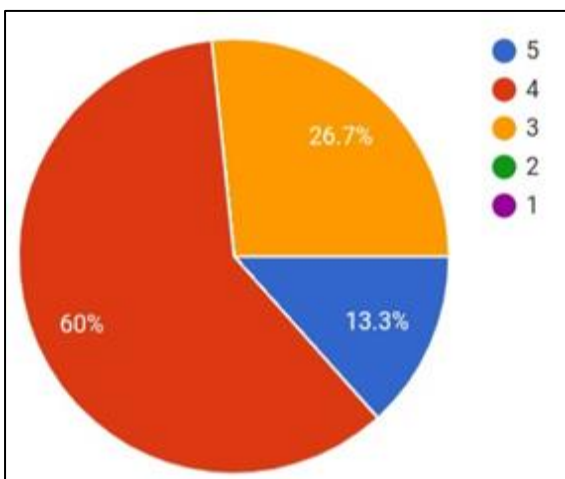


Fig 3: Usability-15 Response



4.0 Results

Table 1.1 and table 1.2 shows a summary of quantitative data that we have collected from questionnaires. Summary of data revealed that the disabled have difficulty understanding their supervisor's instructions and exchanging information with their seniors and negotiating with them. To fix work situations disabled work people often sulked and were misunderstood, but they are more attentive to their work than others. The hearing impaired wanted to have a device to help them communicate, the device must be lightweight and portable. Issues related to environment to be physical barrier in the workplace, problems related to science and inability to hear alarm, difficulty in reading and understanding warnings and instructions signs. People with hearing impairment said that communication aids will help them to communicate effectively and help them in doing their work with greater efficiency. Need for the physical effort is the most problematic area which they encounter while working. Physically disabled people have less strength and find it difficult to climb or get the object from slightly higher places or heavy things. There may be problems with the use of file cabinets and tables and many other things. Grasping tools should be there or instructions in the use of hand tools for physically disabled people having low grip strength and finger numbness, so they need devices to relieve this numbness. The environment can be improved with more shelf space cabinet. Heights and shelf should be adjustable. Training should be conducted for equipment uses and its operation. Physically disabled people require labour

saving devices, adjustable storage space exercise to improve stairs. Tools and furniture used by physically disabled workforce must be safe and appropriated for the job that they perform. Visually impaired workforce prefer to touch materials so surfaces that they contact should not be harmful to the touch.

There are many problems found with office furniture based on the particular type of disability, their uses are subject to the effective seat height and table levels height of the wall cabinets that makes them not assessable. There were many people who had problems with electrical outlets handles and hooks for cloths which were too high to reach. These issues should be addressed to improve work effectiveness and it would create a positive sense that others care about the well-being of all employees.

4.1 Discussions

Focus Group of 15 physically disabled labours was chosen from wholesale shops and small industries, we brainstormed on appropriate product while keeping the need of the disabled person in the centre. It was found that people with some kind of disability need improvement of workplace facilities and improved tools or customised problems office furniture like tables, chairs as well as cabinets for the physically disabled workers. Nevertheless this whole development needed to be a case of problem solving and improvement of work efficiency as per the principles of universal design.

Development of preferred products for the disabled must be in streamline with universal design principles. We have checked compliance to this principle prior using product preferred by disabled peoples. Statistical principles were used to test the effectiveness of those workforces whose workplace facility and rules have been changed in wholesale shops and small industry.

The hypothesis of the research was that the work effectiveness of the physically disabled workforce was improved after using the preferred office furniture and workplace use rules they were formally using at a statistically significant level ($\alpha = 0.05$).

$H_0: \mu$ for the post-test using the preferred furniture and workplace tools $\leq \mu$ for the pre-test (i.e., changes made were ineffective).

$H_1: \mu$ for the post-test using the preferred office furniture and workplace tools $> \mu$ for the pre-test (i.e., changes made were effective).

Researches prior to analysing the gathered data to identify phobic effectiveness check the assumption that the independent variables were following normal distribution in this study. The Kolmogorov-Smirnov one-sample t-test and the Shapiro-Wilk test were done and the results of these test revealed that the dependent variable, work effectiveness of the disabled, was normally distributed at ($\alpha = 0.05$).

Descriptives

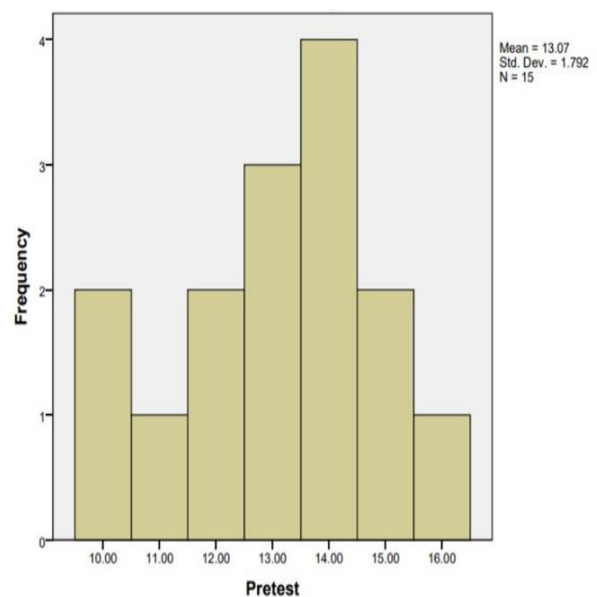
	Statistic	Std. Error
Skewness	.024	.580
Kurtosis	-.454	1.121

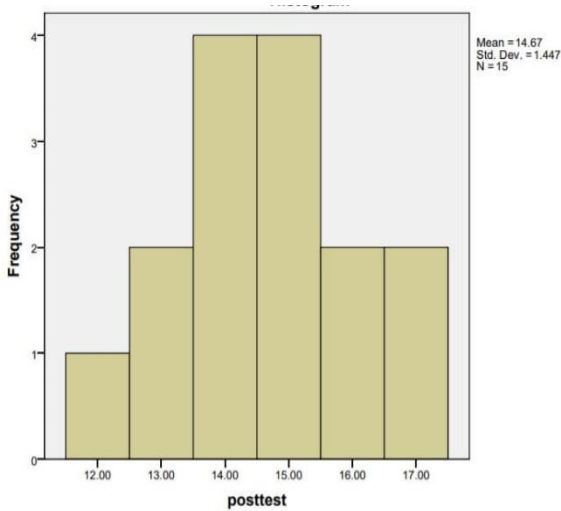
Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.165	15	.200*	.946	15	.459
posttest	.144	15	.200*	.953	15	.579

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction





The average scores after comparison of work effectiveness of the disabled who worked at the wholesale shops and industries was taken. The study showed that the average post-test score was statistically higher than pre-test score ($\alpha = 0.05$). This supports the research hypothesis (H_1). The average score of work effectiveness of people with disabilities on the pre-test and its standard deviation were $X = 13.0667$, $SD = 1.79151$. For the post-test, these values were $X = 14.667$, $SD = 1.44749$.

T-TEST:

```
T-TEST PAIRS=Pretest WITH posttest (PAIRED)
/CRITERIA=CI(.9500)
/MISSING=ANALYSIS.
```

T-Test

[DataSet1] C:\Users\User\Desktop\survey data.sav

Paired Samples Statistics				
	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 Pretest	13.0667	15	1.79151	.46257
posttest	14.6667	15	1.44749	.37374

Paired Samples Correlations				
	N	Correlation	Sig.	
Pair 1 Pretest & posttest	15	.643	.010	

Paired Samples Test						
		Paired Differences			95% Confidence Interval of the Difference	
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper
Pair 1	Pretest - posttest	-1.60000	1.40408	.36253	-2.37755	-.82245

Paired Samples Test				
	t	df	Sig. (2-tailed)	
Pair 1 Pretest - posttest	-4.413	14	.001	

5.0 Conclusions

This research focuses on the work of the disabled workforce and the problems faced by them while doing the work. We chose to focus on wholesale shops and small industries as these entities are in plenty around their residences. Statistical testing was done before and after the introduction of new furniture and tools preferred by disabled people. It was found that people with disabilities can work more effectively and with greater efficiency using the preferred furniture and tools, they also experienced greater convenience and reduced accidents at work in comparison to their previous experience with the former tools and furniture.

In conclusion people with some kind of disability are not given job easily and if they do get it, it becomes very difficult for them to do the job most efficiently as they could not make themselves, with their disability, compatible to the available furniture and tools at the workplace. They often work under compulsion. Owners of the wholesale shops and industries often see them as liability. Seeing disability inclusion as social welfare will ensure that it will never happen as it has to be seen as a commercial and viable business. The physically disabled workforce can become an important and profitable venture for the owners of the wholesale shops and other establishments. Every establishment is driven by the profitability angle and since they don't see these disabled workers as profitable assets, there will always be trust deficit. This research paper will help to stimulate the owners and establishments to make the work place accommodative to disabled workforce. It will also help to bridge the trust deficit. Physically disabled workforce inclusion can happen but only with technology and seeing it as a business proposition rather than of welfare measure. One of the biggest imperative of today is linking the poor disabled to jobs as it can serve multiple objectives of socio-financial upliftment. It can also be seen as an integral aspect of inclusive growth, consequently it will lead to the fulfilment of sustainable development goal 10 which calls for reducing inequalities in income as well as those based on age, sex, disability, race, ethnicity, origin, religion or economic or other status within and among countries. The methodology applied in this research can be used to find the solution of other problems, for example challenges faced by pregnant ladies need to be addressed.

References

- [1] N Saikia, JK Bora, D Jasilionis, VM Shkolnikov. Correction: Disability Divides In India: Evidence From The 2011 Census. *Plos One* 12(2), 2017, 0172596. doi:10.1371/journal.pone.0172596.
- [2] Pruettkomon, Soraj, C Louhapensang. A Study And Development Of Workplace Facilities And Working Environment To Increase The Work Efficiency Of Persons With Disabilities: A Case Study Of Major Retail And Wholesale Companies In Bangkok. *The Scientific World Journal* 2018, 1-12. doi:10.1155/2018/3142010.
- [3] Y Kim. Can Social Enterprise Stand For Persons With Disabilities? The Case Of South Korean Social Enterprises, 2007–2008. *Journal of Asian Public Policy* 2 (3), 2009, 293-308. doi:10.1080/17516230903204760.
- [4] LF Heumann. Assisted Living For Lower-Income And Frail Older Persons From The Housing And Built Environment Perspective. *Journal Of Housing For The Elderly* 18 (3-4), 2005, 165-178. doi:10.1300/j081v18n03_07.
- [5] E Pritchard. Body Size And The Built Environment: Creating An Inclusive Built Environment Using Universal Design. *Geography Compass* 8 (1), 2014, 63-73. doi:10.1111/gec3.12108.
- [6] G Sommer Harrits. More Than Method?: A Discussion of Paradigm Differences Within Mixed Methods Research. *Journal of Mixed Methods Research* 5 (2), 2011, 150-166. doi:10.1177/1558689811402506.
- [7] N Burchett. Book Review: Qualitative Inquiry And Research Design: Choosing Among Five Approaches. *British Journal Of Occupational Therapy* 77 (8), 2014, 435-435. doi:10.1177/030802261407700807.
- [8] RB Johnson, AJ Onwuegbuzie, AL Turner. Toward A Definition Of Mixed Methods Research. *Journal Of Mixed Methods Research* 1 (2), 2007, 112-133. doi:10.1177/1558689806298224.
- [9] JH Cho, N Ken. A Study On The Universal Design: Focused On Role-Playing. *Journal Of Basic Design & Art* 19 (4), 2018, 405-418. doi:10.47294/ksbda.19.4.30.
- [10] S Bonaccio, CE Connelly, IR Gellatly, AJetha, KA Martin Ginis. The Participation Of People With Disabilities In The Workplace Across The Employment Cycle: Employer Concerns And Research Evidence. *Journal Of Business And Psychology* 35 (2), 2019, 135-158. doi:10.1007/s10869-018-9602-5.