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Usability testing of BangBang Robot

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Abstract

The purpose of this thesis was to test usability and evaluate user experience of BangBang Robot to receive information about the functionality in Finnish environment and among Finnish users. Thesis introduced the equipment by its features and presented the implemented usability testing to report an evaluation for the client. Usability testing was implemented in Satakunta University of Applied Sciences with a group of expert participants in home like environment by using empirical user test, thinking aloud testing. Based on the findings, thesis discussed the usability of BangBang in Finland by evaluating environment, climate, and user features and presented summary about the thinking.

BangBang Robot usability and user group was found to be limited in Finnish environment in some respects. There were flaws in design, but some development ideas were introduced in the end. Users were presented to be youngish or healthy elderly, people who suffer from mild disabilities in their lower extremities and have strong upper body with good hand control. They should not have cognitive disabilities and using personal assistance was recommended. The device was found most useful for activities outside home environment. Participants experienced driving BBR fun, and they saw the device as support for users' independent participation to daily living activities.

For future, usability testing of BBR should include real end users and it should be implemented in right context of use. There could be market target for BBR in Finland. Development of BBR should move towards medical assistive technology.

Keywords
Usability testing, User experience, BangBang Robot, Welfare technology, Assistive Technology

CONTENTS

LIST OF SYMBOLS

BBR	BangBang Robot
SAMK	Satakunta University of Applied sciences
APP	BangBang Robot Mobile Application
ISO	International Organization for Standardization
SOTEEKKI	Welfare service center of health and social care in SAMK.
KOKEILIMO	“Kaikkien koti”. Home-a-like environment, designed accessible

1 INTRODUCTION

Need for technology in health and social care has increased lately due to the challenges of ageing population and need for help among health care professionals in their daily work. On top of all, understanding to give people the full capacity to enjoy their life despite having personal limitations or disability, increases demand of assistive technology. The pressure in demographics and lack of resources in our health and social services is making us to find more effective, versatile ways of delivering individualized care. Technology and social and health care sector do not yet have tradition of working closely together in technology development projects. Even though there are good variety of technological innovations available, it seems hard to combine users and right technical solution. Smart eHealth and eCare technology in use of healthcare and social services is promoting health, wellbeing, and quality of life, thereby helping people with impaired or declined functions. (Jaakkola-Hesso, Merilampi, Sirkka & Tupala, 2016, p. 3-4.) In this thesis, studied technology can be categorized as assistive technology, which is quite wide area but is considering assistive tools, equipment, and devices. It is possible to divide this category into two sections: low and high technology, where high technology considers the devices and equipment based on more advantage level of function features (Jaakkola-Hesso, Merilampi, Sirkka & Tupala, 2016, p.4.)

One billion people in the world are using assistive technology today and this number is anticipated to double until the end of 2030. Assistive technology can be determined as tools or equipment that enables and promotes the inclusion and participation of people with disabilities, elderly and people with diseases that cause disability. Purpose of assistive technology is to improve wellbeing, health, independence and enable functioning, participation to education, work, and community as well to reduce the care involvement and support services. (World Health Organization, n.b.)

Usability is quality of certain context, measured by how effectively user will accomplish their goals with the product. In order to consider product as usable, it must have prober functions, easy to learn and to use and most of all give user change to focus on task in hand not to usage of the system. (Riihiaho, 2000, p. 3.) Usability evaluation is a process of measurements, which test usability to achieve goals in redesigned system. Achieving goals is expected to give user best satisfaction using the product. Evaluation methods can be divided many ways, but the most common way is to involve users. If testing involves participant, proper term would be user testing and without any users' term usability inspection could be used. Best way of finding problems relating to user's problems is empirical user testing with real users.(Riihiaho, 2000, pp. 6–8.) From usability testing methods, thinking aloud testing is one of the valuable measurement tools. There subject uses the system or a product and verbalizes all the thoughts out load, which makes the faults, misconceptions and obstacles the user is facing more visible. (Nielsen, 1993, p. 195.)

Satakunta University of Applied Sciences (SAMK) is cooperating with Chinese based company called Shanghai BangBang Robotics Co. Ltd. Company manufactures modern high-tech welfare products, like movable assisting robots for disabled people (Crunchbase, n.d.). One of their products is BangBang Robot (BBR), which has multiple models, and this thesis will focus on the model XZ-Droid Sport, found from SAMK RoboAI laboratory. The company seeks more information about the usability of the product in European market by co-operating with SAMK. To get more knowledge about the functionality of the product this thesis performed empirical usability testing to find out the product possibilities and literature research about the environmental issues. The assumed challenges this assistive technology might face were: user and environmental differences as well the marketing legislations.

2 AIM OF THE THESIS

The aim of the thesis is to assess the usability of mobility assistive device BangBang Robot model XZ-Droid Sport (later stated as BBR) in European use context by testing it in a home-like environment and in daily activities. The research will focus on technical features, design, functionality, and utility. These have influence on what kind of user group could benefit on using BBR. They also affect the applicability of the device in Finnish/European use context. The thesis explores user experience and make a default about device usability among Finnish users. This thesis offers valuable information for manufacturer company (Shanghai BangBang Robotics Co., Ltd.) about comparison of the most significant differences between two market areas (Asia and Europe). This covers characteristics of the user and settings in which equipment is used (climate, premises, surroundings).

Research questions in the thesis were:
How is usability testing implemented for assistive device?
What is the user experience with BBR and how does usability occur?
Could BBR be usable is in Finland and what would be suitable user group?

- How suitable BBR is for users and for what activities?
- What would be the functionality in Finnish environment?

What features of BBR need to be developed?

3 BACKGROUND

BangBang Robot model XZ-Droid Sport is designed by company called Shanghai BangBang Robotics Co., Ltd. One of the devices is founded from SAMK RobotAI laboratory in Pori. It is used for welfare technology studies and is now being evaluated in this thesis for its usability.

3.1 Shanghai BangBang Robotics Co., Ltd.

Shanghai BangBang Robotics Co. Ltd., established in 2016 is modern high-tech Industry Company with an intention to help disabled to return into normal life. Company integrates independent research and development, production, and sales to create ecology of intelligent technology assistive products, aiming to bring healthy life. BangBang Robot is committed to entrepreneurial spirit of "hard work, innovation, care, tolerance, and sincerity" to create future of health and wellness. Company´s goal is to help elderly and the disabled people worldwide, to carry out more equal daily living. (BangBang Robot, 2021). BangBang aims to lead the development of assistive devices of intelligent technology, telemedicine, home rehabilitation and live auxiliary. With about 100 patents and multiple core independent intellectual property rights, the company has products that are sold in 10 different countries and certified by many. These products include mainly home rehabilitation series, traveling auxiliary series and nursing and physiotherapy series. Headquarters is found from Shanghai; China and the company size is about 51-200 employees. (Shanghai Bangbang Robotics Co., Ltd, n.d.)

3.2 BangBang Robot XZ-Droid Sport

XZ-Droid Sport smart mobility aid (Figure 1. & 2.) is one of the BangBang Robot models independently developed by Shanghai BangBang Robotics Co., Ltd. planned to support daily living assistance for people with lower extremity motor dysfunction. XZ-Droid Sport can support moving, standing, partial self-care and rehabilitation, such as squatting exercise, balance training and muscular functioning. Figure 3. shows an example of BBR use in toilet transfer.

Figure 1 & 2. XZ-Droid Sport. (Mesiniemi, 2021)

Figure 3. Person using BBR. (Shanghai BangBang Robotics, 2022)

Product is applicable to people who are having lower limb weakness and are not able to stand or walk independently, are at rehabilitation or sequela phase. People need to be able to extend their legs. Example users are people with motor and sensory neurological dysfunctions after central nervous system injury, such as stroke, traumatic brain or spinal cord injury, poliomyelitis, and cerebral palsy. Also, people with spinal muscular atrophy (SMA), muscular dystrophy, and myasthenia gravis (MG). In addition, elderly with decreased physical functioning and people who are not independently able to transfer longer distances due to the poor physical capacity. It is recommended that persons under 14 and over 65 years old, should use product only under surveillance. BBR ZX-Droid Sport is not suitable for people having orthostatic hypotension, unrecovered fracture dislocation, severe joint deformity, severe scoliosis, or osteoporosis and leg length difference of over 2cm. There should also be caution if person has some condition (visual or cognitive) that would increase risk when operating the product. (Shanghai BangBang Robotics Co., Ltd. n.d., p. 3-6.)

Main features, divides into seven modules: (seen in Figure 4.) 1. upper support module, 2. swing arm, 3. handrail, 4. upper frame module, 5. chassis, 6. leg, and 7. seat module. The Upper support module will give user the support and prevents them to fall forward. It also includes the electric control panel for user to operate the device. Swing arm and the handrail modules are moveable and help user to transfer from sitting to standing and vice versa. Chassis module connects to the upper module and gives user the base for standing. Working as a support for user's legs, legging module is padded plus adjustable and connects to upper frame. Upper frame module is adjustable to users' height. The seat, located behind user, moves electrically backwards and back in. (Shanghai BangBang Robotics Co., Ltd. n.d., p. 7-11.)

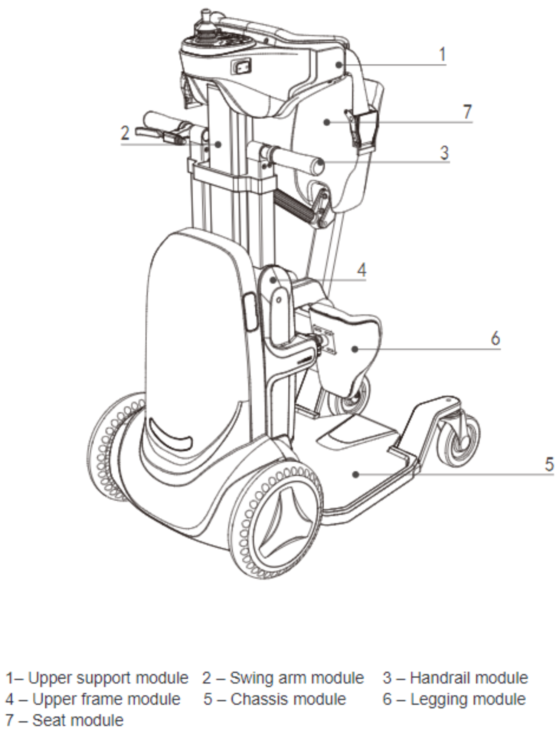

Figure 4. BBR module parts. (BangBang Robotics n.b.)

3.3 Wearables

XZ-Droid Sport includes wearable waistbelt (Figure 5.) to support user when standing on the equipment. It is dressed on around user's waist with a Velcro, secured via straps coming under the user´s lower extremities and with two safety belt clips into products upper module seen in Figure 6. A sequel Velcro is provided for bigger users, who cannot fit only the original belt on. Knee supports located in legging module, are secure with straps around user's knee joint.

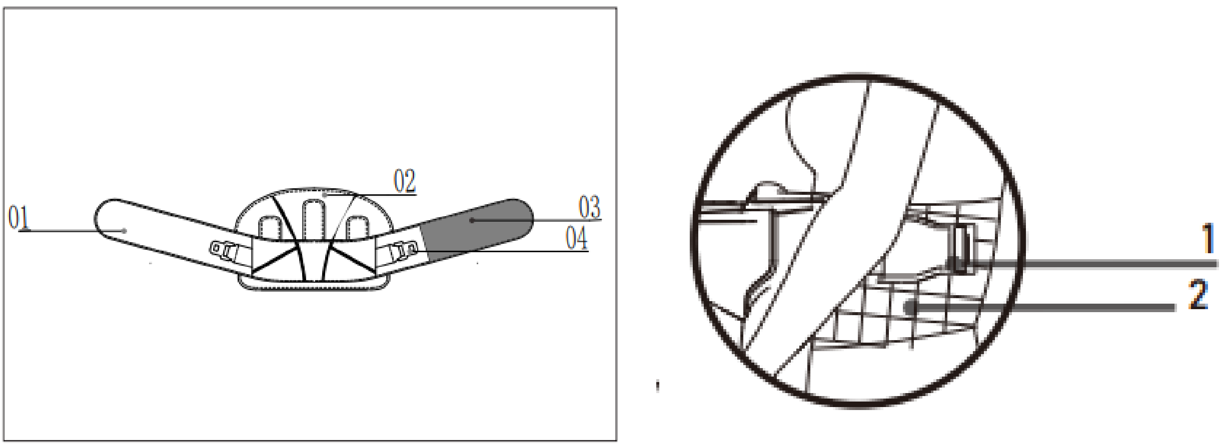

Figure 5. Waist belt. (BangBang Robotics n.b.)

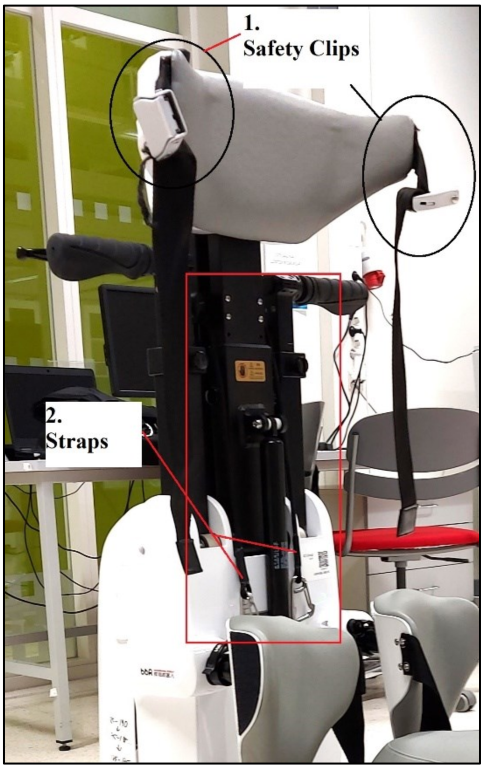

Figure 6. Safety belt clips and straps. (Mesiniemi, 2021)

3.4 Technical and performance features

BangBang Robot dimensions are seen in Figure 7. With adjustments it is about 1,14 to 1,26 meters while up position, 52 centimeters width and from 83 cm to 1,04 meters long, depending on seat position.

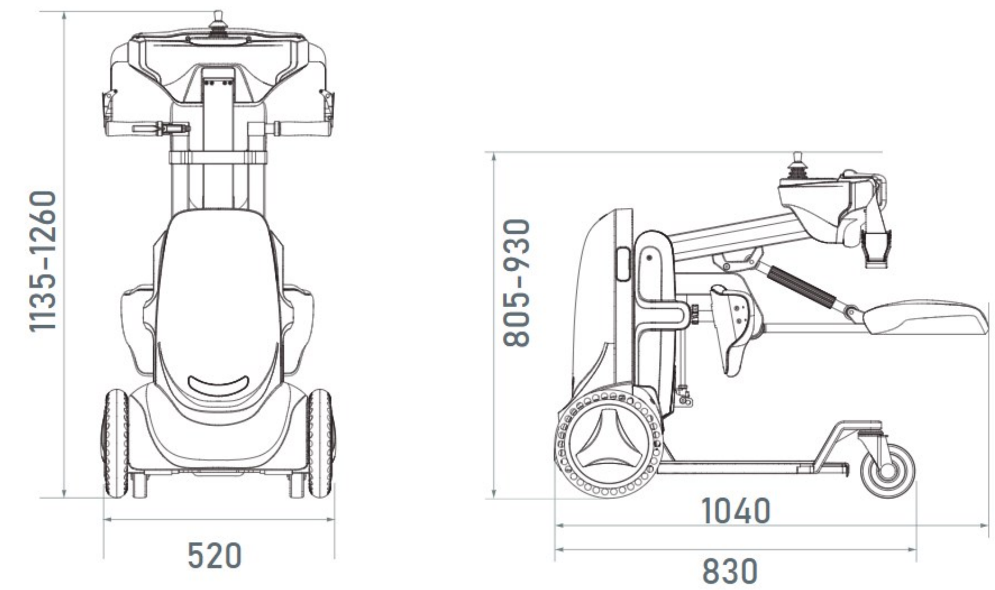

Figure 7. Dimensions in millimeters. (BangBang Robotics n.b.)

Design allows only one-person usage, product is not waterproof, and recommended storing temperature is between 15 to 25 Degree Celsius. Temperatures below 0ºc or over 40ºc are not recommended. In addition, heating energy sources and direct sunlight might damage BBR. Use environment should be flat or accessible and clean. (Tsang, 2019.) Technical features of BBR are combined below in Table 1.

Table 1. Technical features of BBR. (BangBang Robotics n.b.)

Maximum Speed:	Under or equal to 4.5km/h
Battery capacity:	15 km on even surfaces under 25 ºc
Slope:	Under or equal to 5 degrees on accessible pathways
Obstacle clearing capability:	Less than or equal to 50 mm
Maximum width of surmountable trench:	Less than or equal to 50 mm
Users’ height:	1.45m to 1.9m
Users’ weight:	40 kg to 100 kg

Minimum turning radius:	0.63 m
Weight of the device:	105 kg (Deviation 3 kg)
Maximum weight capacity:	100 kg
Bluetooth:	2.4Hz, 1mW
DC input:	DC 28.8V 4A
Charger AC:	AC 100V to 240V

BBR is controlled from panel located on upper support module. In Figure 8, pictured from above the device, are pinpoints of the key functions, lights, and switches. Joystick is in the middle to be easily reached by hand and used for steering the device. Around it goes ring shape light, that includes different colours showing the devices functioning status. To control strap tightness and to adjust seat position back and forward, there are arrow buttons on the sides. Speed button allows to switch between high and low speed mode and SOS is for emergency call. It will start BBR to call for help. By pushing power button/lock button, BBR can be put to sleep mode or to lock the controls. (Shanghai BangBang Robotics Co., Ltd. n.d., p. 17-18.)

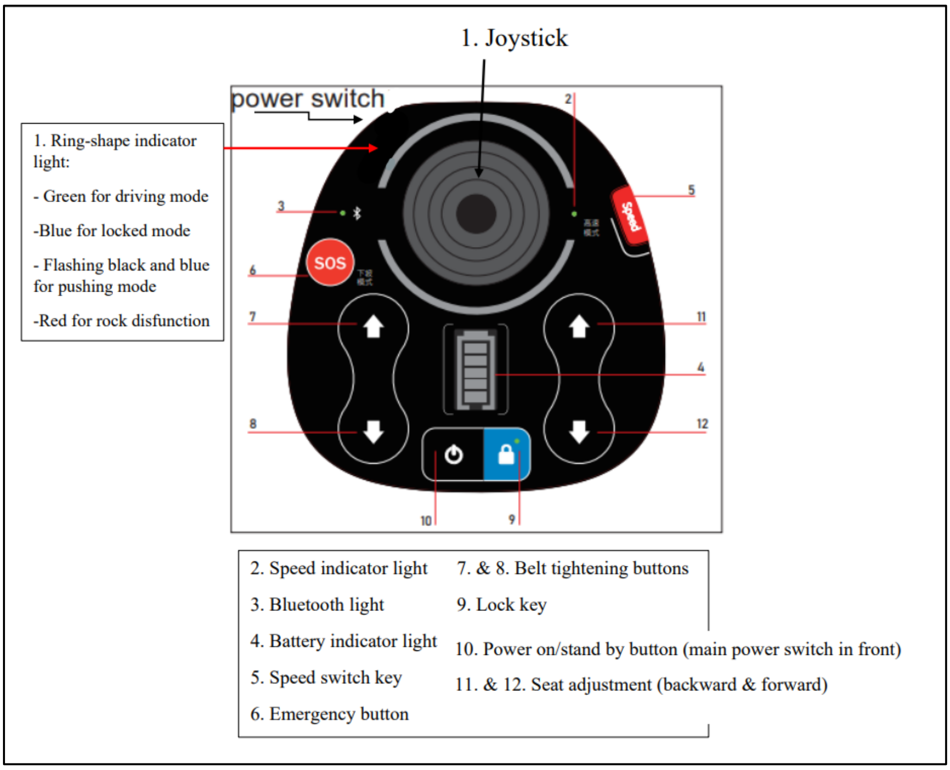

Figure 8. Control panel controls explained. (BangBang Robotics n.b.)

User ergonomic is possible to adjusts based on users' height and lower limb dimensions. BBR allows following module readjustment to make the device individually more suitable for variety of users:

1. Height adjustment of the upper frame module

2. Length adjustment of connecting rod

3. Adjustment of height, width, extension length and angle of leg support

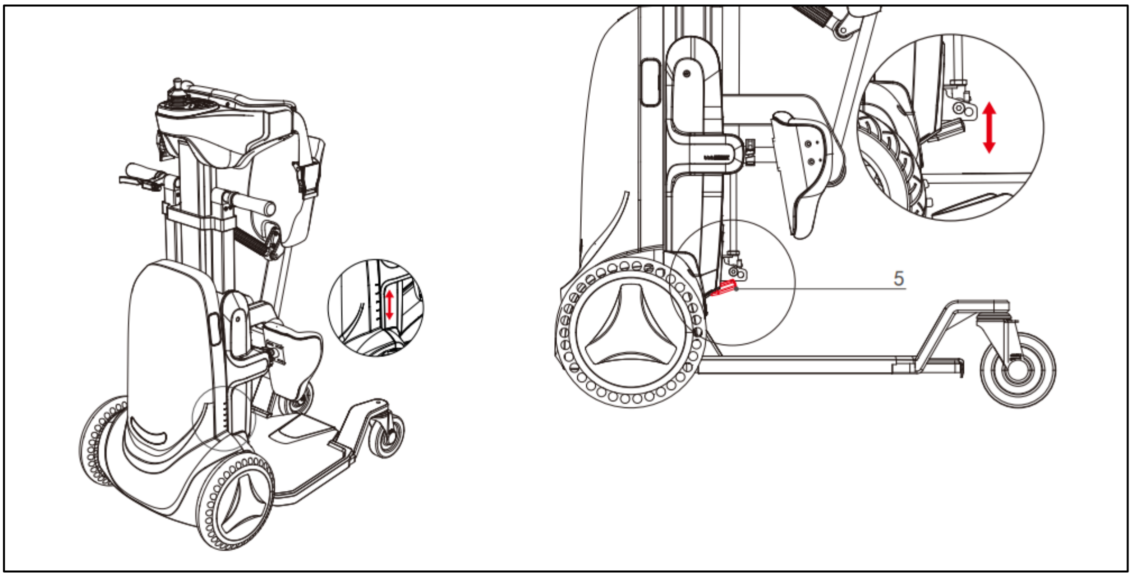

Figure 9. Height adjustment of upper frame module. (BangBang Robotics n.b.)

Recommended heigh adjustments on BBR according to manual are seen in Table 2. It includes user´s height and marked recommended position of upper frame module. By releasing lever seen on Figure 9. pointed with number 5, upper frame module can move up and down to targeted position based on users' height and mark on the frame. This will also move the knee pads to right position for user's shin and knee joint.

Table 2. Ergonomic adjustment recommendations according to users' height. (BangBang Robotics n.b.)

User height in cm	Scale mark on BBR frame
150 – 155	0 – 1
155 – 165	1 – 2

165 – 175	2 – 3
175 – 185	3 - 4
185 – 190	4 – 5

Specific leg adjustments are modified to suite knee area by moving kneepads. Leg supports adjust three (3) centimeters (see Figure 10. right side) in and out from the device by connecting rod. Also, the whole kneepad can be moved up or down and side to side by removing the screws, such as Figure 10 shows. (Shanghai BangBang Robotics Co., Ltd. n.d., p. 19-21.)

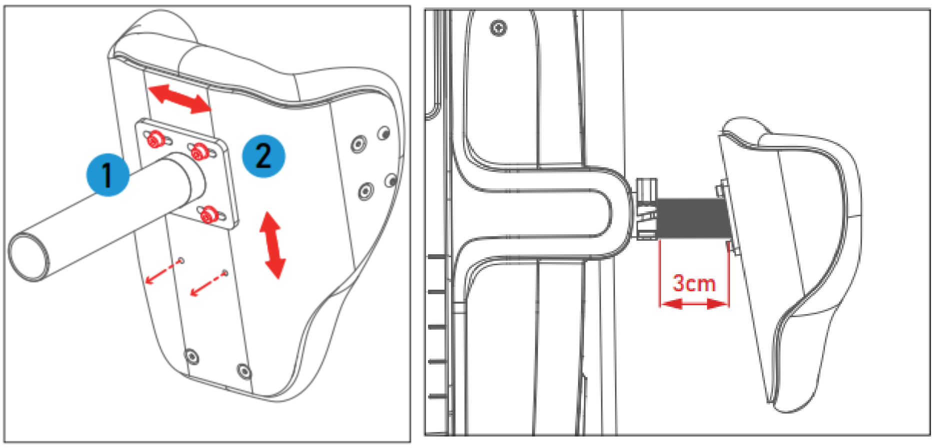

Figure 10. Leg/knee support adjustments. (BangBang Robotics n.b.)

3.5 BangBang Robot Mobile Application (APP)

BangBang Robo Mobile Application, APP, is possible to download for smart mobile phones from application store. Main menu view is shown on left in Figure 11. APP connects to the XZ-Droid Sport via Bluetooth pairing. It allows to control device remotely when user is not on it physically (Shanghai BangBang Robotics Co., Ltd. n.d., p. 14.). Screenshot of remote-control status is on Figure 10 on right. Blue spot represents the joystick and by moving it on screen, the device will move just like driven from stick. With application, user can collect data, get feedback about the using status, and make updates for the software of the device itself. APP includes the exercise programs, riding parameters, adjustments, voice, and general setting of the device. (Shanghai BangBang Robotics Co., Ltd. n.d., p. 14.) Unfortunately, APP was not founded from Android application store to use in this study and was left out of test as irrelevant.

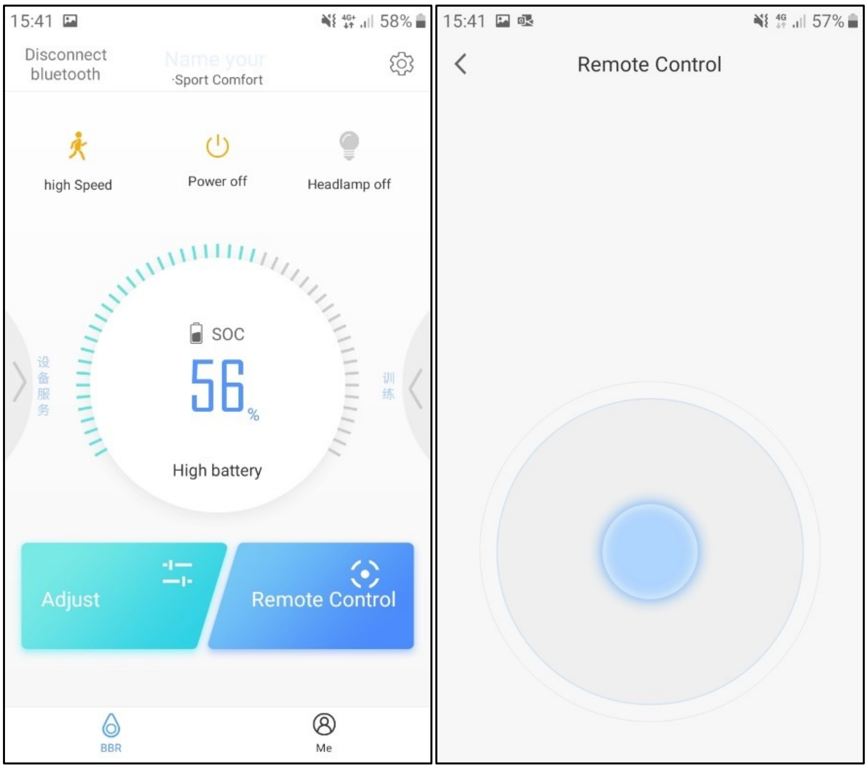

Figure 11. Main view of APP mobile application on left and Remote-control view on right. (Poberznik, 2021)

3.6 Usability

Usability is feature of the product in which it can extend to provide utility for user and achieve the specified goal, it is expected to provide. The term usability has first appeared in software development but soon expanded to all kinds of product development areas, because usability is simply usable product, which is easy to learn, easy to remember how to use it, and it creates satisfaction for the user when achieving wanted task. (Harte et al., 2014, p. 246.) ISO 9241-11 (The international standard) defines usability as the product’s capability to have effectiveness, efficiency, and satisfaction in specified context of use. Effectiveness will provide accuracy and completeness performing the given task and efficiency are resources expected in relation of effectiveness. Usability does not just define the products features and usefulness but is also interaction of the product in the context of use. User, task, physical and social environment, and equipment together with a product, are all seen in Figure 12 as a context. They are interacting together with goals and usability measures. More simply said, usability is the extent to which users can achieve goals in a context of use. (Riihiaho, 2000, pp. 3–4.)

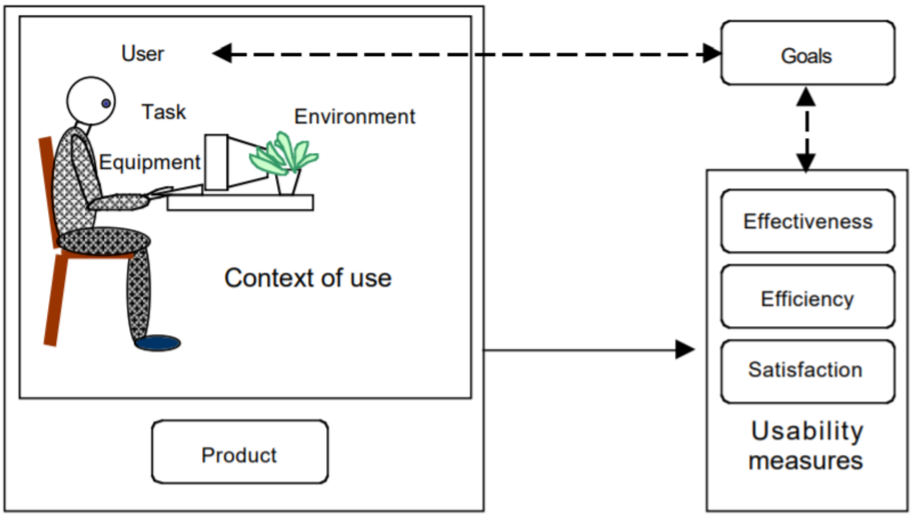

Figure 12. Usability context. (Riihiaho, 2000)

With devices, such as BBR usability is combined with functionality or utility of it in the purpose it has been designed. More directly, it works well even with a person who would have low ability to use it, in its intended purpose and does not create frustration. Nielsen (1993) puts usability into framework by these elements: Learnability, Efficiency, Memorability, Errors, and Satisfaction. (Resnik, 2011, p. 698.)

Learnability stands for how easily product is learned to use. Starting using product, should be effortless, as well performing the task to achieve wanted goal. Once user has learned how to use the product, it should be efficient to use and reach high productivity. This is efficiency. After using the product, memorability will prove, and user can return using the product without need to learn it all over again. In usability, errors are not wanted. If they do occur, retrieval should be easy. Finally, user needs subjectively to feel satisfaction when using the product. (Nielsen, 1993, p. 26.) Usability in relationship between the product and user is seen in how much it will be used. Usability is measure of quality when user is interacting with product, device or system. (Ahson & Ilyas, 2011.)

4 RESEARCH METHOD

Aim of the thesis was to collect and report functions and usability of BBR and consider possible user groups in Finnish environment. Studies shown that the user involvement create benefits in medical equipment testing and product development. User participation has increased access to user ideas and perspectives, same time enhanced design functionality, usability, and quality of medical devices. (Shah & Robinson, 2007, p. 5.) According to Nielsen, user testing with real users is found to be most effective method for usability testing. It will provide the direct feedback from the user and makes challenges they face, visual (Nielsen, 1993, p. 165.). Participants selected to perform the usability testing should represent real life users as much as possible (Riihiaho, 2000, p. 17.).

Implementation of usability evaluation method can however happen with real user participants or with product experts. Expert evaluation done by professionals are informal, but cost effective, do not require massive planning, are fast and they can fit into many development phases. Most helpful expert evaluation appears in the beginning of design and in development phase. (Löytömäki, 2016, p. 12.) In this study, BBR usability testing was an empirical user test, implemented by observation of voluntary users with thinking aloud testing. Test users were recruited from SAMK health and social care students, because getting a real user group to participate would have been too challenging and would have demanded more organization, permissions, and time to be executed. These participants however had general professional knowledge about assumed end users and to give professional opinions.

4.1 Usability testing

There are different approaches to categorize usability evaluation methods. One of them is whether it includes users or it is done without test participants. Usability testing is done with users participating testing. (Löytömäki, 2016, p. 12.) If evaluation includes end users, term empirical user testing is in most cases admitted. Usability inspection does not involve end users and tests are carried out in other way. In some earlier reference's user testing, proved to mean same as usability testing and is involving two or more users performing given tasks under observation. (Riihiaho, 2000, p. 7.) Testing with real users is found to be most effective usability method because its ability to provide straight information about how users interact with the product. Like in all kinds of tests and research, usability testing also requires considering reliability and validity. (Nielsen, 1993, p. 165.)

The key goal of usability testing is to help produce more usable products (Lewis, 2006, p. 6). To be able to perform any testing, one should always think through, what is the purpose of testing, because it has major effect on implementation. Formative and summative evaluation are two different methods to perform testing. Summative evaluation aims at finding out the overall quality of tested product or system. Methods used in summative evaluation are measurement tests. Formative evaluation aims at improving design, as a part of ongoing process and finding out what parts of the design are working. It also wants to improve the design even further. This makes thinking aloud testing good formative evaluation method. (Nielsen, 1993, p. 170.) This test method was used in this study and is explained later in this thesis.

The main goal of evaluation should not be recognizing all the problems of usability. Instead, usability evaluation should aim at finding ways to redesigning and that way meet the satisficing usability features, which can help user to reach the specified goal. Test can include different elements of evaluation, such as how the user is able to perform given task or how the product works compared to competitors. Evaluation can aim at finding out new ideas for the design or what points would be useful to introduce in actual user training. (Riihiaho, 2000, p. 6.) Usability test is based on pre-planned specified tasks user perform under observation. Thinking aloud testing works in most usability tests. (Riihiaho, 2000, p. 8.)

Usability testing will help to understand better the targeted end user and what they want. It gives important information, since it identifies problems of design and product, and it will visualize problems that were still unfound. Core of usability tests with real users is seen on Figure 13. User or participant, facilitator and the tasks are all included in the usability test environment. Facilitator is the one carrying out the testing protocol, guiding participator and the whole testing process. Participant is realistic user of the researched product, who will get the pre-planned realistic real-live tasks to perform. (Moran, 2019.)

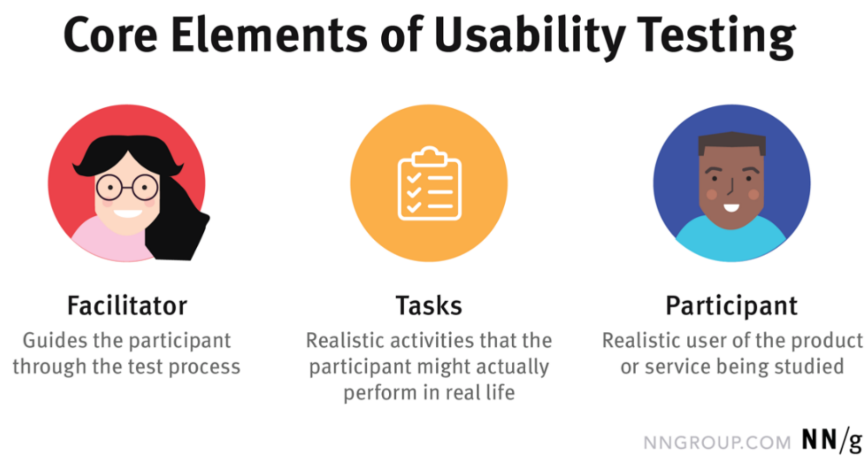

Figure 13. Core elements of Usability testing according to Nielsen Norman Group, (Moran, 2019)

Three steps of Usability testing are designing and preparing the testing, conducting the test, and analysing the results. Hansen, M. (1991) in *Ten steps to usability testing*, gives the ten steps of Usability testing such as introduced below (Riihiaho, 2000, p. 16-20).:

1. Background information about usability testing evaluation
2. Testing plan
3. Design test
4. Arranging test environment and equipment
5. Conducting pilot about the test

6. Recruiting participants
7. Setting up testing room
8. Conducting the actual testing
9. Analysing testing results
10. Making recommendations about changes

Usability testing is recommended to be conducted in representative conditions, meaning in environment where product would usually be used, and context of use is available. These tests can be done in any phase of design process. Test should be performed by team that has knowledge about usability and its evaluation, rather than by developers, because they might have personal feelings or opinions that effect on the results. Participants should be representing real user of the product, if possible. Selection of participants is eased by creating user profiles, making subgroups, and characterizing them and deciding how many participants are included in the test. The best results of testing are proved to be found with no more than five (5) participants. (Riihiaho, 2000, p. 16–20.) In this study health care students worked as proxies for real users. They represented expert participants, who have professional understanding about the device´s intent users. Risk management and safety were important reason not to use real end-users. Getting real users to participate, would have required permission process and deeper consideration of ethics. One of the research questions is about finding the suitable user group. To achieve that it would require comprehensive number of participants and that would have complicated permission process even more. Therefore, the thesis only used voluntary participants that were able to evaluate possible user group.

4.2 Usability testing plan

Once the purpose of usability testing is clear it is time to plan what would be the best way to conduct testing. If the aim is to get overall quality assessment of the product or system and to scan what kind of competition there is, summative evaluation is good way to start. When the purpose is to improve design as a part of development process and simply to find out what features are good and what unusable, formative evaluation is the best way to move forward. Typical method used in formative evaluation is thinking aloud testing. (Nielsen, 1993, p. 170).

Making a testing plan aims at getting approval from management and other organizations involving. But most importantly, to make a clear vision about the purpose of the test. Test plan should include good design about aim, how test will be carried out, what resources are needed and schedule. It needs to clarify the roles, methods used in the test, what tasks users will perform, how data is collected and stored and of course how results will be presented. (Riihiaho, 2000, p. 20.)

Purpose of testing will define what kind of methods is used but will also give guidance to what specific objects test will require and most of the usability tests use several different objectives. (Lewis, 2006, p. 15.) Testing plan will set up all on a stage, it is like manuscript for your testing. This script will work as a roadmap for the whole test team and guideline for possible cited research. When testing is planned properly, it will help team to get the right resources and keep up with the milestones of the process. Testing plan should introduce problem statements that are important for the research of wanted results, hence they are like research questions. (Rubin, 1994, p. n.b.)

4.3 Thinking aloud testing

Thinking aloud testing is simple, cheap, and easy, valuable testing tool of usability engineering. There users are asked to perform tasks with the product or system and verbalize out loud everything they are thinking and doing. (Nielsen, 2021.) This tool is very useful at finding out the most confusing points of design and to discover user´s expectations. Thinking aloud is observation method where users explain every detail about what they are looking, touching, thinking and even feeling. (Think Aloud Testing | Usability Body of Knowledge, p. n.b.)

Method has founded first in the field of psychological studies, used as way to study cognitive processes and then even in empirical studies of mathematic, needed in problem solving. In the 1980´s when usability testing started to emerge, thinking aloud was connected to it in human-computer interaction. As a testing tool it gave good insight about user’s mental process and has later shown to be effective of getting information about usability problem in user interface design. (Riihiaho, 2015, pp. 43–47.)

Thinking aloud testing is widely used and recognized testing tool among usability evaluators. Even though test is found to be beneficial, there has been bias about the implementation. Nørgaard and Hornbæk report two defects in their study about thinking aloud testing. One, the testing set-up usually happens in non-contextual environment for the testing product, such as laboratory settings and with non-expert users. Secondly, the outcome usually attends to give rough measurements, rather than giving detailed picture about process of evaluation. (Hornbaek & Nørgaard, 2006, p. 209.) The weakness of thinking aloud testing is that it does not giving very statistical results. Finally, it is unusual situation mentally and physically, for person to talk all the time and verbalize everything they are going through. There is a possibility that user might try to filter some thoughts or reflect them on their own experiences. This requires the researcher’s ability to prompt the user to keep talking, without over thinking how to say things. Interaction between the facilitator and the user can create bias because prompting and asking clarified questions, or somehow interrupting user can have impact on their behaviour. Thinking aloud testing is not the only usability tool to lean on when doing usability evaluation. It is only one of the methods and part of more diverse process. (Nielsen, 2021.)

Because in thinking aloud testing, participant is speaking action out loud, there has been categories for levels of verbalization. This has an impact on the outcome and results of the testing, because it changes participant behaviour and how they relay to facilitator, but also, how test is implemented. Three categories are presented: time of verbal reporting, level of thinking aloud and form of probing. Time is remarkable thing because of the working memory. User can verbally narrate thoughts at the same time as attending to task (concurrent) or respond after a while of cognitive working (retrospective). Retrospective reports are reported to be less reliable, although they do give more valuable information about actions and recommendations of improvements. Concurrent responses give more procedural information with the product. (Riihiaho, 2015, p. 43.) Concurrent thinking aloud testing is the most popular test pattern. (Riihiaho, 2015, p. 49).

5 IMPLEMENTING USABILITY TESTING

BangBang Robot XZ-Droid Sport is already marketed device by Shanghai BangBang Robotics but not yet reached the European market area. To receive more information about its functionality and suitability for countries such as Finland and with diverse user group, usability testing study was executed as a part of this thesis. Research resources of testing settings and participants were arranged in collaboration with Satakunta University of Applied Sciences.

5.1 BBR usability testing in SAMK

The usability testing took place in two locations, inside the campus of SAMK and in Kokeilimo, “Home for all”- room and in the campus facilities. Kokeilimo, home-a-like environment is designed accessible and offers a test area for different home assistive technologies and solution from furniture to decoration. SAMK campus is 19 $200m2$ square area building including grocery store which was also used as test environment in this study.

Usability testing of BBR took two hours from 10:30am to 12:30pm with Bachelor of Health Care Students doing their professional practice as participants. Students participated voluntarily and were informed about the testing beforehand. Organization of testing day was done by few email conversations between author of the thesis and service counsellor of Soteekki.

There were five (5) students participating to usability testing. They were divided into two groups because two of the participants had their native language different that Finnish and usability testing plan included two different test ensembles, home, and outside home. Figure 14 shows separation of pre-planned tasks in usability testing plan (see appendix 1). Tasks were divided to transfers, using controllers and performing activities. Kokeilimo worked as home environment for transfer tasks, 1 to 3 and performing activities 1 and 2. Campus facilities and grocery store as environment for transfer task 4 and activities 3 to 7. Tasks of using BBR controls were observed continuously in both environments expect task five which was left out of the testing because BBR application (APP) was not available to use. Performing activities 5 and 6, were also left out of the testing, partly due to the time limit but at the time restaurant and library were closed in the testing environment. Task 7 in activities was found not necessary to test because of the short time and task 4 was irrelevant yet came tested while driving BBR in a group of people. Test tasks are good to be independent from each other and presented one at a time, that way some tasks can be left out from the test if time is running out (Riihiaho, 2015, p. 37), like in this case.

Transfers

1. Moving from bed to BBR
2. Moving to toilet
3. Moving from BBR to bed
4. Moving from house to outside: moving to an elevator and through doors

Using BBR controllers

1. Turning on the BBR
2. Getting BBR to user: assisted/application
3. Chancing position from sitting to standing and vice versa
4. Driving BBR: changing speed, stopping, turning
5. Using BBR application: in which situations users might benefit from the use of app?

Performing activities

1. Cooking
2. Toilet visit
3. Shopping groceries
4. Talking a walk with a friend
5. Visiting a library
6. Visiting a restaurant
7. Exercising

Figure 14. Planned Usability testing tasks. (Mesiniemi, 2021)

Alternately participants performed given tasks during their own testing session. While one student was performing, the others observed silently. Facilitator (the author of this thesis) was responsible of execution, guiding testing, giving tasks, and observing participant. Facilitator collected the observed information on paper and on certain situations recorded audio with smart phone recording. Data was stored on author´s personal data space and will be destroyed after the thesis is finished.

Tested device (BBR) was transferred from SAMK RoboAI Laboratory to Kokeilimo before testing was about to start. Participant groups arrived to Kokeilimo on time they were invited, first group at 10:30 and the second 11:30. Test protocol proceeded as following on both testing situation:

Participants were first informed about the voluntary by introducing Research information for participants (appendix 2). Usability testing of BBR started with brief introduction, why and how it will be implemented. thinking aloud testing guidance was given to participants. Observing students were asked not to disturb the one participant performing the task. Facilitator guided one tasks to one participant at a time. At first, participant had free amount of time to perform the given task and if felt like failing, stop the performance. If necessary, facilitator asked to complete the task if participant took too much time or got stuck with the task. After finishing task, participant/user was changed, and the new task introduced. After all tasks completed during one test session, the participants gave feedback in a group interview based on pre-planned questions (introduced later). They were allowed to share thoughts, feelings and development ideas testing brought up and summarize their user experience about BBR. Interviews ended the testing sessions.

5.1.1 Home environment and transfers

The first testing session was planned to be group of three with two exchange students and one Finn. Two of them were second year physiotherapy students, one of them student of 4th year in physiotherapy. Testing situation one aimed at measuring normal daily activities at home environment therefor it was planned to conduct in Kokeilimo. Observation was noted by writing down main points of participants comments. Participant 1 did test of turning BBR to usage mode, transfers from bed to BBR and back. Participant 2 tested transfer from bed to toilet and back. Participant 3 tested what it would be like to cook at home and move around the room with BBR. After informed testing to be ended, all joined for group interview. Testing ended in Kokeilimo, and participants got permission to leave before the next group arrived.

5.1.2 Driving BBR outside home and grocery shopping

Second testing session included two participants, one physiotherapy student and one student in social services. Testing was in Finnish and recorded by smart phone audio recorder because testing was more active and required moving from one place to another, so writing all the notes was difficult. First in Kokeilimo, participants got introduced to research and got the same information about their rights considering study as the first group. Testing moved right from the begging to SAMK campus to represent tasks outside home environment. Participant 4 had to face opening doors, going to an elevator, avoiding people, and switching from low to high speed and back. Participant 5 tested driving BBR and managing grocery shopping. To note, grocery in SAMK campus is located inside campus facilities, so there was no need to move outdoors. For both participants 4 and 5, tasks included multiple activities from transfers to control use. From grocery store, testing continued back to Kokeilimo again testing how to manage elevators/doors and how to control BBR. Usability testing ended in Kokeilimo to final group interview with these participants, using same questionnaire as earlier.

5.1.3 Interview and feedback

After both testing session, participants of that group were interviewed together about their feelings and user experience with BBR. Following interview questions were presented by facilitator and recorded to smart phone audio file. First interview with a group of three participants was in English and the second group with two participants in Finnish. Interview questions performed in the end of testing were:

1. How did you feel about using BBR?
2. Did you manage to do the given task? And were there especially easy or difficult points?
3. What kind of user group you would see using this device?
4. What kind of development ideas would you give?

Interview results are introduced in the next chapter.

6 RESULTS

None of the participants have used BangBang Robot before. Only one commented seeing it in use and knowing its purpose. There was overall unanimous proposal about suitable user group for BBR and some development ideas for the design. Transfers, controls, definition of user, driving, and interview results are introduced more specifically later in this chapter.

During testing continuous prompt to keep participants talking their thoughts out loud, was needed. There was a lot of specifying questions from participants to facilitator, because none of the participants have used BBR before and they faced some difficulties with controls, and technical issues. When asked did participants feel like they achieved their goals of given task, they all answered almost or mostly yes. Most tasks were achievable but in performing them appeared difficulties, which decreased user satisfaction. Even with few limitations in the design and goal achievements, general opinion was BBR to be fun to use, can be developed, and serves specific user group in certain situations. According to overall opinion, good vision, cognitive functions, fine motor functions and environment perception are required from BBR user. Ability to work with BBR, use handles, move to sitting to standing and vice versa, demands strong upper body strength and good hand functioning. The device is more useful outside home environment and for longer distance transfers because its usability was not experienced to be suitable for home activities. It only worked at home for getting up to standing and as a standing support and moving from room to room.

6.1 Transfers

Main transfer for every participant was to get on and off the device. This brought up a lot of thoughts and discussion, since it turned out to be challenging task to perform. Participants agreed that help would be needed for users with more severe lowering in their condition when getting on the device. Users would need good strength and mobility to transfer individually and attach themselves, considering participants were young and healthy and even they struggled with this task.

Participant 1 performed transfer from bed to BBR. First problem was, how to get the device close enough. We did not have the APP in use, so device was moved for the participant. *"I feel scared because I might fall from the bed."* was one of the comments. Positioning of BBR to enable transfer, created problems. Participant 1 finally asked help from others to get on BBR and to do the attachments. Straps and belt were confusing to use, and this participant said the arrows on BBR controls worked wrong way, meaning assumed up went down etc. Participant managed to get back to bed alone. In transfers belt commented to be uncomfortable and clip-on system on leg straps participant found difficult to use.

Transfer to toilet and back got participant 2 frustrated, since with BBR it was impossible to move close enough to toilet seat. Participant said that basic task like getting pants down and up would be very challenging when standing on BBR, not to forget transfer to toilet seat. *"It is impossible to transfer from BBR standing position, because I am not close enough and can´t turn myself to sitting to toilet seat with the device. I feel like I´m stuck here. I would rather to do this activity with a wheelchair."* Participant did not achieve this task goal completely.

Participant 3 explained kitchen and living room transfers to be manageable. However, it is to be noted that, in this testing situation kitchen is designed accessible. It made activities less challenging and not quite comparable to normal home environment. The participant succeeded in reaching goods from the device but carrying things was perceived difficult when using BBR at the same time. Cooking would be possible on standing position if user is able to reach stove and table behind BBR and tops are on right height. Transfer to living room made participant struggle to fit through small spaces. Turning around in the room was made difficult by carpet which made device tires uncontrollable.

Opening the doors and getting though them was not so simple but manageable according to participant 4. To open the door user would need to reach out long distance behind control panel to use door handle and then push it open, at the same time driving BBR by joystick. Depending on how doors work, it would require a lot of mobility and strength to open them while being attached to the device. Automatic doors were easy but to manage heavy handle doors, required extra effort from participants 4 and 5. There were no door thresholds in this testing environment in campus are, but high thresholds would also create challenging obstacles for BBR. Participant 4 learned to open handle of the door first and then pushing doors open with a front of the BBR, which helped a little getting through.

Pushing elevator buttons was found easy but getting in the elevator brought up some thoughts. In testing environment, elevators were roomy and accessible. Participant was able to turn BBR around in SAMK campus elevators and got surprised how small turning circle the device needed. *"But I would not be able to do this in my apartments elevator".* In elevator, participants wanted to test backing up and they found it "scary" mostly because they did not see where they were going. This also made them struggle with steering. Elevator doors closed unexpectedly so controlling BBR fast enough caused challenging situation.

Overall, participants felt like they would not use BBR in home environment transfers and the main points of this test setup is summarized were:

1. BBR was difficult to get close enough to objects to make a safe transfer
2. Need of an assistant is required if severe lowering in condition
3. Picking up objects from floor level was found to be challenging, almost impossible when the thing was small enough.
4. Sitting down took too much time because seat moved slowly, and it was hard to visualize behind. Standing up required a lot of strength and handlebar was rigid.
5. Participants got stuck with device in small home environment places like toilet and living room and in the grocery store if too close to shelf. Elevator and door transfers created these situations also.
6. Getting themselves individually on the device was found to be hard by all participants, due to the distances, device setting and difficulties with wearables

6.2 Controls and wearables

General opinion about BBR wearables was that the user would need good mobility without severe musculoskeletal problems (e.g., rotation limitations), when using BBR alone. One out of five participants commented waist belt to be too small and thought it would cause problems with bigger users. BBR has extra velcro to make belt longer, but it was not tested in this study. Two participants felt waist belt uncomfortable to use, especially on position change situations. Everyone mentioned impracticality of leg straps. Mostly, the attachment system was seen unusable, and device could not tighten them enough to give support. Knee pads can be adjusted suitable for users' height but not individually by user. All except one participant were able to attach knee pad straps by themselves. Getting them off was easier then attaching them and one participant mentioned knee pads felt hard against legs.

Figure 15. BBR control panel. (Mesiniemi, 2021)

BBR control panel (see Figure 15.) got good values from participants. Speech signals that BBR made were commented nice and useful. One of participants asked what if user does not understand English, would BBR be developed to “speak” users’ language? Overall, control panel was reported to be understandable, and easy to learn, expect for one participant who got confused with functions of arrows. One of the participants said sings of functions on the control panel were too small and thought it would cause problems with people having poor eyesight.

Joystick of BBR is used for driving, turning, and controlling the device. At first try, all the participants got surprised by its sensitivity and had to learn controlling the power of their steering. Skill to use joystick was achieved quite fast but raise out some reflections from users´ perspective. Fine motor skills are beneficial and finger functions should be quite normal. Small spaces seemed to be more challenging, driving with joystick, whereas wider areas. One participant asked if steering of BBR could happen from handles, instead of joystick. Using BBR handlebars to get down on sitting and up on standing was commented to be stiff and complicated. All participants agree that user would need to have a great upper extremity strength to be able to use BBR. Learning how the handles work, took some time to practice with few participants. However, participants felt safe going down to sitting because of the good support BBR gave. Problem that all mentioned was the design of the seat. Targeting themselves in line with position of the seat required extra attention.

6.3 Driving

Manoeuvrability was found to be little too sensitive in smaller spaces but got better in more spacious area. Participant 4 tested the speed change from low to high outside home and once learned the controls, commented*: "am I going as fast as I can get now?"* When BBR is used in wider environment, speed of the device stays too low according to participants 4 and 5. In comparison, sensitive steering and speed made some collision situations in home premises. In some points, driving BBR among people got commented annoying or scary and steering was found to be difficult to control on high speed due to the functionality of joystick.

One significant finding was that the participants felt tiredness of legs while standing on BBR for longer period. This comment was made by two participants, one in home area and another while performing grocery task. Since BBR is mobility aid and should ease moving around for people suffering of lower extremity weakness, this can be demerit in usability.

Participant 5 commented that driving BBR felt unpleasant because people turn to stare BBR user coming closer. But there was also pleasant situation when some people made way and opened doors after noticing assistive aid user. Driving in grocery store BBR managed well, but the problems came in collecting goods and carrying items. Participant 5 was not able to carry shopping basket or carry many items without one and be able to drive BBR at the same time. Getting certain food supply from some shelfs was challenging because they were out of reach, had doors in front of them or required moving first to sitting position. Participant got stuck once to a shopping shelf and once in cashier, during this part of the testing. Task of making a payment got achieved nicely but participant needed assistance with backing and carrying groceries.

6.4 Interview results

According to interview, use of BangBang Robot stated to be fun once use of controls and functions were learned. First impression about BBR was confusion which soon changed to enthusiasm for achieving the goals. Weakness in some features and in wearables reduced user experience because those flaws made usage challenging. The device was found impractical for small places and not suitable for everyday living activities. Instead, it was stated to be useful outside home environment. As for BBR being mobility aid, requirement of user physical condition was stated to be high.

All participants experienced that they almost or mostly achieved their task goals, but task performance included some challenges and results were not optimal. In almost every task, participant got stuck with the device or faced troubles with technical issues and it reduced achievement. According to participants, BBR can support some daily activities and individual participation in everyday tasks.

Need of a personal assistance came up few times. Participants saw BBR user would benefit from assistance in transfers and from support in managing tasks. Examples of situations where assistance would be beneficial were dressing the wearables, carrying, and reaching items and opening doors. Steering was commented to be too sensitive and back of the device felt wild when driving but overall device was experienced supportive and stable. Participants had problems with noticing BBR tires, distances of objects and the devices seat when moving to sitting position. Seat was commented possibly to be too small for some users and its slow operation movement did not please participants.

6.5 Conception of user

Hearing about BBR weight limit (max. 100kg), made participants question suitability for certain users, like Finns who are on average heavier and taller that Asian people. Average adult (30-64 years old) male in Finland weights about 88,3 kilograms and female 73,4 kg. Height average on males is 178,2 cm and on females 164,2 cm. (THL, 2017). Average Chinese adult male weights about 69,6kg and female 59kg (Statista, 2022). Height of Chinese adult population is estimated to be 169,2 cm on males and females 158,6cm (Zhu, 1998). BBR is not fully strong enough for heaviest users and is designed for lighter body structure than Scandinavian people can be.

According to interview results, users should have good cognitive capacity functions without memory impairment or other cognitive disability. Possible user could be well-being independent elderly or youngish person with mild disability in stable phase, or a person in rehabilitation phase recovering from trauma. Overall, good upper extremity strength was proved to be necessary when using BBR. User needs to be able to move and lift their own body with a help of arms and control their torso when using BBR handles or transferring on/off the device. Fine motor skills are required with controllers and steering. Would be beneficial if user possess good eyesight. However, one of the participants suggested if users with poor vision could have BBR with voice guidance. On second interview session, participant 4 suggested BBR to be good of children having lower extremity weakness. They have smaller body size and do not necessarily need so much assistance managing tasks, and they would like to move longer distances outside of home. Participants did not see people with severe neurological problems using BBR. Reasons were that it would be unsafe and most likely they would not have enough physical functions to independently use the device. BBR does not safely support person with weak body control or cannot stand on own feet. The device does not assist movement or maintaining position either.

6.6 Development of BBR

Several improvement ideas arose from the interview. Participants would mostly change some technical features and design wearables more specific. Safety and utility would increase with few extra accessories.

Table 3. Development ideas by usability testing participants

Wearables	Different belt sizes. Development to leg straps: different attachment place, easier to be independently use. Easier knee pad adjustments.
Extra equipment ideas	Basket to help carry things, or place were to attach a backet. Mirrors to make perception of environment easier and backing up safer. Signal sound. Ability to carry other assistive aids with: Walking stick. Lights, reflectors.
Controls	Driving BBR from handles. Control panel arrow functions need to be re-evaluated. Voice guidance in users' language and to assistance people with poor eyesight. Handlebars/Swing arm module could be lighter to use.
Seat	Wider, moving faster, when up supporting user from back.

Table 3 combines results of the equipment development ideas for BBR from this usability testing. Participants proposed mirrors, baskets, lights, reflector, and signal sounds for the device's accessories to ease the use experience and safety. More technical development ideas came up for handrail and swing arm module, seat module and wearables. Waist belt should be offered in versatile sizes, and design could be more comfortable to wear. The leg support module was commented to be uncomfortable, and it seemed adjustments were impossible to make without tools or assistance. Secure straps that clip on the device and users wear around legs, did not get approval from participants. They were difficult to wear independently, did not get tight enough and were on the way in some points.

7 DISCUSSION

Purpose of this thesis was to implement usability testing for mobility assistive device, BangBang Robot XZ-Droid Sport by using expert participants. It aimed at finding out user experience and considering suitable user group by examining how the device would fit into Finnish environment. Testing brought up some development ideas for BBR and gave information for manufacturer company. Results suggest that the BBR usability and user group to be limited in Finnish environment in some respects. Overall, participants were satisfied to use BBR, but some environmental features or technical defects reduced their performance. They also found flaws in design that limit user experience and the idea about possible user group. BBR was seen to be useful to use as support for users' independent participation to daily living activities, mostly outside home premises.

Similar informal testing with BBR has been conducted in SAMK 2020, which raise out corresponding results. Tested tasks were also pre-planned to be activities needed in normal daily living, such as transfers in home area, moving outside and taking care of errands. Both testing situations tell the same difficulties with doors, carrying things and transfers to toilet and from bed to BBR. Getting stuck with the device was common as well. Wearables caused problems for participants and steering was found too sensitive to use in both tests. Earlier test also ideates some same development ideas about accessories, such as basket and mirrors. Like in this study, 2020 testing evaluated BBR not to be usable in-home environment and user should have good upper body control. Divergence between study results were that 2020 testing took BBR also outdoors and they did not recommend the device for elderly people. This result goes align with the developer company which also does not recommend that people over 65 years old use BBR alone or without surveillance. Must be considered that in this testing implemented for this thesis; participants saw possible user to be elderly person if their physical condition is good enough.

BangBang Robot was tested with five (5) expert users who were health and social care students having professional knowledge about rehabilitation and working with disabled people. Based on their competence they were able to name user suitability for BBR into youngish or healthy elderly people who suffer from mild disabilities in their lower extremities and having strong upper body with good hand control. User should have good cognitive functions and visual perception to independently use BBR, but participants also recommended having personal assistance to support usage. BBR could enable users' independent participation to activities outside home environment. It suits for daily living activities where user would need to go longer distances to attend and would normally use a walker or even a wheelchair.

Usability testing for BBR was implemented by user testing it in laboratory environment. BBR was already working equipment which made it possible to test it physically with real people in real tasks. Idea was applied from system interface testing which aims at undercovering problems and deficiency in the design. Same way as usability testing is implemented to evaluate website, app, or any digital product, can usability testing be carried out for assistive device. Background is based on carefully planned scenario of tasks that users are performing under observation and the goals is to re-design, develop and learn about the user.

Usability testing of BBR worked well with thinking aloud testing and it had all the right elements in it. Although study did bring out the defect of thinking aloud testing mentioned in background of the thesis because it did use non-contextual environment and users. Also, it represents non statistical results. Time of verbalizing was introduced to be important and even though concurrent verbalization of participants stayed weak; it was good to have the interview in the end. This way participants got time to rethink what they just experienced without pressure of testing. Retrospective verbalization might be less reliable but gives more content and valuable information. Testing was implemented by using expert review where the participants represented end users and brought their experience to the development. Using real end users would be whole another different testing set-up for BBR and is recommended for future development.

Tasks were planned to suit for daily living activities and testing environment included needed facilities. Time reserved for one participant group could have been longer, meaning that start information and introduction should have been on its own time and not included to the one hour of testing. Participants would have benefit from basic guidance to BBR controls before start, although then learnability would not have been tested so deeply. Usability testing is suitable for any product developed enough to safely test with real users. It gives good view about the process and ideas how to create human-centred design with good market value. Usability testing with users gives perspective that developer might lack by being blind to their work or not knowing their end users well enough. And like in this study, testing can open new market areas when product is tested and re-designed to work in a new environment.

Testing set-up was in accessible facilities in SAMK campus area, which diverge normal by being advanced in accessibility. Implementing test in normal home environment or moving test outdoors could form different results and is a whole new testing set-up. In this test environment, BBR managed moderately except for those times when participants got stuck with the device. Participant's skills using BBR controls can be discussed. If skills controlling BBR would get better in time, would it decrease times of getting stuck in so many places? Finland´s Ministry of Justice has regulation about building more accessible environments which should offer more accessible facilities in the future (Finlex, 2017). Now, not even all new apartment buildings, care centers and city architecture meet these regulations and using an assistive device can be challenging. That is way getting BBR tested outside SAMK campus would be beneficial for the future. At the time of testing, there was no possibility to take BBR outdoors, due to the weather. Temperature was low and climate rainy. BBR recommended use temperature is 15 to 25°c, so it was too cold and not advisable to take the device out. Testing plan did not include outside tasks in the first place, because bad weather was expected. Finnish average temperature in a year change between +5 to few minus Celsius, when the coldest can be –30°c and notoriously Finland has snow at least 3-4 months in a year (Ilmasto-opas.fi). This makes usage of BBR in Finnish climate questionable or limited because of the recommended operation temperature and unknown ability to perform in challenging terrain. Not to forget city design which creates challenges in moving even during summer season. Shanghai in China is more suitable climate to use BBR, because its average yearly temperature is 16,6°c and minus temperatures are not that common, just to give comparison (Climate-data.org).

BangBang Robot XZ-Droid Sport could be considered to market in Finland as medical assistive device for people suffering from disabilities that force them to use wheelchair or standing support. It could help in daily living activities like shopping and social participation outside home. BBR can be compared to electricity wheelchairs that are used now from disabled adults to elderly. Only difference with BBR is possibility to standing position but based on findings, that feature does not create huge advantage for BBR due to the angularity in functioning. Compared to similar products found from Finnish market for example from Haltija Group Oy and Respecta Oy, BBR should develop seat, handles, and functionality of position change. Also, technical features are slightly more developed in these competing products. There should be less manual and more electric systems and they should operate more simultaneously. Just to note, usability of competing products is not tested for this study, and evaluation is just based on information offered from companies' website. There is no price range publicly available from those devices so evaluation of possible BBR price for individual users could help marketing. Products, such as BBR on European market must have ISO standardization code and they are approved by European commission medical device legislation. In Finland this legislation is supervised by Fimea, Finnish Medical Agency. Before product can be put into market in Finland, manufacturer must get CE approval to make sure safety, reliability, suitability, and performance are meeting all the requirements. And after that, it needs to be registered in Fimea. (Finnish Medical Agency, 2022) Compared to products introduced earlier, BBR technology start to seem obsolescent without electrical adjustments and angularity in functions.

Author of this thesis represented researcher, facilitator, observer, and interviewer during the whole study. Having knowledge background about rehabilitation and assistive devices, such as BBR, gave certain proficiency to conduct usability testing but might also predispose bias in research. Personal view might be seen in assumptions about BBR functionality. This was first usability testing that author implemented and having it planned in a short time with low resources are seen in the quality of outcome. BBR was not especially familiar for author but compared to participants, author had used the device few times more. This study gave just a slightly deeper information about BBR usability than the earlier tests because similar findings were noted. Study approved the developer's recommendation about users features and gave a lot of new development ideas together with guidance of what to consider if moving to new market area. Based on findings, it was possible to limit user group and use environment into suitable for BBR. Future development is recommended for BBR and need for a development required. It seems that Shanghai BangBang Robotics Co., Ltd. has already made that because company has many new models of BBR available.

7.1 Research ethics

Findings of thesis prove manufacturer recommendations about features of user group. However, this can be kept only as an evaluation, because results are not fully reliable after testing performed with professional participants not with real end users. Physically healthy participants can skip challenging tasks or other way manage problems they face, wherein end user would require assistance. Reliable results would require repeating usability testing in contextual environment with representative participants needing assistive device in their daily lives. Having several observers would also increase the objectivity of the testing. But this study works as a pilot testing for next level of development and serves valuable guidelines for more official testing. Running pilot test before usability testing, stabilizes the test procedures and materials for next more representative test (Lewis, 2006, p. 21).

Results bring markable ideas for the development process of design, considering technical features and addable accessories. Limiting user group into suitable for BBR can help focus on right market areas. This study also confirms importance of testing technical assistive devices in diverse development process phases. Test protocol is easily transferred into formal user test by improving organization, resources, and planning.

In this thesis study, research questions and testing plan were designed to find answers for its purpose of usability evaluation. Used methods were applied from user interface usability studies, where same principles about planning, testing, and evaluating were transferred to test technical assistive device. Results align with previous testing performed in same conditions and prove developers' recommendations of device use.

Use of real-life users as participants would have been safety issue and ethically challenging or at least required more careful arrangements. Safety of participants was emphasized strongly, and they were guided to safe use of the device. Testing was conducted so that no significant risks, damage, or harm faced participants or facilities.

Students participating in this usability testing were voluntarily asked to join as a part of their professional practice. They were informed about research beforehand and with Research information that raise out all rights and responsibilities they have. For example, they had the right to interrupt testing in any time they wanted or even refuse to participate. Participating in usability testing did not influence on their professional practice either. Personal data about participants was never collected, because whole testing was implemented anonymously, without names or information. Test results were collected during testing with observation marked down with notes and interviews were audio recorded by using smart phone. Data from interview was stored in authors own data space and destroyed after published thesis. After published, thesis is public and can be freely read in the Theseus database.

7.2 Development and future studies

Usability testing in this study was conducted in short amount of time, with low recourses, without a research group and in a laboratory environment. Generally, this is proved way to enable informal usability testing but leaves out a lot of important data compared to formal real user test. For future development and following studies would be suitable to take BBR usability testing to a next level by starting professional research with right resources. Proposal is to do more careful planning, implement testing in a right context of use, with real end users and think of a new way to conduct observation and collection of data. Recruiting representative participants and testing

BBR in everyday environment are the key elements. Things such as age, gender, diagnose and need of assistance, must all be noted and should vary to get more versatile participant sampling. Involving real end users, would help understanding user and what they are looking for in the product. What are the problems they face and what kind of user can use the product? In the future, testing environment could be service centers for elderly and disabled people or even individuals own living area. To test BBR in Finnish outdoor environment, it must be scheduled for warm season so it will be suitable for the device's technology. However, testing BBR outdoors whenever might reveal its weaknesses in use.

If implementing this testing now, would be considerable to guide usage of BBR more carefully before starting testing situation. This way participants would be able to focus more on performance and not to take so much time figuring out how to strap themselves on BBR or how to use the controls. Of course, those tasks are also markable issues to find out, but no user starts to use assistive device without introduction. Testing user learning ability would be separate evaluation goal. Pre-planned tasks need modification to more specific and goal oriented. This time audio recording was used to store interview data, but testing could be also video recorded. It would give even more observable information about the usability of the device. Interview part was open conversation, which can influence the way participants answered. Having opportunity to answer with questionnaire or give feedback after could modify the responses or even give more versatile information. Also, timing of testing could be re-designed. Those tasks that were left out of the testing as irrelevant or because of time limit, could be included in the next test with BBR. That would cover the idea about more contextual testing environment when BBR would be tested in library and in restaurant or used for exercising at home.

Unfortunately, BBR smart phone application APP was not tested in this study. According to Shanghai BangBang Robotics, APP is possible to be downloaded from application store for IOS and Android devices but at least for now it was not founded from Google Play store. It would be recommended to get APP available when expanding market area because it is remarkable part of the BBR usability. This would require application to be downloaded in targeted market area and in different languages.

It is possible to develop BBR more sustainable for European users and climate by improving functionality of technology and creating stronger frame. Overall, there can be good market area for BBR in Finland/Europe because there are similar products already sold. Design just needs adjustments and maybe the development should move to a more serious direction and to parallel with medical assistive devices. The number of elderly people is increasing in European countries and the need of these devices comes more significant. Developing BBR usability more suitable for aging population could grow market potential and even the user group.

Results of this usability testing can give guidelines for designing mobility assistive technology and hopefully encourages to run more usability testing with real-life users. Designing technology for disabled people is important but requires careful planning and evaluation. Usability testing is a big part of development process. It makes sure technology of the device meets the usability that it is designed for, and user experience and safety are secured.

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BangBang Robot Usability testing plan.

BangBang Robotics

Usability test Plan

4.11.2021

Jenny Mesiniemi

Master´s Degree in Welfare Technology
Satakunta University of Applied Sciences

Table of Content

Introduction

BangBang Robotics (BBR) is a welfare technology product, designed to assist disabled people in everyday life by providing support to locomotion and perform active daily living tasks. It is designed for people with lower extremity weaknesses, who cannot sit or walk independently, have muscle dystrophy or a temporal condition that weakens the lower limb strength. Instead, upper body strength needs to be grade 4 or more individual to be able to use BBR.

BBR developer, Shanghai BangBang Robotics Co., Ltd. is co-operating with Satakunta University of Applied Sciences (SAMK) looking for report and localization opportunities for their product. As a subject of a Master´s Degree of Welfare technology thesis, this usability testing plan is made to test, collect data and evaluate BangBang Robotics usability and possibly user experience.

Research of usability testing is implemented in one day bases in SAMK, together with Service Center Soteekki.

Usability testing date: 4.11.2021
Time: 10.30-12.30
Place: SAMK Campus and Service center Soteekki, Kokeilumo

Group of Physiotherapy students performing their professional practice at the time, are asked voluntarily to participate to test the BBR with a pre-planned testing pattern and give their comments. Researcher will observe the testing situation and guide the participants through it if needed. Based on these findings researches thesis will evaluate the usability of BBR. Research will be empirical user testing and will be implemented by using a Think aloud method. Testing will be performed in Kokeilimo (home a like- environment) and SAMK campus. Short feedback interview with participants is implemented in the end of testing situation.

Before testing, participants are given a research information and they are informed about their right and responsibilities. This usability plan introduces the methodology, testing set-up, the tasks, goals and result report.

Executive Summary

The goal of this usability testing is to find out and evaluate the usability of BangBang Robotics, in Finnish environment and with users, to see how the features and functions of the product might effect on the usability and to produce report for the developer company.
Functions the are especially evaluated are, how well user can get themselves on the equipment, how technical and mechanical functions are to use and how BBR performs in home environment or outside when taking care of everyday tasks? Is there correlation between users features and BBR features, what kind of user might be optimal for BBR and what kind of product developing ideas comes up if BBR would be used in Finland?

Overall, testing environment where this research is conducted cannot be compared fully to real user environment and the participants (even though they are future professionals of this research field) are not the optimal user group for BBR, this usability testing can give remarkable findings for the thesis this is bases on.

Think aloud method is effective way to hear what users really think of the design. They will be given pre-planned tasks to perform and are asked to comment continually what they are doing, thinking and experiencing. Weakness of the method is that users might need guidance to keep up with the speech, but here the observer making the notes and observing the tasks can lead or bring out some questions and tips to continue the testing. This method is good way of finding out the user's opinions and small mistakes in the design and the grievance between product, user and the environment.

Methodology

One of the most direct and used way to collect information about users using the product is Think aloud method. It is qualitative way of finding out what users experience when using the product and what kind of difficulties they face when learning to use it. During the testing, participants are asked to speak out load what comes to their mind while performing the pre-planned tasks. The person or a researcher how is collecting the data about the testing is observing and guiding by questions participants performance. Observation and final interview will be documented by notes and audio. Participants are informed about data collection forms. Data is maintained in researcher's personal device as long as it is opened to thesis, followed by that destroyed and no longer used.

This method is very cost-effective but need to have working product to be conducted. On the good side, this testing form gives straight feedback to researcher about real thoughts of users and ideas for development.

a. Participants/users are guided to perform task with the product
b. Users is asked to say everything that he or she is thinking throughout the test and say why he or she is doing it
c. Researcher observes the performance and documents the behaviour/comments in some way (audio, notes, video e.g.)
d. After testing, user gives feedback and comments about using the product
e. Results are analysed and reposted

Roles

The usability testing roles are as follows and the individual may play multiple roles. Researcher will be the writer of thesis where this testing is based on. Participants are recruited by Soteekki. Research will be supervised and approved by writer's supervisor in thesis process. Co-operation with Soteekki is done with the service instructor.

Researcher

Researcher is a student in Satakunta University of Applied Sciences, Master´s Degree in Welfare technology, writing a Thesis about Usability testing of BangBang Robotics. Researcher will play a role of being a responsible for implementing the test and organize the testing day. This includes planning the Usability testing plan, arranging equipment, guiding the testing situation, observing the participants and reporting the test results. Researcher will also take into consideration the ethics of the usability testing and be responsible collecting and retaining data. Researcher will be responsible collecting the notes and comments during testing and performing the interviews after the day.

Participants

Service Center Soteekki in SAMK Campus is having physiotherapy students performing their professional practice. This usability testing had an opportunity to ask students to join the testing as a user participant. This participation is voluntary and is combined to normal practice day. Students will get information about their rights and are guided through the testing.

Usability tasks

Tasks given to Users/participants are simple everyday activities that normal users of BBR might face. They include transfers on and away from the equipment, using the device controllers, driving BBR at home and outside home environment and performing daily living activities like toilet visits, grocery shopping, kitchen work and exercise.

Usability testing will start in the Kokeilimo, home like environment, where participants will receive short introduction for the use of BBR. They will also receive information about their participation and guidance to the testing set-up. After participants are orientated to the day, testing will start by researcher stepping back and just dividing the pre-planned tasks, which participants will start performing.

Transfers, daily living and controller testing will happen in Kokeilimo, but the environmental, user experience and outside activity tests will be performed in SAMK Campus and nearby shop.

Transfers

1. Moving from bed to BBR
2. Moving to toilet
3. Moving from BBR to bed
4. Moving from house to outside: moving to an elevator and through doors

Using BBR controllers

1. Turning on the BBR
2. Getting BBR to user: assisted/application
3. Chancing position from sitting to standing and vice versa

4. Driving BBR: changing speed, stopping, turning
5. Using BBR application: in which situations users might benefit from the use of app?

Performing activities

1. Cooking
2. Toilet visit
3. Shopping groceries
4. Talking a walk with a friend
5. Visiting a library
6. Visiting a restaurant
7. Exercising

Interview and feedback

After all the Usability testing tasks are performed, there will be short feedback and interview session with participants to share their thoughts and feelings. Researcher will ask some questions to get more effective feedback. Questions are.

How did you experience using BBR? Were you able to perform the given tasks?

Was there something especially easy or difficult things?

How were the controls to use?

Was there places or situations that effected on your task performance?

What would you develop in BBR?

What kind of user you would see using this equipment?

Reporting the results

Data collected during usability testing will be gathered by notes and audio. That material will be opened to researcher´s thesis as a document about usability evaluation of BangBang Robotics. Data will be presented as research material to justify thesis analysis and assessment. Audio will be opened into written form and notes modified into sensible text form. There might be some direct quates anonymously, but mostly data is transferred to writer's own words, without removing the original contents.

Master´s degree Thesis in a public document published to Theseus database, and all results from this Usability testing can be read from there.

Research information for participants.

TIEDOTE TUTKIMUKSESTA

BangBang Robotics Usability Testing

Pyyntö osallistua tutkimukseen

Teitä pyydetään mukaan tutkimukseen, jossa selvitetään BangBang Robotics laitteen käytettävyyttä ja käyttäjäkokemusta. Olemme arvioineet, että sovellutte tutkimukseen, koska olette kyseisen alan tulevia ammattilaisia ja kykyä toimia laitteen kanssa. Tämä tiedote kuvaa opinnäytetyötä ja teidän osuuttanne siinä. Perehdyttyänne tähän tiedotteeseen teillä on mahdollisuus esittää kysymyksiä vastuutaholle. Perehtymisen jälkeen teiltä pyydetään suostumus opinnäytetyöhön osallistumisesta.

Vapaaehtoisuus

Opinnäytetyöhön osallistuminen on täysin vapaaehtoista. Kieltäytyminen ei vaikuta oikeuksiinne, harjoitteluunne, tai opintoihinne jne. Satakunnan ammattikorkeakoulussa.
Voitte myös keskeyttää osallistumisen koska tahansa syytä ilmoittamatta. Mikäli keskeytätte tai peruutatte suostumuksen, teistä keskeyttämiseen ja suostumuksen peruuttamiseen mennessä kerättyjä tietoja ja näytteitä voidaan käyttää osana Opinnäytetyötä.

Tutkimuksen tarkoitus

Tämän tutkimuksen tarkoituksena on testata BangBang Robot laitteen käytettävyyttä ja toimintoja testiympäristössä. Lisäksi saada huomioita laitteen toimivuudesta, sekä soveltuvuudesta konkreettiseen käyttöön. Testauksen toivotaan tuovan esiin kehittämisideoita, sekä mahdollistaa laitteen käytettävyyden ja käyttäjäkokemuksen arviointia.

Tutkimuksen toteuttajat

Tutkimus toteutetaan Master of Welfare Technology koulutuksen opinnäytetyönä, jossa taustalla on yhteistyö Satakunnan Ammattikorkeakoulun ja Shanghai BangBang Robotics Co., Ltd. kesken. Tutkittavan laitteen ideoinut yritys on toivonut raporttia sen soveltuvuudesta käyttöön. Tutkijana toimii opinnäytetyön kirjoittaja ja testaus toteutetaan Palvelukeskus - Soteekin kanssa, jonka kautta tutkimus saa testausympäristön, sekä osallistujat.

Tutkimusmenetelmät ja toimenpiteet

Tutkimus tapahtuu Kokeilimossa (kodin kaltainen ympäristö), sekä SAMK Kampuksella marraskuussa 2021, yhden päivän aikana, osallistujien harjoittelun lomassa. Osallistujat saavat lyhyen opastuksen BangBang Robotics laitteen käytöstä, jonka jälkeen tulevat toteuttamaan sillä tutkijan määrittelemiä tehtäviä. Tutkimusmenetelmänä toimii "Think outloud" eli suorittaessaan tehtäviä osallistujat voivat vapaasti kertoa ajatuksiaan ja kommentoida tapahtumia. Tutkija tulee observoimaan tilannetta ja tekemään muistiinpanoja, sekä äänittää Audiota. Testauksen jälkeen osallistujat voivat vapaasti antaa palautetta tutkimuksesta ja laitteen käytöstä. Heitä myös haastatellaan testauksen jälkeen lyhyesti. Haastattelu äänitetään. Tutkimukseen osallistujat tulevat osallistumaan anonyymisti, eikä esimerkiksi tiettyjä kommentteja kohdenneta kehenkään osallistujaan vaan ne kirjataan yleisesti.

Tutkimuksen mahdolliset hyödyt

Tutkimus tulee olemaan osa osallistujien ammatillista harjoittelua ja voi näin tuoda uutta tietotaitoa, oppimiskokemuksia sekä osaamista. Osallistujat saavat kosketuksen apuväline, - ja hyvinvointiteknologiaan, sekä saavat uusia näkökulmia ajatella teknologian käyttöä asiakkaan näkökulmasta.

Tutkimuksesta mahdollisesti seuraavat haitat ja epämukavuudet

Tutkimus ei tule aiheuttamaan haittaa tai epämukavuutta osallistujille. Turvallisuus huomioidaan tutkimuksen aikana, jolloin uhkaavat haitat minimoidaan. Osallistujat ovat vapaita keskeyttämään tutkimuksen niin halutessaan, mikäli kokevat epämukavuutta. Laitteen käytössä voi ilmetä lievää hankaluutta teknisten ominaisuuksien vuoksi, mutta ne eivät tule aiheuttamaan osallistujille haittaa, tai estämään tutkimuksen kulkua.

Kustannukset ja niiden korvaaminen

Tutkimukseen osallistuminen ei maksa teille mitään. Osallistumisesta ei myöskään makseta erillistä korvausta.

Tutkittavien vakuutusturva

Satakunnan Ammattikorkeakoulu, SAMK on vakuuttanut opiskelijansa sen varalta, että heidän ammatillisen harjoittelunsa aikana sattuu tapahtumaan jotain, mikä vaatii hoitoa.

Tutkimustuloksista tiedottaminen

Tutkimuksen tulokset tullaan avaamaan sitä käsittelevässä opinnäytetyössä, joka on avoimesti luettavissa julkaisun jälkeen Theseus-tietokannassa. Tutkimuksen aikana osallistujat saavat vapaasti kuulla ja kommentoida tutkimustuloksia ja löydöksiään.

Tutkimuksen päättyminen

Myös tutkimuksen suorittaja voi keskeyttää tutkimuksen, mikäli hän katsoo tutkimuksen etenemisen jotenkin vaativan sellaista. Näitä syitä voivat olla turvallisuuden heikkeneminen, tai tutkimuksen tarkoituksen katoaminen. Lisäksi osallistujien aiheuttaessa haittaa tutkimukselle, voi tutkija keskeyttää tutkimuksen, ehkäistäkseen haitallisen tilanteen.

Tutkimuksen tulokset ovat osallistujilla luettavissa julkaistusta opinnäytetyöstä. Mitään henkilökohtaisia tietoja, tai tuloksia ei tulla tutkimuksen aikana keräämään. Tutkimustilanteessa kirjattujen muistiinpanot on esitetty anonyymisti. Kirjalliset muistiinpanot tuhotaan, niiden opinnäytetyöhön kirjaamisen jälkeen.

Osallistujilla on myös oikeus olla yhteydessä tutkijaan mahdollisten lisäkysymyksien noustessa esiin tutkimuksen päätyttyä.

Lisätiedot

Pyydämme teitä tarvittaessa esittämään tutkimukseen liittyviä kysymyksiä tutkijalle/tutkimuksesta vastaavalle henkilölle.

Tutkijoiden yhteystiedot

Tutkija / opinnäytetyötekijä
Nimi: Jenny Mesiniemi
Puh.
Sähköposti

Tutkimuksesta vastaa / opinnäytetyön ohjaaja
Titteli: Senior Lecturer