SHIP model: redesign the assistive walker for children cerebral palsy with the concept of useability, safety, and efficiency

S Susmartini, L Herdiman, I Priadythama
Industrial Engineering Department, Laboratory Product Planning and Design, Universitas Sebelas Maret, Jln. Ir. Sutami 36A Kentingan, Solo, Indonesia
e-mail: susysus2011@gmail.com, lobesh@gmail.com

Abstract. Cerebral palsy (CP) is a diagnostic term commonly used to describe problems in CP children characterized by body movements and postures that make walking activities difficult. This device is very useful for them to maintain a safe walking pattern. Gait performance analysis walker for CP children must be considered well. Many internal and external factors are involved or forgotten in the redesign decision. We study the need for assistive devices for children CP because our goal is how to apply the redesign through the SHIP model to walker planning in accordance with universal design principles. Data collection in the SHIP model was carried out by semi-structured interviews. A total of 18 participants were involved, including 6 children with cerebral palsy, aged between 12 and 13 years, 6 parents of CP children, 2 caregivers, 2 academics and 2 practitioners. Gait analysis to measure the walking ability for children CP uses a walker and measured at the end of a 1-week training session. The results of the SHIP model obtained several improvements to the initial walker design associated with the redesign of the walker, according to the needs of useability, safety, and efficiency. This redesign of the walker for CP children can increase in speed in the walking in the anterior position is 14.3% and the posterior position is 25%. This shows the importance of interaction between the stakeholders involved, but also provides evidence that the walker needs of CP children may differ from one another because they are at different stages of development and different roles in their environment.

Keyword: SHIP Model, Universal Design, USE Concepts, Walkers, Cerebral Palsy, Gait Analysis.

1. Introduction
The Indonesian in the last decades has sought to improve quality human resources, which began with the handling of the baby in the womb, handling the birth process and care for babies after birth according to standards [1]. This period is the most critical period for the continuity of the child's growth and development and will determine human quality in the future. The children should be prepared in the next stage to become healthy, intelligent, reliable and qualified human beings to be able to continue development [2]. The state should guarantee all children's rights to get health insurance and improve the quality of life [3]. However, almost children with disabilities in developing countries experience many obstacles until they are reduced to participating, limited involvement in daily activities, which ultimately decrease their quality of life [4,5]. Cerebral palsy (CP) is a movement disorder, which results from impaired neuromotor development and body coordinated [6]. The prevalence of CP children in Indonesia is estimated in 1 to 5 per 1,000 live births [7].
A group of motor development and posture disorders can range from mild, such as delays in crawling and walking, to motor disabilities in childhood, defined as cerebral palsy [8]. CP child requires care and assistance in the long term to achieve functional activities independently [9]. In short, CP is abnormal movement or abnormal posture due to impaired brain development. In patients with spastic CP, both legs experience stiffness, causing abnormal posture formation, walking patterns [10,11], and decreased motor skills that can be treated by wearing walking aids.

The walker can help CP children with their mobility problems, including problems with balance and posture [12]. The need for walking aids makes it possible for CP children maintain balance, and facilitate safe walking patterns. This walker also allows children to help bear body weight on their feet. In the case of CP children who walk when not using assistive devices is very slow to maintain an upright position and tends to fall after a few steps while walking. Walking aids in the market are available in various sizes and models; however the choice of these devices raises problems which should be based on a person's physical abilities, needs, environment and posture. However, this problem can be identified starting from the need and finding solutions through a multidisciplinary approach, as stated by Manuaba [13], through a Systemic, Holistic, Interdisciplinary, and Participatory approach or known as the SHIP model [13,14]. The SHIP model is a comprehensive that involves stakeholders to solve problems, where the product to be designed can provide an important role [15].

The systemic in the SHIP model is meant to formalize fundamental changes, are experienced by the whole organization and have an effect on the whole system [15,16]. This change is an effort to improve the ability to walk with CP children in using assistive walkers with an indicator of increased walking balance. All elements of the walking ability variable in CP children using walkers must be understood as systemic [17]. The holistic means that it’s the system consists of subsystems that are interrelated with one another [13,18]. The interdisciplinary emphasizes the problem-solving process with the system as a team [13,19,20]. The function of this activity is how to formulate walkers for CP children from various disciplines in a realistic manner. Participation in all components involved in solving problems in order to carry out an idea as early as possible to achieve maximum results [21,22,23].

The benefits of the SHIP model provide the right steps to find solutions and develop new product redesigns. This is due to the focus on the verbal exchange of design ideas and its importance in the early conceptual design. In this way will produce this rich information to build valuable knowledge for designers from a verbal exchange [24]. Although the framework of the SHIP model does not provide answers, given any redesign problem we can use it as a questionnaire to ask questions about the implications of design decisions when we consider them.

Universal design (UD) in the SHIP model is used to design new products for CP children as a solution to removing physical barriers to the integration of all children [25]. UD is a design approach taken by designers to ensure that products and services can meet user needs [26]. The concept of UD is easily accepted by designers to evaluate products and the environment, so that it can be accessed and used by everyone [27]. The design solutions offered will reduce barriers so that all users can use them without the need for additional services. This concept begins by considering the use of the product; UD results can reduce stigmatization among users. In case the redesign of the walker product uses 13 questions a performance measure with 7 principles of UD. This is done to articulate the scope of the concept and describe the characteristics that make the design universally usable. To achieve the design goals to be carried out effectively, individual participation to share information and resources must be organized. Therefore, this paper is prepared with the concept of Useability, Safety, Efficiency (USE Concept) based on the system design of the distribution of technical functions.

The designer used an unstructured interview technique and 13 questions to five assessment groups related to assistive walker redesign. These questions are grouped according to USE concepts that relate to problems and recommendations with material choices. Encourage participants to more freely convey ideas, without being led through questions. As participants begin answering questions, the designer encourages them to start building a brain storm to present solutions to their problems. Therefore, this study aims to develop anterior-posterior walker as local walkers with the SHIP model through universal design solutions with the USE concept, and to measure the gait analysis of CP children using the redesigned assistive walker.
2. Methodology
This research is part of the SHIP model approach which examines the process of redesigning walking aids for children with CP to increase productivity and quality of life. The complete details of the SHIP model: redesign of the assistive walker for CP and the stage in each stage is summarized in Figure 1.

**Figure 1.** SHIP model: the stage of redesigning assistive walkers for CP children.

The idea development stage
At this stage in the development of ideas, ideas are not limited in terms of scope. Systemic design of assistive walkers involves product designers and consults with ergonomics as well as engineers to determine dimensions or sizes, involves materials experts, and expert walker makers. The holistic subsystem seen in this issue is reviewed, covering internal factors, including age, gender, height, body weight, self-confidence and walking skills. While external factors include stigma in the community in walking and environmental conditions that affect how to walk. Therefore, in this phase, creative licenses can be taken to explore various design possibilities as a preliminary design proposal.

The refinement concept stage
The second stage is the refinement stage of the concept consisting of interdisciplinary and participatory ways to focus on design solutions. At this stage, as with the initial design, the designer uses his knowledge and experience to create new representations of the group by interpreting preferences and input during the second stage session. All groups involved in the discussion included a medical group to evaluate the role and function of organs when starting - walking and also training the muscles of the legs - the waist in order to obtain a natural walking attitude; designer group to evaluate the technical drawings and details of the product; the engineering group from the workshop plays a role in the stage of the material selection process in determining technology and design that are realistic and technically possible in terms of financing, product manufacturing to commercialization costs; the parent group of CP children as a companion in the daily needs of CP children; CP group of children as end-users who will use the walker from the design.

In the participatory where respondents were involved as many as 18 participants who were divided into 5 small groups, 2 caregivers as medical personnel from CP children in Yayasan Pembinaan Anak Cacat (YPAC) Surakarta, 2 academics as designers of walkers for CP children, 2 practitioners as technicians from the local medical device industry, 6 parents from CP children, 6 cerebral palsy children, aged between 12 and 13 years. During participatory sessions, participants were invited to...
brainstorm, write ideas and sketches, unstructured interviews and ask questions that have been determined, held in small groups.

The initial identification is done through articles and scientific journals on the internet. This universal design requirement is done to determine the design criteria for assistive walkers. This criteria will be selected which criteria are suitable for the design of the walker to be made. These criteria for assistive walker design requirements are in Table 1.

| Table 1. Criteria requirements for the first stage of walking aid design. |
| Assitive walker design criteria for the first stage |
| 1. The height can be changed according to interests |
| 2. Reducing friction on the wheels |
| 3. The height is adjustable for comfortable walking |
| 4. The weight of the walker that matches the user's ability |
| 5. Can be folded, to be easily summarized taken outside the house |
| 6. If you need to add wheels or baskets |
| 7. Can maintain body balance when used |
| 8. There is protected to prevent falls |
| 9. Made of a strong and rust-resistant material |
| 10. There is a height adjustment mechanism |
| 11. Accompanied by basket or seat |

UD measurements for assistive walker designs were carried out by means of interviews, and then it filled in with all questions in the questionnaire with the 18 participants involved. Those involved of 2 person medical staff from CP children in the YPAC Surakarta, 2 person academics as designers of walkers for CP children, 2 person practitioners as technicians from the local medical device industry, 6 person representing the parents of CP children, 6 person representing children with cerebral palsy, they are in the entire city of Surakarta, Central Java, Indonesia. Participants who filled out the questionnaire were selected in terms of age, ability and geographical location. Furthermore, this criterion was adjusted to the UD principle 7 and became the basis for making the second stage questionnaire. The questionnaire was given several statements about the criteria and compared to the conditions of the initial walker used every day as well as questions about some additional features needed, as in Table 2.

| Table 2. Criteria requirements for the second stage of walking aid design. |
| No. | Assistive walker design criteria for the second stage |
| 1. | Can be used for all children |
| 2. | Can be adjusted according to pediatric users |
| 3. | Height that can be modified |
| 4. | Can be assembled |
| 5. | Easy to use |
| 6. | Can maintain user balance |
| 7. | No additional brakes are given |
| 8. | Can protect users from falling |
| 9. | Use wheels to reduce friction |
| 10. | A material used is lightweight and rigid |
| 11. | Handlers made of rubber |
| 12. | The size of the walker matches the user's size |
| 13. | Not given additional features (chairs, baskets, etc.) |
The results of the initial identification form the basis for creating a questionnaire in determining the design requirements to be developed. The question of the questionnaire refers to the principle of product design based on UD. The criteria that have been explained then group, according to the 7 principles of the UD. This concept was chosen to develop products that can be effective for all users. The UD questions were designed by adapting according to 7 design principles, as in Table 3.

**Table 3.** The design requirements for assistive walkers adapt to UD principles.

| No. | Principles of UD                  | Questions of Assistive Walkers Design Needs                                      |
|-----|-----------------------------------|----------------------------------------------------------------------------------|
| 1   | Equitable use                     | Q1. Can be used for all children                                                  |
| 2   | Flexibility in use                | Q2. Can be adjusted according to pediatric users                                 |
|     |                                   | Q3. The height that can be modified                                               |
| 3   | Simple and intuitive use          | Q4. Can be assembled                                                              |
| 4   | Perceptible information           | Q5. Easy to use                                                                   |
| 5   | Tolerance for error               | Q6. Can maintain user balance                                                    |
|     |                                   | Q7. No additional brakes are given                                               |
|     |                                   | Q8. Can protect users from falling                                               |
| 6   | Low physical effort               | Q9. Use the wheels to reduce friction                                             |
|     |                                   | Q10. A material used is lightweight and rigid                                     |
| 7   | Approach to size, space and users | Q11. Handles are made of rubber                                                   |
|     |                                   | Q12. The suitability of the walker with the user                                 |
|     |                                   | Q13. Not given additional features (chairs, baskets, etc.)                        |

The assistive walker design concept offered is the concept of Useability, Safety, Efficiency (USE Concept). Useability (must be hard to ensure durability and user friendliness) means that a nuanced and responsive approach to a disability must be involved in designing the design implementation of product features [28,29]. Safety in using assistive walkers aims for users to be able to walk near-normal and not only depending on the sensory motor system [30]. The use of walking aids aims to foster interactions among CP children between executive dimensions such as decision making, cognitive such as stability, perception and affective such as arousal. Efficiency for users aims to improve the efficiency of bodily movements because less energy is expended per step [30].

When walking in CP children with a decreased speed and length of the back is a natural way to help prevent the risk of excessive falls [31]. The results of interviews and discussions with all respondents involved in filling out the questionnaire obtained mapping all questions on USE concepts. The USE Concept is used to test the concept refinement of the proposed; it explained in Table 4.

**Table 4.** Relationship matrix of 7 principles of UD to USE concepts.

| Principle of UD concept on the question | Useability       | Safety             | Efficiency                       |
|----------------------------------------|------------------|--------------------|----------------------------------|
| Equitable use                          | Q10              |                    | A material used is lightweight and rigid |
| Flexibility in use                     | Q11              | Handles made of rubber |                               |
|                                        | Q9               |                    | Use wheels to reduce friction    |
| Simple and intuitive use               | Q8               |                    | Can protect users from falling   |
Perceptible information

| Question | Description |
|----------|-------------|
| Q5       | Easy to use |
| Tolerance for error | Can maintain user balance |
| Q6       | Not given additional features (chairs, baskets, etc.) |
| Q13      | No additional brakes are given |
| Low physical effort | Can be adjusted according to pediatric users |
| Q2       | Can be used for all children |
| Approach to size, space and users | Height that can be modified |
| Q1       | Can be assembled |
| Q4       | The suitability of the walker with the user |
| Q7       | The prototype construction stage |
| Q12      | The third hold is the manufacture of walker products based on detailed technical drawings. In the end, the walker prototype will be made. At this stage, the designer positions as a team leader and as an ergonomics who works closely with a team of technicians from the medical device industry. The design of the assistive walker includes 3 dimensions, namely the height of the walker, the width of the walker and the length of the walker. Determination of walker height requires anthropometry data from elbow height, to determine the width of the walker hip-width data are required and for the length of the walker using anthropometry foot length data [32]. The dimensions of this walker design use 5 subjects as anthropometry data with 50% percentile, as in Table 5.

Table 5. Anthropometric data on subjects of assistive walker users.

| Subjects | Gender | High Elbow (cm) | Hip Width (cm) |
|----------|--------|-----------------|----------------|
| Subject 1 | F      | 95              | 33             |
| Subject 2 | M      | 100             | 37             |
| Subject 3 | F      | 82              | 34             |
| Subject 4 | F      | 74              | 27             |
| Subject 5 | F      | 70              | 24             |

Table 5 explains the significant differences in size between subjects. The design of assistive walker with adjustable is expected to be adjusted to the user's size. Walker length data are taken as the average length of the subject's feet, which is about 22.5 cm because the length of the walker will be adjusted according to the design of the walker. Thus the results of anthropometry measurements obtained specifications for assistive walkers based on the subjects measured are height (75 cm), width (50 cm), length (70 cm), weight (7 kg), front wheel diameter (7 cm), and rear wheel (14 cm).

User trial
This third stage is testing prototypes that have been made by technicians from the medical device industry. In this phase, a designer and an ergonomist observe CP children who try prototypes while discussing the shortcomings of the walker's design. A comments and new ideas from CP child
assistant input from YPAC Surakarta and parents of CP children are noted to create a domain of knowledge for future product improvement. In addition, testing on CP children by measuring the gait analysis at the end of the 1-week training program [31] for the initial anterior walker is commonly used every day. After 1 week the subjects were selected for the gait test on the condition that they could stand in a few minutes and were supported by assistive devices [33]. The results of the first test on the subject by measuring the ability to stand and walk as far as 2 meters without stopping using the initial walking aids are shown in Table 6.

Table 6. Test results on subjects for the ability to stand and walk a distance of 2 meters.

| Subjects          | Standing Ability | Using Walker |
|-------------------|------------------|--------------|
| Subject 1         | Yes              | No           |
| Subject 2         | Yes              | Yes          |
| Subject 3         | Yes              | No           |
| Subject 4         | Yes              | Yes          |
| Subject 5         | Yes              | Yes          |

Subsequent test subjects used only 3 people. Gait analysis parameters in measuring walking ability using assistive walkers include comfortable walking speed, distance and running time. Meanwhile, the analysis variable parameters tested on the subject consisted of speed, cadence, length of footsteps, and length of time for double and single support [34]. Speed walking subjects using assistive walkers. Speed is done by measuring using a stopwatch to determine how long it is at a predetermined distance.

\[
\text{Speed} = \frac{\text{The distance users traveled}}{\text{User travel time}} \quad (\text{M/s})
\]

Cadence on the subjects was measured when walking using an assistive walker with a distance of 2 meters. Cadence is the number of steps per minute in units of steps per minute (steps / minute). The subject's stride length or stride length. The length of the footsteps is determined by dividing the distance travelled by the number of steps and multiplying the result (1 step = 2 steps).

\[
\text{Step length} = \frac{(120 \times \text{speed})}{\text{cadence}} \quad (\text{m})
\]

Double support time (DS) is step length in subjects, which is measured when walking using an assistive walker with a distance of 2 meters. Double support time (DS) is a condition when both feet rest on the floor. Double support times, usually 20% in a single phase position [35]. Before calculating DS the first thing to know is the stride time or time needed in one walk phase. Calculation of stride time can use the help of Kinovea software, where the software is used in gait analysis [36,37], which is a stopwatch tool to display the time of a period in a video and is to change the time as a percentage.

\[
\text{DS} = \frac{\text{Double Support Time}}{\text{Stride Time}} \times 100 \% \quad (\text{Seconds})
\]

Single support time (SS) is obtained from the previous double support time, used to calculate single support time, which is normally 40% for a one-time stride phase [38]. Before the SS is calculated, first calculate the stance phase.

\[
\text{Stance} = 0.6 \times \text{stride time (Seconds)}
\]

After the stance time is obtained, then look for single time support (SS).

\[
\text{Single Support (SS)} = \text{Stance} – \text{DS} \quad \text{(Seconds)}
\]

After that, how to it change the time as a percentage.

\[
\text{SS} = \frac{\text{Single Support Time}}{\text{Stride Time}} \times 100 \% \quad (\%)
\]

Production
The final stage in this research is the planning of assistive walker products to be artifacts of products to be produced and provided for CP children at YPAC Surakarta.
3. Result and Discussion

The purpose of implementing the SHIP model is to organize and coordinate different human resources into one goal that will be achieved together. Resources at the time of discussion are involved in solving problems despite having different insights about human behavior, attitudes, experiences, and knowledge that is applied during interactions, quantitative scientific approaches, and more qualitative applications of their value for generating data. Through an interdisciplinary approach that becomes a bridge in solving, cognitive, medical, design, manufacturing and engineering problems. In this way, it provides an approach to understanding human needs and capabilities to design products, systems, services that are more appropriate, usable and easily accessible.

There are several arguments about the design approach to CP child users; user-centered design standards as the user's representative choice in design. This condition is that everyone has something to propose as a solution in the design session. The SHIP model approaches in the first dialogue process that leads to a needs analysis and will ultimately determine the completion of the final design. Furthermore, from the second dialog will result in the completion of a design prototype, in the end, all these activities can be evaluated and analyzed again. The role of the SHIP model that can lead to product improvement towards a far better product, this can be shown in Figure 2.

![Figure 2. The role of the SHIP model approach in driving towards improvements in a product.](image)

According to Wang and Schulz [39,40], it is explained that product and technology development requires teamwork, including medical, social and behavior parties, and policy regulators, but also include engineers, human factors engineering, designers, and informatics. The SHIP model encapsulates all the parties in the design process-user, medical, engineer, designer, and manufacturer. This step offers everyone to provide input at every stage so that all aspects can be fulfilled for product development. In the discussion, we started by describing the definition of assistive walker for CP children to the participants. The emphasis in this discussion is related to the way the feet of CP children when walking should have stability and balance. Next, we consider how the questions in the questionnaire and UD can be translated in this study.

The recommendation is for how to design by adapting the results of the assessment of the questionnaire in an effort to increase accessibility for participants in the assessment. The Cronbach Alpha value is known to be 0.945; it means that the value of alpha (α) > 0.90 indicates the reliability of the measuring instrument used is very good, so this questionnaire has a very good consistency. The validity testing is done for the questionable items in the questionnaire. Testing is done by comparing the value of r table and r count. Using a significance level of 5% with n = 8, that r table value of 0.706. The results of this test state that all attributes of the questionnaire questions are declared valid and in accordance with the purpose of the measurement. The results of all questions in the questionnaire can be considered in subsequent processing. The results of the questionnaire from the interviewed participants obtained the results in Table 7.

| Principle of UD vs. USE concept on the question | Q10 | Q11 | Q9 | Q8 | Q5 | Q6 |
|-----------------------------------------------|-----|-----|----|----|----|----|
| Equitable use                                  |     |     |    |    |    |    |
| Flexibility in use                             |     |     | 1.75|    |    |    |
| Simple and intuitive use                       |     | 2.25|    |    |    |    |
| Perceptible information                        |     | 2.75|    |    |    |    |
| Tolerance for error                            |     | 5.5 |    |    |    |    |

Table 7. The assessment for each question based on UD principles and USE concepts.
Regarding the scope of the SHIP model and UD research, in the assessment of respondents when the average value is above 5 it can be stated that a design improvement is needed in the assistive walker, and for an average value below 5, an immediate improvement is needed. It is explained in Table 6 that the average respondent assesses where some low principle values such as equitable use, flexibility in use, simple and intuitive use, low physical effort, and approach to size, space and users.

The fourth of the UD principles assessed by respondents against the usability concept on the principle of low physical effort in Q1 with an average value of 3.5; for the concept of safety on the principle of flexibility in use and simple and intuitive use in Q11, Q8 with an average value of 1.75 and 2.75; While for the concept of efficiency on the principle of equitable use and simple and intuitive use, approach to size, space and users in Q10, Q9, Q3 and Q4 with average values of 1.75, 2.25, 2.25 and 3.35. The concept of safety and efficiency has a lower average value than the usability concept. This discussion produces aspects for the assistive walker are equitable use, flexibility in use, low physical effort, and an approach to size, space and users. The aspect of the approach to size, space and users are the focus of improving walking aids by prioritizing safety and efficiency aspects.

This assistive walker design was obtained from design reference information and compared the initial anterior walker at YPAC Surakarta. The main frame structure of this walker is connected by bolts to form the whole construction; it can be disassembled and folded. The frame assistive walker made through the process of bending and drilling process for mounting nuts and bolts, the bottom for walker's feet and mounted wheels. The right and left frame consists of two separate parts. This frame connects the mainframe using bolts. The top of the frameworks as a handy handle, then the bottom of the frame functions as a foot walker and given wheels. The design of the walker wheel serves to minimize the surface friction when used. Wheels are four, where the size of the front wheels is ½ the size of the rear wheels. The front wheels are made smaller to function as a steering wheel, counterweight and so that the walker is lighter when turning, as shown in Figure 3.

![Figure 3. Design anterior-posterior assistive walker and prototype for CP children.](image)

The assistive walker uses an aluminium pipe material, a diameter of 16 mm. The choice of aluminium material in the manufacturing process is because strong, lightweight and it’s not easily corroded. The advantage of the anterior-posterior walker is that it can adjust its users. According to Duxbury, 2000
explained that gait is generated by complex neuromuscular which is synchronized by the brain in the central nervous system in humans, so humans can push their own bodies forward. There is a shift to coordinate movements with one another smoothly so that they can walk comfortably for the individual and provide a minimum to the joints or major muscle groups so as to increase the individual that can be done in other activities. Gait walks, hard to detect, hard to miss by many CP Child caregivers.

The result of observations at YPAC Surakarta is about the daily lives of CP children using walking aids, such as from school to therapy. The walking aid used in CP children is an anterior walker, which is not equipped with a seat belt during gait rehabilitation. Children with CP when using a walker feel uncomfortable when using a walker, which is proven to be easily tired and adjusting the walker to the user takes a long time, as shown in Figure 4.

![Figure 4](image)

**Figure 4.** Learning about walking balance and body stability in CP children at YPAC Surakarta.

Testing walks on CP children are how to use a walker. This test is carried out after being given a training session for 1 week or for 7 consecutive days. After the tenth day, gait testing was performed by comparing the use between the initial anterior walker and the anterior-posterior assistive walker. The ability to walk on CP children uses walker aids by measuring the parameters of the gait variable through subject performance analysis. CP children were given walking training in the anterior and posterior positions of CP children as subjects to be tested as in Figure 5.

![Figure 5](image)

**Figure 5.** The duration of the training session using the assistive walker (a) anterior position (b) posterior position.

The walking test using a prototype assistive walker for CP children was carried out on 3 CP children who had been selected previously. The subjects' characteristics were used in this test, as in Table 8.
Table 8. Characteristics of subjects in testing walking using a prototype the assistive walker.

| Subjects  | Gender | Height (cm) | Weight (kg) | Age (yr) |
|-----------|--------|-------------|-------------|----------|
| Subject 1 | P      | 110         | 33          | 12       |
| Subject 2 | P      | 120         | 38          | 13       |
| Subject 3 | P      | 115         | 35          | 12       |

The criteria for selection in CP children to be measured on the gait walk are classified as GMFCS 1-3; diplegic or hemiplegic; sufficient cognitive skills; without visual deficits; and more than 8 years old. Gait analysis on CP children to walked using an assistive walker with a straight path as far as 2 meters. Gait parameters measured include speed, cadence, step length, double support time and single support time. The results of testing by walking using an assistive walker in the assessment of gait analysis can be explained in Table 9.

Table 9. The results of gait analysis measurements on CP children in both walking aids.

| No. | Parameter Gait Analysis | Anterior Walker Initial | Prototype the Assistive Walker | Anterior Position | Posterior Position |
|-----|-------------------------|-------------------------|--------------------------------|-------------------|-------------------|
| 1.  | Speed (m/s)             | 0.06                    | 0.07                           | 0.08              |
| 2.  | Cadence (steps/min)     | 48.33                   | 51.67                          | 58.67             |
| 3.  | Step Length (m)         | 0.14                    | 0.15                           | 0.16              |
| 4.  | Double support time (%) | 54.00                   | 47.00                          | 43.00             |
| 5.  | Single Support time (%) | 6.00                    | 13.00                          | 15.00             |

Gait analysis can be referred to as "postural assessment" or "postural analysis", a testing protocol mechanism that is made to explain the step-by-step procedures for viewing structural landmarks of the body, both in a weight-bearing and unbalanced position, providing relevant information for researchers on the success or failure of the designed device.

The results of speed in the walking position of CP children using assistive walkers showed that the subjects were in the anterior position in the assistive type for assistive walker prototypes better than the initial anterior walker with increase is 14.3%. The same is true for subjects in the posterior position in assistive devices for the prototype assistive walker type is better than the initial anterior walker with increase is 25%. So it can be concluded based on the gait assistive walker prototype analysis showing it is more feasible and comfortable for CP children.

4. Conclusion
The SHIP model approach can bridge between all respondents in compiling the attribute needs of the assistive walker product redesign. The preparation of functional and technical needs can be easily pursued in the direction of the realization of product manufacturing. Assistive walker prototypes are the result of stages that must be passed according to 7 UD principles based on the USE (Useability, Safety, Efficiency) concept. The result is a decent and efficient assistive walker product used for road rehabilitation devices for CP children. Users can adjust the walker to the position of the body can be anterior and posterior, unlike traditional types of walkers. Assistive walker prototype results from this study can improve on speed in the walking in CP children with anterior position is 14.3% and the posterior position is 25%.

5. References
[1] Aldin I U 2019 “Jokowi Sampaikan Lima Visi untuk Indonesia Lima Tahun ke Depan” Retrieved on Feb 13, 2020 from: https://katadata.co.id/berita/2019/07/15/jokowi-sampaikan-lima-visi-untuk-indonesia-lima-tahun-ke-depan
[2] Soetjiningsih and Gde Ranuh IG N 2002 Tumbuh Kembang Anak Jakarta: EGC p 127-234

[3] World Health Organization (WHO) 1995 The World Health Organization Quality of Life assessment (WHOQOL): Position Paper from the World Health Organization. Soc Sci Med 1995 Nov 41(10) pp 1403-1409.

[4] Michelsen S I, Flachs E M, Damsgaard M T, Parkes J, Parkinson K, Rapp M, Arnaud C, Nystrand M, Colver A, Faconnier J, Dickinson H O, Marcelli M, and Uldall P 2014 European Study of Frequency of Participation of Adolescents with and without Cerebral Palsy Eur. J. Paediatr. Neurol 18(3) pp 282-294

[5] Ramstad K, Jahnsen R, Skjeldal O H and Diseth T H 2012 Mental Health, Health Related Quality of Life and Recurrent Musculoskeletal Pain in Children with Cerebral Palsy 8-18 Years Old. Disabil Rehabil 34(19) pp 1589-1595

[6] Spittle A J and Orton J 2014 Cerebral Palsy and Developmental Coordination Disorder In Children Born Preterm Seminars in Fetal & Neonatal Medicine 19(2) pp 84-89

[7] Sitorus F S A B Mogi T I Gessal J 2016 Prevalensi Anak Cerebral Palsy di Instalasi Rehabilitasi Medik RSUP Prof. Dr. R.D. Kandou Manado Periode 2015 Kedokteran Klinik J 1(1) pp 14-19

[8] Shrader M W and Salzbrenner M 2020 “Cerebral Palsy” Retrieved on Feb 13, 2020 from: https://kidshealth.org/en/parents/cerebral-palsy.html

[9] Kim Y and Lee B H 2013 Clinical Usefulness of Child-centered Task-oriented Training on Balance Ability in Cerebral Palsy J. Phys. Ther. Sci. 25 pp 947-951

[10] Ogoke C C 2018 “Clinical Classification of Cerebral Palsy” InTech, Retrieved on Feb 13, 2020 from: http://creativecommons.org/licenses/by/3.0 pp 2-23

[11] Akbas A N 2016 Assessments and Outcome Measures of Cerebral Palsy InTech Retrieved on Feb 13, 2020 from: http://creativecommons.org/licenses/by/3.0 pp 2-27

[12] Viera K Cortes N and Lightfoot H 2020 “Cerebral Palsy and Mobility” Retrieved on Feb 13, 2020 from: https://cerebralpalsygroup.com/cerebral-palsy/symptoms/mobility-issues/

[13] Manuaba A 2007 A Total Approach in Ergonomics is A Must to Attain Humane, Competitive and Sustainable Work Systems and Products Journal of Human Ergology 36 pp 23-30

[14] Thatcher A and Yeow P H P 2018 Ergonomics and Human Factors for a Sustainable Future, Palgrave Macmillan, Singapore pp 41

[15] Manuaba A 2000 “SHIP” Approach Is a Must to Attain Sustainable Results in Ergonomics Proceedings of the Human Factors and Ergonomics Society Annual Meeting 44 pp 6-384

[16] de Moraes A 2000 Teaching Ergonomics Using A Systemic and Systematic Approach In An Interdisciplinary Design Environment, Proceedings of the Human Factors and Ergonomics Society Annual Meeting 44 pp 2-87

[17] McCormick A Alazem H Morbi A Beranek R Adler R Tibi G and Vilé E 2016 Power Walker Helps a Child with Cerebral Palsy. Proceedings of the 3rd International Conference on Control Dynamic Systems, and Robotics (CDSR’16) Ottawa Canada, May 9-10 129-1-6

[18] Frauenberger C Makhneva J and Spiel K 2017 Blending Methods: Developing Participatory Design Sessions for Autistic Children. Proceedings of the 2017 Conference on Interaction Design and Children, Association for Computing Machinery Digital Library, Stanford California USA, June 2017, 39-49

[19] Kanga M Choo P and Watters C E 2015 Design for Experiencing: Participatory Design Approach with Multidisciplinary Perspectives. INTE 2014, Procedia - Social and Behavioral Sciences, 174 pp 830-833

[20] Adiatmika IP G 2009 Total Ergonomic Approach in Decreasing Quality of Fatigue of Metal Crafters Anima, Indonesian Psychological Journal 25 (1) pp 71-78

[21] Bauera A M and Brown A 2014 Quantitative Assessment of Appropriate Technology. Procedia Engineering 78 pp 345-358

[22] Manuaba A 2006 Total Approach is a Must for Small and Medium Enterprises to Attain Sustainable Working Conditions and Environment, with Special Reference to Bali Indonesia Industrial Health J. 44 pp 22-26
[23] Spinuzzi C 2005 The Methodology of Participatory Design. Technical Communication Research 52(2) pp 163-174
[24] Luck R 2003 Dialogue in Participatory Design Design Studies 24(6) pp 523-535
[25] De Couvreur L and Goossens R 2011 Design for (every) one: Co-Creation as A Bridge Between Universal Design and Rehabilitation Engineering CoDesign 7(2) pp 107-121
[26] Story M F Mueller J L and Mace R L 1998 The Universal Design File: A Guide to Designing for People of All Ages and Abilities Raleigh, NC: NC State University. Center for Universal Design Available at: http://www.design.ncsu.edu
[27] Liu Y E Lee S Kasca k L R and Sanford J A 2015 The Bridge Connecting Theory to Practice - A Case Study of Universal Design Process Universal Access in Human-Computer Interaction (UAHCI): Access to Today’s Technologies 9th International Conference, Part I, Los Angeles, CA, USA, August 2-7 pp 64-73
[28] Lughofer E 2016 Chapter 3: Evolving Fuzzy Systems-Fundamentals, Reliability, Interpretability, Useability, Applications Handbook on Computational Intelligence p 67-135
[29] Demirbileka O and Demirkan H 2004. Universal Product Design Involving Elderly Users: A Participatory Design Model Applied Ergonomics 35 pp 361-370
[30] Martins M M Santos C P Frizera-Neto A and Ceres R 2012 Assistive Mobility Devices Focusing on Smart Walkers: Classification and Review. Robotics and Autonomous Systems 60 pp 548-562
[31] Duxbury A S 2000 Gait Disorders and Fall Risk: Detection and Prevention Comprehensive Therapy 26(4) pp 238-245
[32] Preedy V R 2012 Handbook of Anthropometry Physical Measures of Human Form in Health and Disease New York: Springer Science
[33] Moreau N G Bodkin A W Bjornson K Hobbs A Soileau M Lahasky K 2016. Effectiveness of Rehabilitation Interventions to Improve Gait Speed in Children with Cerebral Palsy: Systematic Review and Meta-Analysis. Physical Therapy 96(12) pp 1938–1954
[34] Duncan P W Weiner D K Chandler J and Studenski S 1990 Functional Reach: A New Clinical Measure of Balance. Journal of Gerontology 45(6) pp M192-M197
[35] Zhang X Fiedler G and Liu Z 2019 Evaluation of Gait Variable Change over Time as Transtibial Amputees Adapt to a New Prosthesis Foot BioMed Research International 2019 Article ID 9252368 6 pages
[36] Parks M T Wang Z and Siu K 2019 Current Low-Cost Video-Based Motion Analysis Options for Clinical Rehabilitation: A Systematic Review Physical Therapy 99(10) pp 1405-1425
[37] Mukaino M Ohtsuka K Tanikawa H Matsuda F Yamada J Itoh N and Saitoh E 2018 Clinical-oriented Three-dimensional Gait Analysis Method for Evaluating Gait Disorder Journal of Visualized Experiments 133 pp 1-7
[38] Hollman J H McDade E M and Petersen R C 2011 Normative Spatiotemporal Gait Parameters in Older Adults. Gait & Posture 34(1) pp 111-118
[39] Wang S Bolling K Mao W Reichstadt J Jeste D Kim H and Nebeker C 2019 Technology to Support Aging in Place: Older Adults’ Perspectives. Healthcare 7(60) pp 1-18
[40] Schulz R Wahl H Matthews J De Vito Dabbs A Beach S Czaja S 2015 Advancing the Aging and Technology Agenda in Gerontology Gerontologist 55 pp 724-734

Acknowledgments
The authors represent a People-Centered Innovation Research Group; we really appreciate Friendship with CV. Rigen Sarana Mukti Surakarta and CV. Yoga Mandiri Surakarta as a provider of medical devices and Yayasan Pembinaan Anak Cacat (YPAC) Surakarta. This research to be conducted at YPAC and the research was conducted in 2019 with an independent research scheme. We Rethink Technology to Help with CP Children. We also want to thank our participating children, families, schools and local industry.