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Designing Functional Clothing for People with Locomotor Disabilities

Oblikovanje funkcionalnih oblačil za ljudi z motnjami gibanja

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Abstract

This article presents a study on functional clothing for people with disabilities. The clothing items which were the subject of research, i.e. polo shirt, T-shirt, shirt, trousers and jeans, were designed for people with physical disabilities, namely for daily activities for people who often sit in wheelchairs. The study used the research method of anthropometric theory, pattern design, textile materials, and an actual survey to analyse and evaluate the reality of movement ability and perception of clothes to determine the requirements for people with disabilities. The authors proposed suitable materials and provided solutions to adjust the basic pattern to become more suitable for people with locomotor disabilities. Finished sewing products were tested and evaluated experimentally by people with leg disabilities at the Center for Sponsoring - Vocational Training and Employment Introduction of Ho Chi Minh City and the Association for the support of people with Disabilities and Orphans of Ho Chi Minh City according to the Likert scale with 5 rating levels for each criterion. The results showed that the Cronbach's Alpha index was over 0.7. The research addressed the comfort of disabled people's clothing, indicating promising further development of other functional clothing.
Keywords: pattern design, functional clothes, locomotor disabilities, leg disability, bamboo fibre, pants, shirt

Izvleček

Članek predstavlja študijo funkcionalnih oblačil za osebe s posebnimi potrebami za dnevno nošenje, kot so polo majica, majica, srajca, hlače in kavbojke. Izdelki so na podlagi raziskav zasnovani tako, da so primerni za ljudi z motnjami v telesnem razvoju, predvsem za vsakodnevne aktivnosti ljudi, ki pogosto sedijo na invalidskih vozičkih. Na podlagi uporabljene raziskovalne metode antropometrične teorije, krojenja, izbire tekstilnih materialov in ankete so bile analizirane in ovrednotene realne gibalne zmožnosti in zaznavanje oblačil, da bi določili zahteve za kostumiranje oseb s posebnimi potrebami. Avtorji predlagajo materiale in rešitve za prilagoditev osnovnega vzorca, ki je primernejši za osebe z motnjami v gibanju. Oblačila so testirale in po Likertovi 5-stopenjski lestvici eksperimentalno individualno ocenile osebe z invalidnostjo stopal v Centru za poklicno podporo in ustvarjanje delovnih mest v mestu Ho Ši Minh in Centru za poklicno usposabljanje invalidov in otrok sirot v mestu Ho Ši Minh. Pokazalo se je, da je Cronbachov indeks alfa višji od 0,7. Raziskava, ki obravnava udobnost nošenja oblačil za invalide, je potencialno ustrezna tudi za nadaljnji razvoj drugih funkcionalnih oblačil.
Ključne besede: krojenje, funkcionalna oblačila, gibalna oviranost, oviranost nog, bambusova vlakna, hlače, srajca

1 Introduction

Clothes, which protect our bodies, also enhance the beauty, hide the flaws of the wearer, and express their style and personality. In the world, there are about 600 million people with disabilities, accounting for about 10% of the population, most of them living in developing countries [1]. In Vietnam, there are about seven million people with disabilities [2]. The demand for clothes for people with mobility impairments is not small. However, the offer of the clothing market for people with disabilities in general and especially for people with locomotor disabilities is still limited, not focused, and needs the attention of designers and fashion brands. Research was conducted that focuses on people with hemiplegia, multiple sclerosis, other injuries, and on people with limited mobility who use a wheelchair. Physical characteristics of people with disabilities cause losing balance due to spinal trauma and change in body shape to disproportion [3]. The lack of blood circulation, low body temperature, physical inactivity of damaged body parts tend to impair muscle functions and lead to muscle atrophy in the extremities. To compensate for the loss of affected body parts, the unaffected body parts are forced to work more than normally; hence, people with lower extremity disabilities have stronger trunks and upper extremities. Using wheelchair leads to the development of related muscle groups of upper extremities [4, 5]. Clothing for people with disabilities should provide ergonomic comfort in sitting positions, improve the quality of life, be designed for everyone, and be suitable for the wearer's physique and awareness. Adaptive or function clothing helps minimise joint movements and pain that patients face when dressing or undressing [6, 7]. In addition, apparel must also be suitable for the socio-cultural context and ensure the comfort of the outfit [8, 9]. Wheelchair users frequently experience difficulty when dressing, as studied by Pruthi and partners, since they feel pain in the upper extremities when putting on clothes and undressing, when undressing the inactive leg, due to incontinent motion, often lying in bed resulting from the loss of mobility, trauma from traction belt [10]. Research showed that the comfort of pants is influenced by four main areas, affected by pressure, i.e. waist (39.17%), knees (16.4%), crotch (13.96%) and calves (6.95%), while the pressure on the areas below the knees and calves does not significantly affect dressing. Comfort is acceptable if the pressure is as low as 20 kPa on hips, waist and crotch, and less than 10 kPa on the back of the thighs and knees. Research which was conducted in 2013 on 10 young women aged 18 to 38 with various disabilities found that design, form, function, self-expression and social identity are essential factors for choosing their clothes. Standing measurements are not applicable to sitting posture measurements due to anatomical variations and different defects [9, 10]. The proportion of people with disabilities tends to increase. The products on the market are not capable of meeting their needs. Therefore, it is extremely important to design and make a suitable garment for people with disabilities in the legs to bring the most convenience to them.

This study proposes options for designing clothes for people with disabilities. The authors recommend suitable materials and, at the same time, provide solutions to adjust the basic pattern suitable for sitting posture and experiment with some designs.

2 Materials and methodology

The study included people with atrophy of legs, poor legs and those in wheelchairs.

The survey locations were the Center for Sponsoring – Vocational Training and Employment Introduction of Ho Chi Minh City and the Association for the support of people with Disabilities and Orphans of Ho Chi Minh City.

Gerber V9.0 software was used to design patterns [11]. IBM SPSS [12] software was used to evaluate the reliability of the fit and comfortable clothes through the Cronbach's Alpha coefficient.

In the study, a 2/1 twill weave (cf. Figure 1) and combined twill weave (cf. Figure 2) bamboo fabric was used. Bamboo fibres give the fabric antibacterial properties, which means that the garment does not leave body odour, it absorbs sweat and creates a soft feeling for the wearer. As it has superior properties, this material is widely used in the garment industry. Due to the fibre structure and constituent compounds, a bamboo fibre fabric has a soft surface and good hygroscopicity. It is also antibacterial, deodorising and UV resistant, making it environmentally friendly to meet the customers' needs [13].

The selected fabric was of moderate strength since the product was intended for the disabled. If the strength is too high, the fabric is of high thickness or high cost, and both of these properties do not

Figure 1: White bamboo fabric: surface of white bamboo fabric (left), performance of rapport 2/1 twill weave of white bamboo fabric (right)

Figure 2: Blue bamboo fabric: surface of blue bamboo fabric (left), performance of rapport of white bamboo fabric (right)

meet the criteria for our study. The fabric was basic in colour, easy to apply and suitable for clothing designs, objects and circumstances. Used accessories were zipper, button, elastic band and elbow pad. Zippers and buttons were arranged in appropriate positions, helping to expand the clothes for easier putting on and taking off. The elastic band helped keep the back of pants snug against the waist while still being easy to wear. Elbow pads, which are frequently used to support hands in wheelchairs or desks, were used as well.

For the purpose of the study, we used theoretical research methods about anthropometric methods, and textile materials to design and sew complete products. The basic pattern set was designed according to the pattern design method of the document [14]. The experimental method was used in surveying, analysing and evaluating research results according to the Cronbach's Alpha coefficient [12].

3 Results and discussion

3.1 Effects of wheelchairs on physical activity of people with leg disabilities

People with leg disabilities often use their upper limbs and upper body musculoskeletal system in their daily activities. At the same time, their sitting posture greatly influences their body shape (cf. Figure 3). Therefore, the design of clothes needs to be adjusted in several positions on the body for more comfort and convenience. Wheelchairs are assistive tools to help improve life, and create an optimistic spirit for users in general, especially people with disabilities. They use wheelchairs during most of their daily activities, especially for mobility, meaning that they need to use a lot their hands and

Figure 3: Body shapes of people with disabilities are disproportionate and abnormal [15]

the upper body musculoskeletal system [16]. As a result of using a wheelchair for longer periods of time, the upper limb musculoskeletal system is much more flexible. At the same time, the lower limbs are weaker and the weight of the entire upper body is concentrated on lower limbs. People with leg disabilities are thus prone to losing balance and falling forward in cases of moving downhill with a sudden change in height [17]. Problems that wheelchair users experience with dressing are pain in the upper extremities when dressing and undressing, difficulty removing clothing from the inactive leg, problem with incontinence hygiene, injuries caused by belt pulling etc. [9, 10, 18].

3.2 Plan for designing clothing

Clothing for people with disabilities must be specially designed and adjusted to provide ergonomic comfort in the sitting position and functional requirements when worn, not causing health problems for the wearer, e.g. skin irritation, sores resulting from pressure, or blockage of blood flow [10, 19]. Garment products must also have an aesthetic and fashionable appearance to help people with disabilities integrate into the society [5]. The plan for the design of apparel products was divided into two groups from the base of the initial survey of 90 people with leg disabilities about clothes ergonomic (cf. Figure 4). In the first group, the pattern was designed in some positions to suit body characteristics to provide the most comfort and convenience. For the pants, it was important to pay attention to the design at the back; the bottom ring was hence higher than that of standard clothes and more elastic at the waist for convenience. Due to the limited mobility in the legs, additional pleats were required at the knee position. In addition, there had to be an opening in the leg and pants for them to be easily put on or taken off. To avoid skin chafing due to seizures of the back and the wheelchair seat, pockets were not to be sewn on the back of the pants. At the same time, the pants' door was opened wider by extending the length of the zipper fly. For the shirt, extra wide adjustments needed to be made at the neck position as most disabled people's necks are more developed than those of non-disabled people. Moreover, the width of shoulders and armhole depth needed to be adjusted to make hand movements more flexible. Furthermore, in order not to sit on the shirt, its length had to be shorter than for an able-bodied person. The sleeves in the elbow area also had to be shaped according to the comfort principle. Sleeves had elbow pads added to increase the durability of the shirt and to make the wearer more comfortable when moving the wheelchair. In the second group, the pattern design, attention was paid to the manipulation required when using the clothes.

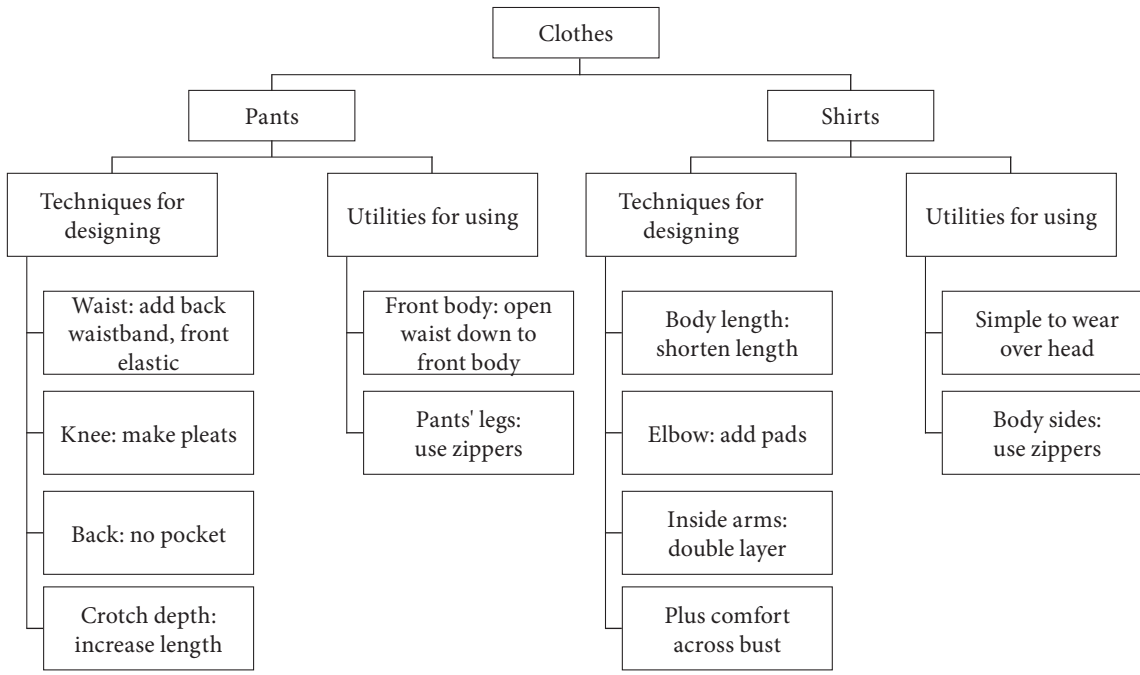

Figure 4: Plan for designing clothing

3.3 Adjusting basic pattern to suit body shape

The patterns for the T-shirt, shirt, trousers and jeans were designed according to the method basic block by Winifred Aldrich [14] with a non-disabled's body dimensions. The unit of measurement was centimetre (cm). In line with section 3.2, the basic block was edited accordingly for the pattern to suit the disabled people's body dimensions.

3.3.1 Adjusting basic trousers pattern

The length of the front bottom pants was reduced, and the width of the front waistline was increased to create a comfortable sitting position for the waist and abdomen. In addition, a 4-cm ply fold was at the front knee to prevent the knee position from being stretched. In the back, the curvature of the buttocks and the height of the back was increased to best suit the sitting posture. The front of the pants was lower than the back by 0.5–1 cm (cf. Figure 5). In the knee-level position, it was open by 3–4 cm to arrange the pillow pleats. The back of the pants was extended by 4–5 cm, and the width of the buttocks was by 2–3 cm larger. The bottom was extended by 0.5–1 cm and by 0.5–1 cm down (cf. Figure 6).

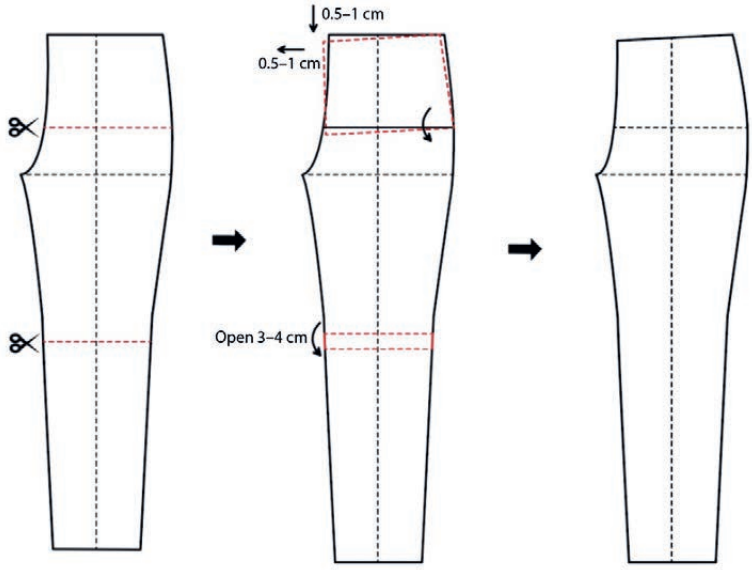

Figure 5: Trousers' front pattern (left), adjustment position (middle), pattern after alterations (right)

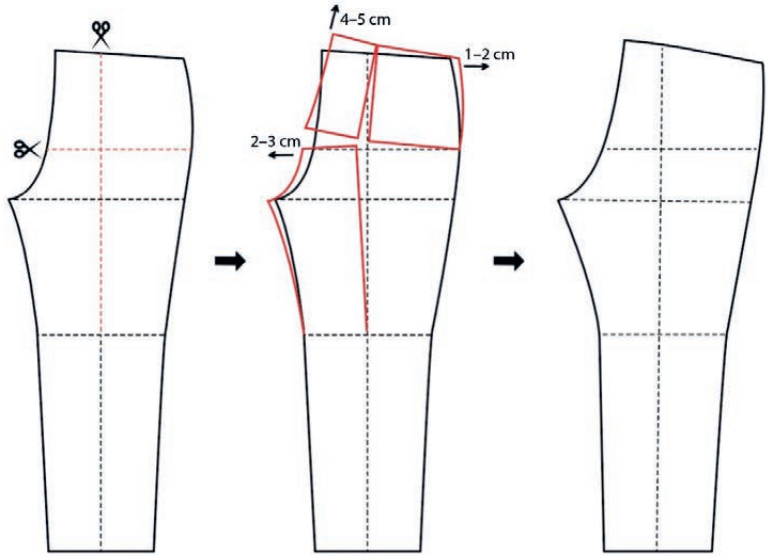

Figure 6: Trousers' back pattern (left), adjustment position (middle), pattern after alterations

3.3.2 Adjusting basic shirt pattern

The neck was extended by 0.5–1 cm (cf. Figure 7). 2–3 cm were added to the length of shoulders and 1–2 cm to the length of lower armpit. The armpit ring was curled and the shirt length was reduced by 3–5 cm (cf. Figure 8).

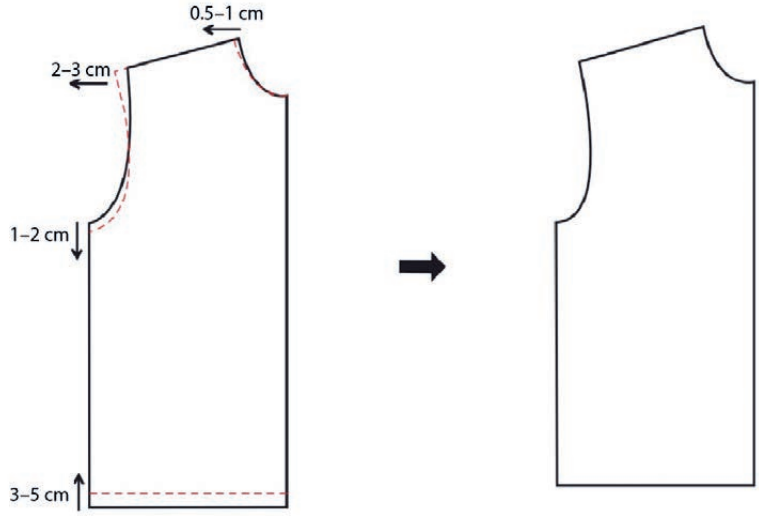

Figure 7: Pattern's front: adjustment position (left), pattern after adjustment (right)

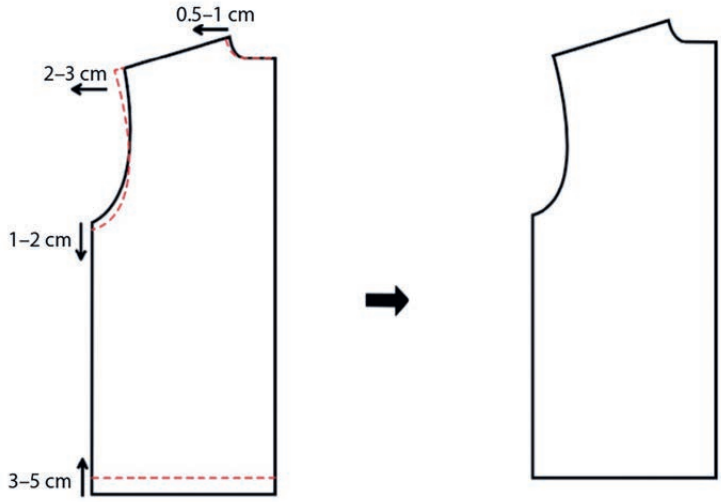

Figure 8: Pattern's back: adjustment position (left), pattern after adjustment (right)

3.4 Adjusting pattern design to support operation of people with disabilities

From the analysed content, the research team experimented with four designs for people with leg disabilities according to the plan of assisting manipulation when using clothes. Figure 9 shows design 1, a polo shirt on a 100% cotton knit base with a side zipper, which makes it easier to put on or take off the shirt.

In design 2, the inner ribs of the sleeves and body were sewn with a mesh fabric for ventilation. In addition, the shirt pillar was cut deeper than for a regular shirt, making it easier for the wearer to put the shirt on through the head (cf. Figure 10).

In design 3, a long-sleeved shirt from bamboo fabric (50% bamboo) was sewn with elbow pads (cf. Figure 11) to help support the lower arm for extended periods of time on a table or wheelchair armrest (cf. Figure 12).

In design 4, pants which could be easily put on with no or less help from the caregiver were designed. The length of zippers was increased or zippers were used on the sides of pants' pockets to make the pants wider (cf. Figure 13). Simultaneously, the back

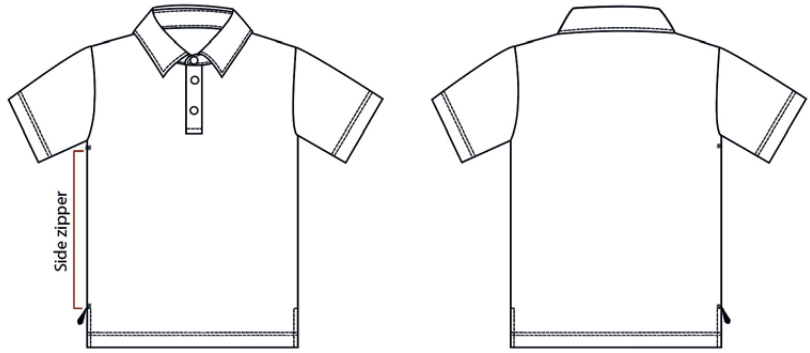

Figure 9: Descriptive drawing of polo with side zipper

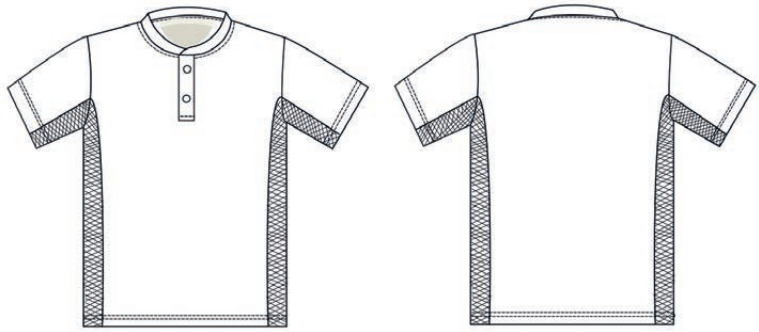

Figure 10: Drawing of T-shirt with mesh

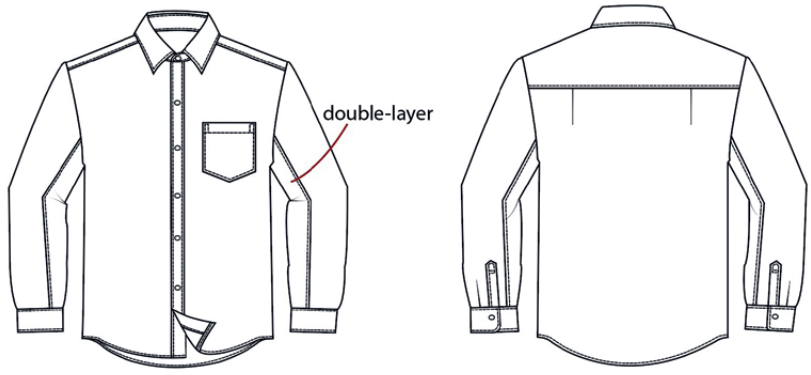

Figure 11: Double-layer long-sleeved shirt

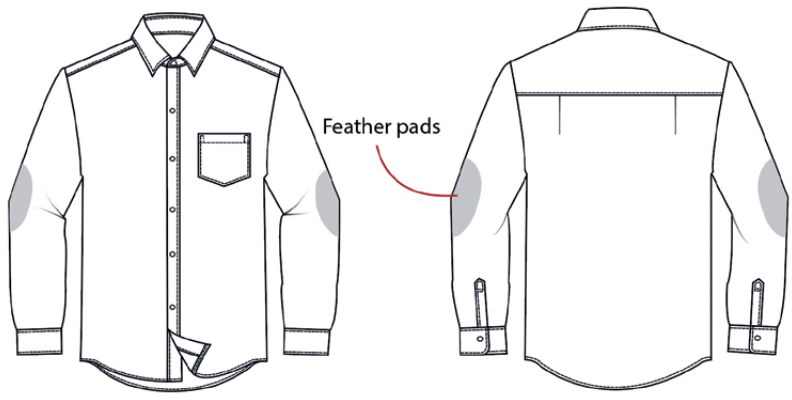

Figure 12: Shirt with sewn elbow patch

of the pants was raised, increasing the curvature of the buttocks and the ply at the knees was folded to suit the sitting position for a longer period of time. A teardrop zipper was added to the inner side of the bottom of trousers' legs to widen the leg while still preserving the look of the pants (cf. Figure 14).

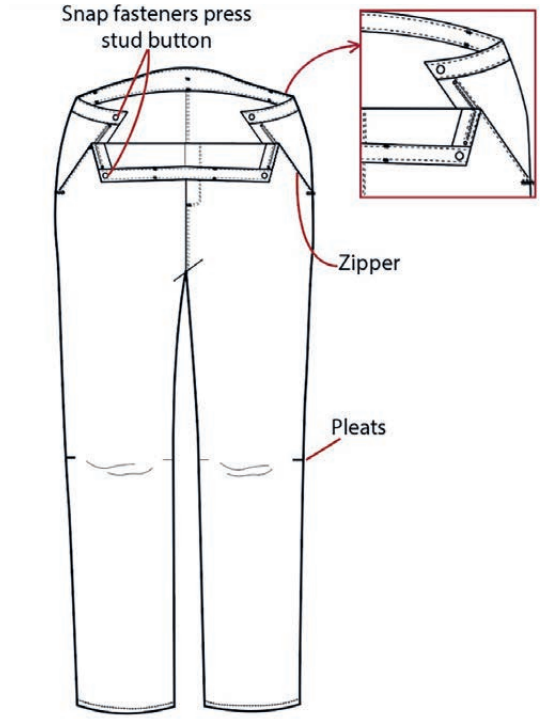

Figure 13: Jeans with open zipper

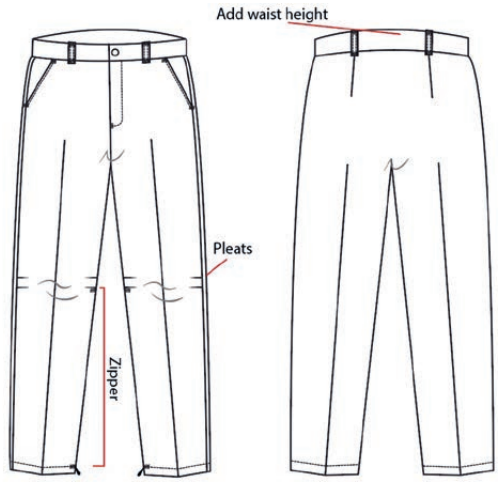

Figure 14: Trousers with inner side zippers

People with severe disabilities need their caregiver's support in dressing and personal activities. Therefore, the authors propose in design 5 models of pants using a knit fabric and an elastic waistband with an open back, which make it easier when going to the restroom and provide comfort during wearing. Moreover, the pants' design makes opening them easier, aiding their personal activities. In these samples, the authors still added length of the buttocks, waist of the pants (cf. Figure 15) and pleats at the knee (cf. Figure 16).

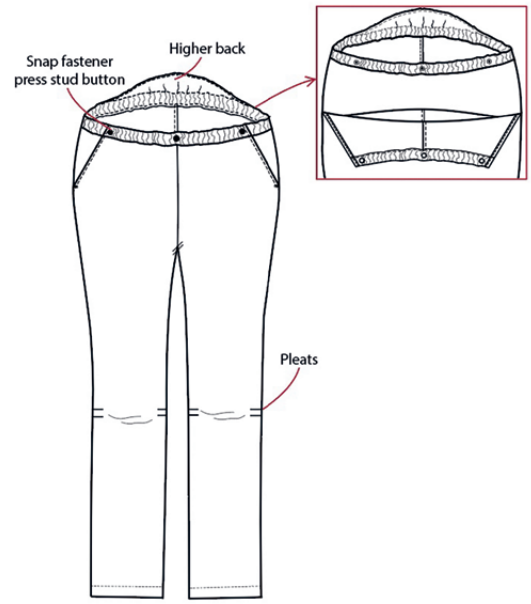

Figure 15: Knit pants with elastic waistband and open front

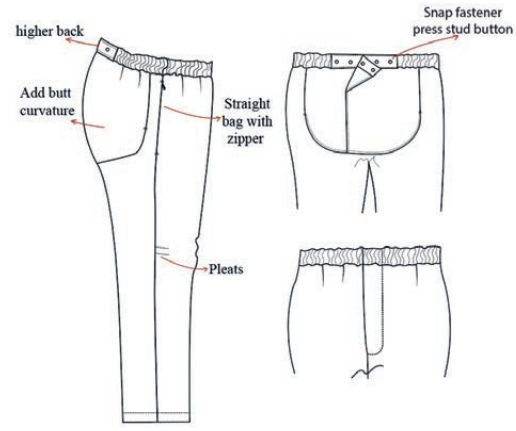

Figure 16: Knit pants with elastic waistband and open back

3.5 Testing and evaluating product feasibility

The products were surveyed and tested on 76 people with leg disability to evaluate the feasibility of the study through the criteria according to the Likert

scale in terms of material, design, convenience, colour, product cost and external assessment. Each criterion was evaluated on a scale from one to five, namely completely dissatisfied, unsatisfied, no idea, satisfied, completely satisfied. The survey was conducted in the Center for Sponsoring - Vocational Training and Employment Introduction of Ho Chi Minh City and the Association for the support of people with Disabilities and Orphans of Ho Chi Minh City. The survey results were analysed according to the Cronbach's Alpha coefficient and showed that the majority of survey participants were satisfied with the given criteria. The survey also showed that the templates need certain changes. The external assessment of all products was acceptable. In design 1, some people had difficulties wearing the trousers. In design 2, a few people felt uncomfortable about the material as bamboo and jeans fabrics were not as soft as the cotton fabric. In design 3, the fabric's colour was quite good. In design 4, the product's shape was evaluated as appealing. However, the test results showed that all observed variables had a suitable total correlation coefficient (over 0.3). The Cronbach's Alpha coefficient of the samples for designing were 0.776, 0.837, 0.807, 0.810 – all over 0.7. The results of the scale used were good in terms of reliability (cf. Table 1), which shows that the products would be highly applicable for people with disabilities.

4 Conclusion

The study provides options for designing clothes and trousers suitable for the physical characteristics of people with disabilities, combined with actual surveys at vocational training centres for people with disabilities to come up with solutions. They

Table 1: Evaluation of reliability through Cronbach's Alpha coefficient

Design	Material	Designs	Convenience	Colour	Cost	External assessment	Cronbach's Alpha
1 (Figure 17)	0.78	0.750	0.728	0.756	0.756	0.671	0.776
2 (Figure 18)	0.795	0.828	0.822	0.833	0.812	0.766	0.837
3 (Figure 19)	0.804	0.771	0.797	0.761	0.784	0.737	0.807
4 (Figure 20)	0.801	0.761	0.786	0.799	0.787	0.745	0.810

Figure 17: Try-on shirt with double layers and trousers with inside zipper

Figure 18: Try-on shirt with elbow pads, and jeans with open waist down the front

Figure 19: Try-on polo shirt with zipper at side and knit pants with elastic at the front and waist opening down the body with pleats at knees, and higher waistband at the back

Figure 20: Try-on T-shirt with zipper at side and knit pants with open back

shared their clothes requirements, proposed suitable materials and solutions to adjust the basic stamping design, suggested the direction to correct the pattern and experimented with some sewing samples for home T-shirts, front and back elastic waist pants. Furthermore, the authors designed shirts and trousers with zippers for use when going out. In each model, the authors paid attention to the manipulation of wearing and taking off the product easily in usual state as well as when needing to go to the toilet. The designs are suitable for people who are often in wheelchairs. The products were after being designed and sewn tested at two initial survey facilities. After analysing the reliability according to the Cronbach's Alpha coefficient, all 4 outfits were over 0.7. The research opened up a new direction in functional apparel design. In the future, designs should be developed to be more diverse for people with disabilities to have more options for their fashion styles, and at the same time develop clothes for other types of disabilities.

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