ORIGINAL RESEARCH

Adjustment of patterns of women's trousers on the base of the lower body

Mong Hien Thi Nguyen[*]

Faculty of Mechanical Engineering, University of Information Technology-VNUHCM, Ho Chi Minh City, Vietnam

[*]**Correspondence:**
Mong Hien Thi Nguyen,
ntmhien14719@hcmut.edu.vn

This article presents the influence of female lower body characteristics as a waist position to the bottom of the foot on the design of women's trousers. First, the author designs patterns for people with straight legs. Second, the product will wear on people with bow legs, X-legs, and people who have big waists and small thighs. Third, the author analyzes the fit of each pattern in every sample and gives directions for pattern correction. Finally, the samples are sewn again until they fit samples and are not wrinkles. The anthropometric theoretical research method is used in the product fit analysis. The theory designs trousers pattern that is used to design patterns for people who have straight legs. The experimental research method is used to conduct actual surveys on 40 people from four groups with different lower body parts through the Likert scale for five evaluation criteria on five levels. The survey results are analyzed on the SPSS software. The results show that Cronbach's alpha index is over 0.7. Research has made practical contributions in the field of garment product design as well as consulting customers when buying and selling clothes.

Keywords: pattern design, women's trousers, bow legs, knock knees, big waist, slender thigh, adjustment

1. Introduction

The production of clothing has brought both advantages and disadvantages to consumers. Numerous studies have shown that, while improving production output, the fit garments have been negatively impacted by mass production methods (1). It can be said that the fit of a garment is an integral part of garment quality and significantly affects consumer satisfaction (2). There is a study that shows that the rate of consumer dissatisfaction with ready-to-wear clothing has reached 50% in women and 62% in men (3). Fit clothing is influenced by various factors such as gender, age, size, trends, culture, style, and perception (4). In particular, satisfaction with the fit of casual trousers is recognized as the least satisfied garment item in ready-to-wear and one of the most difficult to wear because it is related to the crotch area. The crotch area is the main cause of trousers fitting problems because it involves complex structure and body movement (5). The study has built a regression model

to determine the most suitable shape of the male crotch curve. However, due to the lack of integration of features into the crotch seam, the comparison is considered relative. Another study analyzed the bottom curve of women's jeans based on a 3D scanner system. This study was limited to using a female mannequin instead of a human body. Furthermore, because the focus of this study was on the crotch curve, other issues such as hip, waist, thigh, and knee curves were not considered in the study (6). Similarly, in research (7), the author studied the design of curves on men's casual trousers. The content of the research has presented three design methods being used in Vietnam and in the world today, giving advantages and disadvantages of each method. The research team focused on designing the crotch curve, and men's crotch and adjusting the design according to the factors affecting the size parameters and the design method. However, the study was limited to the scope of the crotch and men's trouser curves. Regarding the concept of fit, there are notions that fit is the relationship

between the body, dimensions, and the style of the garment. A well-fitting garment should be smooth, free of wrinkles, defects, or sagging, and be effective for its intended use to provide comfort to the wearer (8). In addition, a well-fitted garment is a garment that is comfortable on the body, has no traction or distortion of the fabric, has straight seams, pleasant proportions, no gaps, is not overly tight on the muscles and body, and is easy to move. The hems of the trousers are parallel to the floor (9). There is a research group that has defined clothes as fit when the wearer feels comfortable and can move freely without any limitations from the clothes (10). There is also a group of authors who argue that the fit of a garment can be considered the tightness, looseness and shape of the garment in relation to the wearer's body (11). In this study, the research content is presented on the causes affecting the fit of women's casual trousers at the design stage for special leg shapes and proposes solutions to ensure the correct fit. The fit of dresses is important to improve the quality of the product.

2. Materials and methods

2.1. Subject

The research is conducted on women's casual trousers for people of the same age to find the causes affecting the fit of casual clothes for bow legs, X legs, and big waist but small thigh.

2.2. Materials and methods

The study was made out on the basis of the standard to assess the fit of the garment product TCVN 2112-77 on the assessment of the product quality (12). The author uses an objective assessment method to analyze the fit of clothes through three-sided photos: front, back, and hip. In addition, it also assesses the fit of clothes subjectively based on feedback from consumers (5, 6, 13–15), through the Likert scale (16). The patterns of the women's trousers set are designed for people with straight legs and are designed according to the 2D pattern design method (17). Measurements include one vertical dimension, which is the length of the trousers, and two horizontal dimensions, which are the waist and hip. The measurement positions are detailed in **Table 1** and **Figure 1**. The fit assessment method is made out by conducting pattern design for four body shapes, including one normal and three special body shapes. They have nearly similar measurements with the same formula and design method. Then, samples will proceed to try on real people to compare and evaluate the difference in fit on different bodies.

TABLE 1 | The table measurement.

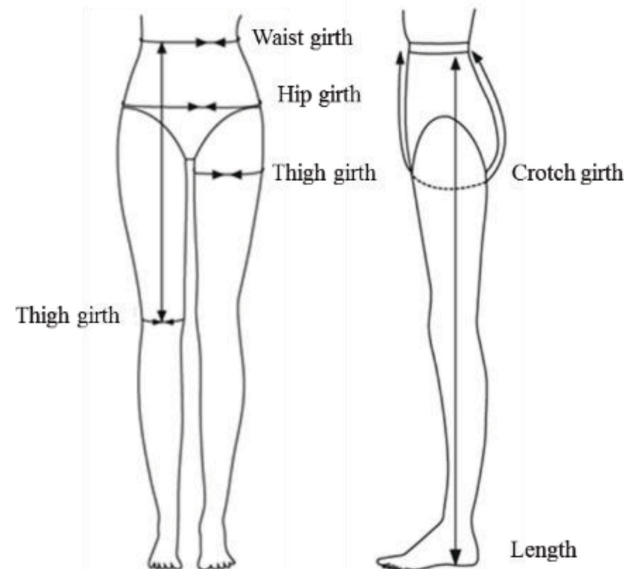| Underbody shape	Measurement (cm)					
	Waist	Hip	Thigh	Knee	Hem	Length
Straight legs	66	88.5	48	36	25	89
O-legs	67	88	49	38	27	89
X-legs	66.5	88	50	38	27	90
Big waist, small thigh	73	89	46	34	24	90

FIGURE 1 | Measurement positions of the women's trousers.

3. Results and discussions

There are many causes of anthropometry of the lower half of the body that affect the fit of women's trousers such as leg shape, waist shape, and hip shape. First, the author designs patterns of the front body and the back body for straight legs. Second, he sews and tests the samples to get the standard pattern. Third, he edits patterns and sews the samples again. In turn, the pattern is designed for people with bow legs, X-shaped legs, and big waists-small thighs. People have similar measurements of leg length, waist circumference, and hip circumference who try on samples. After wearing the samples on the body, those products will be analyzed for fit and suggested pattern correction direction. Finally, he sews the pattern again and comments on the fit. The process of designing and adjustment is shown in **Figure 2**.

3.1. The trousers' patterns for people who have straight legs (Sample 1)

The patterns after designing (**Figure 3**) will be sewed to check the fit and accuracy of the pattern set. **Figure 4** shows a real
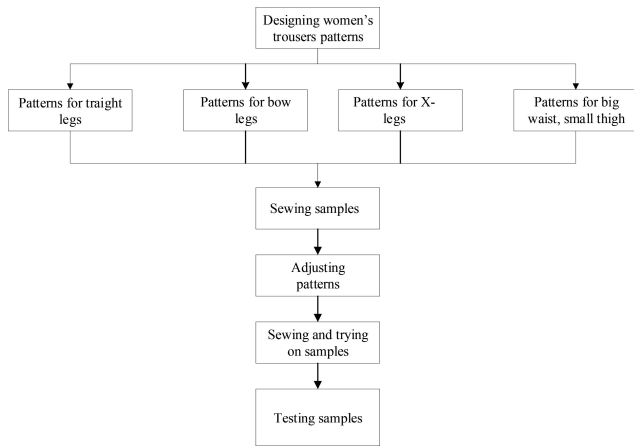
FIGURE 2 | The process of designing and adjustment patterns.
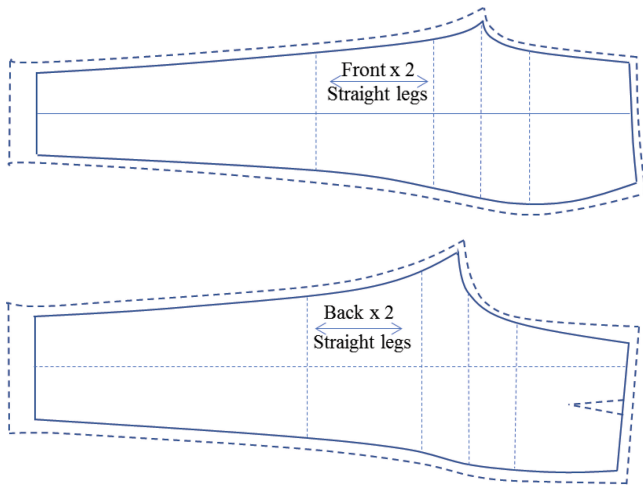

FIGURE 3 | The patterns of the straight legs.

FIGURE 4 | Bow-legged pattern (18).

sample of the product after wearing it directly on the body with a normal figure with straight legs (**Figure 5**). Visually, the samples are fit and esthetically pleasing.

3.2. Causes and directions for adjusting patterns for bow legs (Sample 2)

Esthetic factors fit of trousers styles are affected by differences in body shape according to muscle and physical development, amount of subcutaneous fat and distribution, and increased age work. Increasing the waist and hip circumference and measuring the depth of the bottom are important in the design of the trousers. In addition, the patterns will have many corrections for bodies with an O-shaped leg, also known as a bow leg (**Figure 4**).

FIGURE 5 | Front, back, and sides for the first sample (straight legs).

FIGURE 6 | The front trousers before adjustment.

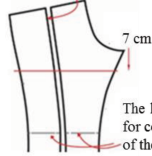**TABLE 2 |** The plan adjusts trousers' patterns for the bow legs.

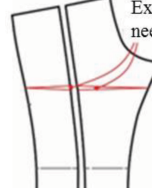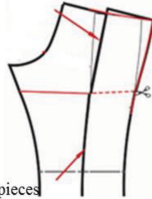| Errors	Causes	Adjustment
Figure 7 | Errors on the front trousers at the knee. Wrinkles appear on the front of the trousers around the knee area down to the hem. Diagonal creases appear along the seam above and below the knee (**Figure 7**).	The two knees face the inside of the body at the calves' positions. Those cause the fabric to shift, stretch on the outseam, and excess on the inseam.	Adjust the length of the outseam and decrease the length of the inseam.
Figure 8 | Errors on the back trousers below the buttocks. The back has many folds with loose excess fabric folds at the thighs below the buttocks (**Figure 8**)	Looking at the picture shows that the excess fabric creates creases in the middle of the thigh, not from the sides of the inseam and outseam.	These folds need to be removed by pinning the excess fabric and removing them as shown in **Figure 9** to ensure a snug fit. Here is how to edit the back pattern, which is to draw a line across the thigh area on the pattern pieces about 7 cm from the junction of the back trousers' body (**Figure 10**). Determine the amount of excess fabric to discard. Then, rotate the pattern to remove excess fabric (**Figure 11**), and lose the folds. The two detailed patterns are assembled in the correct position to take the pillow impression (**Figure 12**). The light wrinkles show that the pattern is stacked, causing the lack of parameters at the waist and buttocks. Rotate the pattern as shown below. Then, smooth out the bends. **Figure 9** | The excess fabric needs to be cut off. **Figure 10** | Drawing a line across the thigh to cut the pattern. **Figure 11** | Rotating the pattern to remove excess fabric. **Figure 12** | Rotating the pattern to combine two pieces of the back.

(Continued)

TABLE 2 | (Continued)

Errors	Causes	Adjustment
	Outseams are not flat due to more curvature relative to body size. And due to the unsatisfactory dart sewing process, the fabric surface is convex and concave.	To reduce the ínseam curvature at the hip position by 0.5 cm on each side. Dart's seams are right, and darts' tail is a point.

Figure 13 | Errors on the back trousers below the buttocks.
The inseams have many wrinkles. Outseam lines are not flat due to more curvature relative to body size (**Figure 13**).

For this type of leg, there are a few common defects of casual trousers after sewing, such as wrinkles that extend from the seams around the knees and calves. The cause of this phenomenon is that the fabric is tight along the seam on the outseam and looser at the seam on the ínseam. To correct the design, it is necessary to first analyze the
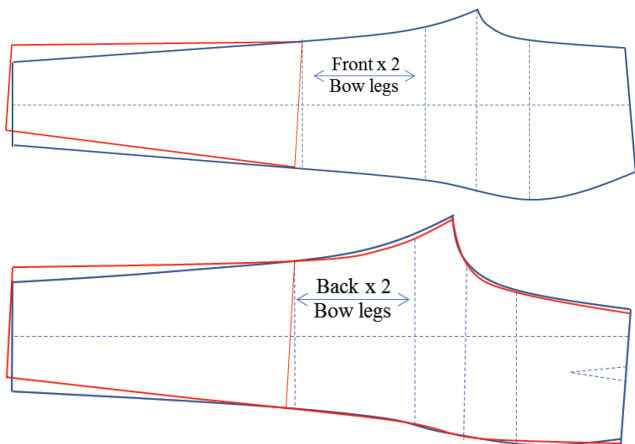

FIGURE 14 | The patterns before and after adjustment for the bow legs (the blue is before the adjustment, and the red is after adjustment).

FIGURE 16 | The X-legs (18).

FIGURE 15 | Trousers' front, back, and side after adjustment for bow legs.

FIGURE 17 | Trousers' front, back, and side before adjustment for X-legs.

product of trousers when worn by people with bow legs (**Figure 6**). That is, the front of the trousers has wrinkles around the knee area down to the hem, with diagonal creases radiating from along the seam above and below the knee. The knees are directed to the inseam of the body, while, at the flexion of the calves, the fabric is deflected and stretched on the outseam line and redundant in the middle. The side of the trousers has loose wrinkles at the hip position. The outseam is not smooth. The trousers' back has many folds extending along the inseam thighs and buttocks, and many wrinkles extend around the knees from the inseam. The trousers' legs are pulled up on the outseam with loose excess fabric folds at the thigh below the buttock. Looking at the figures, we can see that the excess fabric creates a crease in the middle of the thigh, not from the sides of the inseam and outseam. Therefore, it is necessary to edit the patterns on both the front and back to ensure a good fit.

The patterns after adjusting are in red and before adjusting are in blue (**Figure 14**).

The trousers after adjustment show a smooth, flat surface (**Figure 15**).

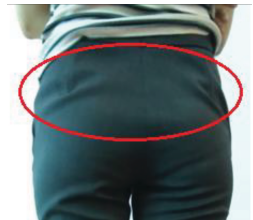When designing for bow legs, it is necessary to rotate the trousers' leg from the knee to the back, tilting toward the outseam according to the shape of the leg so that it is not twisted and there are wrinkles around the leg with the shape of the trousers.

3.3. Causes and directions to adjust patterns for knock-knees (Sample 3)

The knock-knees (X-legs) have ankles that are not facing each other despite standing upright, but the knees are touching each other to create an X shape (**Figure 16**). With this legs' shape, there will be some common defects such as a fly piece creating longitudinal folds from the bottom to the top. The pant leg has wrinkles around the knee area. The side is relatively flat on the outseam, with wrinkles under the buttocks. On the back, horizontal creases stretch the fabric under the buttocks and fold around the knees. The causes of these errors are the fabric that is tight along the seam on the inseam and looser on the outseam (**Figure 17**).

The men's Ao Dai is designed by the 2D method on the Gerber software with patterns as shown in **Figure 3**. The measurements are used to design patterns that have medium measurements in **Table 2**.

TABLE 3 | The plan adjusts trousers' patterns for X-legs.

Errors	Causes	Adjustment
 Figure 18 | Wrinkles at the knees.	Because of the arched leg shape, the knees are brought together toward the inseam of the trousers. As a result, the fabric is stretched toward the inseam, creating folds that pull horizontally from the rib (**Figure 18**).	Move the center line from the knee to the outseam by 0.5 cm. Rotate the back pattern.
 Figure 19 | Wrinkles from the outseams to darts.	The hip side is concave due to the small hips, but the pattern is much curvature. So, the excess fabric creates horizontal folds (**Figure 19**).	Reduce the curvature of the outseam at the hip to 0.25 cm.
 Figure 20 | Wrinkles from lower buttocks to mid-thighs.	The thighs are large in width. This is a cause for the fabric that stretches to the sides, creating wrinkles across the thighs (**Figure 20**).	Again draw the inseam.

The front and back of the trousers are adjusted at the foot position such as on the original basic pattern. This is the origin of the defect. Adjustment details are given in **Table 3**.

The patterns of trousers after adjusting (**Figure 21**) are worn on the body (**Figure 22**), in which the basic pattern is in blue and the adjusting pattern is in red.

Comment: When we design trousers' patterns for X-legs, it is necessary to rotate the trousers' leg from the knee to the hem, tilting toward the outseam according to the shape of the leg. The tube is not twisted, and there are wrinkles around the leg for the tight trousers. However, the best solution is to advise customers to choose the style of wide trousers to help conceal their legs.

3.4. Causes and directions to adjust patterns for the body shape with big waist but small thigh (Sample 4)

The body characteristics of this type of person are big waist and small thigh. The front belly is bigger than the back belly (**Figure 23**). From the above body characteristics, it can be seen that the front body is affected by the measurement of the lower abdomen. In addition, the thigh area will also be affected due to the imbalance with the waist.

Figure 23 shows that areas such as the front door and the back of the trousers at the position of the thigh do not fit and need to be adjusted to the actual measurement of the patterns to ensure the comfort and appearance of the wearer. The details of the adjustment are shown in **Table 4**.

The patterns of trousers after adjusting (**Figure 27**) are worn on the body (**Figure 28**), in which the basic pattern is in blue and the adjusting pattern is in red.

Comment: The trousers after editing are smooth and flat. If body shapes have a large waist and a small thigh, it is necessary caution to cause drawing curves of the bottom and

FIGURE 22 | Trousers' front, back, and side after adjustment for X-legs.

FIGURE 23 | The front, back, and hip sides of the body shape with a big waist but small thighs before adjustment.

the inseam and outseam. Another solution is to choose loose-fitting trousers to hide the flaws of your legs. Also, to cover up their belly, people with big bellies wear trousers with a waist girth that goes around the largest part of the belly. Wearing trousers with a belt that rests above or below the largest belly is not the right approach. This will make your abdomen more noticeable.

3.5. Testing the results for the adjustment of the trousers' patterns

After adjusting and sewing, the trousers were surveyed and tested with a sample of 10 people/trousers style. Survey subjects include four groups of people with straight legs, bow legs, X-shaped body shapes, and big waists and slender thighs.
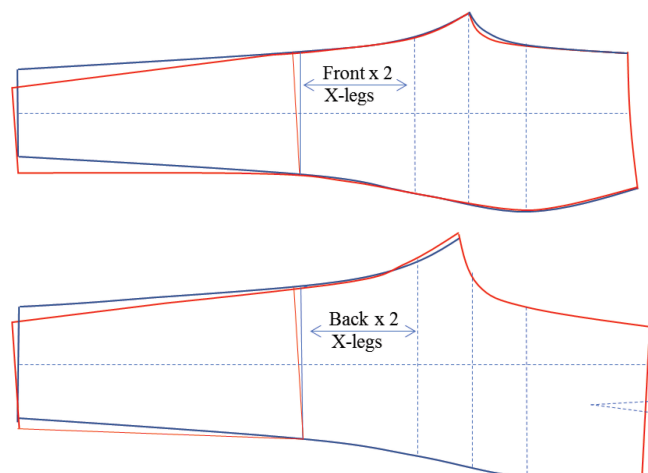

FIGURE 21 | The patterns before and after adjustment for the X-legs (the blue is before the adjustment, and the red is after adjustment).

TABLE 4 | The plan adjusts trousers' patterns for the body shape with a big waist but slender thighs.

Errors	Causes	Adjustment
Figure 24 | The front of the trousers is judged to be relatively fit compared to the body. The right front body is flat and smooth, but the left front body has wrinkles at the crotch position.	Because of the difference between the protruding abdomen compared to the thigh area, the fabric hugs the lower abdomen and the thigh area has excess fabric. The shallow bottom curve causes excess fabric at the crotch (**Figure 24**).	Draw the bottom of the front body deeper, about 0.5 cm.
Figure 25 | There are folds under the buttocks along the thighs.	This phenomenon is caused by the excess of fabric at the thigh position, creating wrinkles that pull down (**Figure 25**).	To overcome the big butt defect, we adjust it by reducing the curve of the outseam from the waist to the thighs by 0.5 cm. In addition, it is necessary to reduce the inseam curve at the thigh area by 0.75 cm.
Figure 26 | On the side: wrinkles appear along the ribs due to the excess of the thighs on the back of the body.	The excess fabric under the butt to the trouser leg (**Figure 26**).	The inseam curves the line from the bottom to the thigh to 0.75 cm to ensure a better fit. At the position of the outseam, reduce 0.25 cm.

In each body shape group, the waist and thigh measurements of the selected test wearer fell within a tolerance of ± 1 cm. The objective of the survey is to assess the satisfaction level of the trousers' fit in each group of testers. Survey respondents try on the product and make a rating by filling in the corresponding boxes after trying on the product. After the adjustment of samples to check and assess the fit, the Likert scale is used to evaluate the quality of samples for five criteria on five levels:

1. Very unsatisfied. The trousers do not fit, the size does not match, and the shape does not fit.

2. Not satisfied.

3. Average. The trousers are fit.

4. Satisfied. The trousers are quite fit.

5. Very satisfied. The trousers are very fit.

The results of Sample 1 are presented in **Tables 5** and **6**.

Based on the average values calculated above, positions such as waist, thigh, pocket, and hip circumference for straight legs have an average value of 3.8–4.3. It is a fit good. The waistline has an average value of 4.3 which is within a very good fit rating. When testing Cronbach's alpha reliability

FIGURE 27 | The patterns before and after adjustment for a body shape with a big waist and small thighs (the blue is before the adjustment, and the red is after adjustment).
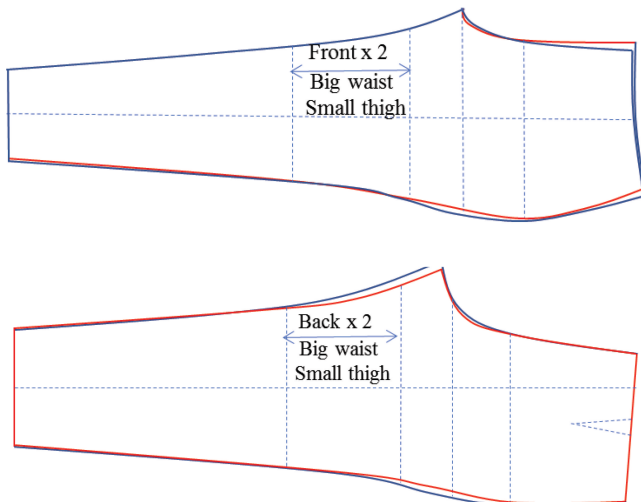

FIGURE 28 | The front, back, and hip sides of the body shape with a big belly, big butt, and small thighs after adjusting.

coefficient on the SPSS software, the results are in the range of 0.636–0.732, and the total result of the evaluation criteria is 0.746. This shows that the survey results are reliable.

The results of the trousers for bow legs of Sample 2 are presented in **Tables 7** and **8**.

Based on the average values calculated above, positions such as waist, thigh, pocket, and hip circumference for bow legs have an average value of 3.9–4.2. It is a fit good. The waistline has an average value of 4.5 which is within a very good fit rating. When testing Cronbach's alpha reliability coefficient on the SPSS software, the results are in the range of 0.679–0.813, and the total result of the evaluation criteria is 0.797. This shows that the survey results are reliable.

The results of the trousers for X-legs of Sample 3 are presented in **Tables 9** and **10**.

Based on the average values calculated above, positions such as waist, thigh, pocket, and hip circumference for X-legs

TABLE 5 | The survey results on the level of satisfaction about the fit of wearers with straight legs.

	Satisfaction with the fit of the trousers				
Wearer	Waist girth	Pocket	Hip girth	Thigh girth	Outseam
1	3	4	4	3	4
2	4	4	3	4	3
3	4	3	4	4	4
4	3	4	4	4	3
5	4	3	4	3	4
6	4	5	5	5	5
7	3	4	3	4	5
8	4	5	5	4	5
9	4	4	3	3	5
10	5	5	5	4	5
Average	3.8	4.1	4	3.8	4.3

TABLE 6 | Analysis results of Cronbach's alpha coefficient of Sample 1.

	Item-total statistics			
	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Cronbach's alpha if item deleted
Waist	16.2000	5.067	0.421	0.731
Pocket	15.9000	4.100	0.677	0.636
Hip	16.0000	4.000	0.612	0.659
Thigh	16.2000	5.067	0.421	0.731
Outseam	15.7000	4.456	0.441	0.732

TABLE 7 | The survey results on the level of satisfaction with Sample 2.

	Satisfaction with the fit of the trousers				
Wearer	Waist girth	Pocket	Hip girth	Thigh girth	Outseam
1	4	3	4	3	4
2	4	5	5	5	5
3	4	3	4	4	4
4	3	4	4	4	3
5	4	3	4	3	4
6	4	5	5	5	5
7	3	4	3	4	5
8	4	5	5	4	5
9	4	4	3	3	5
10	5	5	5	4	5
Average	3.9	4.1	4.2	3.9	4.5

have an average value of 3.9–4.2. It is a fit good. The waistline has an average value of 4.5 which is within a very good fit rating. When testing Cronbach's alpha reliability coefficient

TABLE 8 | Analysis results of Cronbach's alpha coefficient of Sample 2.

	Item-total statistics			
	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Cronbach's alpha if item deleted
Waist	16.7000	6.233	0.368	0.813
Pocket	16.5000	4.056	0.788	0.679
Hip	16.4000	4.711	0.662	0.730
Thigh	16.7000	5.122	0.579	0.758
Outseam	16.1000	5.433	0.506	0.780

TABLE 9 | The survey results on the level of satisfaction with Sample 3.

	Satisfaction with the fit of the trousers				
Wearer	Waist girth	Pocket	Hip girth	Thigh girth	Outseam
1	4	5	5	4	5
2	5	4	3	3	5
3	5	5	5	4	5
4	3	4	4	4	3
5	4	3	4	3	4
6	5	4	5	5	5
7	3	4	3	4	5
8	4	3	4	3	4
9	5	4	5	5	5
10	4	3	4	4	4
Average	4.2	3.9	4.2	3.9	4.5

TABLE 10 | Analysis results of Cronbach's alpha coefficient of Sample 3.

	Item-total statistics			
	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Cronbach's alpha if item deleted
Waist	16.5000	4.944	0.507	0.737
Pocket	16.8000	5.067	0.522	0.731
Hip	16.5000	4.722	0.583	0.709
Thigh	16.8000	5.067	0.522	0.731
Outseam	16.2000	5.067	0.558	0.719

on the SPSS software, the results are over 0.7. This shows that the survey results are reliable.

The results of the trousers for a big waist and small thighs of Sample 4 are presented in **Tables 11** and **12**.

Based on the average values calculated above, positions such as waist, thigh, pocket, and hip circumference for a big waist and small thigh have an average value of 3.9–4.4. It is

TABLE 11 | The survey results on the level of satisfaction with Sample 4.

	Satisfaction with the fit of the trousers				
Wearer	Waist girth	Pocket	Hip girth	Thigh girth	Outseam
1	4	3	3	4	4
2	5	4	5	5	5
3	4	3	4	4	4
4	3	4	4	5	4
5	4	3	3	4	4
6	5	4	5	5	5
7	4	4	4	3	3
8	5	5	4	5	4
9	5	4	3	3	5
10	5	5	4	5	5
Average	4.4	3.9	3.9	4.2	4.3

TABLE 12 | Analysis results of Cronbach's alpha coefficient of Sample 4.

	Item-total statistics			
	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Cronbach's alpha if item deleted
Waist	16.4000	4.933	0.529	0.733
Pocket	16.9000	4.767	0.545	0.727
Hip	16.9000	4.767	0.545	0.727
Thigh	16.5000	4.500	0.541	0.731
Outseam	16.5000	4.944	0.555	0.725

a fit good. The waistline has an average value of 4.3 which is within a very good fit rating. When testing Cronbach's alpha reliability coefficient on the SPSS software, the results are over 0.7. This shows that the survey results are reliable.

4. Conclusion

The study presented the influence of foot shapes on the design of women's trousers, thereby analyzing the errors caused by bow legs, X-shaped legs, and people with big waists, but small thighs. It shows that two people with the same measurements but different physiques will affect the fit and appearance. The type of body shape according to the group of people is very necessary, thereby editing the pattern to suit each group of people. The dimensions' adjustment coefficients between groups are different, and not uniform, some groups adjust at this measurement position. Others are not, such as the crotch curve being adjusted to different degrees between groups to achieve a comfortable fit. In general, the samples are adjusted to the satisfaction of the wearer's fit. The evaluation results of all samples have

usable reliability. The products after adjustment have been sewn and tried on. The number of sample testers includes 10 people for one style of trousers to test according to the five-level Likert scale. The test results show that Cronbach's alpha coefficient is greater than 0.7. The content of the study will greatly support the employees of the pattern designers of the garment companies as well as in the teaching of subjects related to costume design.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. Maria LM, Philip A, Nickolas SS. A new methodology for the development of sizing systems for the mass customization of garments. *Int J Cloth Sci Technol.* (2010) 22:49–68. doi: 10.1108/09556221011008802

2. Hwa Kyung S, Susan PA. Development of automated custom-made pants driven by body shape. *Cloth Text Res J.* (2012) 30:251–66. doi: 10.1177/0887302X124620

3. Susan PA, Lucy D. A study of automated custom fit: readiness of the technology for the apparel industry. *Cloth Text Res J.* (2006) 24:121–36. doi: 10.1177/0887302X06024002

4. Gina P, Lenda JC. Fit preferences of female consumers in the USA. *J Fash Market Manage.* (2007) 11:366–79. doi: 10.1108/13612020710763119

5. Henson SK. *The development of a method for determining the best-fit shape for the crotch seam of men's pants.* Master's Thesis. Virginia Beach: VtechWorks (1991).

6. Lin W. *Determination of Distance Ease at Crotch Curve for Customized Jeans.* Ph.D. thesis. Austin, TX: University of Texas at Austin (2014).

7. Ngo NH. *Nghien cuu thiet ke duong cong tren san pham quan au nam.* Master's Thesis. Hanoi: Hanoi University (2009).

8. Bubonia JE. *Apparel Quality: A Guide to Evaluating Sewn Products.* London: Bloomsbury (2014).

9. Susan PA, Suzanne L, Katherine S, Lindsay LC. Using 3D scans for fit analysis. *J Text Apparel Technol Manage.* (2011) 4:1.

10. Kirsi L, Ingun GK, Benedicte H. Materialize ideals: sizes and beauty. *J Current Cult Res.* (2011) 3:19–41.

11. Stecker P. *The Fashion Design Manual.* Melbourne: Macmillan Education Australia (1996).

12. TCVN 2112-77. *Quan au-Phan loai chat luong cat may bang phuong phap cho diem.* Vietnam: TCVN (1977).

13. Alexander M, Connell LJ, Presley AB. Clothing fit preferences of young female adult consumers. *Int J Cloth Sci Technol.* (2005) 17:52–64. doi: 10.1108/09556220510577961

14. Elizabeth B, Karen LB. An analysis of apparel fit sessions. *J Text Apparel Technol Manage.* (2005) 4:1–5.

15. Hwa KS, Susan PA. An exploratory study of the validity of visual fit assessment from three-dimensional scans. *Cloth Text Res J.* (2010) 28:263–78. doi: 10.1177/0887302X10376411

16. Trong H, Ngoc CNM. *Research Data Analysis with SPSS (2).* Vietnam: University of Economics Ho Chi Minh City (2008).

17. Nguyen TM. *Thiet ke trang phuc.* Vietnam: Vietnam National University Ho Chi Minh City Publishing (2017).

18. Kidzphysio. *Knock knees and bow legs.* Singapore: Kidzphysio (1977).