

# Preface

A large international conference on industrial engineering and operations research was held in Hong Kong, March 21–23, 2007, under the International Multi-Conference of Engineers and Computer Scientists (IMECS) 2007. The IMECS 2007 is organized by the International Association of Engineers (IAENG), a nonprofit international association for engineers and computer scientists. The IMECS conferences serve as platforms for the engineering community to meet with each other and to exchange ideas. The conferences have also struck a balance between theory and application development. The conference committees consist of over 200 committee members who are mainly research center heads, faculty deans, department heads, professors, and research scientists from over 30 countries. The conferences are truly international meetings with a high level of participation from many countries. The response that we have received for the multi-conference is excellent. There have been more than 1100 manuscript submissions for the IMECS 2007. All submitted papers have gone through the peer review process, and the overall acceptance rate is 58.46%.

This volume contains revised and extended research articles on industrial engineering and operations research written by prominent researchers participating in the multi-conference IMECS 2007. Topics covered include quality management systems, reliability and quality control, engineering experimental design, computer-supported collaborative engineering, human factors and ergonomics, computer-aided manufacturing, manufacturing processes and methods, engineering management and leadership, optimization, transportation network design, stochastic modeling, queuing theory, and industrial applications. The papers are representative in these subjects, sitting at the top end of the highest technologies in these fields. This book presents state-of-the-art advances in industrial engineering and operations research and serves as an excellent reference work for researchers and graduate students working with industrial engineering and operations research.

# Chapter 2

## A Study of Comparative Design Satisfaction Between Culture and Modern Bamboo Chair

Vanchai Laemlaksaku and Sittichai Kaewkuekool

**Abstract** The objective of this paper was to examine the cognitive domain when using the modern bamboo chair from Pai Tong (*Dendrocalamus asper* Backer) in size, physical construction, and shape. The modern bamboo chair was compared with the culture one in terms of its design and comfort level. A questionnaire with rating scales was used as a tool to collect data from respondents. Sixty people were randomly selected from King Mongkut's Institute of Technology North Bangkok, Thailand to participate for satisfaction tests. They were asked to rate their responses after sitting on both chairs. The results showed that the modern bamboo chair is appropriate to use and better than the old one. The correlation was shown to be significant at the level of 0.01. The width, height, and depth of the modern bamboo chair were shown more appropriate than the culture bamboo chair by 40.00%, 26.67%, and 26.67%, respectively. Therefore, as shown in the results, the modern bamboo chair is appropriate for shape and could be used to replace the old one.

**Keywords:** Anthropometric · laminated bamboo · chair

### 2.1 Introduction

Anthropometric measurements are an important factor that should be taken into account for all designs. Most designs were considered on basic information received from customer needs and designers who would like to serve those needs. Therefore, the design for 5th and 95th percentiles and average for male and female might

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be used for serving those needs. During the past decade, ergonomic research has focused especially on the design of work furniture based on biomechanics of the human body. Many researchers dealt with the principles for the design of chairs and desks in the workplace, particularly for computer system users [1–3]. This would indicate that a chair should be designed to fit the human rather fitting the human to the workplace. However, for a period of time, little interest was shown in the design of bamboo chair furniture for use in restaurants. During this time, it was called a *culture bamboo chair*.

Potential design variables are numerous and have included variations in seat cushioning, seat fabrics, backrest designs, lumbar support, and seat height. Some of these design variables were shown to have quantifiable impacts upon seat-pan interface pressure. Specifically, many studies have indicated significant differences in degrees of cushion thickness, density, and composition and chair contouring [4, 5]. Based on these variables, many body dimensions were considered for modern bamboo furniture design. However, most designs used static information to design the seat, while working humans have to move their body. Based on this information, movement allowance should be taken into account when considering the modern bamboo chair.

Moreover, due to reduction of wood resources and the increased restriction of wood harvest, the development of wood substitutes has become essential in resolving the shortage of wood resources in many countries. Bamboo has recently been rediscovered as a potential source of wood substitutes owing to its properties of excellent strength, easy processing, and growth that is more rapid than that of common trees.

From the past decade, bamboo has been used in the modern factory for production of paper, bamboo blinds, and barbeque skewers. Bamboo is not commonly used in modern furniture production due to its round shape. However, laminated bamboo, a wood substitute product made from bamboo, became available in Europe and the USA primarily as flooring material. Moreover, laminated bamboo could also be used in many other applications including furniture manufacturing.

The objectives of this research were to study the evaluation of the cognitive domain toward the modern furniture made from laminated bamboo. In this study, a mature *Dendrocalamus asper* Backer bamboo was selected.

## 2.2 Methodology

### 2.2.1 Design and Fabrication

- Determine the body dimensions that were important to use for chair design such as seat height, depth, and width and width of cushion.
- Collect and study information of customers who decide to buy the product. Subjects were randomly selected based on interested groups and were studied for anthropometry data. This information is shown in Tables 2.1 and 2.2 and follows the standard of pheasant in body dimensions as shown in Fig. 2.1.

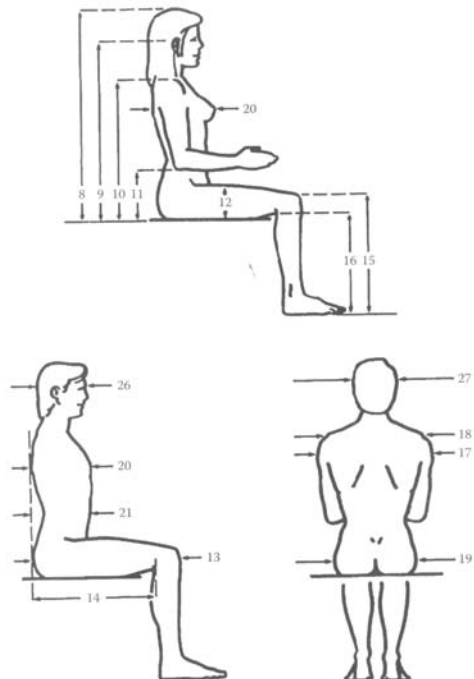
**Table 2.1** Anthropometric estimates of male student of KMITNB (all dimensions in centimeters) [7]

	Body dimensions	Mean	5th percentile	95th percentile	SD
14	Buttock–popliteal length	48.14	43.37	52.81	2.84
16	Popliteal height	39.15	34.35	43.95	2.92
19	Hip breadth	33.68	30.49	36.87	1.94

**Table 2.2** Anthropometric estimates female student of KMITNB (all dimensions in centimeters) [8]

	Body dimensions	Mean	5th percentile	95th percentile	SD
14	Buttock–popliteal length	44.25	37.23	51.27	4.27
16	Popliteal height	36.96	30.97	42.94	3.64
19	Hip breadth	34.97	31.28	38.65	2.24

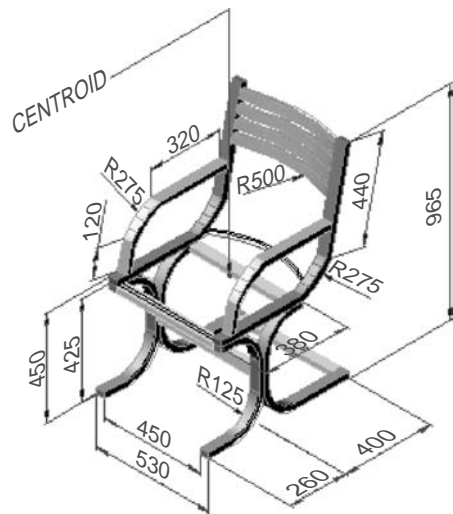
- Determine the body dimension to design for in the modern chair by selecting data for the 5th and 95th percentiles, which should cover all types of users, as follows:
  - Seat height: Selected number 16 popliteal height, 95th percentile of male = 43.95 cm plus the height of shoes = 1.00 cm, which equals 44.95 cm (our design is 45.00 cm).

**Fig. 2.1** Body dimensions [6]

**Fig. 2.2** Culture bamboo chair



- Seat width: Selected number 19 hip breadth, 95th percentile of female = 38.65 cm plus the allowance of width = 6.00 cm, which equals 44.65 cm (our design is 45.00 cm).
- Seat depth: Selected number 14 buttock–popliteal, average of female and male = 46.20 cm (our design is 47.00 cm).
- The concept development was created by a revolution in the culture bamboo arm-chair design, as shown in the Fig. 2.2. The research model is shown in Figs. 2.3 and 2.4. Details of the modern bamboo chair’s fabrication can be found in [9].



**Fig. 2.3** Dimensions of modern bamboo chair

**Fig. 2.4** Modern bamboo chair

### ***2.2.2 Sample Selection***

The participants of this research consisted of staff and students from King Mongkut's Institute of Technology, North Bangkok. Their ages ranged from 18 to 60 years old. A random sampling of 60 people participated by submitting their subjective feedback regarding the modern bamboo chair versus the culture bamboo chair.

### ***2.2.3 Questionnaire***

The questionnaire consisted of three parts.

The first part of the questionnaire was general questions used to record demographic information such as height, weight, gender, and occupation.

The second part reflected the participants' subjective views regarding the culture bamboo chair. This part consisted of two sections. In the first section the participant was asked to rate the culture bamboo chair's dimensional appropriateness for example, height, width, and depth of chair, on an ordinal scale. In the second section the participant was asked to rate the culture bamboo chair's comfort level on an ordinal scale according to eight ergonomic points of the body: neck, shoulders, back, waist, tailbone, thighs, knees, and feet. The scale was from 1 to 4 corresponding to comfortable, slightly uncomfortable, uncomfortable but tolerable, and uncomfortable and intolerable, respectively. Once the subjects rated their responses, the data were used to calculate an average, which was interpreted as follows:

- Score between 1.00 and 1.25 corresponded to comfortable.
- Score between 1.26 and 2.50 corresponded to slightly uncomfortable.
- Score between 2.51 and 3.25 corresponded to uncomfortable but tolerable.
- Score between 3.26 and 4.00 corresponded to uncomfortable and intolerable.

**Table 2.3** The culture and modern bamboo chairs rated by dimensional appropriateness (the top numeral is a tally of votes and the bottom number in parentheses is a percentage of total votes)

	Culture bamboo chair			Modern bamboo chair		
	A	IB	IA	A	IB	IA
SH	40 (66.67%)	20 (33.33%)	0 (0%)	56 (93.33%)	4 (6.67%)	0 (0%)
SW	21 (35.00%)	38 (63.33%)	1 (1.67%)	45 (75.00%)	15 (25.00%)	0 (0%)
SD	36 (60.00%)	22 (36.67%)	2 (3.33%)	52 (86.67%)	8 (13.33%)	0 (0%)
SB	30 (50.00%)	30 (50.00%)	0 (0%)	42 (70.00%)	18 (30.00%)	0 (0%)
HA	–	–	–	47 (78.33%)	13 (21.67%)	0 (0%)

A = appropriate, IB = inappropriate but tolerable, IA = inappropriate and intolerable, SH = seat height, SW = seat width, SD = seat depth, SB = seat back slope, HA = height of chair armrest

The third part reflected the participants’ subjective views regarding the modern bamboo chair. This part consisted of three sections. In the first and second sections, the participant was asked to rate the modern bamboo chair’s dimensional appropriateness and comfort level. The third section consisted of open- and close-ended questions regarding the modern bamboo chair’s aesthetic appeal as it applied to design, cushion, arms, and legs.

## 2.3 Results

### 2.3.1 Dimensional Appropriateness of Chair

From Table 2.3, height of the culture bamboo chair’s appropriateness level was rated at 66.67% compared to that of the laminated bamboo chair’s 93.33%, i.e., 26.67% more people rated the modern bamboo chair’s height as appropriate. The width of the culture bamboo chair’s appropriateness level was rated at 35.00% compared to that of the modern bamboo chair’s 75.00%, i.e., 40.00% more people rated the modern bamboo chair’s width as appropriate. The depth of the culture bamboo chair’s appropriateness level was rated at 60.00% compared to that of the modern bamboo chair’s 86.67%, i.e., 26.67% more people rated the modern bamboo chair’s depth as appropriate. The back slope of the culture bamboo chair’s appropriateness level was rated at 50.00% compared to that of the modern bamboo chair’s 70.00%, i.e., 20.00% more people rated the modern bamboo chair’s back slope as appropriate.

The results on correlation are shown in Tables 2.4 and 2.5. Table 2.4 shows the correlation on culture bamboo chair and indicates that all the designs for SH, SW, SD, and SB were shown significant at the level of 0.01. Although all results

**Table 2.4** Correlation for all designs of the culture bamboo chair

	SH	SW	SD	SB	HA
<b>SH</b>					
Pearson correlation	1	.536**	.844**	.707**	a
Sig. (2-tailed)	.60	.000	.000	.000	
N		60	60	60	60
<b>SW</b>					
Pearson correlation	.536**	1	.629**	.725**	a
Sig. (2-tailed)	.000	.60	.000	.000	
N	60		60	60	60
<b>SD</b>					
Pearson correlation	.844**	.629**	1	.776**	a
Sig. (2-tailed)	.000	.000	.60	.000	
N	60	60		60	60
<b>SB</b>					
Pearson correlation	.707**	.725**	.776**	1	a
Sig. (2-tailed)	.000	.000	.000	.60	
N	60	60	60		60
<b>HA</b>					
Pearson correlation	a	a	a	a	a
Sig. (2-tailed)					
N	60	60	60	60	60

\*\*Correlation is significant at the 0.01 level (2-tailed)

\*Can not be computed because at least one of the variables is constant

SH seat height, SW seat width, SD seat depth, SB seat back slope, HA height of chair armrest

**Table 2.5** Correlation for all designs of the modern bamboo chair

	SH	SW	SD	SB	HA
<b>SH</b>					
Pearson correlation	1	.463**	.681**	.408**	.508**
Sig. (2-tailed)	.60	.000	.000	.000	.000
N		60	60	60	60
<b>SW</b>					
Pearson correlation	.463**	1	.679**	.882**	.911**
Sig. (2-tailed)	.000		.000	.000	.000
N	60	60	60	60	60
<b>SD</b>					
Pearson correlation	.681**	.679**	1	.599**	.746**
Sig. (2-tailed)	.000	.000		.000	.000
N	60	60	60	60	60
<b>SB</b>					
Pearson correlation	.408**	.882**	.599**	1	.803**
Sig. (2-tailed)	.001	.000	.000		.000
N	60	60	60	60	60
<b>HA</b>					
Pearson correlation	.508**	.911**	.746**	.803**	1
Sig. (2-tailed)	.000	.000	.000	.000	
N	60	60	60	60	60

\*\*Correlation is significant at the 0.01 level (2-tailed)

SH = seat height, SW = seat width, SD = seat depth, SB = seat back slope, HA = height of chair armrest



**Table 2.6** Eight ergonomic dimensions of the body for the culture bamboo chair

Dimension	C	S	U	UI	Mean	Variance	Results
Neck	32 (53.33%)	18 (30.00%)	10 (16.67%)	0 (0%)	1.62	0.756	C
Shoulders	23 (38.33%)	32 (53.33%)	5 (8.33%)	0 (0%)	1.69	0.620	C
Back	11 (18.33%)	32 (53.33%)	14 (23.33%)	3 (5.00%)	2.13	0.785	S
Waist	18 (30.00%)	31 (51.67%)	9 (15.00%)	2 (3.33%)	1.90	0.768	S
Tail bone	17 (28.33%)	28 (46.67%)	10 (16.67%)	5 (8.33%)	2.03	0.894	S
Thighs	29 (48.33%)	21 (35.00%)	10 (16.67%)	0 (0%)	1.67	0.747	C
Knees	36 (60.00%)	12 (20.00%)	10 (16.67%)	2 (3.33%)	1.62	0.879	C
Feet	36 (60.00%)	14 (23.33%)	8 (13.33%)	2 (3.33%)	1.59	0.844	C

C = comfortable, S = slightly uncomfortable, U = uncomfortable but tolerable, UI = uncomfortable and intolerable

**Table 2.7** Correlation between eight ergonomic dimensions and the comfort level of sitting in a culture bamboo chair

	Neck	Shoulders	Back	Waist	Tailbone	Thighs	Knees	Feet
<b>Neck</b>								
Pearson Correlation	1	.773**	.785**	.822**	.830**	.958**	.910**	.928**
Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000
N	60	60	60	60	60	60	60	60
<b>Shoulders</b>								
Pearson Correlation	.773**	1	.764**	.841**	.857**	.817**	.726**	.737**
Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000
N	60	60	60	60	60	60	60	60
<b>Back</b>								
Pearson Correlation	.785**	.764**	1	.847**	.894**	.783**	.823**	.813**
Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000
N	60	60	60	60	60	60	60	60
<b>Waist</b>								
Pearson Correlation	.822**	.841**	.847**	1	.925**	.841**	.832**	.836**
Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000
N	60	60	60	60	60	60	60	60
<b>Tailbone</b>								
Pearson Correlation	.830**	.857**	.894**	.925**	1	.838**	.843**	.835**
Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000
N	60	60	60	60	60	60	60	60
<b>Thighs</b>								
Pearson Correlation	.958**	.817**	.783**	.841**	.838**	1	.874**	.893**
Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000
N	60	60	60	60	60	60	60	60
<b>Knees</b>								
Pearson Correlation	.910**	.726**	.823**	.832**	.843**	.874**	1	.979**
Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000
N	60	60	60	60	60	60	60	60
<b>Feet</b>								
Pearson Correlation	.928**	.737**	.813**	.836**	.835**	.893**	.979**	1
Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	
N	60	60	60	60	60	60	60	60

\*\*Correlation is significant at the 0.01 level (2-tailed)

**Table 2.8** Eight ergonomic dimensions of the body for the modern bamboo chair

Dimension	C	S	U	UI	Mean	Variance	Results
Neck	48 (80.00%)	10 (16.67%)	2 (3.33%)	0 (0%)	1.28	0.609	<b>C</b>
Shoulders	48 (80.00%)	12 (20.00%)	0 (0%)	0 (0%)	1.21	0.413	<b>C</b>
Back	47 (78.33%)	12 (20.00%)	1 (1.67%)	0 (0%)	1.26	0.513	<b>C</b>
Waist	49 (81.67%)	11 (18.33%)	0 (0%)	0 (0%)	1.20	0.401	<b>C</b>
Tail bone	46 (76.67%)	14 (23.33%)	0 (0%)	0 (0%)	1.25	0.434	<b>C</b>
Thighs	47 (78.33%)	13 (21.67%)	0 (0%)	0 (0%)	1.23	0.424	<b>C</b>
Knees	53 (88.33%)	7 (10.67%)	0 (0%)	0 (0%)	1.13	0.340	<b>C</b>
Feet	52 (86.67%)	8 (13.33%)	0 (0%)	0 (0%)	1.16	0.416	<b>C</b>

*C* = comfortable, *S* = slightly uncomfortable, *U* = uncomfortable but tolerable, *UI* = uncomfortable and intolerable

showed significant, some correlation designs, such as SH and SW, still needed to be improved. Another correlation result for the modern bamboo chair is shown in Table 2.5; here all the designs for SH, SW, SD, and SB of the modern chair are significant at the level of 0.01.

### 2.3.2 Comfort Level of Chair

From Table 2.6, results for the culture bamboo chair were shown to be comfortable in the area of neck, shoulder, thigh, knee, and feet. The result for correlation between body dimension and comfort of sitting for the culture bamboo chair is shown in Table 2.7. The correlation was shown significant at the level of 0.01 for all dimensions.

As seen in Table 2.8, the results from participants indicate that the modern bamboo chair was comfortable at all eight ergonomic body points. Another result of correlation for designs between body dimension and comfort of sitting for the modern bamboo chair is shown in Table 2.9. The correlation was significant at the level of 0.01 for all dimensions.

Subjects who rated the culture bamboo and modern bamboo chairs as dimensionally appropriate were divided into three weight classes; 40 to 55 kg, 56 to 71 kg, and 72 to 85 kg. As shown in Table 2.10, the weights of participants are a factor in the chair's dimensionally appropriate level. The dimensional appropriateness of the culture bamboo chair's width was found mostly inappropriate because it is too narrow. Data in Table 2.11 show that the modern bamboo chair is dimensionally more appropriate at all participant weight classes.

**Table 2.9** Correlation between eight ergonomic dimensions and the comfort level of sitting in a modern bamboo chair

	Neck	Shoulders	Back	Waist	Tailbone	Thighs	Knees	Feet
<b>Neck</b>								
Pearson Correlation	1	.942**	.930**	.907**	.854**	.895**	.772**	.805**
Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000
N	60	60	60	60	60	60	60	60
<b>Shoulders</b>								
Pearson Correlation	.942**	1	.923**	.948**	.906**	.915**	.727**	.784**
Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000
N	60	60	60	60	60	60	60	60
<b>Back</b>								
Pearson Correlation	.930**	.923**	1	.882**	.918**	.963**	.718**	.759**
Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000
N	60	60	60	60	60	60	60	60
<b>Waist</b>								
Pearson Correlation	.907**	.948**	.882**	1	.859**	.901**	.767**	.828**
Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000
N	60	60	60	60	60	60	60	60
<b>Tailbone</b>								
Pearson Correlation	.854**	.906**	.918**	.859**	1	.953**	.659**	.711**
Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000
N	60	60	60	60	60	60	60	60
<b>Thighs</b>								
Pearson Correlation	.895**	.951**	.963**	.901**	.953**	1	.691**	.746**
Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000
N	60	60	60	60	60	60	60	60
<b>Knees</b>								
Pearson Correlation	.772**	.727**	.718**	.767**	.659**	.691**	1	.927**
Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000
N	60	60	60	60	60	60	60	60
<b>Feet</b>								
Pearson Correlation	.805**	.784**	.759**	.828**	.711**	.746**	.927**	1
Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	
N	60	60	60	60	60	60	60	60

\*\*Correlation is significant at the 0.01 level (2-tailed)

**Table 2.10** Analysis of the weight of participants who rated the culture bamboo chair on dimensional appropriateness

	Appropriate			Inappropriate		
	40–55 kg.	56–71 kg.	72–85 kg.	40–55 kg.	56–71 kg.	72–85 kg.
SH	21 (35.00%)	14 (23.33%)	5 (8.33%)	11 (18.33%)	8 (13.33%)	1 (1.67%)
SW	12 (20.00%)	4 (6.67%)	5 (8.33%)	20 (33.33%)	18 (30.00%)	1 (1.67%)
SD	19 (31.67%)	13 (21.67%)	4 (6.67%)	13 (21.67%)	9 (15.00%)	2 (3.33%)
SB	18 (30.00%)	7 (11.67%)	5 (8.33%)	14 (23.33%)	15 (25.00%)	1 (1.67%)

SH = seat height, SW = seat width, SD = seat depth, SB = seat back slope

**Table 2.11** Analysis of the weight of participants who rated the modern bamboo chair on dimensional appropriateness

	Appropriate			Inappropriate		
	40–55 kg.	56–71 kg.	72–85 kg.	40–55 kg.	56–71 kg.	72–85 kg.
SH	30 (50.00%)	20 (33.33%)	6 (10.00%)	3 (5.00%)	1 (1.67%)	0 (0%)
SW	24 (40.00%)	16 (26.67%)	5 (8.33%)	8 (13.33%)	6 (10.00%)	1 (1.67%)
SD	29 (48.33%)	17 (28.33%)	6 (10.00%)	4 (6.67%)	4 (6.67%)	0 (0%)
SB	22 (36.67%)	14 (23.33%)	6 (10.00%)	11 (18.33%)	7 (11.67%)	0 (0%)
HA	26 (43.33%)	15 (25.00%)	6 (10.00%)	7 (11.67%)	6 (10.00%)	0 (0%)

SH = seat height, SW = seat width, SD = seat depth, SB = seat back slope, HA = height of chair armrest

**Table 2.12** Analysis of the height of participants who rated the culture bamboo chair on dimensional appropriateness

	Appropriate			Inappropriate		
	150–160 cm	161–170 cm	171–180 cm	150–160 cm	161–170 cm	171–180 cm
SH	14 (23.33%)	16 (26.67%)	10 (16.67%)	8 (13.33%)	7 (11.67%)	5 (8.33%)
SW	7 (11.67%)	9 (15.00%)	5 (8.33%)	13 (21.67%)	20 (33.33%)	6 (10.00%)
SD	12 (20.00%)	15 (25.00%)	9 (15.00%)	8 (13.33%)	10 (16.67%)	6 (10.00%)
SB	10 (16.67%)	11 (18.33%)	9 (15.00%)	11 (18.33%)	12 (20.00%)	7 (11.67%)

SH = seat height, SW = seat width, SD = seat depth, SB = seat back slope

**Table 2.13** Analysis of the height of participants who rated the modern bamboo chair on dimensional appropriateness

	Appropriate			Inappropriate		
	150–160 cm	161–170 cm	171–180 cm	150–160 cm	161–170 cm	171–180 cm
SH	20 (33.33%)	23 (38.33%)	13 (21.67%)	1 (1.67%)	2 (3.33%)	1 (1.67%)
SW	15 (25.00%)	19 (31.67%)	11 (18.33%)	5 (8.33%)	6 (10.00%)	4 (6.67%)
SD	18 (30.00%)	20 (33.33%)	14 (23.33%)	3 (5.00%)	4 (6.67%)	1 (1.67%)
SB	14 (23.33%)	15 (25.00%)	13 (21.67%)	7 (11.67%)	9 (15.00%)	2 (3.33%)
HA	18 (30.00%)	16 (26.67%)	13 (21.67%)	3 (5.00%)	8 (13.33%)	2 (3.33%)

SH = seat height, SW = seat width, SD = seat depth, SB = seat back slope, HA = height of chair armrest

Tables 2.12 and 2.13 show the results that rated the culture and modern bamboo chairs as dimensionally appropriate for height. This dimension was divided into three classes: 150 to 160 cm, 161 to 170 cm, and 171 to 180 cm. The dimensional appropriateness of the culture bamboo chair's width and back slope results is shown in Table 2.12. The height appropriateness level was found to be more appropriate for the tallest participants. On the other hand, the results in Table 2.13 show that the modern bamboo chair is dimensionally appropriate for all participant height classes.

## **2.4 Conclusions**

### ***2.4.1 Dimensional Appropriateness of the Chair***

The participants rated the culture bamboo chair's height appropriateness at 66.67% and the modern bamboo chair's height appropriateness at 93.33%. The participants rated the culture bamboo chair's width appropriateness at 35.00% and the modern bamboo chair's width appropriateness at 75.00%. The participants rated the culture bamboo chair's depth appropriateness at 60.00% and the modern bamboo chair's depth appropriateness at 86.67%. Finally, the culture bamboo chair's back slope appropriateness was rated at 50.00%, and the modern bamboo chair's back slope appropriateness was rated at 70.00%. Moreover, the correlations on designs for culture and modern were shown to have significant differences and to be appropriate for use at the level of 0.01. This would indicate that both bamboo chairs need better design.

### ***2.4.2 Comfort Level***

The culture bamboo chair was found to be more comfortable in the area of neck, shoulder, thigh, knee, and feet. Participants' opinions on the culture bamboo chair were shown as slightly uncomfortable for the back, waist, and tailbone areas.

The modern bamboo chair was found to be more comfortable for all eight ergonomic body points: neck, shoulders, back, waist, tailbone, thighs, knees, and feet. Correlations on sitting comfort were shown to be significantly different at the level of 0.01. This would indicate that both culture and modern bamboo chair designs were acceptable and appropriate for use. However, respondents who were asked to rate their sitting comfort liked the modern bamboo chair better than the old one.

### ***2.4.3 Aesthetic Appeal of the Modern Bamboo Chair***

The color of the modern bamboo chair was found to be aesthetically appealing for 68% of the participants. The style of the chair appealed to 70% of the participants. The armrest appealed to 56% of the participants, while 74% of participants found the softness of the cushion comfortable.

## **2.5 Recommendations**

Although the modern bamboo chair's design was strong enough to hold a person weighing at least 85 kg, the width of the modern bamboo chair legs should be increased to look stronger. Participants suggested that an increase in the width of the armrest would be more comfortable. Finally, participants preferred a darker color, closer to the natural bamboo color.

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