

PENERAPAN ANTROPOMETRI MALAYSIA KE DALAM REKAAN BANGKU BAR

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Abstrak

Kajian ini menerapkan data antropometri ke dalam rekabentuk bangku bar bagi menjamin keselesaan. Kajian-kajian lepas telah menunjukkan kepentingan dalam memastikan data tubuh badan manusia dimasukkan ke dalam proses rekabentuk perabot atau produk. Selain itu, pendedahan kepada ketidakselesaan kepada duduk boleh menyebabkan pengguna terdedah kepada gangguan otot-rangka (MSDs) dan juga sakit belakang badan. Objektif utama kajian ini adalah bagi menerapkan data antropometri ke dalam proses rekabentuk bangku bar bagi menjamin keselesaan. Data antropometri yang digunakan adalah daripada pangkalan data yang telah dibangunkan dalam kajian terdahulu di mana ianya terdiri daripada 40 parameter dan melibatkan 1216 responden rakyat Malaysia. Setelah selesai proses analisis data, data antropometri yang telah dikumpulkan digunakan dalam merekabentuk dimensi bangku bar baru yang selesa dan ergonomik. Antara dimensi pengukuran yang digunakan adalah ketinggian tempat duduk, lebar tempat duduk, ketinggian penyandar belakang dan ketinggian tempat letak kaki. Oleh itu, kajian ini telah mengeluarkan satu bangku bar baru yang di rekabentuk mengikut dimensi yang sesuai melalui analisis data antropometri bagi memastikan keselesaan dan keselamatan kepada pengguna.

Kata Kunci: Ergonomik, Antropometri, Bangku Bar, Perabot, Rekabentuk

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INCORPORATION OF MALAYSIAN ANTHROPOMETRY INTO BAR STOOL DESIGN

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1.0 Introduction

Chair and table are common furniture found in every kitchen and restaurant area. But nowadays, high stool seat or bar stool are becoming more popular for kitchen and restaurant. The variety in style compare to common chair and the view while eating, drinking or socializing is keeping the high demand of bar stool. This fact is inline with a survey that conducted by Skinner et al. (2005) that show nearly half of the respondents' preferred bar stool while in the restaurant compared to other types of seat.

Stool seat is a single seat on a base of legs with or without armrests (Huff, Archer & Haynes 1991). While the barstool is a high stool seat usually with a footrest and come out with different design. It is often made either from wood or metal. These bar stools usually based on the same standard dimension with different fit, size and adjustability.

Choosing the right bar stool size is important in order to ensure comfort, which eventually can improve sitting posture. Anthropometry has been considered as the very basic core of ergonomics in an attempt to resolve the dilemma of 'fitting people to machine' (Wang et al. 1999). Bridger (1995) and Chou and Hsiao (2005) believed anthropometry is a research area in ergonomics dealing with the measurement of human body dimensions and certain physical characteristics (Rashid et al. 2013).

Several past studies had been conducted in incorporating anthropometry in furniture design. Wang, Lin & Lin (2018) had come out with a design of a height-adjustable desks and chairs. Indri & Chandra (2018) had compared several desk and chairs following the anthropometry of Indonesian undergraduate students. Besides that, Parvez, Shahriar & Kibria (2018) had designed an ergonomically classrom furniture for primary students in Bangladesh. They had collected data from 300 samples and proposed a suitable funiture for the students. While, a Malaysian anthropometry was used in designing an aircraft passesenger seat design. They had proposed a new dimensions of seat that suitable for Malaysian using anthropometry data (Aminian & Romli 2018).

Application of anthropometry data used in designing furniture is widely used around the world. In Malaysia there were several studies that had been conducted but none of the studies were done in designing a bar stool. Thus, the main objective of this study is to incorporate anthropometry data into the design of an ergonomic bar stool that suitable for Malaysia population.

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2:0 Methodology
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This study was done to incorporate the anthropometric data into the design of bar stool to produce an ergonomically design furniture. For many real-world requirements, a relatively crude data collection and analysis are considered sufficient (Pheasant & Haslegrave 2016). There are established



anthropometry data for both Malaysian male and female adults (Mohamad, Deros & Daruis 2013). The subjects were selected based on their age of 21 and above due to 21 usually defined as responsible adult in certain democracy countries such as Malaysia (SPR 2018). All anthropometric data collected were based on MS ISO 7250 standard (2003).

The equipment used in this study comprised of the anthropometric measuring tools such as the Human Body Measuring Kit and Anthropometer. Figure 1 shows the example of some parameters measured for anthropometric data.

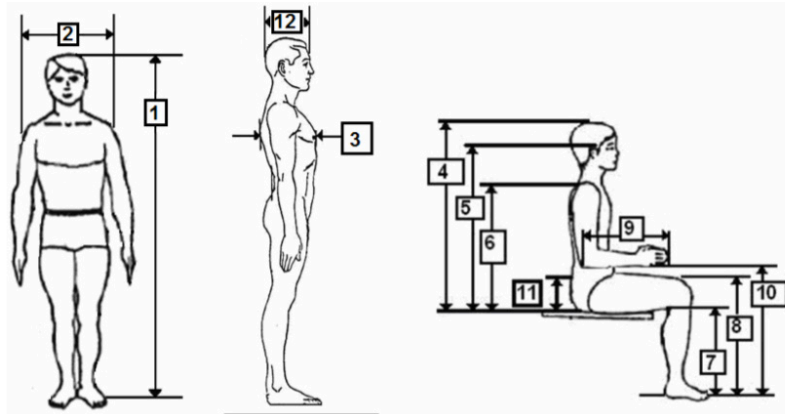


Figure 1: Example of measured anthropometry dimensions

The anthropometric data were measured and recorded in the data form before being transferred into the computerised anthropometric database. For the conceptual design process, the sketches and technical drawing for the designs were done using Solidwork 2017 Software. The design process was conducted as illustrated in Figure 2 according to Morris (2017).



Figure 2: Design process by Morris (2017)

3.0 Results & Discussion

3.1 Anthropometry Measurement

The established anthropometric data published by Mohamad, Deros & Daruis (2013) were consisted of 40 measured dimensions gathered from 1216 male and female Malaysian citizens. As quoted by Bridger (2003), the World Health Organization (1995) recommends that if anthropometric data are to be used as reference standards, a minimum sample size of 200 individuals is needed. The results are tabulated as shown in Table 1 for male and female data. The anthropometric data has been summarized to the mean value, standard deviation value, and the 5th and 95th percentile value. Both percentile values were chosen to cater a wider range of population around 90%.

Table 1: Anthropometric data for 1216 Malaysian citizens with 708 male and 508 female respondents

No	Anthropometric data	Male				Female			
		5%tile	95%tile	Mean	SD	5%tile	95%tile	Mean	SD
1	Stature		1778.67	1636.5	86.16	1494.32	1777.86	1636.09	85.92
2	Eyes Height	1356.1	1685.99	1521.04	99.97	1356.05	1685.27	1520.66	99.76
3	Shoulder Height		1503.55	1344.29	96.52	1184.69	1502.82	1343.75	96.4
4	Elbow Height	875.13	1178.78	1026.96	92.02	875.28	1178.21	1026.75	91.8
5	Oelectron Height	898.11	1170.63	1034.37	82.58	905.58	1161.94	1033.76	77.68
6	Waist Height	568.19	1378.22	973.21		568.7	1377.69	973.2	245.15
7	Knee Height	371.62	558.89	465.25	56.75	371.84	558.99	465.42	56.71
8	Shoulder Breadth	361.64	554.43	458.03	58.42	361.33	554.11	457.72	58.42
9	Chest Breadth	255.02	421.71	338.36	50.51	255.22	421.5	338.36	50.39
10	Chest Depth	143.86	286.74	215.3	43.3	144.22	286.91	215.56	43.24
11	Hip Breadth	262.28	482.06	372.17	66.6	262.64	482.56	372.6	66.64
12	Chest Circumference	652.82	1062.74	857.78		652.95	1062.35	857.65	124.06
13	Wrist Circumference	34.03	303.62	168.83	81.69	34.19	303.45	168.82	81.6
14	Waist Circumference	566.82	1003.27	785.04		567.1	1002.81	784.96	132.03
15	Thigh Circumference	407.57	631.72	519.64	67.92	407.6	631.15	519.38	67.74
16	Calf Circumference	277.5	437.83	357.66	48.58	277.45	437.49	357.47	48.5
17	Sitting Height	707.38	952.86	830.12	74.39	707.55	951.86	829.7	74.03



18	Sitting Eyes Height	588.12	842.19	715.15	76.99	587.82	841.11	714.46	76.76
19	Sitting Shoulder Height	436.8	652.05	544.42	65.23	436.57	651.18	543.87	65.03
20	Popliteal Height	374.83	502.18	438.5	38.59	375.03	502.07	438.55	38.5
21	Cervicale Height	497.6	756.65	627.13	78.5	497.46	755.95	626.7	78.33
22	Buttock Popliteal Length	384.08	541.4	462.74	47.67	384.18	541.23	462.7	47.59
23	Buttock-Foot Length	787.97	1155.06	971.52		793.88	1151.08	972.48	108.24
24	Sitting Knee Height	375.82	614.36	495.09	72.28	376.14	613.71	494.93	71.99
25	Forearm Hand Length	381.2	510.67	445.93	39.23	381.13	510.51	445.82	39.2
26	Shoulder-Elbow Length	280.57	414.1	347.33	40.46	280.47	413.86	347.16	40.42
27	Sitting Elbow Height	137.2	296.6	216.9	48.3	137.23	296.33	216.78	48.21
28	Thigh Clearance	110.64	261.21	185.93	45.63	110.79	261.18	185.99	45.57
29	Hand Length	120.73	247.19	183.96	38.32	120.74	247.09	183.92	38.29
30	Hand Metacarpal Breadth	16.71	154.17	85.44	41.65	16.8	154.09	85.45	41.61
31	Palm Length	43.76	164.77	104.27	36.67	43.78	164.64	104.21	36.62
32	Grip Diameter	8.11	94.85	51.48	26.29	8.13	94.75	51.44	26.25
33	Foot Length	197.45	287.1	242.28	27.17	197.25	287.01	242.13	27.2
34	Foot Breadth	34.11	174.2	104.16	42.45	34.2	174.12	104.16	42.4
35	Shoulder Grip Length	571.87	778.67	675.27	62.67	572	778.31	675.16	62.52
36	Weight	-13.59	142.05	64.23	47.16	-13.8	142.25	64.23	47.29
37	Head Length	152.53	247.17	199.85	28.68	152.56	247.09	199.82	28.65
38	Biacromial Breadth	277.82	472.32	375.07	58.94	277.81	472.11	374.96	58.88
39	Crotch Height	625.61	994.04	809.82		624.45	993.28	808.86	111.77
40	Upper Arm Length	257.61	408.99	333.3	45.87	257.72	408.56	333.14	45.71

The mean value for male stature is 1636.5 (SD = 224) while the mean value for female is 1,564 (SD = 64). Overall, the mean values for all dimensions for male are higher than female dimensions except for hip breadth.

From the dimensions shown in Table 1, several anthropometric dimensions were chosen to



be incorporate in the design of the bar stool. Measurements were chosen with the consideration of the Malaysian anthropometric data for sitting comfort of potential users ranging from 5th percentile to 95th percentile.

3.2 Incorporating Anthropometric Data in Stool Design

In this study, the body dimensions that were incorporated in the bar stool design are thigh clearance, hip breadth and popliteal height. For the evaluation of mismatch between anthropometric measure and the design patterns' dimensions, it was suggested that applied anthropometry and ergonomic principles have to be considered (Castellucci 2010). The calculations used were referred to previous studies by Deros et al. (2013) that incorporate anthropometry data into the design of school laboratory furnitures.

For the value of the bar stool height, the anthropometric data used were the thigh clearance value of 95th percentile male. This data was chosen so that the bar stool height are able to accomodates a wide range of users. The height of bar table was taken from the recommended height for Malaysian population (Cyndee 2016). The calculation for the bar stool height with ergonomic consideration is as follows (NIEHS 2010; Deros et al. 2013):

$$\begin{aligned}\text{Bar Stool height} &= \text{bar table height} - 95^{\text{th}} \text{ male thigh clearance} \\ &= 991\text{mm} - 261\text{mm} \\ &= 730\text{mm}\end{aligned}$$

From the calculation, the height recommended for the bar stool height is 730mm.

Dimension of the seat width was taken from the anthropometric value of hip breadth within the 95th and 50th percentile male. The maximum data was taken from the female population due to women having a wider hip than men that can be explained by the fact that a female pelvis bone is slightly wider than men for reproduction purpose (Mohamad et al. 2010). Thus the value for the seat width is within 483mm and 373mm.

As for the value of the backrest height for this bar stool was taken from guideline for a seat back lumbar support that is around 254mm (Brezlin 2018; Cornell 2016).

The values of the footrests were calculated using the anthropometric data of popliteal height 95th percentile male and 5th percentile female in order to satisfy at least 90% of both male and female population. These footrests are important to avoid the user's leg hanging unsupported while he or she is sitting on the bar stool. The calculation for the footrests was as follows (Deros et al. 2013):

$$\begin{aligned}
 \text{Maximum Footrest height} &= 95^{\text{th}} \text{ male popliteal height} + \text{shoes allowance} \\
 &= 502\text{mm} - 45\text{mm} \\
 &= 547\text{mm}
 \end{aligned}$$

$$\begin{aligned}
 \text{Minimum Footrest height} &= 5^{\text{th}} \text{ female popliteal height} + \text{shoes allowance} \\
 &= 375\text{mm} - 45\text{mm} \\
 &= 420\text{mm}
 \end{aligned}$$

Thus from the data collected in Table 1, the value for bar stool footrest are 547mm and 420mm. The value of the shoes allowance was taken from data suggested by Pheasant (2016). The values that had been calculated were compiled in Table 2.

Table 2: Proposed value of new stool design

No	Bar Stool Dimension	Anthropometric measurement	Estimated value (mm)
1	Stool Height	Thigh Clearance	730mm
2	Seat Width	Hip Breadth	Between 483mm and 373mm
3	Footrest	Popliteal Height	Between 547mm and 420mm
4	Backrest Height	Back Lumbar Support	254mm

3.3 Bar Stool Design Development

The anthropometric data that have been estimated in Table 2 will be incorporated into the bar stool design dimensions. The bar stool 3D developments were constructed using Solid Work 2017 software. Figure 3 shows the proposed dimensions of the bar stool design and Figure 4 shows the isometric view of the bar stool.



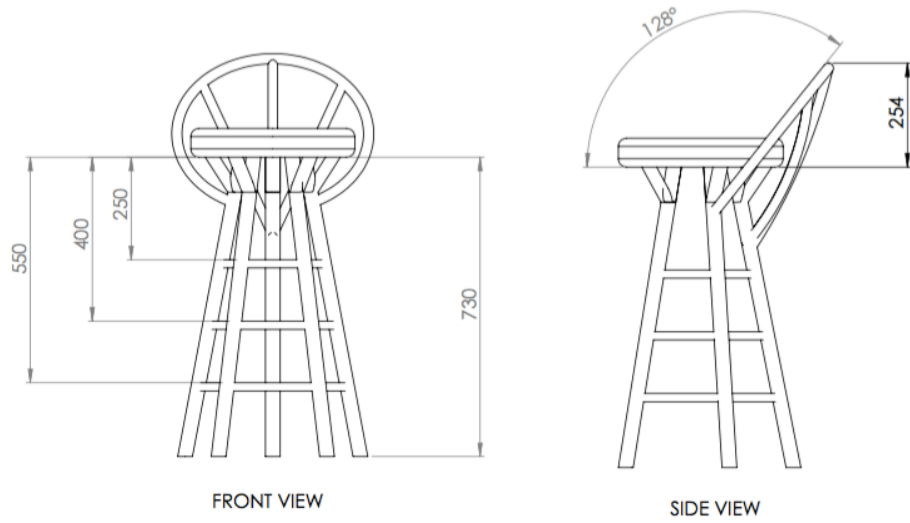


Figure 3: The proposed dimensions of new bar stool





Figure 4: Isometric view of the new bar stool

From the construction of the new bar stool, the proposed height is 730mm. This new height value shows a slight difference from the existing height used, which is usually around 762mm to 900mm. The existing height was proposed according to the European population and as mentioned by past literatures such as Lin et al. (2004) and Hemy et al. (2013) which is often the role of the forensic anthropologist. One of the most valuable steps towards identification is via a biological profile, developed through the application of population specific standards. In disaster victim identification scenarios, fleshed feet are often recovered in footwear; footprints are another potential source of trace evidence found at crime scenes. In medico-legal investigations, feet and footprints can be useful for extrapolating living height, it is thus expedient to determine whether sex can be estimated from the same anthropometric data. The aim of the present study is to develop accurate sex estimation standards for a contemporary Western Australian population from measurements of the feet and footprints. The sample comprises 200 adults (90 males, 110 females, the anthropometric data are different between ethnic diversity and may differ within populations.

4.0 Conclusion

This study had able to produce a new bar stool design by incorporating the ergonomic feature mainly the antropometric data. The objective of this study that is to incorporate the anthropometry data into the design of a bar stool to ensure comfort had been achieved. It is hoped that the outcomes of this study are able to assist the furniture manufacturer and designer in designing a suitable and acceptable bar stool that comply with the Malaysian population through ergonomics approach. The results obtained and disscussed from this study can be served as a standard for furniture's maker in Malaysia in providing a safe and more comfortable furniture to be used by Malaysian population.

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