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Mini-Review

Malaysian Vehicle Seat Anthropometry Studies: A Mini-Review

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ABSTRACT

This paper focuses on anthropometry studies in Malaysia within a 10 years' span. In the beginning, Malaysian anthropometry study has only been the interest of researchers from the medical field. However, in the past 10 years, other fields like the engineering and social studies began to explore aspects of anthropometry. Driver's seat has been the central of ergonomic evaluation and analysis for automotive engineering. The data established for Malaysian driver's seat includes the seat fit parameters, seat postural angles and seat pressure distributions. There were also studies that revealed that the collected data showed significant mismatches between the subjects and the anthropomorphic test device or better known as crash test dummies. Even though currently there are satisfactory data for Malaysian population, these data have to be reviewed subsequently as shown in many nations because there is usually some progress in growth.

Keywords: Anthropometry; Malaysian anthropometry; Seat design; Seat parameters

INTRODUCTION

The anthropometrics design motto is to allow the small person reach and let the large person fit [1]. Anthropometry database development is usually based on specific requirements of the researchers or functional task oriented [2]. Functional task oriented measurements are practiced in many applications especially as ergonomic interventions to solve specific issues rather than for generic purpose or design. It could be specific to a certain workplace or a certain group of subjects. As an instance, a workplace design requires measured anthropometry that could solve complaints such as lower back or upper back pains. However, not all designers especially from the lower end consumer products consider anthropometry in their design. In the end, the users will be the victim of the mismatch, which will either affecting the performance when using the product or causing musculoskeletal disorders.

To illustrate the usage of anthropometry in certain applications, for example in automotive, the vehicle seat design depends on the hip joint or Hip Reference Point (HRP) to the head, hands and the feet. For some manufacturers (of racing cars) it is more common to start with the Accelerator Reference Point (ARP) to the rest of the body going upwards [1]. In the case of cockpit design, the most important aspect is visibility of the many displays to the eye at the correct height. Therefore, in this example, the design starts with the eye or Eye Reference Point (ERP) and to the rest of the body going downwards [3].

The authors of this mini review have been involved in Malaysian anthropometry measurement with focus on vehicle driver's seat data. Daruis, Deros and Nor [4] have been focusing on the static driver's seat data where seat fit parameters were established from 216 subjects; Khamis and Deros [5] study focused on seat pan (body pressure), and Mohamad et al. [6] emphasized on driver's seat adjustability as well as vehicle interior design (seat height, steering wheel position and seat cushion angles). Therefore, the focus of this mini review is on the anthropometry of vehicle seat research.

LITERATURE REVIEW

There are few standards relevant to anthropometry measurement that could be referred to; among others the ISO 7250-1:2017, TR/ISO 7250-2:2010 and TR/ISO 7250-3:2015, ISO 14738 and ISO 15535:2012. These standards provide definitions and

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guidelines of anthropometric measurement methods. Exhaustive databases from Asian are by the Korean Agency for Technology and Standards (2004) and Japan's Research Institute of Human Engineering for Quality Life (2007). NASA (1978) also had quite a large amount of data for their inter-space shuttle designs [7].

Chronologically, anthropometry research in Malaysia began from the clinical and nutritional research area [8,9]. The year 2000 observed more reviews on anthropometry in design for Malaysian context began to appear in academic publications [10,11]. Only circa 2010, there were empirical anthropometry papers on measurements and design [12-14]. However, in the last five years, only a few new data anthropometries were established and few more were predicting more parameters from basic dimensions such as stature and analyzing the existing data statistically [15-18].

Through a subjective evaluation prior to the anthropometry measurement, 100 respondents from the whole 1405 Malaysian subjects from the study by Deros et al. [19] found that seat adjustability is the most important factor that affects comfort followed by cushion material and seat dimensions. It seems that car manufacturers have acquired more or less the dimension that is appropriate for Malaysian's body dimension. Nevertheless, a more recent seat fit parameters were established from 376 Malaysian males and 385 females in a study to design ergonomic driver seats, but the study also suggested seat comfort is by replacing the seat material, from using seat cushion foam to using bean bag foam [20]. Seat dynamic pressure distribution and anthropometric variables i.e. height and weight of the drivers were found to be somewhat correlated [21] and could be a major factor that would influence driving discomfort especially in a long-distance driving or paved road type.

Besides dimensions, and seat pressure, driving posture among Malaysian elderly drivers was recently studied and drivers discomfort was assessed using RULA and QEC [22-24]. And the latest anthropometry study in Malaysia is by Zaki, Husin, Husain, Husain, Ma'aram et al. [25] on Malaysian children and the differences between their data and the existing child dummies for crash tests used by Malaysian Institute of Road Safety Research (MIROS).

Other than automotive-related anthropometry studies, Adnan and Dawal [26] looked at anthropometry of wheelchair users and the able-bodied person and found that the differences are significant. There was also a study that investigated the gap and the error between the Malaysian and Japanese and American population in Digital Enterprise Lean Manufacturing Interactive Application (DELMIA V5R2016) software; where they measured 241 manufacturing industries workers and found 5% error and gap in between the populations [27]. In addition, a very comprehensive children's anthropometric data was collected measuring 2400 school children of 7-11 years old [28].

DISCUSSION

The anthropometric measurement method consists of linear measurements, angular measurements and circumferences. Apart from the ISO documents as above, in order to control the repeatability and avoid variability to reduce random error and bias, World Health Organizations also proposed standardized data collection methodology, strict training and monitoring of data collection personnel, frequent and effective equipment and tools calibration and maintenance and periodic assessment of anthropometric measurement reliability [29].

The diversity of measurement methods can be categorized as one-dimensional (direct anthropometry), two-dimensional (photographic image) and more advanced three-dimensional (scanning image). Table 1 shows the methods used in recent literature to measure and evaluate anthropometry data. Conventional method which is using a manual technique is the most frequent method used in anthropometric data collection. Measuring tape, meter ruler, Vernier calipers, anthropometer, weighing scale are among the conventional equipment used in this data collection.

No	Reference	Conventional methods	Advanced methods	
		1D	2D	3D
1	Khamis and Deros 2018 N=11	Anthropometer	-	-
2	Muralitharan et al. 2017 N=761	Measuring tape	-	-
3	Abd Rahman et al. 2017 N=314	Anthropometer, weighingscale, measuring chair, TTM Martin's human body measuring kit	-	-
4	Mohamad et al. 2016 N=1312	Anthropometer	-	-
5	Deros et al. 2015 N=1405	Ruler, measuring tape,Vernier calipers	-	-
6	Deros et al. 2014	Human body measuring kit, Anthropometer	-	-
7	Ismail et al. 2013 N=3	Measuring tape	Photograph image	-
8	Daruis et al. 2011 N=216	Anthropometer, meter ruler,	-	-

		calipers, measuring tape		
9	Mohamad et al. 2016	L-shape ruler, measuring tape	Vision Assisted Anthropometric Measurement System	-

Table 1: Measurement method for anthropometry parameters.

The photographic and scanning images method can support the existing data collection to be more up to date but with lower cost than the 3D scanning [30]. The significant differences between both conventional and advanced methods could be affected by the measurer's skills, techniques, the interaction with clothing, and technique used by the measurers. Anthropometry measurement requires skill and expertise from an anthropometrist, which during measurement the skin-fold or bone length is hard to measure and cannot be compressed.

Both measurement methods have its advantages and its disadvantages based on the prices, technique and equipment, measurers skills, accuracy and precision. A traditional method has low accuracy and precision caused by a complex anatomy and curvature landmark on the human body. The weakness of two dimensional using photographic image technique affected by the accuracy of numerous images captured, distances, viewing angles and the lighting, nevertheless still very much less cost rather than scanning image (3D). Whilst the most advanced 3D scanning method has strong accuracy in measurement repeatability but for installation equipment and maintenance is extremely pricey.

CONCLUSION

The reliability of anthropometry data might differ from one set to another as there is no gold standard that is agreed or used by all the researchers in Malaysia. More so when there are different techniques available to do the data collection. Even though there are guidelines, however, measurement and analysis of the data profoundly dependent on the expertise of the researchers.

There are few steps that could be taken up to improve anthropometry research in Malaysia. Firstly, other than providing guidelines, a centralized institution that oversees the training of the researcher so that measurement done by any researchers is reliable needs to be established. Secondly, there is an international body that provides a certain anthropometry accreditation scheme. However, a similar body could be developed locally, or at least a local code of practice or a rule is created so that researchers are required to attain the accreditation prior to making any data collection. Finally, no researchers who are doing anthropometry research in Malaysia should be working in silo.

An organization like NIOSH Malaysia or Department of Standards Malaysia could act as the regulator to ensure that the work of various studies is coordinated in a way that ensures communication between various parties transpires. Thus, not only trustworthy anthropometry data could be established, but also, data collected will not be a redundant, instead it will accumulate to the existing records.

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