

Pilot Study: Identifying the Suitable Design of Motorcycle Footboard for Children

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Abstract. It is common to see young pillion riding an underbone motorcycle, whether in urban or federal roads in Malaysia. However, one of the main issues facing young pillion is their safety while on the bike. In motorcycle-related accidents, children usually sustain a lower limb injury because their legs do not properly reach the footrest and make them unbalance on the bike. It is important for young pillion to use a proper footstep pedal accordingly with their correct physical measurements. The main objective of this study is to identify the correct characteristics of the main user and clarify the suitable design of the motorcycle footboard. One of the major aims of this work is to identify children's ergonomics and a child friendly motorcycle footboard to improve body stability on the motorcycle. Using triangulation methodologies, the data were derived from conducting the suitable design of the motorcycle footboard. Based on data, 76% of the underbone motorcycle user used it to send and fetch their children to primary school every day. With that, priority is given to children of 7 to 9 years old. Thus, the anthropometric data of these categories will influence the design criteria of the footboard. On average, the height of young pillion is 122 to 152 cm, which the average footprint size is 19.3 cm to 20.6 cm; whereby these findings were important in design a suitable footboard for children.

Keywords: Children, Pillion, Motorcycle, Safety, Footboard.

1 Introduction

In low- and middle-income countries, motorcycles became one of the main transports. Although the availability of motorcycles has acquired many segments of population mobility that they have not experienced before, a rather rapid increase in numbers vehicles on the road have carried some negatives consequently, including a significant increase in injuries and deaths associated with its circulation [1]. However, motorcyclists have a 26 times higher probability of getting injury or death than car passengers. Meanwhile, accident statistics in Selangor, Malaysia, recorded a decrease last year compared to 2019 [2]. Accident statistics in 2020 recorded 123,244 cases compared to 168, 599 cases in 2019 [2]. A total of 7,525 road accidents, including those involving motorcyclists, were reported during the nine-month implementation of the Movement Control Order (MCO) since March 2020 [3]. According to World Health Organisation (WHO) 2021, the lives of approximately 1.3 million people are cut short due to a road traffic crash every year. Between 20 and 50 million more people suffer non-fatal injuries, with many incurring a disability due to their injury [4]. The number of road accidents in Malaysia is increased during the last 5 years (Figure 1). Meanwhile, the number of fatalities has been steadily reduced from

7,152 in 2016 and showed the lowest number at 6,167 in 2019 during the last 5 years (Figure 2) [5].

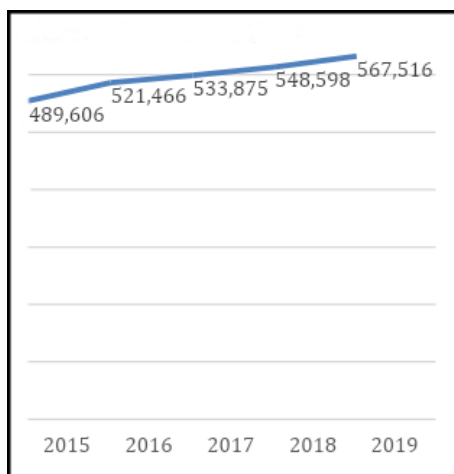


Figure 1: Malaysia Road Accident 2015-2019

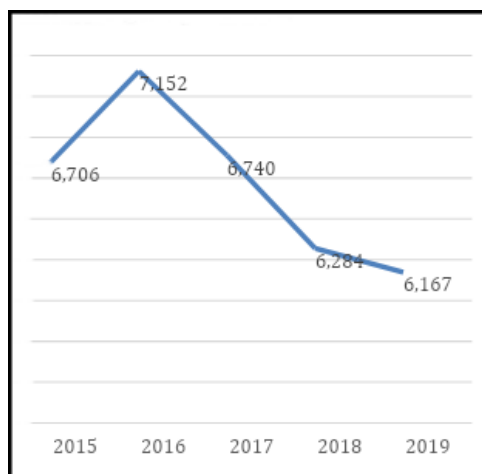


Figure 2: Malaysia Road Fatalities 2015-2019

Children are more likely to get road accidents due to physical development and mentally immature. Minor physical conditions can cause more severe injuries [6]. Some countries have minimum age restrictions of between five and eight years for passengers of on-road motorcycles. However, there is no clear evidence for these limits nor many studies of the physical limits to safe travel as a pillion passenger. Young children under the age of twelve will need constant adult care and guidance as they are extremely vulnerable due to exposure to possible fatal conditions [7]. Based on observations made on children who go to school by motorcycles, the young pillion was uncomfortable and unstable when their feet did not touch the foot pegs or only slightly stepped on them. Apart from that, the observation also found that parents bring their children on motorcycles by sitting in the front, on the fuel tank, in the front basket, and hold with their arms. Existing motorcycles do not have child friendly physical features. However, the rate of motorcycles used is high to send children from home to school daily. Based on each family's ability, then users have no other option to bring their children to school or somewhere. In fact, children need appropriate specifications according to the condition of their characteristics in order to be safer when riding a motorcycle..

2 Young pillion anthropometric data

Motorcycles are one of the most affordable and practical types of motorized transportation around the world. For most of the world's population, motorcycles are the most commonly used type of motor vehicle. There are about 200 million motorcycles in use worldwide or about 33 motorcycles per 1000 people. A large proportion of motorcycles that 58%, are in developing countries such as South and East Asia and Asia Pacific countries, excluding Japan. In 2006, China used 54 million motorcycles, and the annual production of motorcycles are 22 million units. In 2002, production in India with an estimated 37 million motorcycles or mopeds became the largest country using motorcycle vehicles. China ranks second largest in consumption with

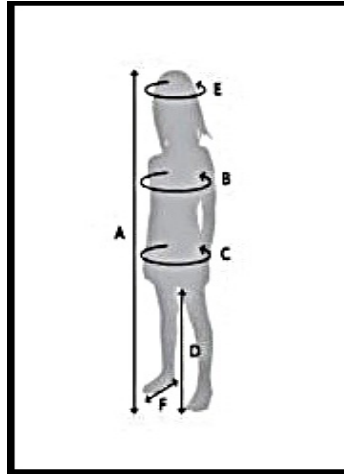
34 million motorcycles or mopeds. There is a total number of registered road motor vehicles in figure 3 [8].

Country / year	2015	2016	2017	2018	2019
Brunei		390	409	282	290
Cambodia	399	526	449	581	646
Indonesia	120786	128069	130562	146859	154376
Lao PDR	1718	1850	1978	2105	2234
Malaysia	26302	27613	28738	29957	31215
Myanmar	5385	6127	6801	7216	7334
Philippines	8707	9252	10411	11595	12725
Singapore	957	956	962	957	973
Thailand	36731	37338	38309	39552	40712
Vietnam	2107	2516	2902	3274	4300

Figure 3: Total Number Of Registered Road Motor Vehicles (In Thousand)

In the chart above, we can see that Malaysia has an increasing number of registered motorcycles every year. This can be concluded; motorcycles are increasingly becoming a necessity for Malaysians. In addition, the rising cost of living in Malaysia is also a reason for the selection of motorcycles as daily transportation. Malaysians use motorcycles a lot in completing daily affairs such as sending children to school.

Anthropometric measurements are a series of quantitative measurements of height and weight [9]. The table below shows that the average height for 7 to 9 years old is 128 cm to 134 cm, the seat is 71 cm, and the inside leg is 59 cm [10].



Age	A. Length in (cm)	C. Seat (cm)	D. inside leg (cm)
7 to 9 years old	128 – 134	71	59

Figure 4: Children Anthropometric (7 To 9 Years Old)

Anthropometric data is important for product design and development in the marketplace. The use of accurate anthropometric measures can improve well-being, health, comfort, and safety, especially for shoe measurements [11]. The human foot is a flexible structure of our body made up of 26 bones. Shoes are a necessary tool to cover the foot and protect it from injury. Shoe sizes that are not based on anthropometric measurements of the feet will cause pain to the user. Moreover, incorrect shoe size will result in injuries and deformities to the feet. One of the causes of leg muscle and tendon tension is incorrect shoe measurement (Luximon and Goonetilkels, 2005). Anthropometric measurements are a necessary tool in developing standard measurements [12]. There is a children shoe size table for ages 7 to 9 years old.

UK	13	14	1	1.5	2	2.5	3	3.5	4
US	1	1.5	2	2.5	3	3.5	4	4.5	5
EURO	32	33	33	34	34	35	36	36	37

Figure 5: Shoe Size (7 To 9 Years Old)

3 Methodology

In selecting a suitable design of motorcycle footboards for young pillion, the researcher has conducted methodological triangulation as a method for data collection. Triangulation is the best method in this study to increase the credibility and validity of research findings. The researcher has observed children aged 7 to 9 years old movement or manner while on the motorcycle. The studies area is the school in a rural area and village road. It clearly shows that most rural parents commute their children by motorcycle to school. The researcher has conducted a survey by constructing 27 questions for parents with primary school children and motorcycle owners. The survey questionnaires have 4 sections that are demographics respondent, family, transportation, and product. This survey is important to know who is the target market and main user. The researcher has interviewed several parents aged 7 to 9 years old who commute to school by motorcycle in their daily routine. The direct interview has got expensive data such as an accident with children while on a motorcycle and the existing problem that parents and children experience while using motorcycles in daily life..

3.1 Observation

Observation is conducted to identify the suitable design of the motorcycle footboard. The movement or manner in which a child gets on and off the motorcycle is observed to assess existing deficiencies. The children pillion's feet are mostly left hanging since the available footboard is not reachable due to their height. In other cases, the children prefer to rest their feet on the parts of the engine or worst on the exhaust of the motorcycle. This had become a habit since they felt more secure and stable while riding the motorcycle [7]. The outcome from this observation, this situation can be concluded to provide a criterion for designing more child-friendly children's footrests. Products that are ergonomic and suitable for the child's physical characteristics should also be considered so that the product can provide optimal comfort for the child.

3.2 Survey

Survey data were collected to identify the target market. The questionnaires were conducted through a google form, email, and other social media. The survey can collect data on shoe size, height of children, how often parents ride with children, and other necessary data. Surveys were conducted on parents with children and motorcycle owners. The size of children's shoes is also considered to get the right size of the footrest. The average shoe size of children 7 to 9 years old is 19.7 cm to 23.2 cm. Optimal comfort should be considered in designing products for children.

3.3 Interview

An interview is used to support and justify the clarification. In this study, parents whose children were in the interview to get further information. Individual selection criteria for the interview are parents with children aged 7 to 9 years, motorcycle users to send their children to school, and the B40 group. This interview aims to obtain clear and more transparent data on the problems of parents when riding with their children on motorcycles. In addition, it can confirm the accuracy of the data in the observation about children often stepping on motorcycle exhaust and whether parents have ever had an accident with their children while riding a motorcycle.

While riding a motorcycle, the children should also be considered whether it is stable, comfortable, or otherwise.

3.4 Analysis

This is a few data analysis that the researcher can conclude through a survey to 150 respondents.

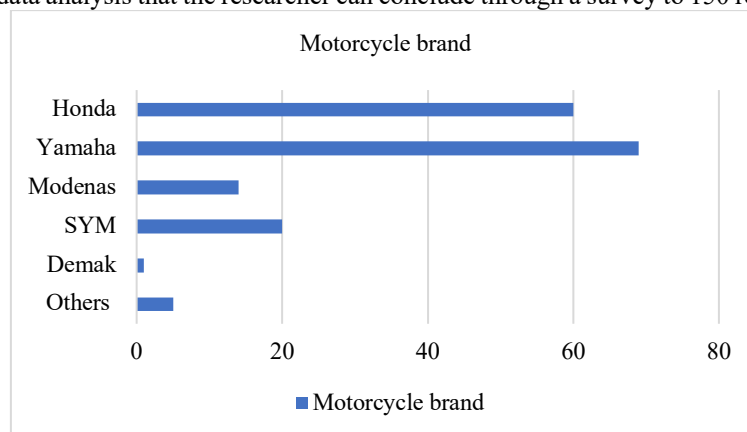
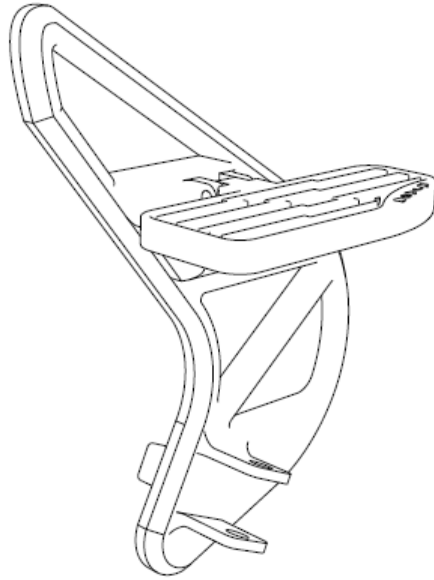


Figure 6: Motorcycle Brand

Figure 6 shows the results of a motorcycle brand survey of 150 respondents. The two motorcycle brands that have the highest number are Yamaha and Honda. While the rest are SYM, Modenas, Demak, and others branded motorcycles. This type of motorcycle needs to be focused on due to differences in specifications and size. This product should be a universal design for all users. The study results found that 128 respondents were in the B40 group, while the rest were in the M40 and T20 groups. The target market for this young pillion footboard product is the B40 group which makes motorcycles as main transportation. As a result of 150 respondents, there were 9 cases of accidents with children, and the rest never had an accident with children. The frequency of commuting to school every day, showing two times highest and the rest once and three times a day. Rural areas show the highest number of motorcycle users compared to the urban which is 82 respondents.

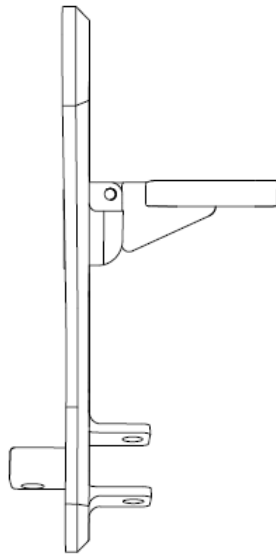
4 Result

The suitable design of motorcycle footboards for children has been identified to produce a good product for the children. A good design with clear anthropometric measurements for children is very important. This good product design that fills up their need for safety can prevent severe accidents. This product will help prevent massive accidents because they can balance their body while riding the motorcycle. The kids cannot sit properly and stable on the motorcycle without help. They have a high risk to accidents because of lack of body balancing, and feet do not reach the footrest. So, a good product for everyone safety is very needed in daily life.



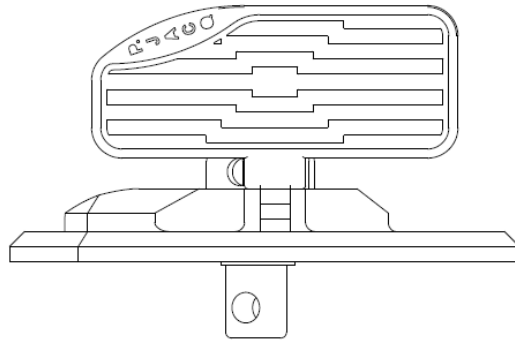
PERSPECTIVE VIEW

Figure 7: Perspective View



REAR VIEW

Figure 8: Rear View



TOP VIEW

FIGURE 9: TOP VIEW

This young pillion footboard has a function that can be folded and opened when the user needs to use it. It is very user friendly for both parties, children, and adults. Moreover, the design of this footrest still uses the original footrest on the motorcycle, thus saving costs. The material has used aluminium, and the manufacturing process will use a metal casting process. The results of children's anthropometry data were used to determine the size of these children's footrests in order to achieve optimal comfort.

5 Finding

5.1 Product Safety

This young pillion footboard design has a good safety feature. It can be folded when not in use, and this is a good safety feature for the following user. The safety design features have been created when a young pillion footboard is not in use to avoid injury to adult users. This design is universal not only can be used for children but anyone and suitable for various types of motorcycles such as Yamaha, Honda, Modenas, SYM and others. The original footrest on the motorcycle can be reused, and there is no need to spend other costs, thus saving costs. In addition, this footrest design can be "DIY" or do it yourself to reduce costs. Another safety feature for this young pillion footboard design is that the surface pattern of the footboard has been designed horizontally to prevent children's feet from slipping outwards, and the foot position is stronger. The figure below is the surface pattern design of the young pillion footboard.

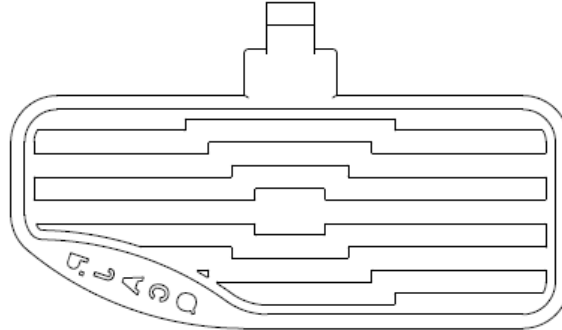


Figure 10: Young Pillion Footboard Surface

5.2 Target Market

From the survey study, the researcher found that most parents who use motorcycles to commute their children to school are B40 group. The income range for this group is RM 4,850 and below. Therefore, these motorcycle accessories are produced to meet the needs of the target market, which is to have an affordable price. This footrest design is specifically designed to reduce costs without ignoring safety. For example, the original footrest can be reused without the need to buy a new one. Thus, it is designed with a shape that is easy to install yourself without the need to go to a motorcycle workshop to install it. This can save on wage costs. The suggestion for the next study is that it is good to see if the motorcycle factory can manufacture this young pillion footboard jointly with the motorcycle parts.

6 Conclusion

In conclusion, the design of this product is to provide optimal comfort and safe for children. With this young pillion footboard, children will be more stable and balanced on the ride. Parents will be more confident about the safety of their children when riding a motorcycle. In addition, the rate of injuries due to road accidents can also be reduced. However, the use of this young pillion footboard is considered as a motorcycle accessory only in terms of the law. As a result of accidents that often occur among children, this young pillion footboard should be the main accessory for underbone motorcycles. This is because to reduce the risk of injury to children.

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References

- [1] Rodrigues, E. (N.D.) (2018). Motorcycle use in the americas measures to improve the safety of motorcycle riders. Retrieved August 2021, available from https://www3.paho.org/hq/index.php?option=com_docman&view=download&alias=46060-motorcycle-use-americas-2018-060&category_slug=factsheets-5288&Itemid=270&lang=es
- [2] Norzamira C. N. (2021). 223 Kemalangan akibat fizikal jalan raya. Berita Harian Online. Retrieved August 2021, available from <https://www.bharian.com.my/berita/kes/2021/01/773051/223-kemalangan-akibat-fizikal-jalan-raya>.
- [3] BUQHAIKRAH, T. (2021). 2,576 Kematian penunggang motosikal direkod. Sinarharian online. Retrieved August 2021, available from <https://www.sinarharian.com.my/article/132720/BERITA/Nasional/2576-kematian-penunggang-motosikal-direkod>
- [4] World Health Organization: WHO. (2021). Road traffic injuries. Who.int; World Health Organization: WHO. Retrieved August 2021, available from <https://www.who.int/news-room/factsheets/detail/road-traffic-injuries>.
- [5] Ministry of Transport Malaysia Official Portal.(2021). Road accidents and fatalities in Malaysia.. Retrieved August 2021, available from Mot.gov.my. <https://www.mot.gov.my/en/land/safety/road-accident-and-facilities>
- [6] M Fatimah, MComH, A Osman, "The risk of road traffic accidents among primary school children in Kuala Terengganu" Med J Malaysia, Vol 52, No 4, Dec 1997
- [7] Ruwaidy M. R., Tuty L. M., Sharifah H. Y. S. A., Azizah E. (2019). Design and development of universal pillion foot board for underbone motorcycle. International Journal of Engineering and Advanced Technology 9(1):1004-101.
- [8] ASEAN Stats Data Portal. (2018). Total number of registered road motor vehicles (in thousand). Retrieved August 2021, available from Aseanstats.org. <https://data.aseanstats.org/indicator/ASE.TRP.ROD.B.005>
- [9] Casadei, K., & Kiel, J. (2021). Anthropometric measurement. Nih.gov; StatPearls Publishing. Retrieved August 2021, available from <https://www.ncbi.nlm.nih.gov/books/NBK537315/>
- [10] Vudieu. (2018). Mini rodini size chart - minimodel rodini size chart a length in cm age b chest c seat d inside leg 5662. Retrieved August 2021, available from <https://dokumen.tips/documents/mini-rodini-size-chart-minimodel-rodini-size-chart-a-length-in-cm-age-b-chest.html>
- [11] Sacco, I. C., Onodera, A. N., Bosch, K., & Rosenbaum, D. (2015). Comparisons of foot anthropometry and plantar arch indices between German and Brazilian children. BMC Pediatrics, 15(1).
- [12] Siti B. B., Mumtazah O. and Naimah M. S. "Foot anthropometry for shoe design among preschool children in Malaysia", Universiti Putra Malaysia Press, 2010.