

PAPER • OPEN ACCESS

Ergonomic portable toilet for women in public facilities

To cite this article: Lamto Widodo *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **508** 012052

View the [article online](#) for updates and enhancements.

You may also like

- [Visualization Of Female Public Toilet Information Service Design And Research Based On Queuing And Waiting Psychology](#)
Jihong Yu, Zijie Xu and Yi Feng
- [Is smart water meter temporal resolution a limiting factor to residential water end-use classification? A quantitative experimental analysis](#)
Zahra Heydari, Andrea Cominola and Ashlynn S Stillwell
- [The Analysis of Toilet Use Efficiency in Expressway Service Area Based on Anylogic](#)
Xufeng Li, Jinliang Xu and Sunjian Gao



245th ECS Meeting
San Francisco, CA
May 26–30, 2024

PRiME 2024
Honolulu, Hawaii
October 6–11, 2024

Bringing together industry, researchers, and government across 50 symposia in electrochemistry and solid state science and technology

Learn more about ECS Meetings at
<http://www.electrochem.org/upcoming-meetings>



Save the Dates for future ECS Meetings!

Ergonomic portable toilet for women in public facilities

Lamto Widodo^{*}, Adianto, Debby, Siti RohanaNasution

Industrial Engineering Department, Universitas Tarumanagara, Jln. Letjen. S.Parman No.1 Jakarta, Indonesia

*lamtow@ft.untar.ac.id

ABSTRACT. Portable toilet is the type of toilet that can be moved easily. It usually has rectangular shape with walls made of fibreglass. Portable toilet is commonly produced for public use. In the designing process of portable toilet, there are some aspects that need to be taken for consideration, such as functional, aesthetic, cultural, and comfortability. To find out the lack of toilet design and complaints about the use of portable toilet, the distribution of open and closed questionnaires were conducted. The questionnaire also contains several questions about the user's wishes. Once the result was obtained, validity test and reliability test are applied to examine the answers and later to create the base for the conceptual design. The design process has been carried out based on ergonomics principles. Dimension of the design is derived from anthropometric data of Indonesian women. The analysis tool being used in this research is Rapid Entire Body Assessment (REBA), to be implemented before and after improvement. Simulation has been done using CATIA software. The final product of the portable toilet design has hexagonal shape with 1600 mm x 2070 mm dimension, equipped with septic tank and water container that uses rain harvesting and solar panel innovation. Result of the simulation foresees a decrease in REBA score, from 6 (medium risk level) to 1 (low risk level).

1. Introduction

Public toilet is among some important facilities meant for public use. This facility is crucial in fulfilling visitors' needs. Meanwhile, the availability of permanent public toilet in Jakarta is still limited. One solution for the problem is by providing a portable toilet. Portable toilet is a toilet that can easily be moved, usually placed inside rectangular-shaped walls made of fibreglass. However, there are still plenty of complaints regarding the facility, especially from women users. Two main complaints include the lack of comforts and poor maintenance. The purpose of this research is to design a portable toilet for women that is comfortable, clean, well-lit, and well-ventilated as an attempt to meet their needs. This innovation is done by redesigning the existing portable toilet for women using ergonomics principle. The dimension of this design uses anthropometry data of Indonesian women. In this attempt, a successful product is defined as a product that can provide benefits as expected by its customers [1]. Thus, improving the quality of public facilities, in this case, a portable public toilet, is a way of ensuring progressive development of technology which can only be done by continuous and in-depth research [2]. This research mainly focuses on comfortability, and thus the measurement of water container, the use of electricity, maintenance and economical aspect of the designed product will not be discussed in detail.

1.1 Ergonomics and Anthropometry

The term "ergonomics" comes from the Greek word *ergon* which means work and *nomos* that translates to natural laws. Ergonomics is a study about people's working environment based on



anatomy, physiology, engineering, management, and design [3]. Ergonomics also plays an important role in improving the safety and health aspect of work. Ergonomics is meant to lower discomforts, fix working posture, design of hand tools, and lessen tiredness in working. It also figures out the best placement of instruments and control system in order to optimize the process of transferring information so that responses can be obtained quickly with minimum risk. Other than that, ergonomics also attempts to improve working efficiency and eliminate health risk caused by improper working method. Meanwhile, anthropometry derives from the word “anthropos” which means human and the word “metron” which means size. Hence, anthropometry is a study of dimension measurement of human’s bodies. Anthropometry is useful in building an effective design as it adapts to the dimension of human’s bodies, whether in static or dynamic condition [3].

1.2. Open Questionnaire and Closed Questionnaire

Questionnaire is a data collecting method done by giving a series of questions to respondent [4]. Questionnaire is classified into 3 types, namely open questionnaire, close questionnaire, and open-close questionnaire [5]. Open questionnaire is a type of question that does not demand one right answer, so that respondent can answer freely. Close questionnaire is a type of question that provide alternate answers to the questions asked.

1.3. Rapid Entire Body Assessment (REBA)

Rapid Entire Body Assessment (REBA) is a measuring method of workers’ physical complaints, developed by Dr. Sue Hignett dan Dr. Lynn Mc Atamney. REBA is used to assess body postures of workers, including the neck, the back, arm, wrist, and legs. One thing that differentiates REBA from other method of analysis is the focus on the whole body. Final score in REBA is given to indicate level of risk and to point at parts which can be improved [9].

Table 1. REBA Score and Level of Actions [9]

REBA Score	Level of Risk	Level of Actions	Actions (include further
1	Negligible	0	None necessary
2 – 3	Low	1	Maybe necessary
4 – 7	Medium	2	Medium necessary
8 – 10	High	3	Necessary soon
11 – 15	Very High	4	Necessary now

2. Research Method

This research is implemented in the Special Capital Region of Jakarta, including Ancol, Museum Fatahillah Kota, Car Free Day, Taman Mini Indonesia Indah, and the manufacturer of the portable toilet, PT. Global Inti Fibertech in Dadap, Tangerang. Data collection process is started by conducting direct interviews and giving open-close questionnaire to 30 respondents. Next, data regarding the postures of the respondents while using the toilet is analysed to measure its REBA score before improvement. After that, complaints and expectations of users are identified, followed by the designing of the portable toilet using the anthropometry data. The final design is simulated using CATIA software to find out its REBA score. This result is later to be compared to the first score to derive the conclusion from.

3. Result and Discussion

Data collecting is done by giving out questionnaires, including open questionnaire and close questionnaire. The total of respondent is 30 women, who have used the portable toilet. The result of the open questionnaire is shown in Table 2. Open questionnaire is conducted to understand the product specification wanted by consumers.

Table 2. Summary of Open Questionnaire Result

No	Questions	Total	Answers
1	Do you prefer a sitting toilet or a flush toilet?	30	19 (sitting toilet)
2	What material do you prefer to be used on portable toilet?	30	22 (fibre)
3	What are your complaints regarding the portable toilet you use?	30	Poor sanitation, too narrow, lack of
4	Do you prefer water tub or hand	30	22 (handshower)
5	Is there any additional function that you expect from portable toilet?	30	Hanger, mirror, good sanitation, air freshener, exhaust fan
6	What would be the best colour for the interior of the portable toilet so that it	30	14 (blue)
7	Do you prefer lever door handle or door knob?	30	20 (lever door handle)

The answers obtained based on the questionnaire result is used as the base of creating the close questionnaire. Multiple-choice close questionnaire can be found in Table 3.

Table 3. Result of Multiple-choice Close Questionnaire

Total Respondent	Type of Toilet	Colour	Wall material	Sanitation tool
30	espondents chose sitting toilet	espondents chose bright colour	espondents chose fibre material	espondents chose hand shower

Posture analysis is conducted based on how users use the existing portable toilet, which is the squat toilet. Documentation of the observation result is captured, and its angle is to be examined to get the REBA score. Documentation of squatting position in the portable toilet can be found in Figure 1



Figure 1. Posture of the Usage of the Existing Portable Toilet

The total of REBA score for the squatting position as shown in Figure 1 is 6. This result is obtained based on REBA worksheet. Score 6 indicates medium risk level which requires second level of action, implying medium need for improvement. Consumers' necessity is identified before creating the product. This process aims to ensure that the product is produced based on customers' needs. This result becomes the basis of constructing final product specification. The result of all identified complaints, expectations, needs, and suggestions can be found in Table 4.

Table 4. Identification of Complaints, Expectations, Needs, and Improvement Planning

No	Complaints	Expectations	Needs	Suggestion for Improvement
1	Poor sanitation and lack of tool for proper sanitation	Users get proper sanitation with proper sanitation tool	Alternate option to provide the needs for water and sanitation tool that is comfortable for usage	Adding more alternatives, using rain harvest method to add more water volume and enlarge the water container in the toilet so that it can be comfortable and lessen REBA complaints
2	Space dimension made it difficult for users to move around	Bigger portable toilet	Expanding the toilet by not only redesigning the space, but also rethinking the door size	Expanding parts of the portable toilet and design it based on the anthropometry of Indonesian women so that users can have more space to move around
3	Lack of ventilation causes breathing difficulty	Adding more ventilation to improve air circulation	Adding more ventilation and providing other alternatives to improve the air circulation	Adding a tool to help with the air circulation, such as exhaust fan, and increasing the number of ventilations in the portable toilet wall
4	Lack of other function, poor placement, and weak frame structure	Adding more functions, fixing the placement, and designing the portable toilet with stronger frame material	Providing more functions despite in the space available and fulfil consumers' needs and demands	Adding more functions, such as grab handle, basin, tissue, trashcan, hanger, and air freshener. Fixing the placement of the additional function by thinking about its positioning inside the portable

Based on the result in Table 4, this research specifies the early product aiming to fulfil the needs of portable toilet users. The early specification can be seen in Table 5.

Table 5. Early Product Specification

Function	Improvement
Design	Dimension, shape, colour
Components' endurance	After usage
Ergonomics dan anthropometry	Lighting and ventilation
Tools	Closet and sanitation tool
Additional facility	Additional tool, K3
Good sanitation	Water container

In the process of designing, new innovation is implemented by looking for the solution for each problem. The innovation regarding the portable toilet is expected to reduce problems, such as lack of water and poor lighting causes by lack of electricity resource. Therefore, in the installation of the new portable toilet design, some new innovations are added including rain harvesting and solar panel.

Data specification acts as a reference in measuring the ergonomics. It aims to adjust the condition of the product for the users. Ergonomics measurement is based on anthropometry data of Indonesian people. Final specification can be found in Table 6 while visualization is shown in Figure 2, Figure 3, and Figure 4.

Table 6. Final Design Specification

No	Components	Specification before improvement	Design specification	Percentage measurement
1	Portable toilet	900 mm x 900 mm	1600 mm x 1600 mm	Based on measurement of women's stretched arm 95 %
2	Door's width	630 mm	730 mm	Based on shoulder size 95 %
3	Door's height	1750 mm	1970 mm	Based on the positioning of wrist and hand position upside while standing 95%
4	Closet's height	0 mm	390 mm	Based on knee fold 50%
5	Closet's base	-	400 mm	Based on the width of waist percentage 95%
6	Length of closet' base	-	490 mm	Based on the distance between the knee fold and bottom 5%
7	Placement of hand shower	520 mm	375 mm	Based on the distance between elbow and tip of fingers 5%
8	Placement of tissue	720 mm	375 mm	Based on the distance between elbow and tip of fingers 5%
9	Height of hand shower	720 mm	511 mm	Based on the distance between elbow while sitting + height of knee fold 50
10	Height of tissue	720 mm	511 mm	Based on the distance between elbow while sitting + height of knee fold 50
11	Height of door handle	850 mm	890 mm	Based on height of elbow while standing 5%
12	Height of ceiling	2000 mm	2070 mm	Based on the height of wrist with vertical hand positioning while standing up 95%
13	Height of hanger	1850 mm	1700 mm	Based on the height of wrist with vertical hand positioning while standing up 5%



Figure 2. Design of Portable Toilet

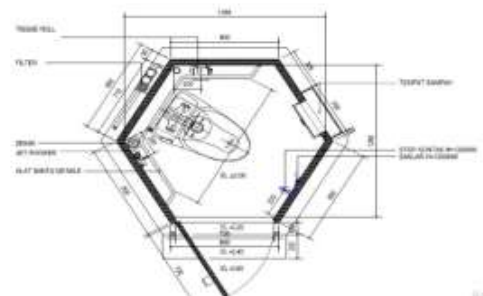


Figure 3. Design Size from Top View



Figure 4. Dimension of 3D Design



Figure 5. Examination of REBA with CATIA

The final stage is simulating the design result by using mannequin model. Simulation is implemented using CATIA software (as shown in Figure 5). Based on the simulation result, REBA score after improvement is 1, meaning it has low risk level. In conclusion, the portable toilet is ergonomic, and that this design is acceptable.

4. Conclusion

There are complaints regarding the existing portable toilet. These complaints mostly come from female users. Hence, this research analyses their complaints, needs, and suggestions for improvement. The analysis regarding postures with REBA method shows score 6, which means improvement is needed. Portable toilet specification is based on anthropometry data of the body of Indonesian people. Therefore, the final product of this portable toilet design is: length and width 1600 mm x 1600 mm, measured from outside the toilet, with the interior size at 1484 mm x 1484 mm, door's width 730 mm, door's height 1970 mm, closet's height 390 mm, width of closet's base 400 mm, hand shower and tissue positioning at 375 mm, height of hand shower and tissue measured from the floor at 511 mm, height of door handle 890 mm, diameter of door knob at 43 mm, height of ceiling 2070 mm, and height of hanger 1700 mm. Based on the simulation using CATIA software, the REBA score after improvement is 1, which means the new design has low risk level.

5. References

- [1] Ulrich, K. T., and S. D. Eppinger. 2001. *Perancangan dan Pengembangan Produk*. Jakarta: Salemba Teknika.
- [2] Wai, K. M. S. 2006. "DESIGN QUALITY OF PUBLIC TOILET FACILITIES". *International Journal of Reliability, Quality and Safety Engineering*, Vol. 13, Hongkong.
- [3] Nurmianto, Eko. 1998. *Ergonomi Konsep Dasar dan Aplikasinya*. Jakarta: Candimas Metropole.
- [4] Sugiyono. 2012. *Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif, dan R&D*. Bandung: ALFABETA.
- [5] Walgito, Bimo. 2010. *Bimbingan Konseling Studi dan Karier*. Yogyakarta: Andi
- [6] Green, L. N., and E. Bonollo, 2002. "The Development of a Suite of Design Methods Appropriate for Teaching Product Design", *Global Journal of Engineering Education*, Vol. 6, No 1, Australia.
- [7] Cohen, Lou. 1995. "Quality Function Deployment, How to Make QFD Work for You". Massachusetts: Addison Wesley Publishing Company.
- [8] Chan, L.-K., & Ming-Lu, W. (2004). *A Systematic approach to qualify function with a full illustrative example*. *Science Direct*, 119.
- [9] S. Hignett and L. McAtamney, *Rapid Upper Limb Assessment (RULA) Applied Ergonomics*, Nottingham: Elsevier, 2000.
- [10] Saaty, Thomas L. 1991. *Proses Hirarki Analitik Untuk Pengambilan Keputusan Dalam Situasi Yang Kompleks*. Jakarta : PT. Dharma Aksaa Perkasa.
- [11] Wignjosobroto, sritomo. *Ergonomi, Studi Gerak dan Waktu*. Surabaya: PT. Guna Widya, 2003.