

Knock Down Design of Ergonomic Water Filter Implementation

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ABSTRACT

For human life, clean water is essential. Currently, the provision of clean water is still a problem in Indonesia. Almost 80% of the population still consumes water that is not in accordance with health standards. The knockdown ergonomic water filter for the supply of clean water becomes consumers' interest in water users. The design of the study was descriptive comparative, and experimental. The majority of the respondents were 30 people using water filters. Data was taken by observation, questionnaire, and experimental results. Data were analyzed using descriptive percentages. The results showed that the C (Portable Water Filter Purifier) Water Filters were the most preferred by consumers (40%), the form of the large interest B (Indoor Drinking Water Filter Stainless Steel Water Purifier) filter (36.6%), and the most interesting number a little form of filter A (Me Water Purifier) (23.3%). The water filter material of 73.3% chose stainless steel. An ergonomic knockdown water filter has the ability to reduce total dissolved solids (TDS) levels of 380 ppm to 156 ppm, down 224 ppm (41%). Conclusions: 1) water filter users have the highest interest in choosing portable knock-down type filters made of stainless steel material, easily installed and used ergonomically, and anti-oxidation does not corrode; 2) water yield from an ergonomic knockdown water filter is 41% clearer than before filtering.

KEYWORDS

Water filter, ergonomics, knockdown, consumer interest, total dissolved solids, R & D, Indonesia

INTRODUCTION

For human life, clean water (H₂O) is very important both for human life and for other living things. Its function for life cannot be replaced by other compounds. Almost all activities carried out by humans need water. For bathing, mopping, cooking, drinking, washing dishes, clothes, and others, all need clean water.

In relation to research on water, there are some previous studies. For example, studies from the world's bank water and sanitation consultants (Utama water filter, 2014-2018) stated that until 2017, there were around 100 million people in Indonesia, around 80% still consuming water that was not in accordance with health standards. The procurement of clean water other than sources also requires tools. An ergonomic knock down water purifier as an alternative water purifier tool needs to be developed. By doing so, there would be no difficulty in obtaining and procuring clean water.

Most of the water comes from groundwater and river sources. Surface water is found in lakes, rivers, and other water sources, while groundwater is found in the soil. Groundwater can dissolve the minerals of the parent material from the soil it passes through. Most of the microorganisms that were originally present in groundwater gradually filtered when water seeps into the soil. Water used by humans is fresh surface water and pure groundwater (Rukaesih as quoted by Nicola, 2015). Groundwater is water that is below the surface of the soil. The main characteristic that distinguishes groundwater and surface water is that the movement of groundwater is very slow, and the residence time is very long, can reach tens or even hundreds of years (Effen in Nicola, 2015).

Mackereth in Nicola (2015) said that conductivity is expressed in units of $\mu\text{mhos} / \text{cm}$ or $\mu\text{Siemens} / \text{cm}$. The value of electrical conductivity (DHL) is closely related to the total dissolved solids / TDS. TDS is usually caused by inorganic materials in the form of ions commonly found in waters. TDS consists of mud, fine sand, and microorganisms, mainly driven by the erosion

of water-borne soil. To reduce the level of TDS in water, it is necessary to filter/purify. One of them is simple water purifier or ergonomic knock down water purifier.

Based on preliminary observations of TDS content during initial data collection, the TDS content above is required. Therefore, it is necessary to make water purifiers to reduce TDS levels. In this case, it is made an ergonomic filter model knock down the water purifier. This purifier can be installed in the bathroom or in the kitchen sink. This ergonomic water purifier can be installed without damaging the installation of water pipes that have been installed. It is expected to save costs in terms of installation, as well as in terms of the product.

In developing a product or tool must pay attention to the level of interest of consumers. Are water purifiers needed by consumers? Ergonomics-based product development is determined by consumers' ratings as users and the ability of water filters to purify water.

METHODOLOGY

Data Collection Phase

Primary data were collected by conducting a location survey taking well water sampling to determine TDS levels. Questionnaires were also distributed to 30 respondents (consumers), who were used to develop water filter designs they needed. The secondary data were obtained from literature studies.

Data Processing and Analysis Phase

The data were analyzed and processed using descriptive comparative and Quality Function Deployment (QFD). Then, QFD was designed and experimented for getting an ergonomic design and design model that suits consumer demand. QFD is represented by a matrix called "House of Quality" (HOQ), as shown in Figure 1.

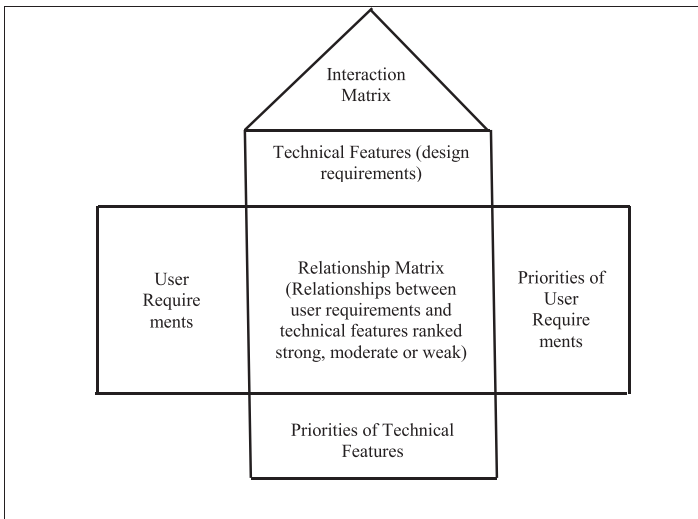


Figure 1. House of Quality Matrix (Demirbilek dan Demirkan, 2004)

RESULTS AND DISCUSSION

In this study, there are three forms of filters offered to consumers (respondents), namely water filters in form A, B, and C. Water filters form A: Mi Water Purifier, which is an elongated rectangular box. This type of water filter has a high flow because without a storage tank. This type is an RO filter design. So, pure freshwater can be drunk directly from the tap. Water filters form B: Indoor Drinking Water Filter Stainless Steel Water Purifier, which is a cylindrical round shape with a long tap. It is a water filter with ceramic material that is able to filter particles from 0.2 to 0.5 microns. Water filters form C: Portable Water Filter Purifier, which is a cylindrical roundable knock-down round shape. This filter is made of high-strength aluminum alloy, not corrosive, not oxidizing, and can be used in any environment.

Furthermore, based on the interest calculation, in the form of a water filter (Table 1), it is the form C water filter that is the most demanded by the consumers (40%). The form of filter B is small (36.6%), and the form filter A (23.3%) is the least number, as in Table 1.

Table 1. Great Interest in the Form of Water Filters

Form	Interest	Percent(%)
A	7	23,3
B	11	36,7
C	12	40,0
Total	30	100

All three forms of water filters in this study are knock-down filter types such as water filter types of A, B, and C, as seen in Figure 2.

Bentuk Filter Air		
Water filters form (A): Me Water Purifier (2010 – 2018)	Water filters form (B): Indoor Drinking Water Filter Stainless Steel Water Purifier (Lelong. my, 2018)	Water filters form (C): Portable Water Filter Purifier (GEERTOP, 2018)

Figure 2. Form of Water Filter

In terms of consumer interest in water filter materials, it can be seen in Table 2. It indicates that consumers have the greatest interest in using stainless material: housing (63.3% enthusiasts) and protective filter material inside (enthusiasts 73.3%). For water filter materials using plastic and fiberglass, they are less attractive to consumers.

Table 2. Large Interest in Water Filter Materials

Material	<i>cassing</i>	Protector of Inner Filter Material
Stainless	19 (63,3 %)	22 (73,3 %)
Plastic	7 (23,3 %)	6 (20,0 %)
Fiber Glass	4 (13,4 %)	2 (6,7 %)
Total	30	30

Based on the analysis of the data calculation, it can be concluded that: consumers are more interested in C-type filters, namely, Portable Water Filter Purifier. It is the Water Filter Portable Water Filter Purifier round cylindrical portable knockdown. The preferred filter material is stainless.

The properties of high-strength stainless steel materials include neither corrosive nor oxidizing. According to Logam Ceper (2017), stainless has characteristic, namely: high chromic content (to protect environmental influences), corrosion resistance is not easy to oxidize, low maintenance, high hardness, resilient, and silver-white.

In terms of ergonomics, the portable cylindrical round-shaped water filter is knock down. A round shape is a form that does not accidentally scratch the skin. This is a precaution so as not to cause the filter users to get scratches on their skin. This is due to the fact that the objects are shaped by being sharp, and the sharp ones are very vulnerable because they scratch on people's skin or bodies. Therefore, pointed angled water filter objects are considered unsafe, and this must be avoided.

In addition, the water filters that attract the consumers, namely cylindrical round-shaped knock-down cylinders are classified as ergonomic. This water filter is portable, light and it can be placed anywhere, easily installed. Besides, it does not damage the installed water network. The knockdown filter can be easily removed and easily installed again. These knockdown water filters are all easily removable, brought in concisely, then re-installed where the location is needed as long as there is water or water lines. An equipment that makes the user easy is included in ergonomic equipment. Diane (2014) states that one of the principles of ergonomics is to make sure all existing objects are easy to use. More importantly, Quality Function Deployment is also carried out based on the consumer's voice. The results are as follows:

1. Attribute Technical Requirement

Technical requirement is the translation of consumer needs into technical languages. It can be obtained from interviews, tracking documents, and group discussions with companies that have product design capabilities. The Technical requirement information is obtained as in Table 3.

Tabel 3. *Technical requirement filter air*

No	Technical Requirements
1	Knock down filter model
2	Tube model filter design
3	Portable filter
4	Size 30x16cm
5	Material sus 316/stainless
6	Do not change installed water installations
7	There is a knockdown filter bag
8	There are usage instructions

2. Raw Weight Calculation and Row Weight Normalization

Raw weight values can be used as a basis for determining product attributes that must be developed because the components are quite complete. The higher the value, the more priority the attribute gets.

Tabel 4. Raw Weight Value and Row Weight Normalization

No	Level of importance attribute	Level of importance	Improvement ratio	Sales point	Weight	weight Normalization %
1	Attractive design	3.84	1.20	1.5	6.89	16%
2	Material is not easily corrosive	4.23	1.49	1.5	9.45	22%
3	Material is not easily broken	3.32	1.29	1.5	6.43	15%
4	Resistant to rust	3.42	1.35	1.5	6.91	16%
5	Products are easy to carry / simple	3.92	1.15	1	4.49	11%
6	Cheap price	2.58	1.10	1	2.84	7%
7	Easy installation	3.21	1.37	1.2	5.28	12%

Based on the weight in Table 3, it shows that the level of importance attribute that has the highest weight value is the material that does not easily corrode. The House of Quality (HoQ) can be seen in Figure 3. 3):

Gambar House of Quality

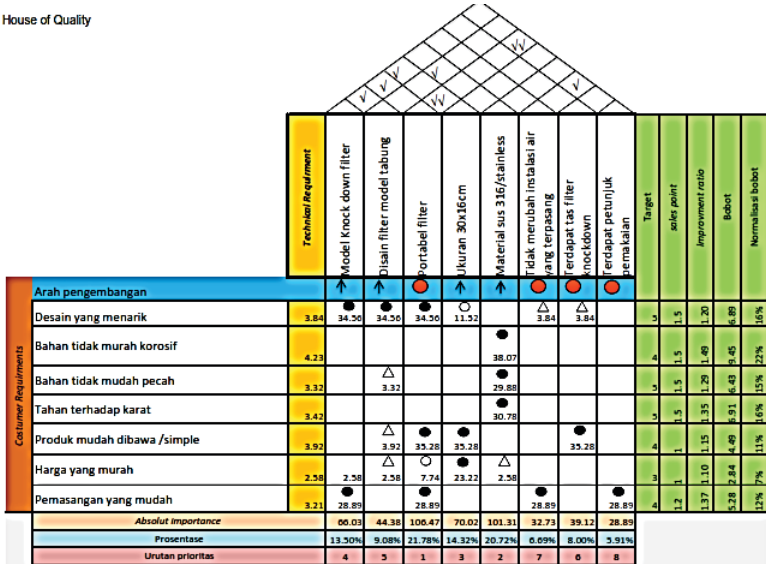


Figure 3. HoQ Knock-Down Ergonomic Water Purifier

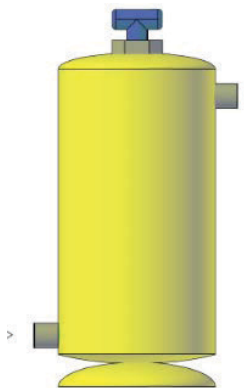
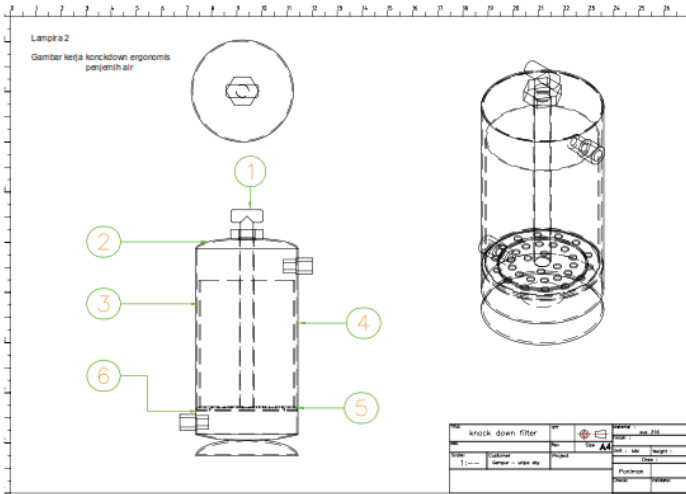


Figure 4. Ergonomic Knock Down Design of Water Purifier



Description: 1. Stutbolt; 2. Top button; 3. Filter; 3. Casing; 4. Seal / Packing; 5. Rail pack

Figure 5. Layout Design Ergonomic Knockdown Water Purifier

3. Water Filtering Ability

Table 5. Average Total Dissolved Solids and Water Acidity in Water Filter Experiments (June 2019)

TEST	MATERIAL & TREATMENT	TIME	INITIAL WATER CONDITION		CONDITION AFTER FILTRATION	
			TOTAL DISOLVE SOLID (ppm)	Ph LEVEL	TOTAL DISOLVE SOLID (ppm)	Ph LEVEL
The condition of the initial well water	-	-	380	7,4	380	7,4
1st Test	Carbon, silica, zeolite, ceramic, foam		380	7,4	378	7,1
2nd Test	Carbon, silica, zeolite, ceramic, foam	1 week after 1st Test	378	7,1	345	6,8

TEST	MATERIAL & TREATMENT	TIME	INITIAL WATER CONDITION		CONDITION AFTER FILTRATION	
			TOTAL DISOLVE SOLID (ppm)	Ph LEVEL	TOTAL DISOLVE SOLID (ppm)	Ph LEVEL
3rd Test	Carbon, silica, zeolite, ceramic, foam ELECTROLYSIS (12V 10A)	Electrolysis for 24 minutes	345	6,8	330	6,8
4th Test	Carbon, silica, zeolite, ceramic, foam ELECTROLYSIS (12V 10A)	Electrolysis for 54 minutes	330	6,8	296	6,9
5th Test	Carbon, silica, zeolite, foam, ferrolite, manganese & jade	-	296	6,9	156	7,3

Based on the results of experimental filter material (see Table 5), ergonomic knock down water filters have the ability to reduce total dissolved solids (TDS) level of 380 ppm to 156 ppm, down 224 ppm (41%). Material experiment (several types of gravel and foam) by changing various materials and doing electrolysis. The filter material that produces the best water filtration is obtained: carbon, silica, ziolite, foam, ferrolite, manganese, and jade.

CONCLUSIONS

The study concluded that based on the results of the analysis of the House of Quality (Hoq) for the manufacture of ergonomic knock down water filters, there are seven attributes of the level of consumer needs, namely: a) Attractive design, b) Non-corrosive material, c) Non-fragile material, d) Rust-resistant, e) Products are easy to carry / simple, f) Low prices, and g) Easy installation. 2). Ergonomic knock down water filters has the ability to reduce levels of total dissolved solids (TDS) of 380 ppm to 156 ppm, down 224 ppm

(41%) by electrolysis method with carbon filter material, silica, ziolite, foam, ferrolite, manganese, and stone jade.

LITERATURE CITED

Wahyu Ariani, D. (1999). Manajemen kualitas. *Universitas Atma Jaya Yogyakarta: Graha Indonesia*. Retrieved on 7 July 2019 from <https://onesearch.id/Record/IOS3744.JATIM00000000020413>

Diane Ingle, 2014, **Workplace effeciency improved with ergonomics**, *Occupational nurce educator public heath office, USA*.

Gitosudarmo, Indriyo. 1995. **Manajemen Pemasaran**. Yogyakarta: BPFE.

Geertop, 2018, **High-Quality Portable Water Filter Purifier, REMOVABLE & WASHABLE FILTERS**, For Camping, Outdoors - Long Lift, retrieved on 28 June, 2020, from <https://www.amazon.co.uk/GEERTOP-High-Quality-Portable-Purifier-REMOVABLE/dp/B01CY25BCS>

Gempur Santoso, 2004, **Ergonomi Manusia, Peralatan Dan Lingkungan**. Prestasi Pustaka Publisher, Jakarta.

Lelong.my, 2018, **Indoor Drinking Water Filter Stainless Steel Water Purifier**, <https://www.lelong.com.my/>; <https://www.amazon.co.uk/GEERTOP-High-Quality-Portable-Purifier-REMOVABLE/dp/B01CY25BCS>

Logam Ceper, 2017, **Sifat-Sifat Stainless Steel**, retrieved on May 27, 2029 from <https://logamceper.com/sifat-sifat-stainless-steel/>

Mi Water Purifier, 2010-2018, retrieved on April 2029 from <https://www.mi.com/en/water/>

Nicola, Effendra (2015) **Hubungan Antara Konduktivitas, TDS (Total Dissolved Solid) Dan TSS (Total Suspended Solid) Dengan Kadar Fe²⁺ dan Fe Total Pada Air Sumur Gali**. Skripsi Jurusan Kimia Fakultas Matematika Dan Ilmu Pengetahuan Alam Universitas Jember.

Indonesia, P. R. (1990). Peraturan Pemerintah No. 20 Tahun 1990 Tentang: Pengendalian Pencemaran Air. Retrieved on July 3, 2029 from [http://kamuskeuangaeraah.com/images/a/a5/PP_20_tahun_1990_\(Pengendalian_Pencemaran_Air\).pdf](http://kamuskeuangaeraah.com/images/a/a5/PP_20_tahun_1990_(Pengendalian_Pencemaran_Air).pdf)

Rahayu, N. I., Partawi, S. G., & Siswanto, N. (2015). Model Rotasi Pekerjaan Berdasarkan Faktor Ergonomi (Doctoral dissertation, Tesis, Institut Teknologi Sepuluh Nopember Surabaya). Retrieved on May 21, 2019 from [http://mmt.its.ac.id/download/SEMNAS/SEMNAS%20XXIII/MI/51.%20Prosiding%20Nitabian%20Iftita%20Rahayu%20Ok\(1\).pdf](http://mmt.its.ac.id/download/SEMNAS/SEMNAS%20XXIII/MI/51.%20Prosiding%20Nitabian%20Iftita%20Rahayu%20Ok(1).pdf)

Scholastica Gerintya - 20 Maret 2018, **Bagaimana Mutu dan Akses Air Bersih di Indonesia?**, retrieved on July 4, from <https://tirto.id/bagaimana-mutu-dan-akses-air-bersih-di-indonesia-cGrk>

Suharno, Yudi Sutarso (2010.). Marketing in practice / Suharno, Yudi Sutarso. Yogyakarta. Graha Ilmu. Retrieved on May 35, 2029 from <https://opac.perpusnas.go.id/DetailOpac.aspx?id=675994#>

Utamawaterfilter,2014-2018, **Masalah Air Bersih di Indonesia Seperti Tidak Pernah Usai**, Utama Filter <http://www.utamawaterfilter.com/>

Wignjosoebroto, S. (2000). Ergonomi Studi Gerak dan Waktu: Teknik Analisis untuk Peningkatan Produktivitas Kerja. Surabaya: Guna Widya. Retrieved on July 17. 2029, from

Santoso, G. (2019). Consumers Interest For Ergonomic Knock-Down Water Filters. Tibuana, 2(01), 1-4. Retrieved on May 20, 2019 from <http://jurnal.unipasby.ac.id/index.php/tibuana/article/view/1766>

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