

Water and Sanitation Technology Citizen Needs Assessment in Kolorai Island

Yudha Pracastino Heston¹ and Yonanda Rayi Ayuningtyas

Balai Penelitian dan Pengembangan Sosial Ekonomi Bidang Permukiman.
Jl. Laksda Adisucipto No.165 Yogyakarta. Telp/fax (0274) 555205/546978

¹pracastino@yahoo.com

Abstract. Kolorai is an island located in Pulau Morotai Regency. Its existence as an island in the National Tourism Strategic Area (KSPN) of Morotai. It has a land area of 4.33 km², with a population of ± 550 people. The citizen relying on wells as a source of clean water, and has been developing a piping system to distribute clean water, using a water reservoir which is located in each resident's house. There are 11 public toilets scattered in Kolorai Island. The emerging problems are related to the availability of energy for the distribution and adequacy of clean water source quality. The research was conducted to answer the problem solution needs in a participatory method, with technology product support from Ministry of Public Work and Housing, Research and Development Agency. The research was conducted with qualitative approach, using mix method. The research result is a comprehensive solution to fulfill the needs of clean water and sanitation.

1. The first section in your paper

Kolorai Island is one of the villages in Pulau Morotai Regency. It has a land area of 4.33 km², with a population of ± 550 people from 113 families [1]. It is one of the supporting tourist attractions, which supports Dodola Island as one of the main attractions in Morotai Island Tourism Area. It developed into a tourist village, while most of its citizens have tourism awareness. The tourist village function is supported the existence of homestays, which managed by the citizens. It have been developed as a part of Sail Morotai 2012 event [2].

The water distribution and sanitation system facilities condition in Kolorai Island has not been able to fulfill domestic and non-domestic needs. A common problem with the clean water provision is the lack of energy for the distribution. Currently available water sources do not have sufficient capacity and quality [2]. There are several households in Kolorai Island do not have a private toilet, and few residents defecate on the beach. There is no adequate waste management system, either for black water or gray water yet.



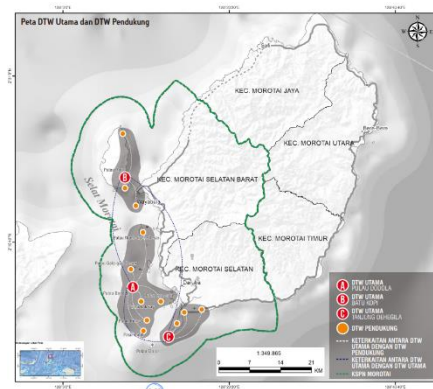


Figure 1. Map of Morotai Island Tourism Attractions [2]

2. Another section of your paper

Brikke dan Bredero describe the factors that influence community-based water supply technologies selection are [3]:

Table 1. Factors affecting community-based clean water technology [3]

Factors	Substances	
Technical factors	1. Demand 2. Capital costs 3. Extension capacity 4. Compability with norms and legal frameworks	5. Compability with existing water-supply systems 6. Comparative advantages 7. Technical skills
Environmental factors	1. Availability, accessibility, and reliability of water 2. Seasonal variations 3. Water quality and treatment	4. Water source protection 5. Risk of a negative environmental impact
Institutional factors	1. Legal framework 2. Regulatory framework 3. National strategy 4. Existing institutional set-up	5. Support from government, NGOs, external support agencies (ESAs) 6. Stimulation of private sector 7. Transferring know-how
Community and managerial factors	1. Local economy 2. Living patterns and population growth 3. Living standards and gender balance 4. Household income and seasonal variations 5. Users preferences	6. Historical experience in collaborating with different partners 7. Village organization and social cohesion
Financial factors	1. Capital costs 2. Budget allocations and subsidy policy 3. Financial participation of users	

While the factors that influence community-based sanitation technology selection are:

Table 2. Factors affecting community-based sanitation technology [3]

Factors	Substances
Technical factors	Design preference Technical standars and expeted lifetime of the the technology Availability of construction materials Cost of construction
Environmental factors	Soiltexture, stability, permeability Groundwater level Control of environmental pollution Availability of water Possibility of flooding

Institutional factors	Existing national/local strategies Roles and responsibilities of actors implied Training capacity Availability of subsidies and loans Availability of workers,
Community factors	Sociocultural aspects Motivational aspects Discouraging factors Social organization factors Other factors

Tim Teknis Pembangunan Sanitasi explains that sanitation mapping process is influenced by other factors, to provide system and technology selection [4]. The system selection are influenced by (1) physical, ie population density, land use, and land suitability (2) arrangements, ie sanitary, management, institutional, O&M and asset ownership arrangements, (3) and finance - funding, this is related to the city's fiscal capacity, support and funding mechanism. The technology selection is influenced by (1) environment, ie health risks, utilization of ground water and surface water, (2) culture - behavior, by looking at the awareness level and community management skills, (3) Investment costs and recurring, related to affordability and technological precision.

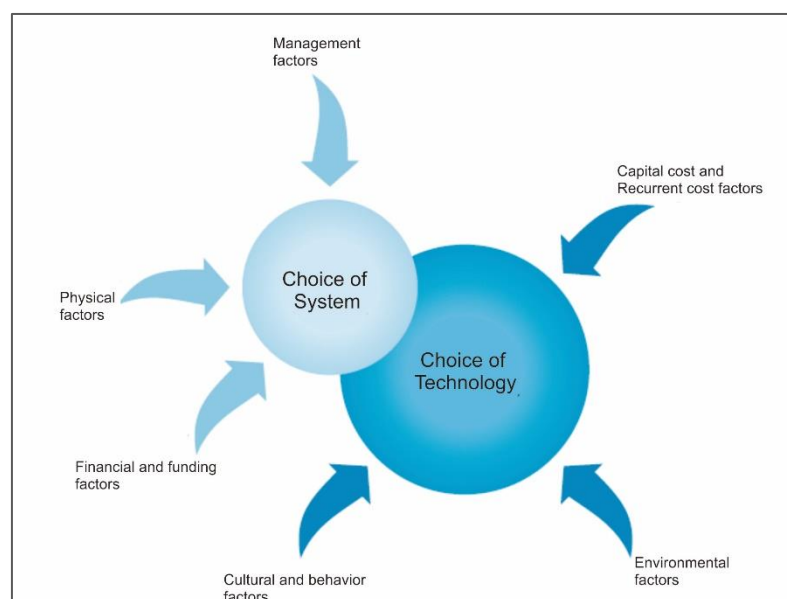


Figure 2. Variable Determination of Technology Selection [4]

3. Data and Methods

This research used qualitative data collection method, direct observation, questionnaire, and direct interview. Qualitative data collection methods may take several considerations [5] such as the situation, time, researcher involvement, participant involvement, participant anonymity, software requirements, and data forms. The application of clean water and sanitation technology is based on public perception needs, with participatory method in Kolorai Island.

The need of technologies synchronize with Ministry of Public Work and Housing, Research and Development Agency (Balitbang PUPR) water and sanitation technology products suitability and availability.

The analytical method used qualitative analysis with mix method. The analysis has done with the scope of the discussion factors, that is:

1. Environmental, Kolorai Island geographical condition, clean water condition by identifying potential sources, reservoir, distribution, and utilization of clean water, as well as waste water disposal, collection and treatment systems, and existing waste management systems.
2. Community, Kolorai Island socio-economic conditions, settlement patterns, and technology used based on public preference.
3. Financial, public economic conditions in order to see ability and willingness to pay more money to better facilities.
4. Institutional, regional government and realted institusional clean water and sanitation program and activities.
5. Technical, Balitbang PUPR technology availability and readiness level.

4. Results

4.1. Environmental Factors

4.1.1. *The geographical condition of Kolorai Island*

Kolorai Island is administratively part of Morotai Selatan District, Pulau Morotai Regency. It has beautiful coastline as a tourist attractions. Tourists can experience daily life activities of local communities. This island located approximately 1 hour drive by using a motor boat or speedboat from Daruba Port. It has plain topography with white colour sand beach [6].

4.1.2. *Condition of clean water*

Kolorai Island communities rely on well as a source of clean water. The main water reservoir source is obtained from the wells with solar powered pump, then distributed to the resident's houses with a piping system.



Figure 3. Solar Powered Water Reservoir

The emerging problems are related to the availability of energy for the distribution and adequacy of clean water source quality. There are wells in each 3-4 houses, that taken with electric water pump which powered by a generator set, or manually using a bucket. Water that distributed from the main well is in good quality, tasteless, colorless, and odorless, and there is no significant difference between the dry season and the rainy season for its quality. Some respondent (16%) taste salty or brackish.

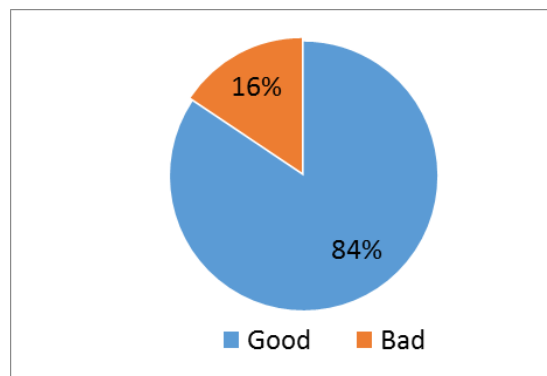


Figure 4. Water Quality According to Public Perception

Based on public perception, the degree of water sufficient described as follows:

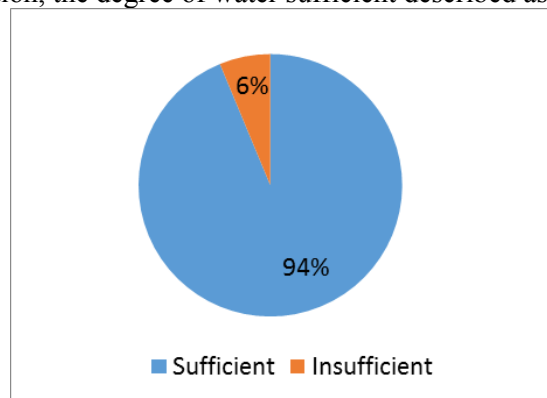


Figure 5. Water Quantity according to public perception

From the figure 5, most of the respondent consider that the quantity of clean water is sufficient for domestic and non-domestic needs. However, few people encounter insufficient water quantity distribution. Territorially, people who live close to the main well do not have insufficient water supply. Otherwise people who live far away from the main well have insufficient water supply. It is also related to water continuity which can be described as follows:

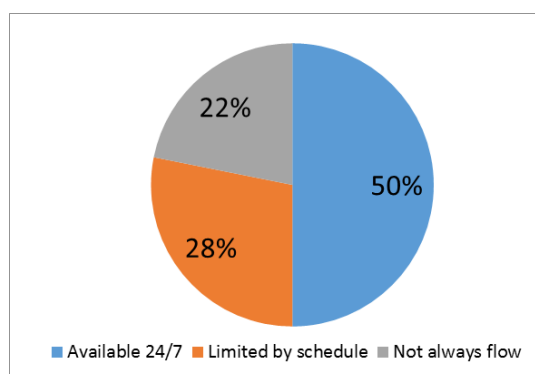


Figure 6. Water Continuity According to Public Perception

From Figure 6. it can be seen that 50% of people get clean water that flows every time and smoothly. While people who are farther away from the location of the main well complain about water that is limited by schedule (28%) and not smoothly distributed (22%). It proof that not all household have good quality, quantity, and continuity of water supply.

4.1.3. Condition of sanitation

Related to the ownership of sanitation in Kolorai Island, the following is a description of ownership of bathing (Mandi), washing (Cuci), toilet (Kakus) facilities (MCK):

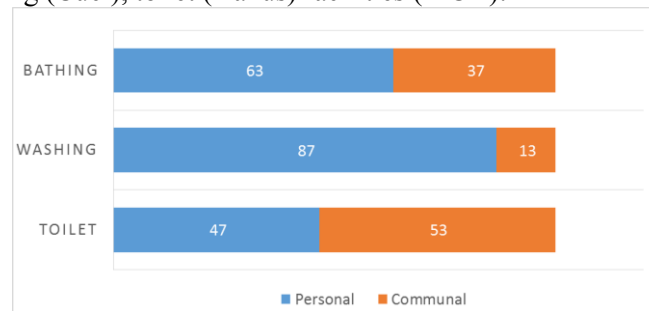


Figure 7. Mandi Cuci Kakus Ownership

Some households do not have a private toilet. There are 11 public toilet/MCK scattered over Kolorai Island for households who do not have a private toilet yet. For black water, each toilet is equipped with septictank, but there is no maintenance and regular suctioning faeces. For gray water, each household does not have a sewer, and discharge to the yard.

According to the statement of a nurse in n medical facility in Kolorai Island, open defecation (on the beach) is still high. Although there are private and public toilet available. Numbers of open defecation in Morotai Island reached 57% [7]. Open defecation free socialization have been frequently conducted by local medical officer, but public awareness is still low.

4.1.4. Waste management system

The garbage on Kolorai Island is managed conventionally. Here is an overview of waste management by communities on Kolorai Island:

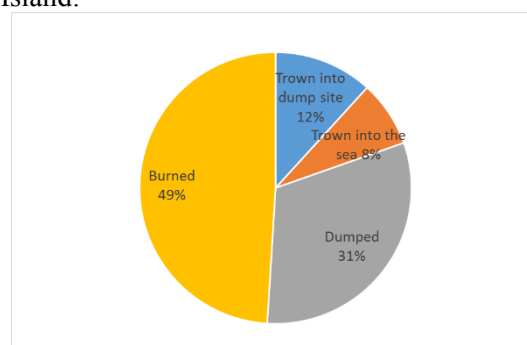


Figure 8. Waste handling by Kolorai Island Community

Figure 8 illustrate that most of household burn and dump their waste. Every household collect their waste and then disposed it to appointed location, and then the waste is dumped or burned. In small islands like Kolorai, the problem of waste management system becomes one of the environmental problems [2].



Figure 9. Piles of rubbish by the beach

4.2. Community Factors

4.2.1. *Socio-economic conditions*

Kolorai Island citizen is dominated by Galela, Tobelo, Ternate and Bajo tribes with Moslem religion majority. Most of them work as a fisherman, so their daily income is uncertain. Women on Kolorai Island mostly are housewives, and there are other tourism-related professions, such as pandan craftsmen and seaweed cultivator.

4.2.2. *Settlement Patterns*

The physical condition of settlement areas improved significantly after the Sail Morotai 2012 event. Homestay facilities was built in several houses, as well as public toilets, solar cell-powered water reservoir and fences in front of the house. Most of the houses are built as permanent building, with concrete walls, zinc roofs, and cement floors.



Figure 10. Settlement in Kolorai Island

Their settlement pattern is oriented to the main docks. The homestay gathered on the main road to the dock. There is a mosque in the center of the settlement, it is also used as a public space. The citizen mobility are by walk, considering by the short space between houses, there are no vehicles on the Island.



Figure 11. Settlement Pattern

4.2.3. Preferences of Technology Use

The adequacy of clean water and sanitation is seen from the community perception, which is described in the graph as follows:

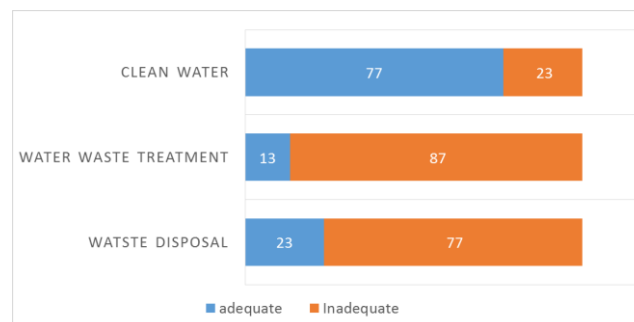


Figure 12. Public perception related to clean water and sanitation

From figure 11 can be seen that respondents have assumed that clean water (77%), as just waste water treatment facilities (13%) and waste disposal (23%) is adequate. This indicates that clean water facilities are adequate, but there are still 23% households have insufficient water supply. While waste water treatment and waste disposal is insufficient.

The community are welcome to water and sanitation technology. Exclude from the willingness to pay for technology, the potential of human resources to perform operational and maintenance for technology is exists. This can be demonstrated by a water reservoir with solar cell power that still exists and functioning well for use. One of the residents is appointed to be able to maintain and operate the the technology.

4.3. Financial Factor

Communities in Kolorai Island have not reached piping system by PDAM. The lack of electricity in this island causes the distribution of water use a generator set, both gasoline and diesel fuel. According to an interview with the community, to meet energy needs, including water distribution, each household requires Rp 20,000 to purchase gasoline or diesel fuel. But in holiday season when tourist come to the island, the need for energy and clean water becomes larger, reaching Rp 100,000 per day. Based on the results of interviews and questionnaires, the community is willing to pay more if quality of clean water and sanitation systems improved, with the following price ranges:

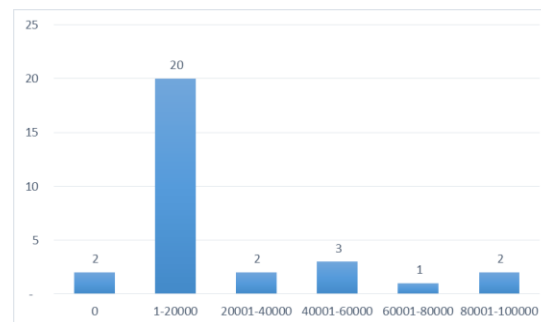


Figure 13. Willingness to Pay

Figure 12 shows most of the community is willing to pay more to get better water quality. The willingness to pay for the operation and maintenance is below price range Rp 20,000.

4.4. Institutional Factors

Along with the National Sanitation Settlement Development Program (PPSP), a program that aims to improve the quality of regional sanitation, in line with efforts to achieve Millennium Development Goals (MDGs) targets, the Government of Pulau Morotai has established a Working Group Team for the Acceleration of Sanitation Development Program of Pulau Morotai [8]. Its vision is "The realization of Morotai DALOHA in Development of Environmental Friendly Sanitation 2020". It is divided into support programs related to sanitation development in Pulau Morotai.

Bappeda Kabupaten Pulau Morotai (2017) provides recommendations of tourism support infrastructure in Kolorai Island, including water supply and sanitation. MCK are recommended to build near the main dock [9]. Recommendation for water needs use desalination of sea water and built near the village office or polindes. At the same time, recommendation for waste management system improvement is by providing garbage transporter using shuttle from Daruba.

Badan Pengembangan Infrastruktur Wilayah provides recommendations related to clean water and sanitation programs, such as drinking water treatment system, construction of rainwater catchment technology in homestay area, construction of waste management system scale area "TPS 3R" and settlement area development through the application of water-saving technology [2].

4.5. Technical Factor

Technically, Balitbang PUPR has technology that is ready to be applied and adapted to the needs. Its technology related to clean water are raw water source technology, processing system, and distribution. As for technology related to sanitation are waste water treatment and waste management system. It includes sorting and processing garbage that environmentally friendly. Advanced analysis of technology readiness level should be done. In 2017, technical advice by Balitbang PUPR only covers the study of technology needs in the main island of Pulau Morotai. It is related to the slum areas development on Daruba Beach, and has not cover the study of technology needs in small islands, including Kolorai Island.

4.6. Technology Requirement

From the analysis, the specific conditions or problems related to clean water and sanitation in Kolorai Island are:

1. Insufficient of water quantity
2. Brackish water quality
3. Limited water continuity (capacity and energy for water distribution)
4. There is no wastewater treatment system (black and gray water)
5. Traditional waste management system (dumped and burned)

Based on the problems above, can be formulated appropriate water and sanitation technology in Kolorai Island. For clean water technology, brackish water treatment into drinking water using a solar cell system. It designs with large capacity, which can be installed in 2 different locations, to ensure the affordability of the entire community in Kolorai Island. This technology aim to solve problems related to quantity, quality, and continuity of water at once. We should pay attention to water management and governance which plays an important role [10], including for water management on a small scale, aspect such as electricity or diesel fuel for groundwater pumps.

Waste water treatment is required communal wastewater treatment system to accommodate, collect, and process black water and gray water, so the effluent can be discharged directly to the sea. As for the waste management system, the current condition of the community is still collecting waste and processed with dumped and burned. However because of the geographical conditions of a small island, the condition will have a time limit. The burned garbage will accumulate because it can not burn out completely. As for the dumped garbage, the land used for hoarding is also limited. The sanira furnace (the burning furnace of non-toxic waste) is a technology from Balitbang PUPR. It can be a solution for waste management system in Kolorai Island, because zero waste, easy to use, using local furnace component, and energy saving [11]. Its operation use solar powered. Community participation in operation and maintenance is also crucial. In order to prove healthy and meaningful livelihoods for all of humanity, which is our major challenge in this century [12], this can be done, one of them by ensuring good service on drinking water supply and sanitation.

5. Conclusion

Potential and community mapping is needed in provision of clean water and sanitation facilities. The availability of clean water and sanitation is a key and primary element on tourism development in Kolorai Island. From research results, it can be concluded that the necessary technology for community are; the installation of processing and distribution of water with solar powered, communal wastewater treatment system, and sanira furnace for the processing of garbage. The chosen technology that suits to these needs, can be accommodated by technology products by Balitbang PUPR in accordance with the conditions and needs of Kolorai Island. In its implementation, further study is needed related to other technology application factors.

This research can be used to solve water and sanitation problems in other areas, especially on small islands, based on the application of community-based technologies

6. Acknowledgement

This research was supported by Research and Development Agency, Ministry of Public Works and Housing. We thank Nur Alvira, Arif Koeshernawan, Rivaldo Okono, for assistance with methodology, and Achjat Dwiarno, Ning Wiyatiningsih, and S.H. Aqsha for comments that greatly improved the manuscript.

References

- [1] BPS Kabupaten Pulau Morotai 2016 *Kecamatan Morotai Selatan Dalam Angka Tahun 2016* Another reference
- [2] Badan Pengembangan Infrastruktur Wilayah 2016 Rencana Pembangunan Infrastruktur Terpadu MOROTAI (Marine Heritage)
- [3] Brikké, F., & Bredero, M 2003 Linking technology choice with operation and maintenance. WHO Press, 142. (Retrieved from http://www.who.int/entity/water_sanitation_health/hygiene/om/wsh9241562153.pdfaccesse, 2017, May 1)
- [4] Tim Teknis Pembangunan Sanitasi 2010 Buku Referensi Opsi Sistem dan Teknologi Sanitasi
- [5] Neville, S., Adams, J. and Cook, C. 2016 Using internetbased approaches to collect qualitative data from vulnerable groups: reflections from the field, *Contemporary Nurse*, 52:6, 657-668, DOI: 10.1080/10376178.2015.1095056

- [6] Direktorat Pendayagunaan Pulau-Pulau Kecil 2012 Kolorai (http://www.ppk-kp3k.kkp.go.id/direktori-pulau/index.php/public_c/pulau_info/10695 accessed, 2017, July 1 Juli)
- [7] PPSP Kabupaten Pulau Morotai 2014 Buku Putih Sanitasi Kabupaten Pulau Morotai. Kabupaten Pulau Morotai (2014)
- [8] PPSP Kabupaten Pulau Morotai 2014 Strategi Sanitasi Kabupaten (SSK) Kabupaten Pulau Morotai (2014)
- [9] Bappeda Kabupaten Pulau Morotai 2017 Rencana Induk Pengembangan Obyek Wisata Pulau Dodola, Pulau Sum-sum, dan Pulau Kolorai
- [10] Wada, Yoshihide and Bierkens, Marc. 2014 Sustainability Of Global Water Use: Past Reconstruction And Future Projections, *Environmental Research Letters Environ. Res. Lett.* 9 (2014) 104003 (17pp) doi:10.1088/1748-9326/9/10/104003
- [11] Balitbang Kementrian PUPR 2015 Katalog Layanan Badan Litbang PU, Pelayanan Uji Laboratorium, Sertifikasi, dan Advis Teknis (PULSA)
- [12] Cosgrove, W. J., and D. P. Loucks 2015 Water management: Current and future challenges and research directions, *Water Resource. Res.*, 51, 4823–4839, doi:10.1002/ 2014WR016869.