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# Role of Water District Operation in Public Health and Environmental Protection

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**Abstract**

The operation of water districts plays a critical role in safeguarding public health and promoting environmental protection. This study examines the multifaceted responsibilities of water districts, focusing on water quality management infrastructure maintenance and regulatory compliance. It explores how operational practices, such as monitoring water sources and managing distribution systems, directly influence public health outcomes by preventing waterborne diseases, reducing exposure to chemical contaminants and ensuring the continuous supply of safe drinking water.

Through data analysis, this research identifies the best practices of water district that enhance operational efficiency while meeting public health and environmental protection. Additionally, it underscores the active community engagement to address the complex challenges that water districts are facing today

The findings suggest that an adaptive management approach, one that integrates public health and environmental sustainability is vital in ensuring the long-term safety and resilience of water system. This research imparted actionable recommendations for board of directors and water district officers to strengthen the water governance and protect both human and the environment.

**Keywords:** Water District, Public Health, Environmental Protection

## INTRODUCTION

The importance of water for humankind lies primarily in its economic viability as well as the different ecological aspects that it covers. The increasing population of the world and urbanization make demands very high for today and future generations. Today, it gets even more difficult to get water supply systems that are safe, hygienic, and reliable. Such agencies include the water districts tasked with the responsibilities of management of distribution, treatment regarding their conservation through their building resources as they exist in either urban or rural communities. Not only provision of water to the consumer but this covers far more facets dealing with the environment and public health especially where most public health environments are created as a result of environmental protection. To the end that public health is being affected directly by how activities of the water districts impact the quality of water, free from contamination by bacteriological, viral, chemicals, and heavy metals, water is very good in the prevention of waterborne diseases; hence the communities' health is also ensured. Furthermore, in quite many cases, water districts assume the additional responsibility of wastewater treatment: discharging effluents into environment bodies without harm to health or ecosystems. Efficiency in the operation of water districts and compliance with regulations in effectiveness role in chlorination, dysentery, and all other waterborne GI infections. The water districts will now have to brace themselves towards adaptation

and mitigation to risks presented by emerging contaminants like microplastics and pharmaceuticals affecting the water resources.

Therefore, water districts do not only merely provision drinking water and sanitation services but also can be viewed as environmental protection actors. The basic functions of natural ecosystems need water management for their water bodies that have been created by man, rivers, lakes, wetlands, and aquifers, are kept clean and healthy so that they can serve human beings with drinking water and provide a habitat to various plants and animals. Their mismanagement entails grave situations like over-extraction of water, water pollution, and infrastructural inefficiencies, which can adversely impact upon nature and humanity by causing ecosystem degradation, biodiversity depletion, and eventual loss of vital natural resources. Water districts are bestowed with unique chances to mediate human needs with those of environmental protection for the sustainable use of water; this entails the knowledge of technology, environmental regulation, and participation in discussions. On the other hand, water districts are now ideally positioned to monitor to some extent some of the new risks that climate change represents. Changes occur in patterns of rainfall and increase in the world's temperature, thereby adding pressures on the availability and quality of the water resources is greater than normal frequency and intensity of extreme weather events or natural disasters. Thus, water districts must develop infrastructure and operations in a climate- resilient manner through alternate methods, including water reuse, advanced filtration, and sustainable water source creation. In this regard, water districts must revise their infrastructure and operation to be climate-resilient through alternate means including water reuse, advanced filtration, and creation of sustainable water sources. Also, carbon footprints of the water district operations can be reduced through adoption of energy-efficient technologies and green infrastructure.

## METHODS

This study used a quantitative descriptive research design to analyze the impact of water district operations in Cabuyao, Calamba, Siniloan, Pakil, and Mabitac. A purposive sampling method selected 151 respondents (30% of staff from each district). Data were collected using structured survey questionnaires focusing on operational efficiency, water quality management, supply reliability, and customer service. Public health and environmental protection outcomes, customer satisfaction, and regulatory compliance were measured.

Data were analyzed using descriptive statistics (mean, standard deviation) and Pearson correlation analysis to identify relationships between operational factors and key outcomes.

## RESULTS AND DISCUSSION

### Level of water district operation in terms of Operational Efficiency, Water Quality Management, Water Supply Reliability and Customer Service

In this study, the researcher sought to determine the level of water district operation in terms of Operational Efficiency, Water Quality Management, Water Supply Reliability and Customer Service.

The following tables show the statement, mean, standard deviation, remarks and verbal interpretation based on the respondents' perspectives.

**Table 1. Operational Efficiency**

| STATEMENT | Mean | SD | Remarks |
|---|---|---|---|
| Water district provides a reliable and consistent water supply | 4.46 | 0.63 | Very High |

| | | | |
|---|---|---|---|
| Water district is quick to address service disruptions or complaints | 4.60 | 0.57 | Very High |
| Water district staff is approachable and promotes professionalism | 4.66 | 0.55 | Very High |
| The district involves the community in decision-making processes related to water management | 4.07 | 0.81 | High |
| Overall operational efficiency of the water district meets community needs | 4.34 | 0.65 | High |
| **Overall Mean** | **4.43** | **0.50** | **Very High** |

Legend:4.20 - 5.00 – Very High; 3.40 - 4.19 – High; 2.60 - 3.39 – Neutral; 1.80 - 2.59 – Low; 1.0 -1.79 – Very low

Table 1 shows the level of water district operation in terms of operational efficiency. The average score for operational efficiency is 4.43 out of 5, which is interpreted as Strongly Agree. This indicates that, on average, the respondents view the water district's operational efficiency positively. The standard deviation of 0.50 (0.49518) means the operational efficiency is consistent and clustered around it.

Gleick's research highlights the crucial role of effective water management and infrastructure in improving public health outcomes. His findings support this observation that the operational efficiency of water districts is closely linked to better public health and environmental protection. As stated by Gleick, P.H, efficient water delivery helps reduce waterborne diseases and minimizes service disruptions, ultimately benefiting the entire community's health **(**Gleick, P. H. (2004).

**Table 2. Water Quality Management**

| **STATEMENT** | **Mean** | **SD** | **Remarks** |
|---|---|---|---|
| Water district implements effective measures to meet safety standards | 4.56 | 0.50 | Very High |
| The water district takes adequate steps to prevent contamination of the water | 4.58 | 0.53 | Very High |
| Efforts by the water district to monitor and reduce contaminants are satisfactory | 4.53 | 0.54 | Very High |
| Water district conducts regular monitoring to ensure water quality | 4.60 | 0.49 | Very High |
| Regular maintenance of water facilities and pumping stations is performed to ensure quality | 4.64 | 0.48 | Very High |
| **Overall Mean** | **4.58** | **0.40** | Very High |

Legend: 4.20 - 5.00 – Very High; 3.40 - 4.19 – High; 2.60 - 3.39 – Neutral; 1.80 - 2.59 – Low; 1.0 -1.79 – Very low

Table 2 shows that the average score (mean) for water quality management is 4.58 and the standard deviation (SD) is 0.40 (0.40328). This indicates that the water districts are performing well in managing water quality. The smaller standard deviation implies that the responses are consistent and aligned, though there may be some minor concerns or differences in how respondents perceive the effectiveness of water

quality measures. The district likely excels in implementing the safety standards and monitoring water quality, though continuous improvement could further boost satisfaction

The Trust in Public Water involves, as Gleick (2014) points out, not only assured supply of clean and safe water services, but also the trust of citizenry reflected in very high satisfaction enjoyed by managed services in their water quality delivery.

**Table 3. Water Supply Reliability**

| STATEMENT | Mean | SD | Remarks |
|---|---|---|---|
| Water district provides a reliable and consistent water supply throughout the year | 4.30 | 0.61 | Very High |
| Interruptions in the water supply are infrequent and resolved promptly | 4.33 | 0.57 | Very High |
| District effectively communicates scheduled water outages to concessionaires | 4.44 | 0.61 | Very High |
| Water districts' pumping stations/infrastructures is well -maintained to ensure reliable water delivery | 4 .49 | 0.64 | Very High |
| Water pressure remains consistent across different times of the day | 3.84 | 0.81 | High |
| **Overall Mean** | **4.28** | **0.51** | High |

Legend:4.20 - 5.00 – Very High; 3.40 - 4.19 – High; 2.60 - 3.39 – Neutral; 1.80 - 2.59 – Low; 1.0 -1.79 – Very low

With a general weighted mean of 4.28 across the table and a standard deviation of 0.51, it is evident that the satisfaction attained is mostly high with respect to the service of the district in taking care of the water facilities. The standard deviation is low, meaning respondents are likely consistent in their responses with regards to the whole service quality of the district. While some aspects are rated positively, somewhat lower scores in water pressure consistency indicate the part that may need further improvement.

Overall, the water district is performing well, with strong performance in areas such as infrastructure maintenance, communication of outages, and managing water interruptions. However, water pressure consistency stands out as an area that may need further investigation and improvement. Continuing to maintain high standards in communication and infrastructure will further strengthen customer satisfaction, while improving the reliability of water pressure could elevate overall ratings even higher.

**Table 4. Customer Service**

| STATEMENT | Mean | SD | Remarks |
|---|---|---|---|
| customer service team displayed a genuine willingness to help | 4.48 | 0.54 | Very High |
| customer service representative was friendly and professional | 4.58 | 0.50 | Very High |
| kept informed about the status of my request or inquiry | 4.32 | 0.59 | Very High |
| customer service team demonstrated strong knowledge and expertise | 4.42 | 0.50 | Very High |
| overall experience with the customer service team exceeded my expectations | 4.35 | 0.48 | Very High |
| **Overall Mean** | **4.43** | **0.44** | **Very High** |

Legend: 4.20 - 5.00 – Very High; 3.40 - 4.19 – High; 2.60 - 3.39 – Neutral; 1.80 - 2.59 – Low; 1.0 -1.79 – Very low

The customers think positively about customer service, while the mean score is 4.43 on Table 4, with a .44 (0.43619) SD pointing to agreement on the customer service quality aspect.
The customer service team is greatly valued by respondents as being professional, helpful, knowledgeable, and able to go above and beyond expectations. Mentions, however, were noted about slightly improving the communication around the status of the request; besides this one little flaw, communication is still generally viewed as a strength. Thus, the high consistency in responses amounting to positive opinion supports the great performance of the team.
To summarize, the results back up the effectiveness and efficiency of the customer service team, with just minor improvements in communication possible. High overall satisfaction infers successful provision of customer needs and subsequently building positive relationships with them.
Customer service excellence is often attributed to professionalism, willingness to help, and good communication by the staff. As explained by Zeithaml et al. in 2018, overall customer satisfaction is defined by the competency of service staff and communication with them throughout the service experience, in which any lapses in communication can draw negative inferences from all service perceptions.

**Level of performance of water district operation when it comes public health outcomes, environmental outcomes, customer satisfaction and compliance to regulations**

- In this study, the researcher sought to determine the level of performance of water district operation in public health and environmental protection outcomes, the customer satisfaction and compliance to regulations.
- **Overall Mean = 4.45**: Respondents generally perceive that the water districts have a positive impact on public health.
- **Standard Deviation = 0.48080**: Low standard deviation suggests consistency in the perception of public health outcomes.

The following tables show the statement, mean, standard deviation, remarks and verbal interpretation from the perspective of the respondents.

**Table 5. Public Health Outcomes**

| STATEMENT | Mean | SD | Remarks |
|---|---|---|---|
| People are aware and knowledgeable of the local water district's operation in terms of public health | 4.40 | 0.64 | Very High |
| Quality of water provided by the local water district impacts public health | 4.45 | 0.61 | Very High |
| Aspects of water quality that concern you the most include contaminants, cost, taste and odor, availability during emergencies and pressure of water | 4.43 | 0.63 | Very High |
| Water district contributes to the prevention of waterborne illnesses or diseases | 4 .34 | 0.64 | Very High |
| Interested in participating in further discussion about safety and public health | 4.60 | 0.58 | Very High |

| | | | |
|---|---|---|---|
| **Overall Mean** | 4.45 | 0.48 | Very High |

Legend: 4.20 - 5.00 – Very High; 3.40 - 4.19 – High; 2.60 - 3.39 – Neutral; 1.80 - 2.59 – Low; 1.0 -1.79 – Very low

Table 5 shows the overall mean of 4.45 (4.4464), reflecting the perception of respondents that the water districts exert positive influence on public health.

The low standard deviation of 0.48 (0.048080) indicates the consistency in the perception regarding public health outcomes.

Such responses will probably reflect strong acknowledgement of the inherent role of the local water district in respect to public health, with respondents considerably concerned about the water quality for its resultant effects on their well-being. It is presumed that the people are also well aware of how the water district operates in the prevention of waterborne diseases. General concerns of responses include acknowledgment of specific matters about the quality of water in terms of contaminants, cost, and taste.

Furthermore, there are good indications that the respondents are greatly interested in discussing issues related to safety and public health, which means that the community is organized and willing to put their efforts into water quality solution issues.

All statements have high mean scores varying from 4.34 to 4.60, which suggests a fairly strong agreement that the activities of the water district are closely related to public health, but at the same time, there is a need for continuous dialogues and improvements. However, with those standard deviations indicating variability among responses, it implies that perhaps different individuals may have different priorities or concerns.

Effective water quality management not only prevents the onset of waterborne diseases but also secures public health. Outlined by WHO (2017), public health care systems and the involvement of the public are part of the many components that strengthen water safety.

**Table 6. Environmental Protection Outcomes**

| Statement | Mean | SD | Remarks |
|---|---|---|---|
| Community is aware and knowledgeable of the local water district's operation in terms of environmental protection | 4.38 | 0.67 | Very High |
| Quality of water provided by the local water district impacts environmental protection | 4.47 | 0.53 | Very High |
| Water districts implement sufficient measures to protect the environment, including conserving water and reducing pollution | 4.52 | 0.53 | Very High |
| Water district collaborates with the community to promote water conservation and sustainable practices | 4.57 | 0.57 | Very High |
| Satisfied with the information provided by the water district about its efforts to enhance or improve environmental sustainability | 4.57 | 0.65 | Very High |
| **Overall Mean** | 4.50 | 0.50 | Very High |

Legend: 4.20 - 5.00 – Very High; 3.40 - 4.19 – High; 2.60 - 3.39 – Neutral; 1.80 - 2.59 – Low; 1.0 -1.79 – Very low

As indicated by the weighted mean of 4.50 (4.5020) in Table 6, there is a general agreement among the respondents that the water districts have made positive contributions toward environmental health. The standard deviation of 0.50 (0.49900) indicates a moderate response consistency.

Overall findings point toward an enormous degree of agreement with the water district's roles in environmental protection and sustainability. This is reflected by the mean scores ranging from 4.38 to 4.57, wherein respondents see the district as being active in environmental protection, community participation, and sustainability programs. The efforts of the district in water conservation, pollution reduction, and working with the community on sustainable practices are strongly acknowledged. Moreover, the satisfaction with the information shared highlights effective communication between the water district and the public.

The effect size of responses, as highlighted by their standard deviations (0.50 – Very High) indicates a number of respondents aligned with their views while there are some who are in contrast. However, the communities generally appear to be knowledgeable, happy, and confident with regard to the district's environmental work.

As indicated by the Environmental Protection Agency (EPA, 2012), the water districts must follow both technical measures and community outreach so that the efforts to conserve water and reduce pollution become effective and gain widespread support.

**Table 7. Customer Satisfaction**

| STATEMENT | Mean | SD | Remarks |
|---|---|---|---|
| Water district effectively communicates important updates and information about water safety, outages, and community programs | 4.48 | 0.64 | Very High |
| Water district billing system is clear and easy to understand | 4.62 | 0.51 | Very High |
| Water district resolves customer complaints and concerns effectively and promptly | 4.53 | 0.56 | Very High |
| Satisfied with the reliability of water supply, like minimal outages and consistent pressure | 4.23 | 0.59 | Very High |
| Water district contributes effectively to the public by ensuring safe and clean drinking water | 4.32 | 0.59 | Very High |
| **Overall Mean** | **4.44** | **0.46** | **Very High** |

Legend: 4.20 - 5.00 – Very High; 3.40 - 4.19 – High; 2.60 - 3.39 – Neutral; 1.80 - 2.59 – Low; 1.0 -1.79 – Very low

Table 7 presents the weighted mean of 4.44 (4.4358), indicating that the respondents are generally satisfied with the service they receive from the water district on aspects akin to public health and environmental health.

A low standard deviation of 0.46 (0.46366) indicates that respondents are consistent in their rating of customer satisfaction in all the dimensions. They are generally satisfied with the services provided by the water district across all the parameters.

The respondents rated strong communication regarding water safety, outages, and community programs, along with their billing practices as clear and understandable, one of the district’s strengths. The district is said to handle customer complaints well and provide reliable water supply with very few outages. Water

supply reliability was rated favorably, but it was rated the lowest on the mean score, indicating that some respondents may have concerns on occasion. There is community appreciation of the water district's role in delivering safe drinking water for public health, as shown in the high scores across areas.

In conclusion, the water district has done well in communication, customer service, and public health programs, with minor opportunities on reliability and water supply disruptions for an increase in customer satisfaction.

Effective communication, clear billing systems, and prompt complaint resolution are essential for customer satisfaction in water utilities. As noted by Afonso et al. (2016), customer satisfaction in water services is strongly influenced by the clarity of communication, the reliability of service, and the efficiency in addressing customer concerns.

**Table 8. Compliance to Regulations**

| STATEMENT | Mean | SD | Remarks |
|---|---|---|---|
| The staff demonstrate familiarity with applicable water quality regulations and environmental protection regulations | 4.32 | 0.61 | Very High |
| Regulatory standards are communicated effectively to concessionaires by the water district | 4.25 | 0.59 | High |
| Water district completely adheres with public health and environmental regulations | 4.34 | 0.54 | Very High |
| Water district provides sufficient transparency regarding its compliance with the regulations | 4.38 | 0.59 | Very High |
| Water districts should adopt additional measures to ensure compliance with regulations | 4.39 | 0.61 | Very High |
| **Overall Mean** | **4.34** | **0.49** | **Very High** |

Legend: 4.20 - 5.00 – Very High; 3.40 - 4.19 – High; 2.60 - 3.39 – Neutral; 1.80 - 2.59 – Low; 1.0 -1.79 – Very low

Table 8 shows a weighted mean of 4.34 (4.3391), with a remark of Strongly Agree, indicating that respondents believe the water districts are compliant with regulations. The standard deviation of 0.49 (0.49369), suggests a moderate level of consistency in responses regarding regulatory compliance.

The respondents are relatively satisfied with the compliance of the water district with regulatory standards and their dissemination regarding environmental protection and public health regulations. However, most respondents are fairly confident in the transparency and compliance of the district but with a slight manifestation, there is a little more that could be done to improve communication and strengthen compliance further. Overall, the comments indicate that the water district is rather performing well in regulatory matters but still has much to improve its communication towards both concessionaires and the general public about these issues.

These high mean scores across all constructs seem justified and suggest that the respondents are well aware of the standards prescribed by the regulations and trusted that the water district would conform to them. Furthermore, apart from communicating regulatory compliance and being transparent about it, the public health and environmental regulations applicable to the water district are taken very seriously.

As pointed out by Dore et al. (2018), regulatory compliance of water management also takes account of people's health but mainly focuses on the idea of transparency and improved growth in the attainment of environmental standards.

**Significant relationship between water district operations and public health outcomes in the communities they serve**

**Table 9. Significant relationship between water district operations and public health outcomes in the communities they serve**

| Water District operation | Performance of water district operation in public health and environmental protection | r value | p value | Strength of Correlation | Analysis |
|---|---|---|---|---|---|
| Operational Efficiency | Public Health Outcomes | 0.01 | .31 | Low Correlation | Significant |
| | Environmental Health Outcomes | 0.01 | .43 | Moderate Correlation | Significant |
| | Customer Satisfaction | 0.01 | .56 | Moderate Correlation | Significant |
| | Compliance to Regulation | 0.01 | .55 | Moderate Correlation | Significant |
| Water Management Quality | Public Health Outcomes | 0.01 | .48 | Moderate Correlation | Significant |
| | Environmental Health Outcomes | 0.01 | .60 | Moderately High Correlation | Significant |
| | Customer Satisfaction | 0.01 | .60 | Moderately High Correlation | Significant |
| | Compliance to Regulation | 0.01 | .59 | Moderate Correlation | Significant |
| Water Supply Reliability | Public Health Outcomes | 0.01 | .46 | Moderate Correlation | Significant |
| | Environmental Health Outcomes | 0.01 | .60 | Moderately High Correlation | Significant |
| | Customer Satisfaction | 0.01 | .73 | Moderately High Correlation | Significant |
| | Compliance to Regulation | 0.01 | .66 | Moderately High Correlation | Significant |

| | | | | | |
|---|---|---|---|---|---|
| Customer Service | Public Health Outcomes | 0.01 | .37 | Low Correlation | Significant |
| | Environmental Health Outcomes | 0.01 | .31 | Low Correlation | Significant |
| | Customer Satisfaction | 0.01 | .48 | Moderate Correlation | Significant |
| | Compliance to Regulation | 0.01 | .60 | Moderately High Correlation | Significant |

The table shows that all relationships between the water district's operation, including operational efficiency, water quality management, water reliability and customer service, and the outcomes from public health, environmental protection, customer satisfaction, and compliance with regulations are statistically significant, with p-values less than 0.01. This Pearson correlation indicates that there is a significant relationship between the water district's operation and the public health and environmental protection in the communities it serves.

Among the factors studied, Water Supply Reliability has the strongest correlations with customer satisfaction (r value = .73, p value = 0.01) and compliance with regulations. At the same time, Water Quality Management shows strong associations (r value = .66, p value = 0.01) with public health and environmental protection outcomes.

| **Correlation Coefficient Value (r)** | **Direction and Strength of Correlation** |
|---|---|
| 0.80 to 1.00 | High Correlation |
| 0.60 to 0.79 | Moderately High Correlation |
| 0.40 to 0.59 | Moderate Correlation |
| 0.20 to 0.39 | Low Correlation |
| 0.1 to 0.19 | Negligible Correlation |

Thus, the data support the concept that improving water districts' operations-including reliability in supply of water, management and maintenance of water quality-considered public health and environmental impacts as well as customer satisfaction and compliance with regulations.

Water Supply Reliability is the most pending of all operational factors concerning customer satisfaction and compliance to regulations: it shows the deepest correlation with both. This alone proves the need to maintain a stable and constant water supply to build and foster public confidence and trust. Water Quality Management also has a link to health and environmental impacts, signaling assurance of the safety of drinking water in preventing health issues and promoting community well-being.

Also, the data reveal that although less powerful than water-related ones, Operational Efficiency and Customer Service carry weight in the productivity and health-related outcome of the households served. Most importantly, these two factors affect the health-related outcome of the public being served as well as the satisfaction outcome related to customer service; however, they represent far out-numbered predictors in terms of strength by one particular group of variables-defining the quality and reliability of water services extended by the district.

These findings shed light on how water districts link up with health and environmental protection results. They then go on to say that if water quality, reliability of supply, and communication with customers can be improved, health will improve, satisfaction will increase, and trust will be engendered within communities. Thus, the water district should focus on these areas in order to maximize the public good.

The study on the performance of water districts with respect to public health and environmental protection reveals a range of correlations among the performance measures applied. Operational efficiency has been shown to correlate poorly to moderately with health and environmental outcomes, whereby the highest correlation is noted with customer satisfaction and compliance with regulatory issues. Water quality management bears the strongest correlations with environmental health outcomes as well as customer satisfaction, demonstrating moderate-to-high and very-high correlations, respectively. Water supply reliability allows for significant bonds with public health and environmental health, with moderately high correlations to customer satisfaction and regulatory compliance. In contrast, customer service records the weakest links with public health and environmental health outcomes but nonetheless maintains a moderately-to-moderately high correlation with customer satisfaction and compliance with regulatory issues. All correlations are statistically significant, emphasizing the importance of these operational aspects in achieving regulatory compliance and customer satisfaction in water district management.

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