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Impact of Sociocultural and Economic Factors on the Non-Technical Components of the Raw Water Performance Index Model

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Abstract: Socio-cultural and economic factors encompass the norms, values, customs, practices, and mindsets that are commonly accepted and transmitted across generations within a society. The aspects of socio-culture play an important role in forming individual identity and behavior in society. Water and nature are directly related by ontology; therefore, humans' consideration of water and nature plays an important role in the system of trust, religion, and world culture tradition. This research intends to analyze the effects of socio-economic factors and culture on the management of water resources in Nusa Tenggara Barat Province, mainly in Lombok Island and Sumbawa Island. The methodology consists of analysis using PLS-SEM to evaluate nontechnical variables that focuses on the socioeconomic dimension and culture. The result shows that factors such as water accessibility, water price, and the surrounding society culture regarding water sources have a significant influence on raw water performance. The result of the model shows good validity and reliability with consistent effect values from socioeconomic and cultural dimensions. This foundation provides a better understanding of the importance of analyzing socio-economic and cultural aspects in managing water resources. It is important to determine water sustainability and availability that is suitable for society, mainly in vulnerable areas like Nusa Tenggara Barat Province.

Keywords: water resource management, economics, socio-culture, raw water performance.

社会文化和经济因素对原水性能指数模型非技术成分的影响

摘要：社会文化和经济因素包括社会中普遍接受和代代相传的规范、价值观、习俗、实践和心态。社会文化方面在形成社会中的个人身份和行为方面发挥着重要作用。水和自然在本体论上直接相关；因此，人类对水和自然的考虑在信任、宗教和世界文化传统体系中发挥着重要作用。本研究旨在分析社会经济因素和文化对西努沙登加拉省水资源管理的影响，主要在龙目岛和松巴哇岛。该方法包括使用偏最小二乘扫描分析来评估非技术变量，重点关注社会经济维度和文化。结果表明，水的可及性、水价和与水源有关的周围社会文化等因素对原水性能有显著影响。该模型的结果显示出良好的有效性和可靠性，社会经济和文化维度的

效应值一致。这一基础更好地理解分析了社会经济和文化方面在水资源管理中的重要性。确实适合社会、尤其是在西努沙登加拉省等脆弱地区的水资源可持续性和可用性非常重要。

关键词：水资源管理、经济、社会文化、原水性能。

1. Introduction

Thales from Miletus (634-546 SM) stated that water is the source of all life. Likewise, in ancient Tiongkok-Guanzhong (720-645 SM), a legalist and Qi country update canceler during the spring and fall seasons in Tiongkok history recognized that more than 2000 years ago, water came from everything [1]. Life on earth comes from water, and water is a source of life on our planet. The existence and prosperity of mankind depend on safe water access, which has become a key to sustainable civilization. All major civilizations have arisen and developed around water. Water is not only needed for drinking and cleaning; however, but water is also the base for agriculture, trading, transportation, and even defense against enemies. Human growth, culture evolution, and civilization have strong relationships with water resources [2]. The ancient civilizations, including those of Egypt, Rome, the Venetian Empire, and the Omayyad Dynasty, were largely dependent on sustainable water resources, which permitted them to thrive and advance. Human sustainability and the development of society in the past and present have been influenced by scientific advances in water science and engineering. In this section, this research examines the long-standing influence of water on the development of various civilizations and the resulting impact on the culture, trust, and confidence of human society [3].

The examination of water footprints has revealed the challenges faced in altering cultural practices, particularly in regards to the principles of trust and standards for water usage in economic production. Product consumption that results in wasted water, such as in agriculture, is considered to be one of the major contributors to environmental damage. The challenge of water usage culture is one of the main economic and water resource development issues [4, 5]. Drawing upon the study of socio-hydrology and the societal practices of ancient civilizations, a narrative emerges to illustrate how population growth, migration patterns, technological advancements, and institutional developments are intertwined in the co-evolution of societies that rely on water resources. This co-evolution is particularly evident in environments facing water-related challenges [6].

Water is a very important resource for human life and economic development [7], but urbanization and industrialization all over the world have caused the pollution of natural and aquifer water sources. This pollution poses a threat to water quality and availability

because water is contaminated by physical, chemical, and biological dirt. It has a significant social impact because access to clean and safe water is essential for society's health and well-being. Furthermore, the disparate distribution of water resources can result in social disparities [8] as the disadvantaged members of society are frequently the most affected by water pollution and scarcity.

Water availability cannot be separated from water resource sustainability; of course, the socio-cultural factors of the society surrounding a water source will influence the maintenance of sustainability. Water availability is influenced by some socio-cultural and economic factors. They include cultural practices and attitudes toward water usage, economic systems that determine access to water resources, and policies and regulations that govern water management. These factors can have both positive and negative effects on the availability of water. For instance, in some cultures, there may be a traditional or ritual practice that involves more water usage, which can cause water scarcity. In terms of economic impact, water availability may also be affected by factors such as industrial development and urbanization. In addition, an economic system that prioritizes profit and growth can prioritize water resource allocation for industry or commercial activities, which has the potential to increase access to clean water for marginalized communities. The influence of socio-cultural and economic factors on water availability is essential for sustainable water resource management [9].

One of the potential socio-cultural effects on water availability is the cultural practices and trust systems surrounding water usage. For example, in certain cultures, there may be traditional practices or rituals that involve wasting water, which can contribute to water scarcity. Another significant effect of socio-culture is the perception of water as a symbol of purity, cleanliness, and spiritual interest in certain cultures. This perception often leads to an increase in efforts to sustain and protect water sources. In general, the influence of socio-cultural and economic factors on water availability can be substantial. Consequently, it is imperative to take these factors into account when formulating water management and conservation efforts to bridge the gap in water resources, promote equitable access to water sources, and ensure sustainability and accessibility of water for all.

During the development of Hinduism and Islam, water's significance was paramount in religious rituals,

leading to the belief in its spiritually purifying properties. Therefore, the holy places are generally on the banks of rivers, seas, and mountains. The juncture where mainland and two or more, preferably three, rivers converge holds significant meaning and is highly revered. The Holy River is considered to serve as an equalizing force. For example, in the Gangga River, it is believed that one's purity increases, while impurities are eliminated, albeit only temporarily. In sacred waters, the distinctions imposed by caste are thought to be diminished as all sins are believed to be purged [19].

In Islam, there is a well-known technical term for irrigation, which is referred to as Qanat. This is a prime example of water engineering introduced by the Persians. Qanat is a vital dry land irrigation method utilized during the pre-Islamic period. The Achaemenid Empire was the first to develop a tunnel well, which consists of a series of wells connected over a considerable distance to collect sub-surface water. This irrigation system is commonly used in desert regions for several reasons. First, it differs from other irrigation facilities like shaduf, dulab, and noria (na'urah) in its lack of reliance on external energy sources, instead utilizing gravity to facilitate the flow of water. Second, water can be transported through sub-surface channels over long distances with minimal evaporation and no risk of contamination. Finally, the water flow in qanat is regulated by the available supply in the aquifer, and with proper maintenance, the channel can produce a dependable water supply for up to a century [10].

The objective of this research was to investigate the impact of socio-cultural and economic factors, which comprise the non-technical elements of the raw water performance model. Socio-culture and economy pertain to the societal aspect of life that encompasses norms, values, customs, traditions, and attitudes accepted and passed down from one generation to the next. The aspects of socio-culture play an important role in forming individual identity and behavior in society. However, socio-culture can also influence patterns of consumption and preference in society. For example, in a particular society that values environmental

sustainability and conservation, individuals often opt for products and services that promote eco-friendliness and safeguard water sources for availability and sustenance.

Water and nature are directly related by ontology; therefore, humans' consideration of water and nature plays an important role in the system of trust, religion, and world culture tradition. In fact, conceptions of water and nature are substantively influenced by theological orientation, religion, and culture tradition [11].

2. Materials and Methods

2.1. Limitations of the Research

1. The research location is in Nusa Tenggara Barat Province, which is spread across two big islands, Lombok Island and Sumbawa Island.

2. The study was conducted by distributing questionnaires and completing field forms in accordance with the research site.

3. The analysis method utilizes the Likert scale for the questionnaire distribution and partial least squares structural equation modeling (PLS-SEM) to identify the parameter that is most affected by socio-cultural and economic factors [12-14].

4. This study focuses on the socio-economic and cultural aspects of water resource management and water users.

2.2. Research Locations

The research location is in the province of Nusa Tenggara Barat, which has two large islands, Lombok Island and Sumbawa Island. The selection of each island is based on the continued functionality of its raw water infrastructure, and in certain instances, management-by-management institutional practices have been implemented at the local general institution level. Table 1 presents the research locations for the non-technical aspects of socio-cultural and economic parameters.

Table 1 Research locations (Raw water database, 2023)

No.	Raw water unit	Regency	Source type	Intake structure type
Lombok Island				
1	Sempaga Valley	West Lombok	Spring	Broncaptering
2	Sarasuta	West Lombok	Spring	Broncaptering
3	Remening	West Lombok	River	Weir
4	Serepak	West Lombok	River	Weir
5	Sesera	Middle Lombok	Spring	Broncaptering
6	Rangat	West Lombok	Spring	Broncaptering
7	Pandanduri	East Lombok	Dam	Dam
8	Sekeper	North Lombok	River	Weir
9	Tibu Ulik	East Lombok	Small Dam	Small dam
10	Sordang	East Lombok	River	Free intake
11	Singang Pitu Nai	North Lombok	River	Free intake
12	Jonplanka	North Lombok	Spring	Broncaptering
13	Otak Aik	West Lombok	Spring	Broncaptering
Sumbawa Island				

Continuation of Table 1

1	Semongkat	Sumbawa	River	Weir
2	Brangdalap	Sumbawa	River	Weir
3	Tiu Pasai	Sumbawa	Small Dam	Small dam
4	Labangka	Sumbawa	Dam	Dam
5	Mongglenggo	Dompu	River	Weir
6	Ncoha	Dompu	Small Dam	Small dam
7	Patula	Bima	River	Weir
8	Rababaka	Dompu	River	Weir

2.3. Data Collection

The data utilized in this study include both secondary and primary data, focusing on socio-economic and cultural parameters. These parameters consist of the accessibility of water sources for water users and stakeholders, achievable water prices, economic prospects, social impacts, societal culture surrounding water sources, and policies or regulations.

The method for collecting secondary data is as follows:

a. Distributing questionnaires to respondents from the water source community, users, and water resource

managers.

b. Conducting surveys at 21 research locations to observe the socio-economic and cultural aspects of the water sources.

2.4. Research Concept Scheme

The research concept of this study, particularly the non-technical component/variable, is illustrated in Fig. 1. This figure demonstrates the non-technical element, which has several test parameters, one of which is the dimension of socio-economics and culture.

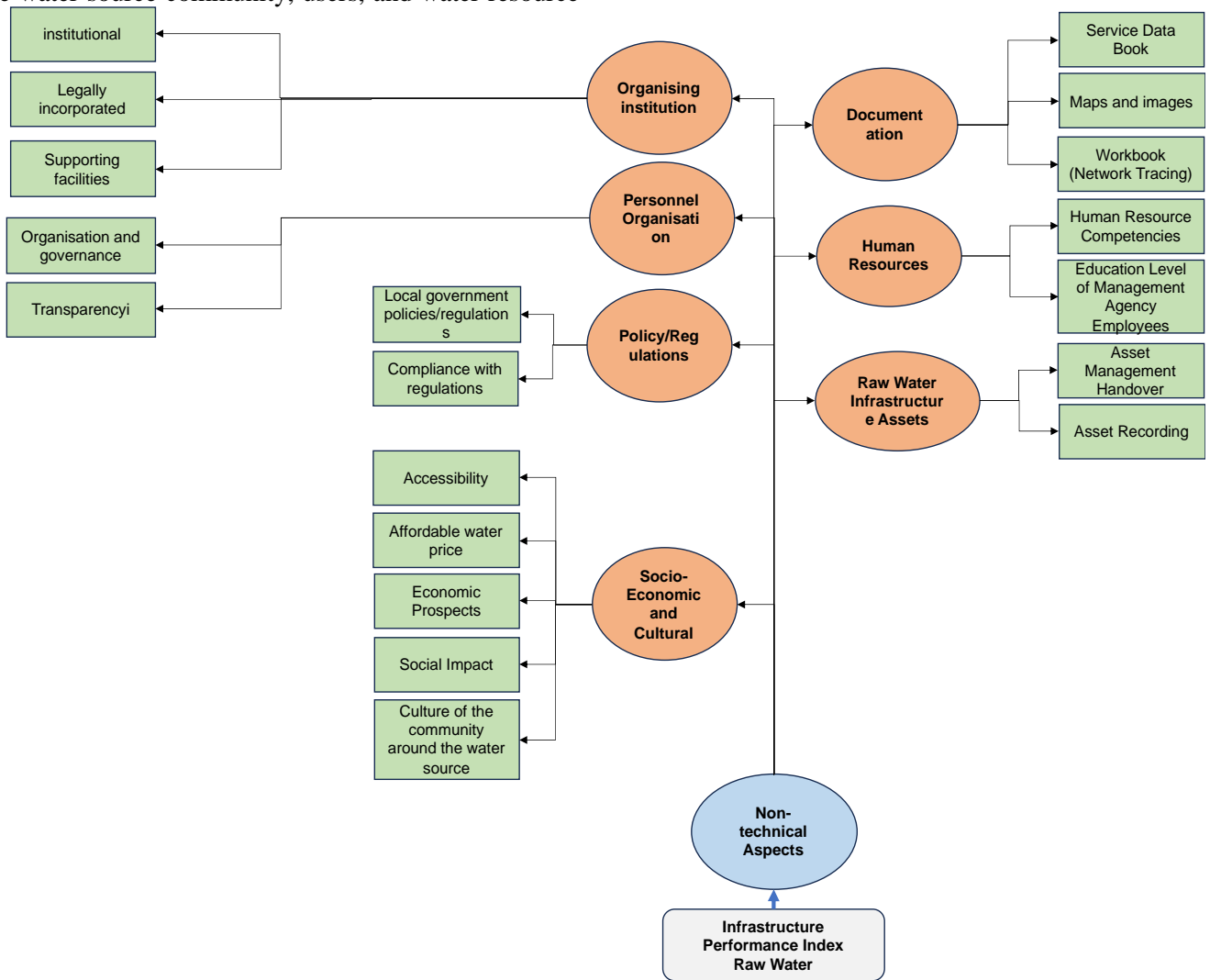


Fig. 1 Parameter scheme for socioeconomic and cultural factors in non-technical context (Own study)

3. Results and Discussion

The research examined the impact of socio-economic and cultural factors on non-technical variables to create a performance index model for raw

water in 21 locations across Nusa Tenggara Barat Province. Each dimension of socio-economic and cultural life comprises several indicators that have different weights, which are determined by statistical

analysis of the questionnaire results and secondary (field) data.

3.1. Variable Analysis

This research employs a non-technical variable that comprises seven dimensions and nineteen indicators, one of which is the socio-economic and cultural dimension. The socio-economic and cultural dimension contains five indicators, as depicted in Table 2. Table 2

Table 2 Variables, dimensions, and indicators of nontechnical model development (Own study, 2023)

Variable	Dimension	Indicator
Non-technical (B)	Socioeconomic and cultural factors (B1)	Accessibility (B1.1)
		Achievable water price (B1.2)
		Economic prospects (B1.3)
		Social impact (B1.4)
		Culture of society surrounding a water source (B1.5-B1.7)
		Policy/regulations of the local government (B2.1)
		Obedience to the regulations (B2.2)
	Policy/regulations (B2)	Organization and management (B3.1)
		Transparency (B3.2)
	Personal organization (B3)	Institution (B4.1)
		Legal corporate (B4.2)
	Manager of the institution (B4)	Support facility (B4.3)
		Service data book (B5.1)
		Maps and figures (B5.2)
	Documentation (B5)	Workbook (network rooting) (B5.3)
		Competence of human resources (B6.1)
	Human resources (B6)	Management staff education level (B6.2)
		Handover of asset management (B7.1)
	Raw water infrastructure (B7)	Asset recording (B7.2)

Table 3 contains information on the classification of data used in non-technical variables related to socio-economic and cultural dimensions and indicators of socio-economic culture.

Table 3 Data requirements for non-technical variables (Own study, 2023)

Data Requirements	Data Classification
Non-technical variable	Questionnaire data collected from 160 participants on two islands: Lombok and Sumbawa.
Dimension of socio-economic and cultural aspects	Questionnaire data and field survey data (completion of the survey form)

3.2. Nontechnical Raw Water Performance Index Model

The process of setting up a non-technical model for examination through the application of PLS-SEM, which has been validated and verified by GRG for determining the impact of socio-economic and cultural factors, is an integral component of the non-technical model analysis.

illustrates the non-technical variable, the socio-economic and cultural dimension, and their respective indicators that are integral to this research. To assess the validity and reliability of the measurement model in PLS-SEM, cross-loading analysis is conducted. The first step in determining whether the indicators within the variable and dimension are interrelated is by conducting cross-loading analysis [15]. The results of the cross-loading analysis are presented in Table 4.

3.3. Statistical Analysis Using PLS-SEM

This study employs the PLS model using the SmartPLS program to investigate the non-technical variables related to socio-economic and cultural dimensions. As shown in Fig. 2, which is part of the PLS-SEM analysis results, the development of non-technical variables encompasses seven dimensions, one of which is the socio-economic and cultural dimension. The values of the socio-cultural and economic dimension range from 0.831 to 0.880, with the highest weight assigned to B1.6 (culture of society surrounding a water source) and the lowest weight to B1.1 (water accessibility). The socio-economic and cultural dimension comprises seven indicators derived from the questionnaire results. The PLS-SEM analysis of the non-technical variables for the socio-economic and cultural dimension includes seven indicators: B1.1, B1.2, B1.3, B1.4, B1.5, B1.6, and B1.7. The value of each indicator weight is greater than 0.5; thus, it can be considered consistent and valid [16, 21].

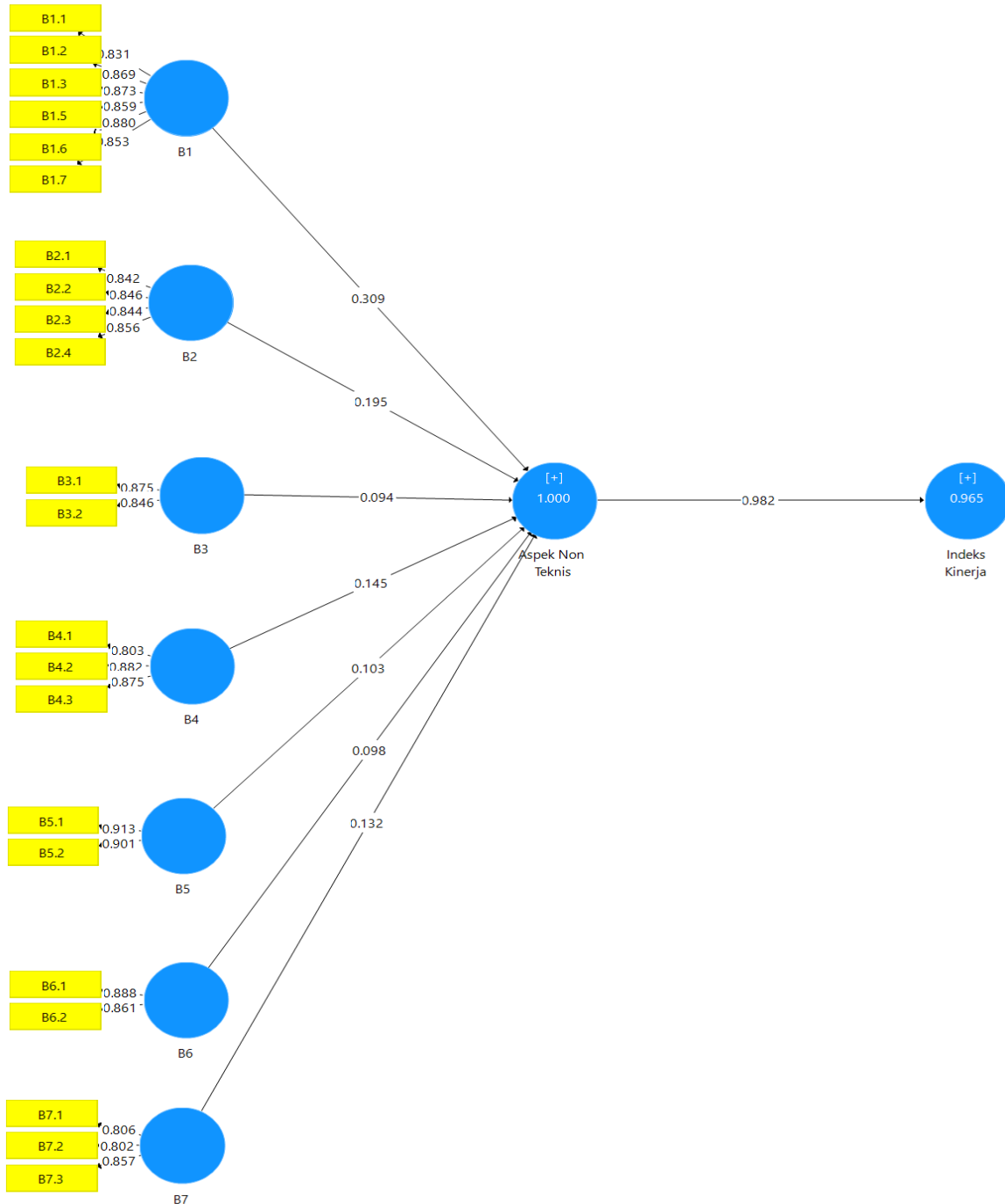


Fig. 2 Relationship between the research variable and indicator (Own study)

Table 4 presents the cross-loading of non-technical variables, encompassing socio-economic and cultural dimensions. The value produced from cross-loading is greater than 0.7; thus, there is a strong relationship between the indicator and latent variable. The value of cross-loadings greater than 0.7 indicates that the indicator measures a construct that is more significant than another construct, providing evidence of discriminant validity. Overall, the analysis of cross-loadings in PLS-SEM is an important step in assessing the validity and reliability of a measurement model.

Table 4 Cross-loading results for nontechnical variables (Own study, 2024)

	B1	B2	B3	B4	B5	B6	B7
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	B1	B2	B3	B4	B5	B6	B7
B1.1	0.931	0.897	0.870	0.889	0.906	0.841	0.885
B1.2	0.929	0.906	0.842	0.879	0.877	0.875	0.901
B1.3	0.917	0.867	0.870	0.905	0.856	0.861	0.861
B1.4	0.893	0.869	0.819	0.849	0.837	0.870	0.833
B1.5	0.906	0.888	0.839	0.867	0.830	0.833	0.854
B1.6	0.918	0.862	0.856	0.852	0.853	0.862	0.856
B1.7	0.900	0.849	0.845	0.855	0.846	0.860	0.824
B2.1	0.889	0.932	0.839	0.870	0.827	0.860	0.879
B2.2	0.906	0.940	0.871	0.886	0.844	0.848	0.884
B2.3	0.886	0.925	0.868	0.872	0.848	0.857	0.866
B2.4	0.911	0.943	0.884	0.907	0.880	0.871	0.922
B3.1	0.923	0.898	0.959	0.881	0.898	0.905	0.893
B3.2	0.853	0.872	0.954	0.869	0.838	0.837	0.845
B4.1	0.891	0.867	0.858	0.926	0.839	0.852	0.888
B4.2	0.872	0.880	0.857	0.925	0.806	0.828	0.874
B4.3	0.880	0.875	0.821	0.922	0.846	0.841	0.854
B5.1	0.889	0.859	0.888	0.854	0.941	0.836	0.849

	B1	B2	B3	B4	B5	B6	B7
B5.2	0.876	0.849	0.819	0.835	0.939	0.831	0.846
B6.1	0.885	0.876	0.858	0.857	0.840	0.957	0.855
B6.2	0.912	0.884	0.888	0.884	0.859	0.959	0.869
B7.1	0.889	0.902	0.868	0.889	0.860	0.845	0.954
B7.2	0.888	0.907	0.863	0.893	0.846	0.851	0.957
B7.3	0.904	0.898	0.861	0.909	0.864	0.869	0.940

The validity and reliability of cross-loading were assessed using AVE (average variance extracted),

which includes the value of Cronbach's alpha, rho A, and composite reliability [8]. The results of the AVE test are presented in Table 5, which indicates that the AVE value is greater than 0.5. This satisfies the minimum requirement of an AVE value greater than 0.5, which is necessary for a latent variable or construct to be considered suitable with indicators that exceed 50%.

Table 5 AVEs (Own study, 2024)

	Cronbach's Alpha	rho_A	Composite Reliability	AVE
B1	0.930	0.931	0.945	0.741
B2	0.869	0.871	0.910	0.718
B3	0.650	0.654	0.851	0.741
B4	0.814	0.818	0.890	0.730
B5	0.785	0.787	0.903	0.823
B6	0.695	0.699	0.867	0.766
B7	0.759	0.764	0.862	0.675
Non-Technical Aspect	0.972	0.973	0.974	0.635

The evaluation of AVE was conducted through significance testing, also known as structural model testing. The outcomes of this test are presented in Table 6 and indicate a positive inter-indicator value that is incorporated as a variable and dimension. The test result reveals a P-value of 0.00, which is less than 0.05, suggesting that the relationship between the indicators is positive and non-negative. The non-technical model

yields values of O=0.336, M=0.337, STDEV=0.034, and P=0.000. Furthermore, an analysis was conducted to determine the value of R square in the non-technical model, which considers socio-economic and cultural dimensions and their influencing indicators. The R square analysis yielded a value of 1.000 and an adjusted R square of 1.000.

Table 6 Structural model test (Own study, 2024)

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
B1	0.308	0.308	0.006	53.731	0.000
B2	0.193	0.192	0.006	31.874	0.000
B3	0.095	0.095	0.003	32.617	0.000
B4	0.145	0.145	0.004	37.849	0.000
B5	0.104	0.104	0.004	29.043	0.000
B6	0.098	0.098	0.003	31.627	0.000
B7	0.133	0.133	0.004	30.511	0.000
Non-Technical Aspect -> Performance Index	0.336	0.337	0.034	9.824	0.000

The model developed for the non-technical variable influenced by socio-economic and cultural factors is as follows:

$$IK_{\text{non-technical}} = 0.120 B_1 + 0.090 B_2 + 0.100 B_3 + 0.120 B_4 + 0.090 B_5 + 0.180 B_6 + 0.300 B_7 \quad (1)$$

$$B_1 = 0.931 B_{1,1} + 0.929 B_{1,2} + 0.917 B_{1,3} + 0.893 B_{1,4} + 0.906 B_{1,5} + 0.918 B_{1,6} + 0.90 B_{1,7} \quad (2)$$

$$B_2 = 0.932 B_{2,1} + 0.940 B_{2,2} + 0.925 B_{2,3} + 0.943 B_{2,4} \quad (3)$$

$$B_3 = 0.959 B_{3,1} + 0.954 B_{3,2} \quad (4)$$

$$B_4 = 0.926 B_{4,1} + 0.925 B_{4,2} + 0.922 B_{4,3} \quad (5)$$

$$B_5 = 0.941 B_{5,1} + 0.939 B_{5,2} \quad (6)$$

$$B_6 = 0.957 B_{6,1} + 0.959 B_{6,2} \quad (7)$$

$$B_7 = 0.954 B_{7,1} + 0.957 B_{7,2} + 0.940 B_{7,3} \quad (8)$$

3.4. Validation

The development of a non-technical performance index model necessitates the use of GRG (generalized

reduced gradient) for model testing, which is a combination of MS Excel and regression analysis (sum of squared residuals (SSR)) based on the number of data used. The objective is to reduce the data in the SSR to produce a valid model [17, 18]. Another evaluation method for linear regression models is RMSE (root mean squared error), which measures the estimation result of a model with accuracy. The RMSE can range from 0 to ∞ and may be negative-oriented. A lower RMSE value indicates a better performance, with smaller values indicating that the predicted value is closer to the observed value.

The mean squared error (MSE) is a widely utilized evaluation metric in statistics and machine learning for gauging the precision of regression models in forecasting numerical values. The MSE calculates the difference between the model prediction value and

actual value from the data and then squares the difference to ensure that there is no negative difference. By decreasing the MSE value, the regression model is better at predicting the numeric value. Therefore, the MSE should be used when aiming to select the most accurate regression model [20]. Fig. 3 presents the curve of the GRG test between the model and field for nontechnical variables.

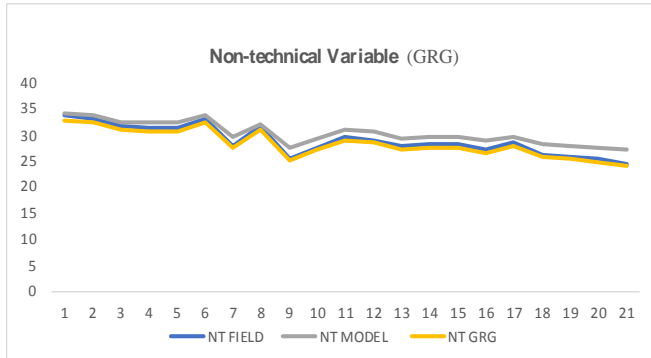


Fig. 3 GRG test curve for non-technical variables between the model and field (Own study, 2024)

The GRG test was conducted on the non-technical performance index model using field analysis data, as depicted in Fig. 3. The resulting values are $B_1=2.00$, $B_2=0.794$, $B_3=0.950$, $B_4=0.970$, $B_5=0.201$, $B_6=0.950$, and $B_7=0.970$. Additionally, the values of SSR, RMSE, and MSE are 7.263, 0.128, and 0.146, respectively. Fig. 3 demonstrates that the non-technical field model of the performance index and GRG yielded comparable results, confirming that the input data were consistent.

3.5. Socio-Cultural and Economic Influence Analysis

This research examines the consequences of socio-cultural and economic factors for raw water performance in the Nusa Tenggara Barat Province, with a particular focus on Lombok and Sumbawa Islands. The study employs the PLS-SEM analytical method, which reveals that socio-cultural and economic factors play a substantial role in elucidating variations in raw water performance.

First, the water accessibility aspect is proven to influence raw water performance. The existence of suitable infrastructure for accessing clean water becomes key to ensuring suitable water availability for society. The limitation of access to clean water can hinder efforts to improve the health and prosperity of society and decrease economic productivity.

Second, water prices play an important role in determining water usage and management. An achievable water price can stimulate efficient usage and sustainable management, whereas a high or unachievable price can hinder access to clean water, especially in low-income societies.

The impact of societal culture on surrounding water sources also extends to the performance of raw water. The practices and beliefs of water users, particularly those related to trust and culture, can influence the

consumption patterns and management of water resources. Being cognizant of the significance of maintaining cleanliness and access to clean water within the context of local culture can serve as a motivator for water conservation efforts.

The analysis demonstrates that sociocultural and economic factors are connected and impact raw water performance. Successful and sustainable water management necessitates a comprehensive approach that evaluates the intricate dynamics between these factors. By acknowledging the influence of sociocultural and economic aspects, policymakers can create effective and enduring strategies for preserving critical water resources in Nusa Tenggara Barat Province, which are essential for the well-being and growth of society.

4. Conclusions

This research underscores the need to take into account sociocultural and economic factors when managing water resources in Nusa Tenggara Barat Province, with a focus on Lombok and Sumbawa Islands. By utilizing the PLS-SEM analysis approach, the study found that factors such as water accessibility, water price, and local cultural practices near water sources have a substantial impact on raw water performance. The developed model exhibits strong validity and reliability, with a consistent influence value for the socio-economic and cultural dimensions.

This analysis shows that sociocultural and economic factors are interrelated and impact raw water performance. Effective and sustainable water management requires a holistic approach that analyzes the complex dynamic between the aspects. The implications of this research are important for the development of effective and sustainable policies and strategies in water management. Through examination of socio-cultural and economic factors, governments and stakeholders can enhance their efforts to preserve water resources, which are vital for the well-being and development of communities in the region.

Furthermore, this study offers valuable insights into the intricate relationship between socio-cultural and economic factors and raw water performance. It serves as a solid basis for subsequent efforts aimed at preserving sustainable water resources in the Nusa Tenggara Barat Province.

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