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Editorial Note

Pathway Towards a Developed Country

Dharendra Wardhana

EDITOR

Although in this edition only one paper that specifically examines cities in the Southeast Asia region, I The publication of current The Journal of Indonesia Sustainable Development Planning (JISDEP) edition is accompanied with record-breaking article submissions. This is really surprising particularly considering the fact that these days we have been busy with assignments mostly unplanned and imminent. For civil servants in the last three years, there has been increasing workloads (mostly administrative) caused by regulations pertaining to performance measurement. Multiple applications were introduced along with required documentations as requisite evidence to determine one's performance. That said, non-administrative works—often dichotomously called substantive works—seem to significantly increase at accelerating rate, especially approaching the end of fiscal year when everyone seems to rush for the sake of budget absorption.

Regulation on measuring performance these days tend to be overly administrative and increasingly complicated. This trend started from the last decade when the government has been committed to implement bureaucratic reform (reformasi birokrasi) that encompass multiple aspects of governance. Consequently, each civil servant needs to devote special time to prepare and submit their documentation. The pursuit of performance measurement inevitably leads to the seemingly never-ending endeavour which involves various amount of metrics and indexes. Challenges abound for occupations with intangible products like planners and analysts. Meanwhile, metrics using indexes as adopted in academics are not without any problem. We can still recall the cobra-effect and unintended consequences of this measurement.

Fortunately, there are still a number of civil servants who are still passionate in writing academic articles. Few amongst those contributed in The Journal of Indonesia Sustainable Development Planning (JISDEP) that you read at the moment. Academic journals on development like The Journal of Indonesia Sustainable Development Planning (JISDEP) encompass wide range of topics from public services to security. In addition, there are numbers of AI-generative applications that really help to formulate

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framework and compose early drafts of our articles. This can lend us a massive support for researchers to get over with writer's block and to some degree can increase productivity.

Themes on development particularly in developing countries are limitless and these days boundaries between topics are no longer relevant. An article on public services "Public Services Availability Linked to the Village's Welfare" is written by Pauline Gaspersz. Meanwhile, three articles on environment are written by Hossain et al (Assessment of Domestic Water Usage and Wastage in Urban Bangladesh), Fahmi et al (Preliminary Analysis of Life Cycle Assessment on Single-Use Plastic Cutlery Set Substitutes in the Catering Industry), and Putri et al (Risk Perception in Facing Post-Disaster of Tidal 'Rob' Flood in North Jakarta Coastal Using Social Network Approach).

An article with emphasis on infrastructure development in this edition is provided by Sutriadi titled Soft Infrastructure in Smart Sustainable Cities A Literature Review. An article on nuclear energy is written by Josia. A commentary by Nur and Komariah address gender issues within the context of Bugis-Makassar culture. Last but not least, a book review by Viartasiwi on a recent publication by Istania (2023) on the theme of territorial conflicts in relation with provincial proliferation.

Approaching the end of medium-term development plan in 2024, it is crucial to gather contribution of thoughts from experts with many disciplines. Taking the benefit of hindsight, we can clearly see that development targets become more challenging if not nearly impossible to achieve. This is the consequence of stepping up the ladder into the group of developed nations. All in all, taking the analogy of running, the journey towards long-term development in Indonesia is a marathon, not a sprint. It is a path that intertwines the threads of tradition and innovation, sustainability and growth, human capital and technology. As Indonesia navigates this path, it is critical to remember that development is not solely about economic indicators.

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Research Paper

Assessment of Domestic Water Usage and Wastage in Urban Bangladesh: A Study of Rajshahi City Corporation

Imran Hossain[1], A.K.M. Mahmudul Haque[2], and S.M. Akram Ullah[3]

Department of Political Science, University of Rajshahi, Rajshahi-6205, Bangladesh[1,2,3]

***) Corresponding author**: imranbd.ru@gmail.com

Abstract

This study investigates domestic water consumption and waste patterns in Rajshahi City Corporation (RCC), Bangladesh, with an emphasis on identifying factors influencing water waste. Employing a mixed-methods approach involving surveys, monitoring, and interviews, the research evaluates both quantitative and qualitative data. The findings indicate significant positive correlations between water consumption, education level, water safety awareness, availability, and source proximity. Notably, a negative relationship between consumption and water source closeness is observed. Variations in consumption across residential zones, including households exceeding recommended water consumption, are highlighted. Water waste practices, such as taps left running and excessive usage, are identified. Additionally, inadequate access to clean drinking water is also revealed. The study offers insights into research-based strategies to conserve water, enhance sustainable management, and ensure efficient urban water resource utilization in Bangladesh.

Keywords: domestic water use; safety of water; urban water consumption; water wastage pattern; water supply

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1. Introduction

Access to clean and sufficient water is crucial for human health, well-being, and economic development (Ahmed, 2023). Water quality is one of the most critical factors in human physiology. Thus, Water is one of the 30 substances necessary for maintaining life, health, and ecosystems (Etim et al., 2013). About 1.1 billion people cannot access improved water supplies (Ochilova et al., 2021). Due to population growth, land use, excessive groundwater use, and economic growth over the past century, water demand and water quality have been declining. Moreover, due to unexpected urbanization, Bangladesh has experienced extreme poverty and disparities in access to water services (Kashem et al., 2023). Domestic water consumption and waste patterns play a vital role in this context, as they directly impact the availability and sustainability of water supplies. As a result, water quality is at an all-time low, and health risks related to poor water quality are of significant concern in Rajshahi City Corporation (RCC). RCC's supply water quality still needs to be improved. It has an excessive amount of iron and odor issues. Extreme levels of turbidity and hardness are also present (Ferdous et al., 2018). High concentrations of iron and manganese, coliform bacteria contamination, arsenic contamination, and total hardness are the main factors limiting the availability of drinking water in the RCC (Rasul & Jahan, 2010). These conditions make the water unsafe for drinking and have been linked to high levels of morbidity in the RCC. The RCC's supply water quality has remained relatively high. Despite its poor quality, people still use this unsafe water daily. People in the RCC use water for various purposes. In this context, domestic water consumption varies depending on consumers' living conditions in urban and rural areas (Abubakar, 2019). The researchers mainly focus on the residents' urban domestic water consumption and waste behavior. Household water consumption may include drinking, cooking, washing clothes and utensils, cleaning, bathing, etc. A study by Bari et al. (2015) found that people use the most water when they shower (125 LPCD), go to the bathroom (63 LPCD), wash their hands and brush their teeth (32 LPCD), and prepare the dishes (30 LPCD). Their research revealed that Greater Kuala Lumpur residents consumed an average of 288 liters of water daily.

Despite the significant variations in water consumption, it is clear that showering makes up the most significant portion of domestic water use. It is important to remember that even though showering accounts for most household water use, other activities like using the toilet, washing hands, and doing the dishes also contribute significantly. Daily water consumption may be correlated with some other variables. The amount of water used was significantly associated with several socioeconomic factors, the size of the household, and the type of water sources used by the individual (Abubakar, 2019; Koop et al., 2019). Moreover, a household's distance from the water source can be another critical factor in water consumption (Behailu et al., 2016). Specifically, households with a lower economic status located further from the water source tended to use less water than those with a higher financial status or who were closer to a water source. The size of the household, the availability of the water supply, and the education and age of the household's head are important factors that influence how much water is used (Koop et al., 2019). The findings of these studies demonstrate that the amount of water consumed by households is heavily influenced by various socioeconomic factors. Furthermore, water availability and the cultural practices or habits of water consumers typically determine the variability of water consumption. Moreover, water consumption patterns also depend on a household's age, sex, and region of residence (Rosinger & Young, 2020). Thus, it is clear that the amount of water a household uses is affected by a wide range of factors, from availability to socioeconomic and demographic factors. This information is important as it provides a better understanding of how water consumption patterns can vary from region to region and how these factors influence the amount of water consumed.

While numerous studies on domestic water use and waste patterns have been carried out in various nations worldwide, Rajshahi City Corporation in urban Bangladesh has yet to be the subject of one. There is a need for more in-depth studies that concentrate on behavior change, even though existing research has identified common waste practices and factors influencing water waste. By examining household waste and water usage patterns in Rajshahi City Corporation, Bangladesh's fourth-largest city, this study seeks to overcome that gap. This study evaluates domestic water use and waste patterns in urban Bangladesh, focusing on Rajshahi City Corporation. This study attempts to provide significant insight into the current water management practices in the city and propose recommendations for enhancing water conservation efforts by examining the factors that affect water consumption and identifying typical waste practices. The results of this study will advance our understanding of water use and waste in the cities of

Bangladesh. This will be an invaluable tool for formulating evidence-based strategies for sustainable water management for policymakers, urban planners, and water management authorities. The significance of this study lies in its potential to address the critical water issues that Rajshahi City Corporation and comparable urban areas of Bangladesh are currently facing, resulting in improved water conservation and improved quality of life for the urban residents. Moreover, access to clean and safe water is a fundamental human right and critical to sustainable development. The United Nations' Sustainable Development Goal 6 (SDG 6) emphasizes the global commitment to ensure the availability and sustainable management of water for all. As part of this broader agendum, the research investigates the intricate dynamics of domestic water consumption and waste patterns within the urban context of Rajshahi City Corporation in Bangladesh. This study contributes to realizing SDG 6's aspirations for equitable and efficient water resource management by examining the interplay between water usage behaviors, socio-economic factors, and availability. In a world suffering from increased water stress and scarcity, understanding the complexities of water consumption patterns becomes crucial in formulating effective strategies that balance human needs, environmental conservation, and achieving sustainable development goals.

2. Methods

2.1 Study Area

The study area of this research is Rajshahi City Corporation (RCC) in Bangladesh (Figure 1). One of Bangladesh's first municipalities, Rajshahi, was founded in 1876 and upgraded to a city corporation in 1987. It has a surface area of 96.72 square kilometers, is located between 24° 21' and 24° 25' N and 88° 32' and 88° 40' E, and has a population of about 0.85 million. According to 2011 census report, RCC had a population of 449,757, up from the beginning of 1991, when it had a population of 284,056. Currently, there are about 0.85 million people living in the RCC, with a population density of 4,318 people per square kilometer. RWASA (Rajshahi Water Supply and Sewerage Authority) supplies water to Rajshahi City through a distribution network in the RCC region to meet the water demand. The increased population in RCC has caused an increased demand for water services, which has put pressure on the existing water resources. Water scarcity and a lack of other essential services have caused great suffering in the RCC. Most people in the RCC regions rely on submersible pumps and tube wells for water. Many people mainly depend on submersible pumps for managing drinking water. They also rely on government-provided water for bathing, cooking, and other activities (the government provides water through a pipe network). The study examines the relationship between various factors influencing residents' water consumption in the RCC. The factors under exploration encompass age, gender, income, and education level. Additionally, an assessment has been conducted on the distance of the RCC from the nearest water source and the water quality provided by the government. By examining these factors, a comprehensive understanding of RCC residents' varying water consumption patterns is anticipated, facilitating insights into equitable access to safe drinking water strategies.

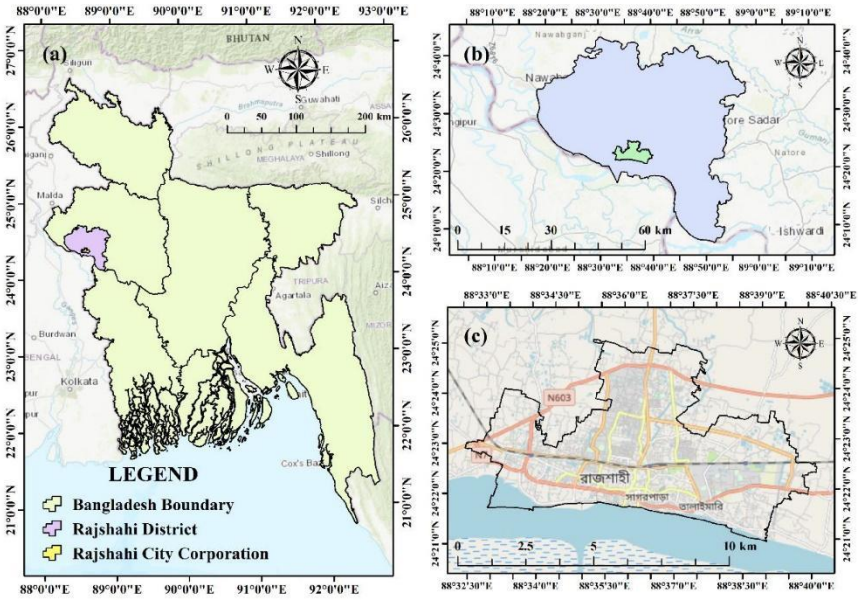

Figure 1. Location of the study area (a) in Bangladesh (b) in Rajshahi district (c) RCC (Dey et al., 2021)

2.2 Materials and Method

This study employs a mixed-methods research design to assess domestic water usage and waste in the Rajshahi City Corporation (RCC). It combines qualitative and quantitative approaches, where data have been collected from primary and secondary sources. Primary sources included household surveys, in-depth interviews, and focus group discussions. On the other hand, various research reports and articles, official statistics, relevant books, daily newspapers, etc., have been used as secondary data sources. Simple random sampling techniques have been employed for selecting household members or participants. The structured questionnaire used in the household surveys has gathered information on water consumption patterns, sources of water, respondents' behaviors, and conservation practices. Using the questionnaire, data have been collected from 384 stakeholders in the RCC. In-depth interviews have been conducted with key stakeholders, including officials from the RCC, the water supply authority, and relevant non-government organizations. Focus group discussions have been organized with community members to explore their perceptions, behaviors, and attitudes toward water usage and waste.

The data have been analyzed using simple and suitable mathematical and statistical tools like frequency, percentage, arithmetic mean, and standard deviation using the SPSS program. Using the SPSS program, Pearson correlation and various tests like the chi-square and One Sample T-test have been used to examine the relationship between the dependent and independent variables. Results have been presented through graphs, tables, narrative texts, simple computations, and logical reasoning. Data integration has been employed to combine quantitative and qualitative findings, providing a comprehensive understanding of water usage and waste patterns.

3. Results and Discussions

3.1 Water Consumption Related to Other Variables

Urban household water consumption is subject to a wide range of influencing factors, with each factor significantly contributing to the overall water usage within a household. A correlation matrix is constructed to comprehensively understand the relationship between water consumption and these influencing elements. This matrix encompasses 11 variables meticulously designed to illustrate the intricate relationship between urban household water consumption and the diverse array of factors that impact this consumption pattern (Table 1). The correlation matrix allows researchers to identify factors

that have a stronger or weaker influence on water consumption. By analyzing the matrix, policymakers and urban planners can prioritize interventions and develop strategies to promote more sustainable water usage in urban areas. The correlation matrix shows that there is a significant relationship between water consumption and factors like age, profession, educational level, monthly income, source of water, safety of water, remoteness of the source of water, and availability of water. The most significant factor influencing water use is the safety of water, which is significantly positively correlated with water use ($r = 0.523$, $p<0.05$). Thus, the correlation matrix indicates that water safety is a major factor in determining water consumption in urban households. Moreover, people are more likely to drink safe water than unsafe water. Therefore, it is evident that improving water safety and increasing awareness of the health risks associated with unsafe water can help reduce overall water consumption in urban households. The availability of water supplies is another factor that displayed a statistically significant correlation with domestic water consumption. According to Table 1, there is a significant correlation between the amount of domestic water consumption and the availability of water ($r = 0.449$, $p<0.05$). It implies that people living in areas with a high availability of water tend to consume more water than those living in areas with limited access to a reliable water supply. This is an important finding, as it indicates that water availability can influence the amount of water used for domestic purposes. As the availability of water supplies increased, it appears that domestic water consumption also increased.

There is also a significant correlation between the amount of domestic water consumption and the distance to the water source ($r = 0.232$, $p<0.05$). This indicates that people living closer to water sources may be more likely to use more domestic water. Access to the water source is complicated in the selected study area. As a result, households located in remote areas are often limited in terms of water consumption due to the difficulty of accessing their source. Consequently, access to a water source is an important factor in determining water consumption behavior. In developing countries, inadequate infrastructure and the lack of safe, reliable water sources are major issues that prevent many households from accessing sufficient amounts of water. The household's level of education also demonstrated a statistically significant correlation with domestic water use. Domestic water consumption and household education level have a positive and significant relationship ($r =.311$, $p<0.05$). As the educational level of the household increases, their water consumption also increases. Households with higher educational levels also have greater access to financial resources, making it easier to invest in water. Additionally, higher education levels are associated with larger households or more luxurious lifestyles, both of which can contribute to increased water usage. Thus, this suggests that the educational level of the household can play a significant role in determining the amount of water they consume. Therefore, there is a statistically significant negative correlation between the source of the water and the amount of domestic water used ($r = -0.537$, $p<0.05$). In this regard, the source of water can have a significant impact on water consumption behavior. People living in urban slums often lack access to enough water, which can lead to decreased water consumption behavior. This can be especially detrimental to those in lower socio-economic classes, who cannot purchase more water from other sources. Furthermore, the household's monthly income can have a minor but positive impact on water consumption ($r = 0.107$). Low-income households often cannot afford the extra water needed for their daily needs, leading to decreased water consumption. In addition to this, there is a significant negative relationship between the age of the household and the amount of domestic water consumption ($r = -0.156$). The age of people was significantly correlated with water use, such that younger people consumed more water than older people. Older people may have different attitudes toward environmental issues, as a result of which they are less knowledgeable about and less concerned with water conservation. Table 1 also reveals that there is a statistically insignificant and negative correlation between household profession and water use ($r = -0.109$).

Table 1. Relationship between water consumption and other variables

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Water Consumption	1									
Gender	-.071	1								
Age	**-.156****	-.139**	1							
Profession	-.109*	.011	-.239**	1						
Education Qualification	**.311****	-.213**	-.268**	.007	1					
Monthly Income	.107*	-.377**	.341**	-.338**	.312**	1				
Source of Water	**-.537****	.040	.259**	.004	-.187**	.068	1			
Safety of Water	**.523****	-.042	-.240**	-.029	.239**	-.022	-.742**	1		
Remoteness of the Water Source	**.232****	-.062	.023	-.010	.092	.062	-.176**	.192**	1	
Availability of Water	**.449****	-.012	-.295**	-.038	.229**	-.010	-.785**	.773**	.072	1

** Correlation is significant at 0.01 level.
* Correlation is significant at 0.05 level.

3.2 Daily Water Consumption Scenery

The amount of water consumed daily by people and its application area are shown in Table 2. On average, per household, people drink 19 liters of water every day. This is an average and won't accurately reflect the usage of many individuals. Most water consumption is used for cleaning, washing, and bathing. Each household uses 30 liters of water daily for cooking, 125 liters for bathing, and 119 liters for cleaning. People use more water for bathing purposes. Cleaning also plays an important role in using much more water. The people of RCC use 294 liters of water per household for drinking, bathing, cooking, and other purposes.

Table 2. Per Capita Water Consumption

	Maximum L (Mean L)	**Source of Water**	**Safety of Water**	**Duration of Water Supply**
Drinking	60 (19.87)	Supply = 128 (33.3) Tube well = 30 (10.0) Submersible = 226 (58.9)	Very Safe = 30 (7.8) Safe = 209 (54.4) Neither Safe nor	Always = 175 (45.6) Most of the time = 67 (17.4) Sometimes = 92 (24.0) Rarely = 50 (13.0)
Cooking	100 (30.51)	Supply = 220 (57.3)	Unsafe = 22 (5.7)	
Bathing	500 (125.12)	Tube well = 14 (3.6)	Unsafe = 118 (30.9)	
Cleaning	350 (119.32)	Submersible = 150 (39.1)	Very Unsafe = 5 (1.3)	

Note. Parenthesis in the Table indicates %

3.3 Sources of Water

Water comes from a variety of sources in the RCC. Submersible pumps are primarily used by the residents of RCC to collect their drinking water. For managing drinking water, they also rely on tube wells and other private sources. Table 2 shows that 58.9% (N = 226) of the inhabitants primarily depend on submersible pumps to collect drinking water. Additionally, tube wells are used by 10% of all respondents. Table 2 also makes clear that 33% (N =128) of urban residents drink water that is provided by the government. Most people have separate sources for drinking and cooking water. In this regard, a large population depends on the water the government provides for bathing, cooking, cleaning, and other uses. Table 2 shows that 57% (N = 220) of the respondents depend on public water supplies to meet their needs for drinking, cooking, and other uses. The water is provided by the government. This supply system also uses water pumped up from the ground via a network of pipes that span the city. The government's water supply is unsatisfactory, so most people collect their drinking water using submersible pumps. The supplied water has issues with odor, iron, and a dark color, respectively. Government water is frequently contaminated with trash, filth, and an offensive odor (Ferdous et al., 2018). The source of the water can have a significant impact on how much water people use. Table 1 also demonstrated that the water source has a significant negative correlation with water consumption. Some people draw water from a residential pump or a long-distance tube well. They attempt to drink less water. Some people also use their own submersible pumps to collect their own drinking water. They try to consume more water in this regard (Barakoti et al., 2019). Moreover, water consumption depends on the type of water source system. In this regard, those who obtain their drinking water from a submersible pump, however, might not be aware of the significance of protecting this invaluable resource. It is important to educate individuals who rely on submersible pumps for their drinking water about the importance of preserving this precious resource. By understanding the significance of water conservation, residents can consciously reduce waste and ensure its long-term availability for themselves and future generations.

3.4 Safety of Water

Bangladesh's water is arsenic-contaminated (Nasher, 2022). This has caused major health issues for the local people and has become an immense challenge for the country. Contaminated water leads to many illnesses, such as diarrhea, skin diseases, and other major health complications (Hasan et al., 2019). Moreover, groundwater contains bacteria and other harmful elements. Surface water is not regarded as a direct source of drinkable water because it is already polluted. One of the main causes of groundwater contamination is arsenic pollution, which affects over 70 million people globally. Even though 97% of the population has access to water, the purity of the water is never guaranteed. Iron, arsenic, and many other harmful elements have been found in the water that is supplied by the RCC. The safety of water is an important factor that affects the consumption of water. From Table 2, It is understood that only 54.4% (N = 209) of respondents believe that their water usage is safe. A large number of people (30.9%, N = 118) think that using water is not safe for them. These results suggest that, although the vast majority of respondents have access to treated and safe water, their knowledge about it is not sufficient to consume this water with confidence.

There are a lot of reasons for drinking unsafe water. Among them, distance is an important reason for drinking unsafe water. Distance is a critical factor in improving water quality (Nygren et al., 2016). Besides that, distance plays an important role in preserving water quality and ensuring available water to the residents. It also plays an important role in water consumption (Ibrahim et al., 2021). A Chi-square test was performed to understand the effect of distance on the safety of water. The chi-square test results are presented in Figure 2. A chi-square test for independence with $\alpha = 0.05$ has been used to assess whether the distance was related to the safety of the water. The chi-square test was statistically significant, $\chi 2$ (4, N= 384) = 22.951, P<0.05 (P= 0.000), with Phi and Cramer's V (ϕ) coefficient of 0.244, indicating a medium relationship between distance and safety of water. As seen in Figure 2, many people are drinking unsafe water because of its remoteness.

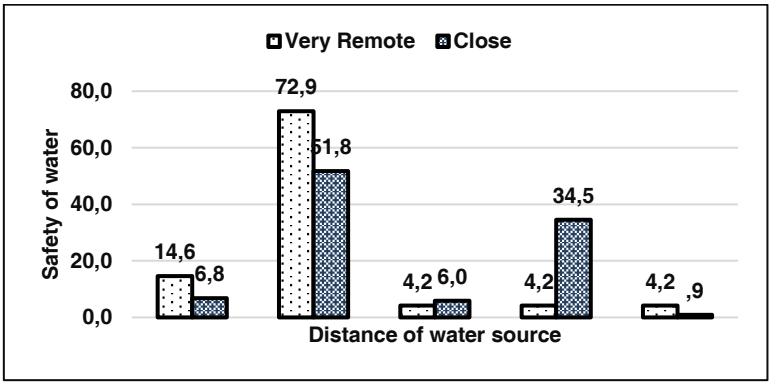

Figure 2. Effect of Distance in Ensuring Clean Water

The quality, accessibility, and reliability of the water source can have a significant impact on the amount of water that is consumed by a population. In areas where water sources are unreliable or inaccessible, people may be unable to access enough water for their basic needs. Additionally, the safety of the water source is also a key factor in determining how much water a resident can consume. If the quality of the water is uncertain, people may choose to use other sources of water, such as bottled water or others. This can lead to decreased consumption of water and potential health risks if the alternative water sources are not safe. For example, if the water source is contaminated, people may avoid drinking it, leading to lower water consumption. On the other hand, if the water source is easily accessible and reliable, people may consume more water.

3.5 Availability of Water

The residents of the RCC do not have access to available water. The supply length within cities frequently varies, as it does across seasons. During the dry season, the RCC suffers severe water shortages. Table 2 indicates that water doesn't remain all the time. Every day, people receive water for a specific amount of time. It isn't accessible 24 hours a day. The duration of the water supply has an impact on the consumption habits of the RCC citizens. While a significant portion of respondents, comprising 46% (N = 175), reported an absence of water scarcity issues, the remaining 54% highlighted concerns regarding water supply challenges. Notably, a substantial 13% characterized their water supply situation as 'terrible.' This distribution underscores a noteworthy divide in water availability perceptions among the surveyed population. This issue has significant implications for citizens living in the RCC areas, as the duration of the water supply affects their water consumption habits. For example, when the supply of water is limited, households may try to limit their use of it to conserve it. As such, this could lead to some households neglecting basic needs such as laundry, washing dishes, and even bathing or resorting to buying water from private sources to fulfill their daily needs. Moreover, Wardak and Abed (2019) highlighted that water availability is critical in promoting water consumption. Therefore, it is clear that the duration of the water supply and its implications on water consumption habits have serious implications for people living in the RCC areas. To conclude, the duration of the water supply is a crucial factor for household water consumption in the RCC areas.

3.6 Patterns of Water Wastage

The issue of providing everyone in the community with access to clean water and sanitary facilities is water waste. On the other hand, many individuals do not have access to the daily amounts of water they require (Stavenhagen et al., 2018). In urban Bangladesh, the issue of water wastage is particularly concerning, with an alarming average wastage of up to 113 liters of water per person each day. This significant water loss translates into substantial financial losses daily (Shuaib & Rana, 2020), raising

profound concerns, especially in a world where many people still lack access to clean water facilities. Water can be wasted in a variety of ways. Some people take a long time in the shower when they take a bath. A lot of individuals constantly waste water for cleaning and other uses. The per capita water consumption pattern varies greatly among different countries and regions around the world. Some countries have abundant water resources and high per capita water consumption, while others have limited water resources and low per capita water consumption. In general, developed countries tend to have higher per capita water consumption due to factors such as high standards of living, widespread use of water-intensive technologies and industries, and a greater reliance on water-intensive agriculture. On the other hand, many developing countries face water scarcity due to factors such as limited access to clean water, inadequate water infrastructure, and over-extraction of groundwater. In these countries, per capita, water consumption is often much lower. The residents of the RCC, consume 294 liters of water per person per day. Additionally, Libya uses 354 liters of water per person each day, ranking first in the world for water consumption. Greater Kuala Lumpur needs 268 liters of water per capita. Additionally, Melbourne, USA, and the India each use 240, 262, and 117 liters of water (Table 3).

Table 3. Comparison of per capita water consumption with other countries (LPCD)

Activities	This Study	Grater Kuala Lumpur	Libya	Melbourne	U.K.	USA	China	Sierra Leone	India
Bathing	125	125	160	-	-	212	-	-	-
Cleaning	119	81	132	-	-	96	-	-	-
Cooking	30	39	15	-	-		-	-	-
Drinking & Others	19	23	47	-	-	64	-	-	-
Total	294	268	354	240	146	262	70	112	117

Source: Grater Kuala Lumpur (Bari et al., 2015), Libya (Alharsha et al., 2019), Melbourne (Rhodes et al., 2012), UK (Vieux et al., 2020), USA (Inskeep & Attari, 2014), China (Fan et al., 2017), Sierra Leone (Ibrahim et al., 2021), India (Singh & Turkiya, 2013)

These findings suggest that there is a significant disparity in water consumption between developed and developing countries. The comparison of daily water usage across different regions yields concerning findings into water consumption patterns and highlights the contextual influences on this vital resource. In this study, the daily water usage of 294 liters per household demonstrates a significant volume, potentially indicating diverse water-related behaviors and needs within the studied population. This figure, higher than that of some developed countries like Korea, the UK, and the USA, underscores the significance of understanding the factors contributing to such consumption rates. The data reveals variations that could be attributed to a blend of cultural, economic, and infrastructural disparities among these regions. These differences underscore the role of cultural norms, technological advancements, climate conditions, and government policies in shaping water consumption behaviors.

Above the analysis, we observe that people in the RCC are wasting water. The average amount of water used by residents of the RCC in Bangladesh is shown in Table 4. In moderate temperatures around the world, a 1-tail T-test revealed an average water use of 250 liters per day (Haque & Islam, 2021). The study sample utilizes, on average, 294.8177 liters of water, as shown in Table 4. This exceeds the test value by 44.81771 liters. This indicates that Bangladesh's urban population uses more water than the world as a whole (44 liters extra). The result is statistically significant because the level of significance is 000 (< 0.05). From one sample T-test (Table 4), we understand that people usually waste about 44 liters of water per day on average.

Table 4. Per Capita Water Usage One-Sample T-Test with the Test Value of 250

	N	Mean	Std. Deviation	Std. Error Mean
Computed Daily Water Usage	384	294.8177	169.84784	8.66751

	T	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Computed Daily Water Usage	5.171	383	.000**	44.81771	27.7758	61.8596

Note. ** indicates P<.05

Additionally, wastefulness rates were higher for graduate and postgraduate students. Table 5 reveals that postgraduates need 370 liters of water each day. On the other hand, illiterate people need 319 liters of water each day. So, water use is higher among educated people than uneducated people (Table 5). According to this study, higher education often leads to higher incomes, allowing these households to afford larger homes with more bathrooms and amenities that require more water. Educated people often have higher socio-economic status, leading to larger households, more water-intensive appliances, and a propensity for water-intensive activities such as gardening or swimming pools. Moreover, education can introduce a range of water-demanding activities and behaviors, such as advanced hygiene practices, hobbies, or business operations, that collectively contribute to higher water usage. This study also reveals that educated people allocate more time at home, increasing water usage.

Table 5. Daily water usage scenery based on Educational Qualification

Educational Qualification	Mean	Minimum	Maximum	Percentage
Illiterate	319.00	93.00	517.00	3.4%
Primary	304.89	97.00	670.00	9.6%
Secondary	208.83	36.00	495.00	14.1%
Higher Secondary	187.60	35.00	578.00	22.9%
Graduate	356.94	52.00	632.00	21.6%
Post Graduate	370.37	65.00	695.00	28.4%

There are a number of steps that can be taken to reduce water waste and improve clean water access for people living in the RCC. These steps include educating citizens on water and sanitation management, implementing efficient water and wastewater management systems, ensuring access to appropriate water resources and technologies, monitoring water quality and safety levels, creating incentives for the conservation of water resources, and establishing proper systems. Moreover, Water waste can be reduced by utilizing mobile technology. Water waste management can be controlled using mobile-enabled smart water level control systems (Shankar & Dakshayini, 2018). By monitoring and controlling water levels, as well as providing alerts when necessary, this technology can help reduce the amount of water wasted. Additionally, educational programs that encourage water conservation and Public awareness campaigns about the importance of conserving water can be implemented. Water waste can be decreased by raising awareness and feelings about waste water.

Conclusion

Water is essential for life, so it is not surprising that people consume it for various purposes. The main aim of this study was to look at how people in urban Bangladesh use water and whether they waste it. People use water for things like drinking, cooking, cleaning, and bathing. It is found that factors like age, job, education, and income can affect how much water someone uses. If people think the water is safe, they tend to use more of it. Also, how far they are from a water source can influence water use. In Rajshahi City Corporation, many people don't have enough water, and they often use different sources for different tasks. On average, each household uses 294 liters of water and wastes about 44 liters every day. Surprisingly, educated people tend to waste more water. In this present situation, people in the RCC regions should be much more careful regarding water wastage.

To combat water wastage, governments, and NGOs should strive to spread awareness of the importance of conserving this limited resource. By educating people and providing them with necessary resources, they should focus on setting up programs that help to conserve water as well as discourage wasteful practices. Furthermore, water waste management can be controlled using mobile-enabled smart water level control systems (Shankar & Dakshayini, 2018). By monitoring and controlling water levels, as well as providing alerts when necessary, this technology can help reduce the amount of water wasted. Additionally, educational programs that encourage water conservation and public awareness campaigns about the importance of conserving water can be implemented. Water waste can be decreased by raising awareness and feelings about waste water (de Miranda Coelho et al., 2016).

The government should take the necessary steps to utilize surface water, such as river water and rain water. The government should implement projects related to surface water and groundwater purification plants. The government and NGOs should also encourage using water-saving techniques such as rainwater harvesting, wastewater reuse, and efficient irrigation systems. By investing in developing infrastructure related to water resources, the government can ensure that the environment is preserved and that water is used sustainably.

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Research Paper

Preliminary Analysis of Life Cycle Assessment on Single-Use Plastic Cutlery Set Substitutes in the Catering Industry

Muhammad Ainul Fahmi [1*], Maghfur Rozudin [2], Suci Oktaviani Putri [3], and Jani Raharjo [4]

Padjadjaran University, Bandung, Indonesia [1]
Sepuluh Nopember Institute of Technology, Surabaya, Indonesia [2]
Surabaya State University, Surabaya, Indonesia [3]
Petra Christian University, Surabaya, Indonesia [4]

***) Corresponding author**: muhammad.ainul.fahmI@unpad.ac.id*

Abstract

Single Use Cutlery plastic is an item easily obtained from food catering packages, such as tableware and cutlery sets from the catering industry and is very harmful to the environment. Therefore, this study conducted a Life Cycle Assessment (LCA) analysis to identify the key factors influencing the replacement of single-use cutlery sets within the catering industry. Data collected from the catering industry in Surabaya were processed using SEM PLS modeling. The results showed that the factors Goal and Scope Definition, Life Cycle Inventory, Impact Assessment, and Result Interpretation impact the Life Cycle Assessment of the Catering Industry in Surabaya City as evidenced by all p-values of the inner model being less than 0.05.

Keywords: Life Cycle Assessment; Single Use Plastic Cutlery Set Substitutes; Catering Industry; Structural Equation Model

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Fax: +62 21 31928281
E-mail: journal.pusbindiklatren@bappenas.go.id

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1. Introduction

The issue of plastic waste and its environmental impact is a significant global concern (Chae & An, 2018; Potocka et al., 2019). While plastics are widely used due to their convenience, durability, and low cost, the mismanagement of its waste has led to the pollution of land, waterways, and oceans, posing threats to ecosystems and wildlife (Iñiguez et al., 2018; Kwon et al., 2018). Dumping plastic waste into the deep sea or unused land is an unsustainable approach that merely relocates the problem, potentially causing harm to marine life, soil quality, and groundwater (Chae & An, 2018; Zhao et al., 2018). Similarly, exporting plastic waste to less affluent nations as a disposal method raises ethical concerns and fails to address the root problem. Calls for an outright ban on plastics often arise from the pressing need to combat plastic pollution (Blettler et al., 2018; Monteiro et al., 2018). However, it is important to recognize that plastics serve numerous valuable purposes in the daily lives of humans, and a complete ban may not be practical or feasible in many cases. Instead, a more intensive approach is needed to reduce plastic waste and promote responsible plastic management (Jandas et al., 2019; Liu et al., 2023).

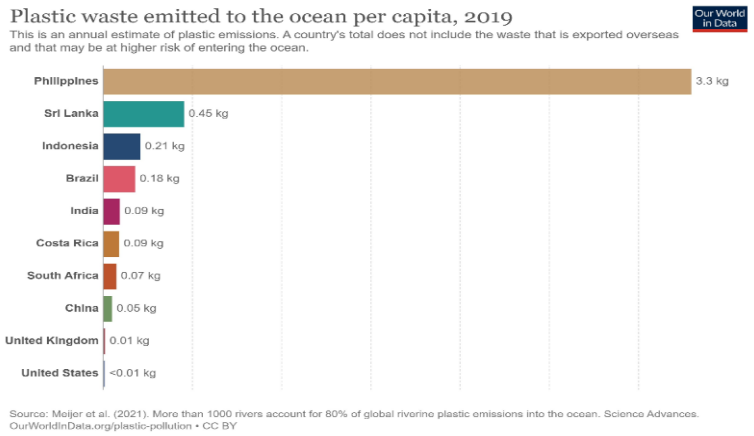

Figure 1. Plastic Waste Emitted to the Ocean per Capita, 2019

Source: (Meijer et al., 2021)

Indonesia deserves recognition for its proactive stance in addressing plastic pollution and its commitment to decreasing its contribution to oceanic plastic waste. Given its substantial role as a contributor to plastic pollution, as shown in Figure 1, the nation must prioritize initiatives to combat this issue and promote sustainable practices (Meijer et al., 2021). The focus on reducing single-use plastic products represents a crucial stride in the right direction. Single-use plastic items, such as cutlery sets and tableware commonly employed in the catering industry, are widespread and substantially contribute to the global plastic waste dilemma, as shown in Table 1 (Organization for Economic Co-operation and Development [OECD], 2019). Therefore, by targeting these specific applications, Indonesia has the potential to wield a significant influence on reducing plastic waste.

Table 1. Single Use Plastics Applications

Time	2019	2020	2021	2022	2023	2024
Plastics applications						
Other	66.315	66.004	66.978	68.725	70.47	72.138
Consumer Products	*46.662*	*46.427*	*47.141*	*48.517*	*49.814*	*51.15*
Transportation	54.431	51.319	53.824	56.272	58.586	60.853
Industrial/machinery	2.683	2.694	2.724	2.788	2.855	2.913
Personal care products	0.027	0.325	0.224	0.156	0.11	0.079
Total	170.118	166.769	170.891	176.458	181.835	187.133

The use of environmentally friendly alternatives to single-use plastic products, such as biodegradable cutlery sets and oxo-biodegradable tableware, is undeniably a pivotal strategy in combatting plastic pollution (Chen et al., 2021; Tan et al., 2021). These alternatives can diminish the ecological impact of plastic waste and pave the way for a more sustainable future (Di et al., 2021; Wei et al., 2022). Biodegradable products are engineered to naturally decompose into non-toxic components over time, typically facilitated by microorganisms. They help alleviate the accumulation of plastic waste in landfills and ecosystems (Moshood, Nawanir, Mahmud, Mohamad, Ahmad, & AbdulGhani, 2022). By using biodegradable cutlery sets and tableware, the reliance on traditional single-use plastics can be reduced, thereby minimizing the long-term environmental consequences (Markowicz & Szymańska-Pulikowska, 2019; Moshood, Nawanir, Mahmud, Mohamad, Ahmad, AbdulGhani, & Kumar, 2022). Conversely, oxo-biodegradable products are conventional plastics modified with additives to expedite their degradation process (Markowicz & Szymańska-Pulikowska, 2019). These additives promote the fragmentation of plastics into smaller pieces, which can subsequently undergo further breakdown through biological or chemical processes. Oxo-biodegradable products are often seen as an intermediate solution that aims to reduce the persistence of plastic waste in the environment (Chiellini & Corti, 2016).

The life-cycle perspective plays a pivotal role in addressing the pressing issue of plastic pollution, as it offers a holistic view of the environmental impacts of various products and their disposal methods. Life-cycle assessment (LCA) methods provide a structured approach to thoroughly evaluate the entire life cycle of a product, including its production, use, and end-of-life stages (Wei et al., 2022). The study by (Sun et al., 2021), underscores the potential environmental benefits of replacing 60% of disposable plastic tableware with reusable or recyclable alternatives, including biodegradable or oxo-biodegradable options. This substitution reduced carbon emissions by an impressive 92%, illustrating the significant positive impact that transitioning away from disposable plastic tableware can have on carbon emissions within this sector. When considering compostable and biodegradable plastic tableware, it is important to highlight their enhanced environmental performance, particularly when properly composted. This is particularly relevant in the catering service sector, where there is often a practice of mixing food waste with disposable tableware. Fieschi and Pretato (2018) stated that composting these materials can lead to favorable environmental outcomes. Furthermore, proper composting enables the organic components of food waste and compostable tableware to naturally break down, contributing to the sustainable circular use of resources.

However, it is important to acknowledge that the environmental performance of diverse tableware options can fluctuate due to various factors, encompassing the materials used, production processes, disposal methods, and the prevalent waste management systems in a given region. This intricacy is exemplified by the study of Blanca-Alcubilla et al. (2018), which adopted a life-cycle perspective to scrutinize plastic products within the catering sector. The study revealed that reusable items contributed more to global warming potential than single-use items, underscoring the multifaceted nature of assessing environmental impacts throughout the life cycle. To effectively address the issue of plastic pollution and to make well-informed decisions, it is imperative to account for various factors. These include the unique contextual aspects, waste management practices, available infrastructure, and the inherent environmental trade-offs associated with different alternatives (Blanca-Alcubilla et al., 2020). Striving for an exhaustive understanding of the life cycle assessment (LCA) ramifications of distinct tableware choices can provide valuable guidance for fostering more sustainable practices within the catering industry and across broader domains (Wei et al., 2022).

In this context, the essence of Life Cycle Assessment (LCA) and its relevance in supporting Sustainable Development Goals (SDGs) has become particularly evident. LCA serves as a potent instrument employed to quantify and assess the environmental consequences associated with the complete life cycle of a product, process, or system, extending from its inception to its end-of-life phase. This holistic approach considers all stages of the value chain, including raw material extraction, production, use, and end-of-life management. Therefore, by evaluating resource use and emissions throughout the life cycle, LCA allows for a more comprehensive understanding of the environmental impacts of a product or process. Life Cycle Assessment is a valuable tool that promotes a systems-based approach to sustainability. It aids businesses and policymakers in making well-informed decisions that contribute to a more sustainable future and align with the attainment of the Sustainable Development Goals (SDGs) (Sala et al., 2019).

This study examined the replacement of single-use tableware or cutlery sets through the lens of life cycle assessment (LCA), considering the pivotal elements of goal and scope definition (GSD), life cycle inventory (LCI), impact assessment (IA), and results interpretation (RI) using a structural equation modeling partial least square (SEM PLS) method (Wei et al., 2022). Structural equation modeling (SEM) is a statistical technique employed to scrutinize relationships between variables and elucidate the causal pathways that connect them. Partial least squares (PLS) represent a specific variant of SEM that proves particularly valuable when dealing with intricate models, limited sample sizes, or non-normally distributed data (Hair et al., 2014). Through the application of SEM PLS, researchers aimed to gauge the ramifications of various variables related to substituting single-use tableware or cutlery sets throughout their life cycle. This comprehensive analysis can aid in assessing the environmental, social, and economic implications associated with different scenarios, ultimately contributing to evaluating their overall sustainability performance (Hair et al., 2017).

The study would likely involve the following steps (Wei et al., 2022):

1. Goal and scope definition (GSD): Clearly define the research objectives, boundaries, and assumptions of the study, such as the functional unit (e.g., number of meals served), system boundaries, and time frame for the analysis.
2. Life cycle inventory (LCI): Collect the inputs (e.g., raw materials, energy) and outputs (e.g., emissions, waste) data associated with each stage of the life cycle of the tableware or cutlery sets. This collection process encompasses details about production, transportation, utilization, and eventual disposal.
3. Impact assessment (IA): Assess the potential environmental, social, and economic impacts of the different life cycle stages using impact assessment methods. This process involves quantifying and characterizing the impacts in categories such as greenhouse gas emissions, energy consumption, water usage, waste generation, and potential human health effects.
4. Results interpretation (RI): Analyse and interpret the impact assessment results to understand the overall sustainability performance of the different scenarios. This includes identifying the key drivers of impact and evaluating trade-offs and synergies between different environmental and social indicators.

By applying SEM PLS, the relationship between variables, such as material choices, transportation methods, waste management practices, and environmental impacts within the framework of the life cycle, can be modeled and analysed. This approach can provide valuable insights into the overall sustainability performance and identify strategies for improving tableware or cutlery sets' environmental and social impacts (Hair Jr et al., 2021). Careful consideration of data quality, selection of impact assessment methods, and ensuring that the model accurately reflects the real-world system being studied must be considered when conducting a study using SEM PLS and LCA. Additionally, stakeholder engagement and consultation are important for setting relevant goals and meaningfully interpreting results (Hair & Alamer, 2022; Wei et al., 2022).

2. Methods

This study delved into the analysis of Life Cycle Assessment regarding alternative plastic cutlery sets within the catering industry in Surabaya City. The study framework encompassed key components, namely Goal and Scope Definition (GSD), Life Cycle Inventory (LCI), Impact Assessment (IA), and Result Interpretation (RI). Wei et al. (2022), presented a new synthesis model of analysis of Life Cycle Assessment on plastic cutlery set alternatives in the industry catering in Surabaya City using a structural equation modeling partial least square (SEM PLS), as shown in Figure 2.

A total of four alternative hypotheses related to the relationships between different factors and Life Cycle Assessment (LCA) were formulated as follows:

H1: Goal and Scope Definition (GSD) significantly and positively influences LCA.

H2: Life Cycle Inventory (LCI) significantly and positively influences LCA.

H3: Impact Assessment (IA) significantly and positively influences LCA.

H4: Result Interpretation (RI) significantly and positively influences LCA.

The principal objective of PLS is to establish the significance of the alternative hypothesis, enabling the dismissal of a null hypothesis through the demonstration of substantial t-values. The null hypothesis will be rejected when the t-value surpasses 1.96 (at $p < 0.05$), signifying the presence of an effect between the elements of GSD, LCI, IA, and RI with the components of LCA (Hair Jr et al., 2021).

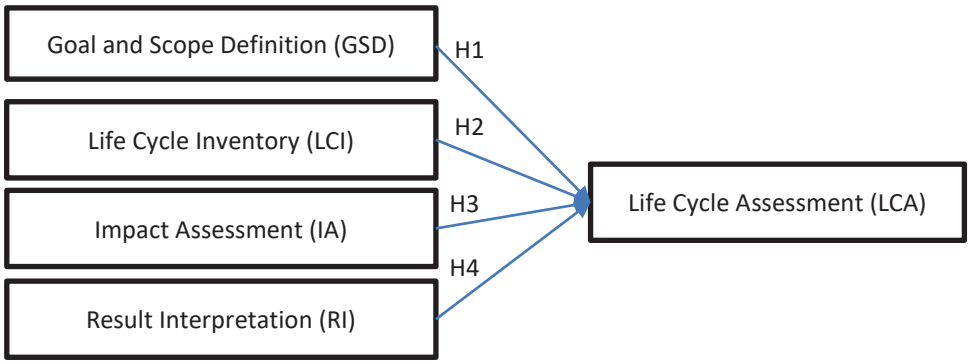

Figure 2. Conceptual Model of Study

A quantitative study was carried out to test these hypotheses, with data collected through closed-ended questionnaires that included alternative responses constructed on a Likert scale (Hair et al., 2017). The Likert scale is a commonly employed tool in surveys used to measure the attitudes and perceptions of respondents on a range of response options. An experiment was carried out through the distribution of questionnaires to all catering industries in the city of Surabaya using a Google form. The selection of samples was conducted using a purposive sampling approach, which involved the withdrawal method using certain criteria. In this case, the criteria for sample selection were catering industries in Surabaya City that had adopted substitutes for single-use plastic cutlery sets. The number of samples to be used in this study is based on (Hair Jr et al., 2021), who explained that the minimum sample size based on the minimum R^2 values starts from 0.1, 0.25, 0.5, and 0.75. These values are for endogenous constructs in Structural Equation Modeling (SEM), with significance levels of 1%, 5%, and 10%, considering the maximum number of constructs in the PLS Path Model. In the context of this study, where there are four PLS paths with an R2 of 0.75 and a significance level of 5%, the minimum required sample size is 33 (Hair et al., 2014).

The collected data were analyzed using the Structural Equation Model (SEM) and Partial Least Squares (PLS) methods. According to preliminary studies, SEM is a statistical technique used to test and model complex relationships between observed and latent variables (Hair et al., 2014; Hair et al., 2017; Hair Jr et al., 2021). Meanwhile, PLS is a variant of SEM beneficial for analyzing models with a smaller sample size or non-normal data distributions (Hair & Alamer, 2022). By utilizing SEM and PLS, the relationships between the GSD, LCI, IA, RI, and LCA variables were determined. These statistical analyses help identify the strength and significance of these relationships and provide insights into the factors influencing LCA in the context of plastic cutlery set alternatives in the catering industry in Surabaya City (Hair Jr et al., 2021; Wei et al., 2022).

Table 2 consists of data from the study by Hair and Alamer (2022), which was processed by SmartPLS 4.0. The data described LCA's analyzed variables, items, indicators, mean, and standard deviation. Furthermore, Tables 3 and 4 were obtained from the values of loading factor and AVE (as convergent validity) and cross-loading (as discriminant validity) using the SmartPLS 4.0 processed data. Table 5 contains alpha and CR values obtained from the reliability values, while Table determined the f-square values. Finally, Table 7 analyzed the hypothesis containing path coefficient, t-value, and p-value values.

Table 2. Descriptive Analysis Life Cycle Assessment (Variable, Items, Indicator, Mean, and Standard Deviation

Variable	Items	Indicator
Goal and Scope Definition (GSD)	GSD1	There is a purpose for using a single-use plastic cutlery set replacement for the LCA process
	GSD2	There is a function of replacing single-use plastics cutlery sets with biodegradable cutlery sets or oxo-biodegradable optio
	GSD3	There is an LCA system that will be used to replace single-use plastics cutlery sets in the catering industry
	GSD4	There is a time frame to carry out the LCA concept which will be used to replace single-use plastics cutlery sets in the cate
	GSD5	There are clear problem limits and assumptions related to the LCA concept that will be used to replace single-use plastics
Life Cycle Inventory (LCI)	LCI1	There is data to determine the raw material from replacing single-use plastic cutlery sets to biodegradable or oxo-biodegr
	LCI2	There is data to find out the energy used during the production process from replacing single-use plastic cutlery sets to bi
	LCI3	There is data to find out how much waste can be removed from replacing single-use plastic cutlery sets with biodegradabl
	LCI4	There is data to find out how much greenhouse gas emissions can be eliminated from replacing single-use plastic cutlery s biodegradable or oxo-biodegradable cutlery sets in your catering industry green supply chain practices
	LCI5	There is data to find out green supply chain activities from procurement, production, transportation, use to waste manage single-use plastic cutlery sets to biodegradable or oxo-biodegradable cutlery sets in your catering industry green supply ch
Impact Assessment (IA)	IA1	There is a process of measuring potential influences on environmental aspects
	IA2	There is a process of measuring potential influences on social aspects
	IA3	There is a process of measuring potential influence on economic aspects
	IA4	There is a process of measuring the potential influence on aspects of waste generation
	IA5	There is a process of measuring potential influences on aspects of human health effects
Result Interpretation (RI)	RI1	There is a process of measuring potential influences on aspects of human health effects
	RI2	There is a process of interpreting activities to create alternative scenarios for replacing single-use plastic with biodegradab
	RI3	There is a process of identifying driving factors to encourage alternatives to replace single-use plastic with biodegradable
	RI4	There is a process of evaluating trade-off factors to encourage alternatives to replacing single-use plastic with biodegrada
	RI5	There is a synergy process with environmental and social aspects to encourage alternatives to replace single-use plastic w
Life Cycle Assessment (LCA)	LCA1	There is a Goal and Scope Definition
	LCA2	Life Cycle Inventory process
	LCA3	Impact Assessment process
	LCA4	There is a Result Interpretation
	LCA5	There is a process to carry out LCA activities in your catering industry

3. Results and Discussions

3.1 Descriptive Analysis

The components of the test used to gauge Life Cycle Assessment (LCA) in the Catering Industry in Surabaya City, show that the perceptions of the respondents are markedly shaped by their level of agreement with the statements provided in the instruments (See Table 2). It is well known that the statement IA4 garners the highest index, indicating that respondents exhibit strong agreement with the assertion, "There is a process of measuring the potential influence on aspects of waste generation." Conversely, the statement with the lowest index is RI3, suggesting that respondents are less aligned with the statement, "There is a process of identifying driving factors to encourage alternatives to replace single-use plastic with biodegradable or oxo-biodegradable cutlery sets."

3.2 Outer Model

The measurement model indicates the capacity of the manifest or observed variables to effectively represent the latent variables under consideration. It is important to note that a loading factor value is ascertained to have high validity when greater than 0.5 (Ghozali & Latan, 2015). The results from the outer measurement model using the PLS analysis tool for each indicator are shown in Table 3.

Table 3. Convergent Validity Life Cycle Assessment (Loadings Factor)

Item	Outload	AVE	Result	Item	Outload	AVE	Result	Item	Outload	AVE	Result
GSD1	0.810			IA1	0.880			LCA1	0.839		
GSD2	0.816			IA2	0.896			LCA2	0.913		
GSD3	0.865	0.710	Supported	IA3	0.891	0.769	Supported	LCA3	0.876	0.772	Supported
GSD4	0.856			IA4	0.831			LCA4	0.893		
GSD5	0.866			IA5	0.827			LCA5	0.872		
LCI1	0.903			RI1	0.789						
LCI2	0.908			RI2	0.800						
LCI3	0.943	0.761	Supported	RI3	0.822	0.763	Supported				
LCI4	0.975			RI4	0.823						
LCI5	0.993			RI5	0.838						

Table 4. Discriminant Validity Life Cycle Assessment (Cross Loadings)

Variable	GSD	LCI	IA	RI	LCA	Variable	GSD	LCI	IA	RI	LCA
GSD1	**0.810**	0.465	0.477	0.091	0.156	IA4	0.631	0.416	**0.651**	0.166	0.182
GSD2	**0.816**	0.401	0.479	0.079	0.092	IA5	0.627	0.424	**0.702**	0.132	0.194
GSD3	**0.865**	0.413	0.534	0.123	0.165	RI1	0.133	0.451	0.338	**0.789**	0.588
GSD4	**0.856**	0.434	0.535	0.185	0.244	RI2	0.170	0.593	0.547	**0.800**	0.838
GSD5	**0.866**	0.462	0.526	0.120	0.203	RI3	0.085	0.395	0.296	**0.822**	0.534
LCI1	0.314	**0.903**	0.580	0.568	0.735	RI4	0.107	0.410	0.314	**0.823**	0.535
LCI2	0.319	**0.908**	0.598	0.556	0.752	RI5	0.100	0.418	0.299	**0.838**	0.569
LCI3	0.443	**0.799**	0.509	0.132	0.133	LCA1	0.218	0.565	0.596	0.661	**0.839**
LCI4	0.475	**0.696**	0.500	0.133	0.170	LCA2	0.190	0.651	0.615	0.752	**0.913**
LCI5	0.493	**0.660**	0.530	0.160	0.181	LCA3	0.176	0.736	0.471	0.690	**0.876**
IA1	0.445	0.628	**0.880**	0.428	0.581	LCA4	0.172	0.713	0.480	0.676	**0.893**
IA2	0.380	0.670	**0.896**	0.536	0.662	LCA5	0.220	0.631	0.477	0.643	**0.872**
IA3	0.633	0.458	**0.691**	0.166	0.246						

Based on the information provided in the table, it is evident that all measurement items have successfully met the criteria of the outer loading test. These items were considered suitable for measuring each respective latent variable, as they exhibit values for the question indicators exceeding 0.60. Additionally, the average variance extracted (AVE) values for these items surpass the threshold of 0.50.

To address the issue of discriminant validity for each construct, the next step involves examining the correlation values between constructs in the model, often referred to as cross-loading (Garson, 2016). The results, as shown in Table 4, indicate that all cross-loading values within each of the desired constructs are significantly higher than the cross-loading values with other constructs. This finding supports the conclusion that all indicators are valid, and discriminant validity remains intact. In other words, the measurements effectively distinguish between the intended constructs, reinforcing the validity of the model.

Cronbach alpha and composite reliability scores were used to assess the reliability of each latent construct. This is in addition to the use of the rho value to assure the reliability of the PLS construction score (Dijkstra & Henseler, 2015). It is important to note that both Cronbach alpha and composite reliability need to ideally exceed 0.70 (Hair Jr et al., 2021), while composite reliability is indicated by the rho a value, which should also be 0.70 or higher, as shown in Table 5. Based on the presented Cronbach Alpha and Composite Reliability coefficient values, all of which surpass the 0.70 thresholds, the table unequivocally demonstrates all variables employed in this study exhibit excellent validity and reliability. This suggests that these variables are highly practical and reliable for use in the study.

Table 5. Reliability Test Life Cycle Assessment (α and CR)

Variable	α	CR
GSD	0.902	0.938
LCI	0.783	0.928
IA	0.843	0.971
RI	0.875	0.895
LCA	0.926	0.929

3.3 Inner Model

The Inner Model was used to establish the causal connection between the variables studied with the outcome of the factors shown in Figure 3 and Tables 6-7 (Hair et al., 2017).

Table 6. f-Square Life Cycle Assessment (f-Square and Effect Size)

Correlation	f-Square	Effect Size
GSD -> LCA	0.096	Small
IA -> LCA	0.053	Small
LCI -> LCA	0.366	Large
RI -> LCA	0.581	Large

Table 7. Hypothesis Test Life Cycle Assessment (Path Coefficient, T-Statistics, P-Values)

Hypothesis	Path Coefficient	T statistics	P values
GSD -> LCA	0.196	6.109	0.000
LCI -> LCA	0.463	10.373	0.000
IA -> LCA	0.174	4.951	0.000
RI -> LCA	0.464	11.622	0.000

Based on Figure 3 and Tables 6-7, GSD, LCI, IA, and RI, have a positive and significant influence on LCA. The test results between GSD, LCI, IA, and RI with LCA show path coefficient values of 0.196, 0.463, 0.174, and 0.464, which are close to the +1 value. The T-Statistic values are 6.109, 10.373, 4.951 and 11.622 (>1.96), with f-square values of 0.096, 0.053, 0.366 and 0.581, valued at 0.000 (<0.05).

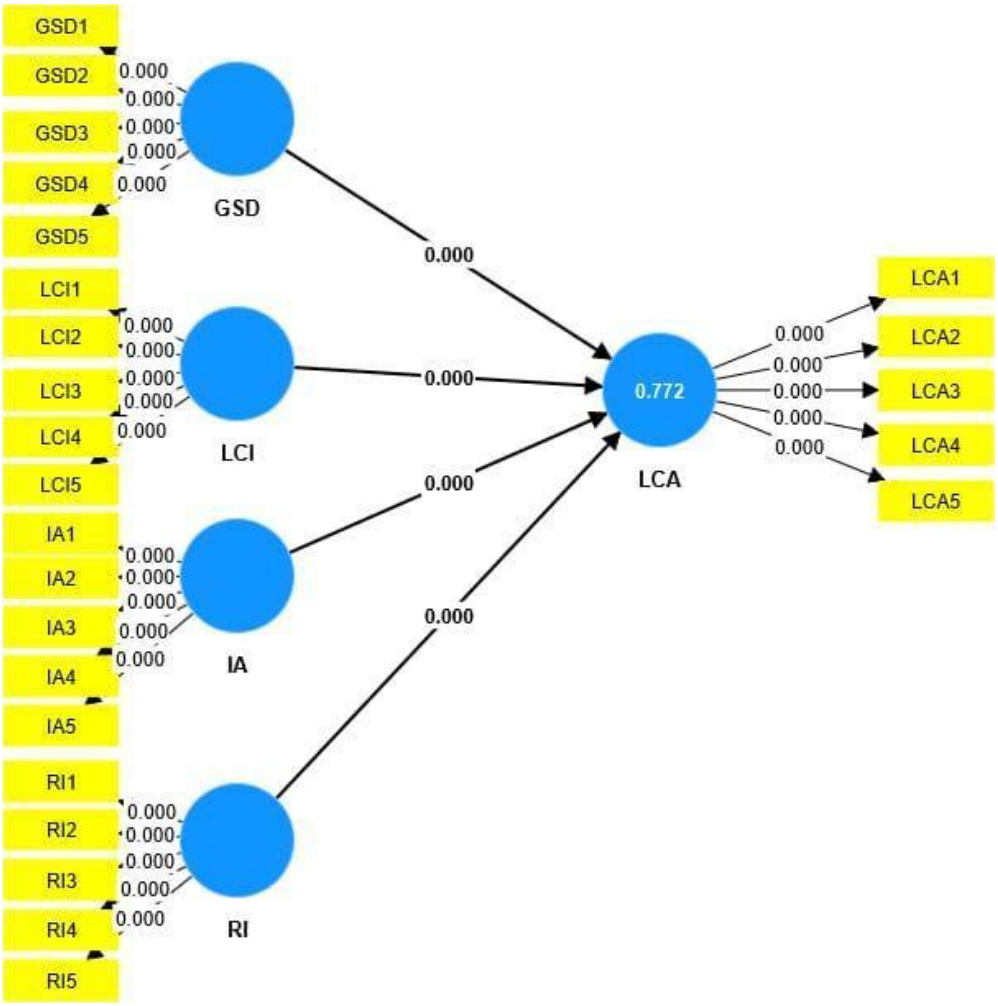

Figure 3. Hypothesis Test Results Life Cycle Assessment (all P-Values <0.05)

Source: Smart PLS 4.0 Output Results (2023)

3.4 Discussions

Based on the test results, it is evident that Goal and Scope Definition (GSD), Life Cycle Inventory (LCI), Impact Assessment (IA), and Result Interpretation (RI) all exert a positive and significant influence on Life Cycle Assessment (LCA). This is substantiated by the path coefficient values for each of these factors, which are 0.196, 0.463, 0.174, and 0.464, respectively, and are close to the +1 value. Additionally, the T-Statistic values for each path are well above 1.96, namely 6.109, 10.373, 4.951, and 11.622. The f-square values are 0.096, 0.053, 0.366, and 0.581, indicating significant effects, while all p-values are below 0.05, specifically 0.000, signifying statistical significance. The hypotheses H1, H2, H3, and H4 were supported, confirming that Goal and Scope Definition (GSD), Life Cycle Inventory (LCI), Impact Assessment (IA), and Result Interpretation (RI) all have significant and positive effects on Life Cycle Assessment (LCA). These findings align with prior studies (Wei et al., 2022). The finding of this study shows that collaboration between Goal and Scope Definition (GSD), Life Cycle Inventory (LCI), Impact Assessment (IA), and Result Interpretation (RI) encourages the Catering Industry to establish Life Cycle Assessment (LCA).

The novelty of this study lies in creating a conceptual model employing the SEM PLS method, which can serve as a foundation for future research. Based on survey results from the catering industry, this study elucidates that Life Cycle Assessment (LCA) is indeed influenced by four primary factors, namely Goal and Scope Definition (GSD), Life Cycle Inventory (LCI), Impact Assessment (IA), and Result Interpretation (RI). This study marks an initial exploration of applying SEM PLS modeling in LCA analysis, as opposed to previous ones, which had to use laboratory-based methods or use certain measuring devices to measure the level of impact assessment. The result interpretation of the LCA level on a product, including cutlery set products, was determined using a concept that LCA is indeed significantly and positively influenced by 4 factors, namely Goal and Scope Definition (GSD), Life Cycle Inventory (LCI), Impact Assessment (IA), and Result Interpretation (RI).

The goal and scope definition (GSD) of this Life Cycle Assessment (LCA) study is to assess and compare the environmental performance of plastic cutlery and alternative options, specifically focusing on their application within the catering industry. This study aimed to provide insight into the environmental impacts of different tableware materials, thereby assisting stakeholders in making decisions based on sustainability considerations. The main goal and scope are to determine the optimal alternative to plastic tableware while considering the environmental impact of the entire product life cycle (cradle-to-grave). Furthermore, the functional unit (FU) on the goal and scope definition of LCA is used as a reference for comparison between various tableware materials. FU is defined as the request for tableware required to serve 1000 meals, which allows for a consistent evaluation of the environmental impact of each material when used in the context of the catering industry. The goal and scope definition in this LCA study encompasses the entire life cycle of tableware and its alternatives, encompassing the following phases (Wei et al., 2022):

1. Acquisition of raw materials: This stage includes the extraction and processing of raw materials necessary to manufacture tableware.
2. Production of materials and tableware: The manufacturing process involved converting raw materials into finished tableware products.
3. Use and reuse of tableware: The use stage includes the environmental impact of using tableware to serve food, while the reuse stage involves reconsideration.
4. Waste management: The management of waste generated during the life cycle, including disposal, recycling, and other scenarios for the end of life of tableware, is also included.

The goal and scope definition (GSD) in this study adopted a comparative approach, which enabled the assessment of the environmental performance of plastic tableware in contrast to viable alternatives throughout the entire life cycle phase. Therefore, by employing a cradle-to-grave model, the analysis comprehensively covered all phases of the life cycle, encompassing both upstream and downstream processes. An important aspect of this approach is establishing an alternative limitation designed to maintain consistency, such as a set of tableware consisting of a knife, fork, and spoon, which is considered a standard package to be served with food. This standardization ensures a fair and consistent basis for comparing different tableware materials. By conducting LCA studies with predetermined goals and scope definition, this study aimed to provide valuable guidance for the catering industry and other stakeholders. The aim is to assist them in making informed choices regarding tableware materials that exhibit the lowest environmental impact and represent the most sustainable options (Wei et al., 2022).

Life cycle inventories (LCI) in LCA studies were created by collecting data from primary and secondary sources. Primary data is collected directly from the source, while secondary data are obtained from other parties and are available for use in the study. The following is an explanation of the use of primary and secondary data in lifecycle inventories (LCI) (Razza et al., 2015):

1. Primary Data:
    - This data type was used to collect information about the weight of each type of tableware included in a set, such as a set of knives, forks, and spoons. It is used to calculate the environmental impact of using the material in each set of tableware.
    - The direct collection method was used by the research team to weigh each cutlery and get an accurate measurement.

2. Secondary Data:
    - This data type is used to understand material inputs and outputs in various phases of the tableware life cycle, such as raw material acquisition, production, and waste management.
    - It comes from pre-existing sources, such as Environmental Impact Assessment (EIA) reports, scientific research results, previous LCA studies, industry statistics, environmental databases, and other related scientific literature.

In the lifecycle inventories (LCI) stage, data sourced from both primary and secondary sources are leveraged to model material and energy flows throughout the tableware lifecycle, encompassing production to final disposal. This primary and secondary data synthesis enables researchers to compute each tableware type's environmental footprint or impact and its potential alternatives. This calculation hinges on understanding the materials, energy, and processes entailed in the life cycle of each product. It is important to note that the accuracy and validity of the data collected are important factors in the overall quality of the LCA study. Therefore, during the life cycle inventory phase, dedicated efforts should be made to ensure the data used is accurate, reliable, and representative of the real-world conditions of the system under evaluation (Razza et al., 2015).

Environmental impact assessment (IA) through life cycle modeling, often facilitated by GaBi software, constitutes a prevalent approach in LCA studies. GaBi (Global Approach to Biological Systems) software is one of the leading LCA software used to analyze and assess a product's or system's environmental impact from a life cycle perspective. This method unravels and assesses the material flow across every phase of the tableware life cycle, from production to ultimate disposal. Environmental impact quantification is executed using the CML (Centrum voor Milieukunde) method 2001-Jan.2016. This method stands among several environmental impact assessment techniques and typically encompasses an array of distinct environmental impact categories. By gauging environmental impacts across multiple categories, LCA studies can provide a more exhaustive portrayal of the environmental implications associated with each alternative. Below are the 11 environmental impact categories examined in this study using the CML method 2001-Jan.2016 (Wei et al., 2022):

1. GWP 100: Global Warming Potential, measures the impact of greenhouse gases on climate change.
2. AP: Acidification Potential, assesses the impact of increasing environmental acidity.
3. EP: Eutrophication Potential, measures the impact of excessive nutrient release and causing eutrophication problems in waters.
4. ODP: Ozone Depletion Potential, measures the impact on stratospheric ozone layer depletion.
5. ADP Element: Abiotic Depletion Potential of natural elements, examines the depletion of non-organic natural resources.
6. Fossil ADP: Fossil energy depletion potential, evaluates the impact on fossil energy resource depletion.
7. FAETP inf.: Photo-oxidation formation potential of organic matter, assesses the photo-oxidation pollutant formation.
8. HTP inf.: Hydrocarbon formation potential measures the hydrocarbon formation.
9. MAETP inf.: Potential formation of strong acid compounds, assesses the formation of strong acid compounds.
10. POCP: Expanded photo-oxidant ozone formation potential, examines the photo-oxidant ozone formation at the ground level.
11. TETP inf.: Potential for the formation of oxygen compounds, measures the impact of the formation of oxygen compounds.

Following calculation of environmental impact data within each category, the ensuing step involves result interpretation (RI). This process culminates in drawing conclusions and offering recommendations based on the environmental impact analysis of each available alternative. These insights serve as valuable reference points for decision-makers when selecting the most sustainable tableware materials, ones that minimize environmental impact. The interpretation of findings from this LCA study empowers

stakeholders, including the catering industry, to make more environmentally responsible decisions, aligning their practices with sustainability principles and responsible resource management (Wei et al., 2022).

Conclusions

Based on the results and discussions presented in the hypothesis testing chapter, several conclusions were drawn from this study. The study involved testing four hypotheses, and all four were valid. Furthermore, the conceptual model of the study identified four factors, named Goal and Scope Definition (GSD), Life Cycle Inventory (LCI), Impact Assessment (IA), and Result Interpretation (RI). These factors significantly and positively influenced the Life Cycle Assessment (LCA) of single-use cutlery set substitutes in the catering industry.

These results highlighted the importance of integrating Life Cycle Assessment into the business practices of the catering industry to replace single-use tableware or cutlery sets. By incorporating LCA concepts and implementing the four factors mentioned, catering businesses effectively reduced waste, minimized their environmental impact, and enhanced their overall Life Cycle Assessment performance. through the replacement of single-use cutlery sets in the catering industry.

These findings offered a robust basis for the catering industry to adopt and enhance the implementation of Life Cycle Assessment concepts. Further study was recommended to explore how these strategies influenced long-term Life Cycle Assessment and how are optimized for maximum impact.

Overall, this study underscored the significance of Life Cycle Assessment practices for addressing social, environmental, and economic aspects. By embracing LCA, the catering businesses contributed to sustainable development and improved their overall environmental performance, which aligned with their operations with principles of sustainability and responsible resource management.

Limitation

This study serves as an introductory examination of the substitution of single-use tableware, or cutlery sets through the application of Life Cycle Assessment principles, which was only carried out in the catering industry in Surabaya. Future study needs to be carried out with a wider range of respondents, such as in Indonesia or around the world.

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Research Paper

Linking Public Service Availability to Village Welfare

Pauline Gaspersz

Interdisciplinary Graduate Program in Behavioral Socioeconomics, Ewha Womans University, Seoul, Republic of Korea

paulinegaspersz@ewhain.net

Abstract

This study aims to provide a village-level analysis explaining the link between the availability of essential services and welfare, which is scarce in this study area. The accessibility of state-provided facilities is related to poverty reduction. On the other hand, the village, the lowest administrative level in Indonesia, is entrusted with a particular delegation of authority and budget. Therefore, the efficient management of delegated authority and budget at the village-level should be reflected in good infrastructure. By employing logistic regression, this study examines the relationship between the village development's status as a proxy for people's welfare and the availability of essential services in Maluku and Maluku Utara, two neighboring provinces with significant differences in poverty rates. The main finding of this research is that infrastructure plays an important role in improving people's welfare at the village level. In addition, surprisingly, crimes contribute to the village's development.

Keywords: Infrastructure; Poverty; Indonesia; Village

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Fax: +62 21 31928281
E-mail: journal.pusbindiklatren@bappenas.go.id

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1. Introduction

Studies in poverty discourse have found that infrastructure development has emerged as a prominent and decisive dimension in determining people's poverty status. Adequate infrastructure improves people's access to human, social, financial, and natural resources, thereby enhancing their quality of life economically and socially over time (Ge et al., 2021). Infrastructure has become a crucial factor in categorizing a country's success or failure. Indeed, basic infrastructure facilities significantly impact people's daily lives and ensuring accessible public services for the sustainability of households and business affairs presents a significant challenge in achieving sustainable economic development. Primarily, poverty is closely linked to access to state-provided facilities (Zhang et al., 2023). The availability of basic infrastructures such as transportation, clean water, health care, and electricity can sometimes be the determining factor in labeling individuals as poor or not. As infrastructure development aims to fulfill people's fundamental needs, its availability and quality directly influence their quality of life. Naraya et al. (2000), in "Can Anyone Hear Us?: Voices of the Poor," utilize community-level poverty to depict the absence of critical infrastructure in particular communities, highlighting that poverty reduction is inseparable from accessible basic infrastructure. Similarly, high poverty rates in Indonesia are concentrated in areas with inadequate infrastructure (Pramono & Marsisno, 2019).

SDG 2 focuses on ending hunger, achieving food security, improving nutrition, and promoting sustainable agriculture through the enhancement of rural infrastructure. The SDGs employ localized development approaches that cater to local demands and resources to attain this objective (Vazeer, 2021). By doing so, the SDGs remind governments worldwide to prioritize small-area development, particularly their role in providing essential services, considering that providing "a package" of infrastructure is more effective in reducing poverty compared to addressing it partially (Robles Aguilar & Sumner, 2020). "Localizing" refers to actions taken at the subnational, local governments, cities, and regional levels. In the context of Indonesia, this also includes villages.The village, being the lowest administrative level in Indonesia, receives delegated authority and budget to oversee governance and manage finances in the government's efforts to improve people's quality of life, foster community empowerment, and enhance services for the community. According to Article 4 Law No. 6/2014, village development aims to improve public services for community members, thereby accelerating the realization of the general welfare. In alignment with this objective, since 2015, Indonesia has been disbursing *Dana Desa* (Village Funds) to balance the funds allocated to villages through the district government. This initiative aims to narrow the gap between urban and rural areas across various dimensions of life, particularly in the area of poverty reduction. It indicates that, to some extent, the village administration is also responsible for providing public infrastructure. However, the reality is that many areas still grapple with high poverty rates. This situation suggests inefficiencies in fund management, which include constraints in human resources within village administration, as highlighted by the World Bank (2019),

> *"Village governments have yet to realize the full potential of the Law, with institutional capacity and the scale and diversity of the country among the main challenges."*

Numerous village-level studies have explored the issue of poverty, with a notable focus on Dana Desa as a variable in the context of Indonesia. Darmi and Mujtahid (2020) discovered that *Dana Desa* contributed to poverty alleviation. Sunu and Utama (2019) state that Dana Desa positively impacts poverty reduction, indicating that higher *Dana Desa* allocations correlate with lower poverty rates. Sigit (2020) reached the conclusion that *Dana Desa,* alongside *Alokasi Dana Desa* (Allocation of Village Funds), *Produk Domestik Regional Bruto* (*Gross Regional Domestic Product*), and *Belanja Modal* (Capital Spending), collectively influence poverty in Indonesia. However, contrasting views also exist. Some researchers have argued that connecting *Dana Desa* to the poverty situation is premature (Pramudyasmono, 2020; Riyanda et al., 2022). While *Dana Desa* aims to alleviate poverty, its effectiveness depends on various factors, including the competence of its managers (Azhari et al., 2022), the severity level of the village (Joetarto et al., 2020; Saragi, 2021), and the presence of stringent supervision (Akbar & Sihaloho, 2019; Hermawan & Ahmad, 2019).

In the end, well-delivered public funds such as *Dana Desa* should be reflected in a satisfactory level of development (Vaishar & Šťastná, 2021). The effective management of *Dana Desa* that is most relevant for poverty analysis, is its physical utilization, specifically in terms of infrastructure performance. This

study emphasizes that using the availability of public services is a better indicator to assess the effectiveness of *Dana Desa*'s implementation. Moreover, given the contemporary emphasis on SDGs, this study finds it crucial to incorporate SDGs-related variables in the analysis. By doing so, this study simultaneously provides insights into the progress of SDG achievement at the village level in the regions under scrutiny. Several variables used in this study are standard in the poverty analysis, such as electrification, sanitation, clean water, educational institutions, transportation, and access to credit. However, studies that combine these variables into a village-level analysis remain scarce. In addition, this study introduces crimes and access to police services as variables to gain insights into the safety perspective's role in enhancing village-level welfare, which is the first endeavour in conducting a village-level analysis related to poverty.

Therefore, in the collective pursuit of poverty reduction, governments at all levels, including the grassroots, are actively engaged. This study proposes that electrification, sanitation, clean water, educational institution, public transportation, access to credit, the prevalence of crimes, and access to police services collectively influence people's welfare at the village level. This study also offers insights into governance efficiency at Indonesia's lowest administrative level, particularly in the administration of *Dana Desa*. Such insights could prove invaluable in assessing current policies and their effectiveness in providing essential public services people need to obtain a better quality of life.

2. Methods

This study utilizes the 2018 *Podes* data – village-based data from the Village Potential Statistics of Indonesia – as provided by BPS-Statistics Indonesia and the village development status is obtained from the 2018 publication of *IDM* (*Indeks Desa Membangun* – Village Development Index) by the *Kementerian Desa Republik Indonesia* (2018) – Ministry of Villages, Development of Underdeveloped Areas and Transmigration, the Republic of Indonesia. The choice of the year 2018 is based on the availability of village-level data and its positioning in the pre-pandemic era. The data processing is conducted using IBM SPSS Statistics 20.

Referring to the publication Maluku Province in Figures 2019 (Badan Pusat Statistik Provinsi Maluku, 2019), Maluku consists of 118 sub-districts and 1,233 villages+*kelurahan,* while Maluku Utara has 116 sub-districts and 1195 villages+*kelurahan* (Badan Pusat Statistik Provinsi Maluku Utara, 2019). In Indonesia's administration, alongside *kelurahan*, the village is a subdivision of the sub-district. However, *IDM* only covers villages and excludes *kelurahan* and areas in preparation to be villages, such as *Unit Pemukiman Transmigrasi* (*UPT* – Transmigration Unit). Consequently, the data's coverage in this analysis is slightly less than the actual total number of villages. This analysis incorporates 1176 villages for Maluku Province and 1049 for Maluku Utara.

The Ministry of Villages, Development of Underdeveloped Areas and Transmigration, the Republic of Indonesia initiated the publication of IDM (*Indeks Desa Membangun* – Village Development Index) in 2016. This index assigns a specific rating and development status to each village, sub-district, district, and province. Village development progress and independence rate, as determined by *IDM*, are classified into five groups: Autonomous Village, Advanced Village, Developing Village, Underdeveloped Village, and Very Underdeveloped Village. *IDM* was compiled based on the enumeration conducted by The Ministry of Villages, Development of Underdeveloped Areas and Transmigration, the Republic of Indonesia. At the same time, *Podes* (*Potensi Desa* - Village Potential Statistics) is a village-level dataset provided by *BPS*. While some questions in these enumerations overlap, *IDM* and *Podes* are independently developed. This study also draws data from the National Socio-economic Survey (*Survei Sosial Ekonomi Nasional* – *Susenas*) 2018 to further elucidate several independent variables.

This study examines the relationship between the Village Development Status as the dependent variable (Y) and essential services across all villages in Maluku and Maluku Utara as independent variables (Xs). Despite their close proximity, the former is among the most underprivileged provinces in Indonesia, while the latter fares better in comparison. The rationale for employing village development status lies in the perception that it can serve as an indicator of the poverty circumstances of its residents (Handoyo et al., 2021).

Table 1. Variables

Variable	Description	Codes
Dependent Variables		
Vil_Dev_St	Village's Development Status	1 = Developing or more 0 = Underdeveloped or less
Independent Variables		
No_electricity	Less than or equal to 25 percent of households without electricity.	1 = Yes 0 = No
Toilet	The use of defecation facilities by most families	1 = Yes 0 = No
Drinking_water	Source of drinking water	1 = Bottled/refilled and tap water 0 = Else
Middle_edu_access	Ease of access to middle school	1 = Easy 0 = Not easy
Public_transport	Public transportation with regular routes passing through the village	1 = Available 0 = Not available
Credit	Received credit for the past year	1 = Yes 0 = No
No_crime	No crime incidents in the last year	1 = Yes 0 = No
Police_access	Ease of access to a police station	1 = Easy 0 = Not easy

The logistic regression is conducted because it can robustly classify the unit of analysis in this study (villages) as developing or underdeveloped and reveal the underlying factors driving this categorization. Logistic regression aims to estimate the relationship between a binary categorical variable as the dependent variable and a set of independent variables, which can be either metric or nonmetric. This study follows the five stages of logistic regression as outlined by Hair et al. (2019). The initial stage involves defining the objectives of the logistic regression, which encompass both explanation and classification. The measurement of predictive accuracy emphasizes accurate classification, accounting for various types of misclassifications and their associated costs. The second stage revolves around designing research for logistic regression. The dependent variable with binary values is represented as 0 and 1. Logistic regression employs maximum likelihood estimation (MLE) and requires a substantial overall sample size to adequately support its estimation. While there is no consensus on an exact ideal sample size, it is crucial to remember that small samples yield significant sampling errors. Hosmer et al. (2013) recommend sample sizes exceeding 400.

In stage 3, we ensure that the underlying assumption is met: independence of observations. Stage 4 involves the estimation of the logistic regression model and the evaluation of the overall fitness of the model. Logistic regression estimates coefficients for the independent variables, using the logit value as the dependent measure, which ensures that any predicted value can be converted back into a probability within the range of 0 and 1. The model's formulation is as follows:

$$Logit_i = ln\left(\frac{prob_{event}}{1 - prob_{event}}\right) = b_0 + b_1X_1 + \cdots + b_nX_n \quad (1)$$

However, the coefficients estimated in the aforementioned model pertain to effects on a logged odds value, rendering the model less straightforward to interpret. Dealing with this issue requires transforming the model formulation into an equivalent form that pertains to changes in odds, thus facilitating easier interpretation.

$$Odds_i = \left(\frac{prob_{event}}{1 - prob_{event}}\right) = e^{b_0 + b_1X_1 + \cdots + b_nX_n} \quad (2)$$

Two methods are employed to evaluate the fitness of logistic regression model. The first method involves an overall measure of the statistical significance of the model fit and "pseudo" R2 value. The

second method pertains to predictive accuracy, which is the model's ability to classify the outcome measure correctly. Regarding the "pseudo" R^2 value, there are two measures to be considered: the Cox and Snell R2 and Nagelkerke. These measures offer insights into the extent of variation accounted for by the model. Logistic regression employs a classification matrix and a chi-square-based fit measure to assess overall predictive accuracy. A classification matrix is a cross-tabulation of the outcome variable with the predicted outcome, thereby quantifying the accuracy of predicted group membership and any associated misclassifications. The associated statistical test of significance used in logistic regression is the Hosmer and Lemeshow Test. This test evaluates the classification-based significance of actual outcomes compared to predicted outcomes. A nonsignificant value in the Hosmer and Lemeshow Test indicates a well-fitted model aligning actual and predicted outcomes.

Stage 5 entails the interpretation of the results. The sign of the original coefficients (positive or negative) indicates the direction of the relationship. In addition, we also need an exponentiated logistic coefficient for the transformation (antilog) of the initial logistic coefficient, a feature predominantly accessible in various computer programs. The exponentiated coefficients above 1.0 indicate a positive relationship; less than 1.0 represent negative relationships.

3. Results and Discussion

Before proceeding with the analysis, it is essential to ensure that the utilized independent variables do not exhibit multicollinearity issues, considering that the presence of multicollinearity can reduce the distinct impact of these independent variables, along with their estimated coefficients and standard errors.

Table 2. The Results of Collinearity Statistics

	Maluku		Maluku Utara	
	Tolerance	**VIF**	**Tolerance**	**VIF**
No_electricity	.869	1.150	.813	1.230
Toilet	.891	1.122	.910	1.099
Drinking_water	.952	1.051	.885	1.130
Middle_edu_access	.817	1.224	.791	1.264
Public_transport	.805	1.243	.920	1.086
Credit	.828	1.207	.917	1.091
No_crime	.938	1.066	.909	1.100
Police_access	.739	1.354	.716	1.396

The more pronounced degrees of multicollinearity are represented by the lower tolerance values and higher VIF values (Hair et al., 2019). Tolerance values greater than 0.1 and VIF values significantly less than 10 serve as evidence of low multicollinearity within the dataset.

Table 3. Categorical Variables Coding

	Category	**Parameter coding**	**Frequency**	
			Maluku	**Maluku Utara**
No_electricity	Else	0	254	198
	Lowest through 25 percent	1	922	851
Toilet	No	0	169	69
	Yes	1	1007	980
Drinking_water	Else	0	1014	731
	Bottled/refilled and tap water	1	162	318
Middle_edu_access	Not easy	0	216	122
	Easy	1	960	927
Public_transport	Not available	0	732	178
	Available	1	444	871
Credit	No	0	623	620
	Yes	1	553	429
No_crime	No	0	320	378
	Yes	1	856	671
Police_access	Not easy	0	479	349
	Easy	1	697	700

There is no consensus regarding an ideal size in logistic regression, but it is crucial to remember that small samples can result in high sampling errors. Logistic regression is sensitive to small or empty cells, leading to an unstable model, large logistic coefficients, and an odd ratio for independent variables (Hair et al., 2019). Table 3 indicates that the data used in this analysis has sufficient overall and cell sample sizes.

3.1 Baseline Analysis

The classification in Table 4 shows that in the absence of any independent variables, the optimal prediction is to classify all villages as underdeveloped or less. By adopting this approach, we can accurately classify 76.0 percent of villages in Maluku Province and 76.5 percent of villages in Maluku Utara Province.

Table 4. Classification Table

Observed		Predicted		
		Village Development Status		Percentage Correct
		Underdeveloped or less	Developing or more	
Maluku				
Village Development Status	Underdeveloped or less	894	0	100.0
	Developing or more	282	0	.0
Overall Percentage				**76.0**
Maluku Utara				
Village Development Status	Underdeveloped or less	802	0	100.0
	Developing or more	247	0	.0
Overall Percentage				**76.5**

3.2 Model Fit

The omnibus tests of model coefficients in Table 5 provide insight into the predictive capability of the model in contrast to having no independent variables. The model exhibits statistical significance (p < 0.05; **"Sig."** column) at the significance level α=0.05, where $\chi^2(8) > \chi^2$ distribution table = 15.5073.

Table 5. Omnibus Tests of Model Coefficient

		Chi-square	df	Sig.
Maluku				
Step 1	Step	279.835	8	.000
	Block	279.835	8	.000
	Model	279.835	8	.000
Maluku Utara				
Step 1	Step	191.062	8	.000
	Block	191.062	8	.000
	Model	191.062	8	.000

In addition, the overall predictive accuracy of the model, assessed using the Hosmer and Lemeshow goodness of fit test, demonstrates a strong alignment between actual and predicted values, which suggests a good predictive model.

Table 6. Hosmer and Lemeshow Tests

	Step	Chi-square	df	Sig.
Maluku	1	2.629	8	.955
Maluku Utara	1	6.436	8	.599

The Hosmer and Lemeshow test are not statistically significant, yielding p = .955 for Maluku and p = .599 for Maluku Utara (as shown in the "**Sig.**" column). This suggests that both models do not exhibit poor fit. Similarly, both $\chi^2(8) > \chi^2$ distribution table = 15.5073. Table 7 illustrates that the variation in the dependent variable based on this model ranges from 21.2 percent to 31.7 percent for Maluku and from 16.7 percent to 25.1 percent for Maluku Utara.

Table 7. Model Summary

	Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
Maluku	1	1015.752[a]	.212	.317
Maluku Utara	1	954.011[b]	.167	.251

Upon inclusion of the independent variables, the overall model's correct classification is observed to improve for both provinces, as presented in Table 8. Overall, the model correctly classifies 79.2 percent of villages in Maluku and 78.4 percent of villages in Maluku Utara into their accurate categories: underdeveloped as underdeveloped and developing as developing. In other words, the model inaccurately classifies 20.8 percent of villages in Maluku and 21.6 percent of villages in Maluku Utara into erroneous classifications.

Table 8. The Results of Classification Table

	Observed	Predicted		
		Village Development Status		Percentage Correct
		Underdeveloped or less	Developing or more	
Maluku				
Village Development Status	Underdeveloped or less	843	51	94.3
	Developing or more	194	88	31.2
	Overall Percentage			**79.2**
Maluku Utara				
Village Development Status	Underdeveloped or less	771	31	96.1
	Developing or more	196	51	20.6
	Overall Percentage			**78.4**

*S*ensitivity refers to the proportion of villages with the status of "developing or more," which were accurately predicted by the model (true positives), and it stand at 31.2 percent for Maluku Province and 20.6 percent for Maluku Utara. Specificity, on the other hand, represents the true negative rate, signifying the percentage of actual negative outcomes that were correctly predicted for both provinces that exceeds 90 percent.

Table 9. Measures of Predictive Accuracy: Overall, Actual Outcomes, and Predicted Outcomes

Measure	Maluku	Maluku Utara
	Overall Predictive Accuracy (%)	
Accuracy	79.2	78.4
	Predictive Accuracy for Actual Outcome (%)	
Sensitivity	31.2	20.6
Specificity	94.3	96.1
	Predictive Accuracy for Predicted Outcome (%)	
Positive Predictive Value	63.3	62.2
Negative Predictive Value	81.3	79.7

To enhance our classification performance assessment, the Receiver Operating Characteristic (ROC) graphs presented below offer a useful tool for visualizing and evaluating classifiers.

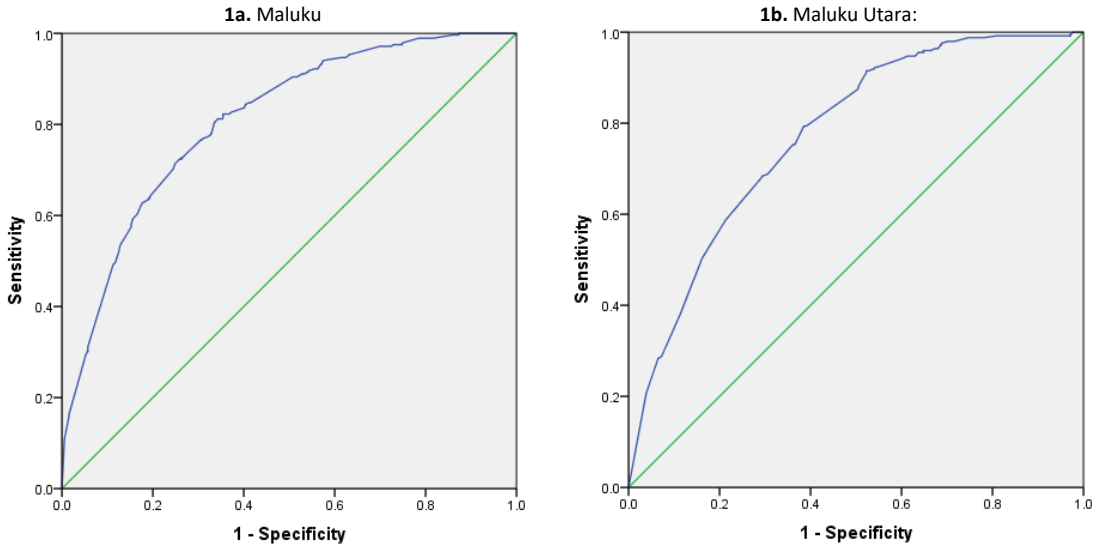

Figure 1. ROC Curves

The green diagonal line that equally divides the areas on the ROC curve, represents a null model, the lowest acceptable threshold. The blue line positioned above the green one measures discrimination – the higher it is, the better the discrimination. Figure 1 depicts Maluku Province exhibiting superior discrimination. The Area Under Curve (AUC) measure, as shown in Table 10, serves as a comprehensive assessment of predictive accuracy.

Table 10. Area Under the Curve

	Area	Std. Error	Asymptotic Sig	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
Maluku	.808	.014	.000	.781	.836
Maluku Utara	.774	.016	.000	.743	.805

The AUC value of .808 of Maluku's model categorizes its discrimination within the range of excellent discrimination, while Maluku Utara's model with an AUC value of .774, falls within the level of acceptable discrimination.

3.3 Variables in Equation

The contribution of the eight independent variables to the model and their statistical significance are presented in Table 11.

Table 11. Variables in the Equations

	B	S.E.	Wald	df	Sig.	Exp(B)
Maluku						
No_electricity	.543	.255	4.522	1	.033	1.721
Toilet	1.453	.439	10.943	1	.001	4.276
Drinking_water	.630	.199	10.041	1	.002	1.878
Middle_edu_access	.786	.325	5.840	1	.016	2.195
Public_transport	.733	.164	20.020	1	.000	2.080
Credit	.941	.169	30.848	1	.000	2.562
No_crime	-.521	.165	9.941	1	.002	.594
Police_access	.796	.204	15.256	1	.000	2.217
Constant	-4.852	.558	75.710	1	.000	.008
Maluku Utara						
No_electricity	1.157	.353	10.768	1	.001	3.181
Toilet	1.544	.748	4.264	1	.039	4.683
Drinking_water	.742	.167	19.803	1	.000	2.100
Middle_edu_access	1.115	.544	4.203	1	.040	3.048
Public_transport	1.290	.349	13.671	1	.000	3.632
Credit	.700	.162	18.611	1	.000	2.015
No_crime	-.393	.165	5.683	1	.017	.675
Police_access	.451	.225	4.005	1	.045	1.570
Constant	-6.637	.976	46.277	1	.000	.001

All independent variables hold significance within the model at α = 0.05 significance level. The logistic regression equation uses the B coefficients (**"B"** column) to predict the probability of an event transpiring, considering certain interpretive aspects. Thus, it is common to use the exponentiated logistic coefficient (**"Exp(B)**" column), which involves the transformation (antilog) of the initial logistic coefficient and represents the alteration in odds for every unit increment in the independent variable.

For the context of Maluku Province, the logistic regression formulated between the dependent and independent variables is as follows.

$$ln\left(\frac{p_{event}}{1-p_{event}}\right) = -4.852 + .543\ No_{electricity} + 1.453\ Toilet + .630\ Drinking_{water} + .786\ Middle_{edu_{access}} + .733\ Public_{transport} + .914\ Credit - .521\ No_{crime} + .796\ Police_{access} \quad (3)$$

or,

$$\left(\frac{p_{event}}{1-p_{event}}\right) = \exp(-4.852 + .543\ No_{electricity} + 1.453\ Toilet + .630\ Drinking_{water} + .786\ Middle_{edu_{access}} + .733\ Public_{transport} + .914\ Credit - .521\ No_{crime} + .796\ Police_{access}) \quad (4)$$

The model exhibits statistical significance, $\chi^2(8) = 279.835$, with a significance level of $p < 0.05$. Additionally, there were 27 standardized residuals with values greater than 2.000 standard deviations, which were retained in the analysis. Villages with

- about 25 percent or fewer households that lack electricity experience 1.721 times higher odds of transitioning into developed villages compared to villages with a greater percentage of households without electricity,
- most families utilizing the defecation facilities had 4.276 times higher odds of becoming developed villages compared to villages where most families do not use them,
- most families using bottled/refilled and tap water as their drinking water source had 1.878 times higher odds of becoming developed villages compared to villages where most families lack access to such water sources,

- most families with convenient access to middle school facilities had 2.195 times higher odds of becoming developed villages, in contrast to villages where most families lack such access.
- public transportation passing through them had 2.080 times higher odds of becoming developed villages compared to villages without such transportation,
- most families having access to credit facilities had 2.562 times higher odds of becoming developed villages, compared to villages where most families lack access to such facilities,
- no reported crimes during the past year had 0.594 times higher odds of becoming developed villages, compared to villages with reported crimes, and
- most families having easy access to the police station had 2.217 times higher odds of becoming developed villages, in contrast to villages where most families lack such access.

The logistic regression analysis between the dependent and independent variables for Maluku Utara Province is as follows.

$$ln\left(\frac{p_{event}}{1-p_{event}}\right) = -6.637 + 1.157\ No_{electricity} + 1.544\ Toilet + .742\ Drinking_{water} + 1.115\ Middle_{edu_{access}} + 1.290\ Public_{transport} + .700\ Credit - .393\ No_{crime} + .451\ Police_{access} \quad (5)$$

or,

$$\left(\frac{p_{event}}{1-p_{event}}\right) = \exp(-6.637 + 1.157\ No_{electricity} + 1.544\ Toilet + .742\ Drinking_{water} + 1.115\ Middle_{edu_{access}} + 1.290\ Public_{transport} + .700\ Credit - .393\ No_{crime} + .451\ Police_{access}) \quad (6)$$

The model was statistically significant, $\chi^2(8) = 191.062$, $p < 0.05$, with 20 standardized residuals having values greater than 2.000 standard deviations, which were retained in the analysis. Villages with

- about 25 percent or fewer households that lack electricity had 3.181 times higher odds of becoming developed villages compared to villages with a higher percentage of households without electricity,
- most families using the defecation facilities had 4.683 times higher odds of becoming developed villages compared to villages in which most families do not use such facilities,
- most families using bottled/refilled and tap water as their primary drinking water source had 2.100 times higher odds of becoming developed villages compared to villages in which most families do not have access to it,
- most families having easy access to middle school facilities had 3.048 times higher odds of becoming developed villages compared to villages where most families lack such access,
- public transportation passing through them had 3.632 times higher odds of becoming developed villages compared to villages that don't have such transportation,
- most families having access to credit facilities had 2.015 times higher odds of becoming developed villages compared to villages where most families lack access,
- no reported crimes during the past year had 0.675 times higher odds of becoming developed villages compared to villages with reported crimes, and
- most families having easy access to the police station had 1.570 times higher odds of becoming developed villages compared to villages where most families do not have such access.

3.4 Discussion

3.4.1 Electricity

Electricity is an essential infrastructure that enables people to lead socially and economically productive lives. Access to electricity has been linked to a reduction in malnourished individuals (Sambodo & Novandra, 2019). Electrification helps generate farm income, promote the development of non-farm activities, and increase the availability and accessibility of education and healthcare services (Wirawan & Gultom, 2021). Indeed, ensuring sufficient access to electricity is instrumental in preventing poverty.

There is a significant disparity in the odds of villages with 25 percent or fewer households lacking electricity being classified as developed villages in Maluku and Maluku Utara. Maluku exhibits a factor of 1.721, whereas Maluku Utara shows a substantially higher factor of 3.181. This discrepancy underscores that electricity significantly influences village development progress in Maluku Utara to a greater extent compared to Maluku.

Table 12. Percentage of Villages by the Households' Electricity Access and Number of Industries, 2018

Districts	Households with access to State-owned_electricity					Number of Micro and Small Industries
	≤ 25%	> 25% and ≤ 50%	> 50% and ≤ 75%	> 75%	Total	
8101 Kepulauan Tanimbar	31.6	10.1	6.3	51.9	100.0	408
8102 Maluku Tenggara	32.1	1.1	2.2	64.7	100.0	875
8103 Maluku Tengah	8.7	1.6	2.2	87.5	100.0	4,685
8104 Buru	12.2	3.7	3.7	80.5	100.0	1,101
8105 Kepulauan Aru	95.7	0.9	0.0	3.4	100.0	886
8106 Seram Bagian Barat	9.0	1.1	11.2	78.7	100.0	2,989
8107 Seram Bagian Timur	29.4	1.0	5.2	64.4	100.0	1,491
8108 Maluku Barat Daya	61.1	0.9	4.4	33.6	100.0	1,435
8109 Buru Selatan	41.6	9.1	9.1	40.3	100.0	712
8171 Ambon	0.0	0.0	0.0	100.0	100.0	2,025
8172 Tual	33.3	0.0	0.0	66.7	100.0	313
MALUKU	**33.8**	**2.4**	**4.1**	**59.8**	**100.0**	**16,920**
8201 Halmahera Barat	11.4	1.2	3.6	83.8	100.0	8,293
8202 Halmahera Tengah	18.0	4.9	9.8	67.2	100.0	786
8203 Kepulauan Sula	30.8	2.6	2.6	64.1	100.0	3,916
8204 Halmahera Selatan	47.3	1.7	5.1	46.0	100.0	1,177
8205 Halmahera Utara	13.3	2.0	6.1	78.6	100.0	9,605
8206 Halmahera Timur	21.6	3.9	2.0	72.5	100.0	1,194
8207 Pulau Morotai	13.6	1.1	1.1	84.1	100.0	585
8208 Pulau Taliabu	78.9	2.8	0.0	18.3	100.0	455
8272 Tidore Kepulauan	4.1	0.0	0.0	95.9	100.0	4,405
MALUKU UTARA	**27.1**	**2.1**	**3.9**	**66.9**	**100.0**	**30,416**

Source: Village Potential Statistics 2018

As one of the primary energy sources for both commercial and non-commercial activities that drive economic growth, electricity stands as a decisive factor influencing the competitiveness of the domestic industry in which its distribution plays a vital role in supporting industrial development (Hadi et al., 2021; Kumari & Sharma, 2018). Therefore, as shown in Table 12, the superior electrification in Maluku Utara prompted the more pronounced industrial development, even at the micro and small-scale industry

levels. As the industry sector absorbs the workforce and boosts economic growth, it helps reduce poverty over time. Using the National Socio-economic Survey 2018 in both provinces, this study provides further evidence of the impact of electricity on people's welfare. The Fisher's Exact Test conducted between households without electricity and household poverty status reveals a statistically significant association between these variables (p = 0.000).

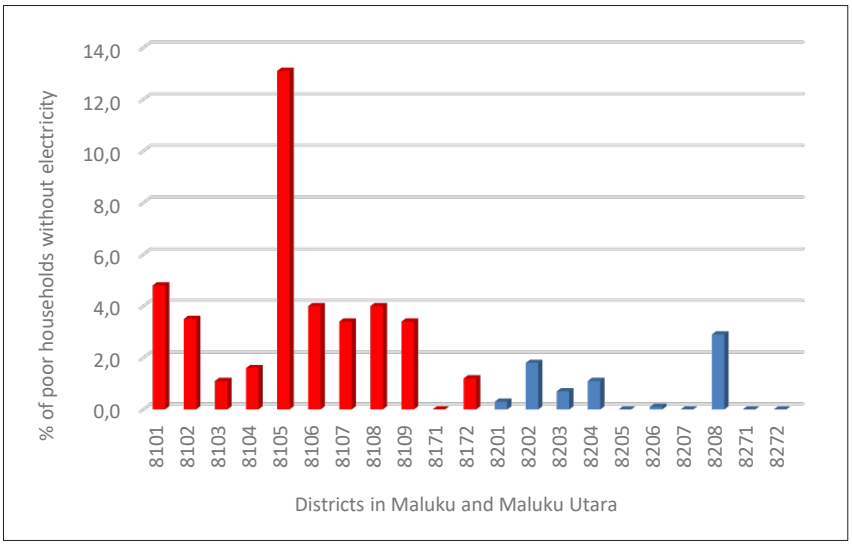

Figure 2. Percentage of poor households without electricity by District in Maluku and Maluku Utara, 2018

Source: Susenas 2018

The discrepancy wherein a greater number of impoverished individuals in Maluku and its districts lack access to electrification compared to Maluku Utara is illustrated in Figure 2. For the sake of clarity in the figure's presentation, Figure 2 and other analogous charts utilize district codes identical to those in Table 12 and subsequent tables. Additionally, further clarification is provided: the code "8271" pertains to Ternate. Ternate is the capital of Maluku Utara Province, and all administrative divisions at the village level are referred to as *kelurahan*, which is not covered in this study.

3.4.2 Toilet

Sanitation plays a significant role in health issues and economic growth, as its availability prevents avoidable issues, including fatalities. It is crucial to adequately grapple with sanitation issues to improve people's well-being and create high-quality living environments within communities. An example highlighting this importance is the toilet revolution in China (Cheng et al., 2018).

Regarding housing defecation facilities, the difference between the odds of villages, where most households have access to the toilet, being classified as developed villages in Maluku and Maluku Utara is minimal. In Maluku, villages with most families using the defecation facilities exhibit 4.276 times higher odds of becoming developed compared to villages where most families lack such facilities. In Maluku Utara, the possibility is 4.683 times. Among the eight independent variables used in this study, "sanitation/toilet" holds the highest odds ratio in Maluku and Maluku Utara. These statistics underscore the importance of proper housing defecation facilities in shaping a village's performance in both provinces.

Table 13. Percentage of Villages by the Majority's Household Defecation Facilities and Population with Health Complaints, 2018

Districts	Housing Defecation Facilities [1]					Percentage of Population Having Health Complaints [2, 3]
	Own Toilet	Shared Toilet	Public Toilet	No Toilet	Total	
8101 Kepulauan Tanimbar	86.1	1.3	11.4	1.3	100.0	20.16
8102 Maluku Tenggara	81.5	1.6	11.4	5.4	100.0	22.59
8103 Maluku Tengah	79.3	3.8	15.2	1.6	100.0	17.27
8104 Buru	69.5	2.4	9.8	18.3	100.0	17.24
8105 Kepulauan Aru	25.6	7.7	41.0	25.6	100.0	17.60
8106 Seram Bagian Barat	62.9	2.2	28.1	6.7	100.0	21.49
8107 Seram Bagian Timur	51.0	4.1	12.9	32.0	100.0	29.71
8108 Maluku Barat Daya	77.0	5.3	13.3	4.4	100.0	23.06
8109 Buru Selatan	35.1	0.0	20.8	44.2	100.0	16.32
8171 Ambon	100.0	0.0	0.0	0.0	100.0	20.69
8172 Tual	85.2	0.0	3.7	11.1	100.0	15.85
MALUKU	**65.7**	**3.2**	**16.7**	**14.4**	**100.0**	**19.99**
8201 Halmahera Barat	72.5	1.8	25.1	0.6	100.0	18.62
8202 Halmahera Tengah	72.1	1.6	19.7	6.6	100.0	26.35
8203 Kepulauan Sula	87.2	1.3	2.6	9.0	100.0	15.33
8204 Halmahera Selatan	56.1	2.1	32.1	9.7	100.0	18.80
8205 Halmahera Utara	53.6	2.6	41.8	2.0	100.0	16.37
8206 Halmahera Timur	58.8	4.9	31.4	4.9	100.0	29.70
8207 Pulau Morotai	64.8	6.8	21.6	6.8	100.0	25.38
8208 Pulau Taliabu	60.6	7.0	5.6	26.8	100.0	30.22
8272 Tidore Kepulauan	89.8	2.0	8.2	0.0	100.0	24.84
MALUKU UTARA	**64.3**	**3.1**	**26.0**	**6.6**	**100.0**	**19.94**

Source: (1) Village Potential Statistics 2018; (2) Statistik Kesejahteraan Rakyat Provinsi Maluku 2018; (3) Provinsi Maluku Utara dalam Angka 2019

The percentage of villages with most households having toilets in Maluku is slightly higher than in Maluku Utara. Conversely, the rate of villages where most families lack toilets is greater in Maluku compared to Maluku Utara. Interestingly, the percentage of the population with health complaints is also identical, despite this seemingly similar level of housing defecation facilities in both areas. This fact should warn the stakeholders to take concrete measures to improve sanitation policies. This is particularly significant considering that one in five people in Maluku and Maluku Utara experienced health issues at this level of housing defecation facilities.

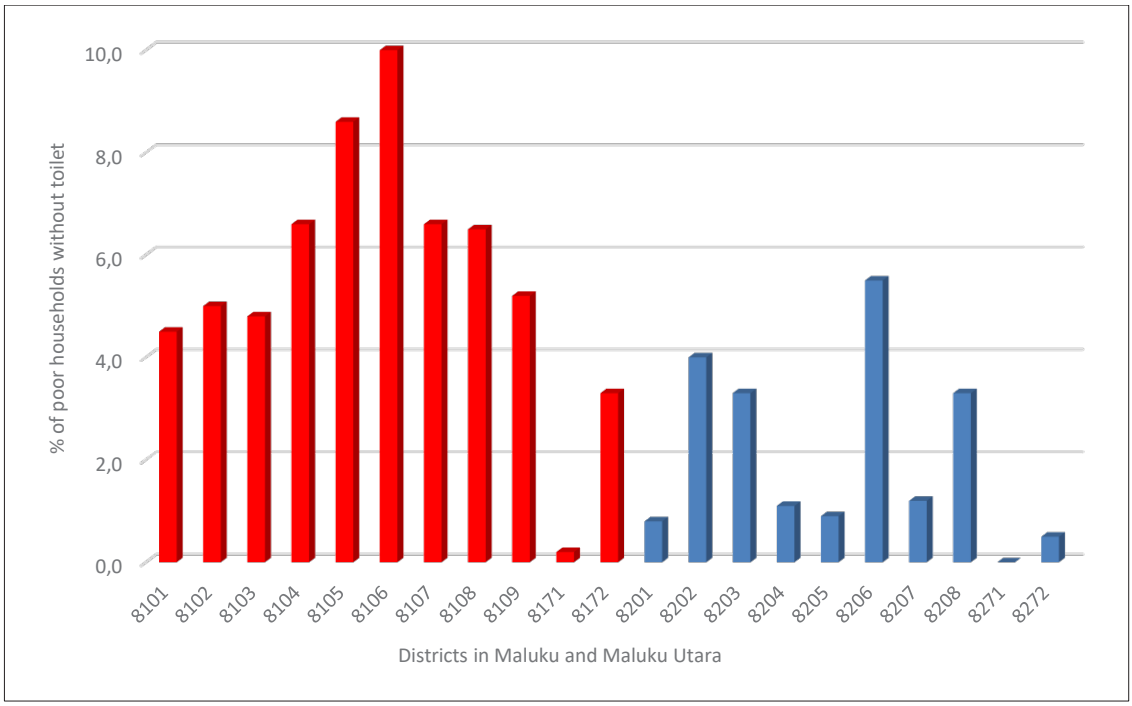

Figure 3. Percentage of poor households without toilets by District in Maluku and Maluku Utara, 2018

Source: Susenas 2018

Figure 3 illustrates a higher number of financially disadvantaged individuals across districts in Maluku who lack housing defecation facilities compared to Maluku Utara. This underscores the imperative for intervention programs in poverty reduction to address this concern effectively. Children growing up in communities with inadequate sanitation are more likely to be deprived and lose the opportunities they deserve for an improved quality of life. Additionally, the detrimental environmental impact of poor sanitation is evident in both the short and long term, including the pollution and adverse health effects resulting from improper disposal and treatment of household wastewater.

Using the National Socio-economic Survey 2018, the Fisher's Exact Test conducted between households without toilet facilities and household poverty status reveals a statistically significant association between these variables (p = 0.000).

3.4.3 Drinking Water

Improving people's welfare is closely tied to the availability of easily accessible clean water. Indonesia's Constitution underscores its significance, emphasizing that government involvement in ensuring access to clean water can effectively contribute to reducing inequality and improving overall welfare (Budiono & Purba, 2022). Moreover, effective management of clean water is essential for improving the well-being of rural communities (Nadeem et al., 2018).

Villages in Maluku where most families use bottled/refilled and tap water as their primary drinking water source have 1.878 times higher odds of becoming developed villages compared to villages where most families lack such access. In Maluku Utara, the odds are 2.100 times. Even though the difference is subtle, these statistics reveal that access to clean drinking water in Maluku Utara has a more considerable effect on village development compared to Maluku.

Table 14. Percentage of Villages by the Household's Drinking Water Source, 2018

Districts	Bottled/Refill and Tap Water[1]	Well/Spring[1]	Others[1]	Percentage of poor people that obtain drinking water by buying[2]
8101 Kepulauan Tanimbar	26.6	70.9	2.5	9.8
8102 Maluku Tenggara	14.1	76.6	9.2	6.3
8103 Maluku Tengah	25.5	70.7	3.8	4.8
8104 Buru	35.4	63.4	1.2	3.4
8105 Kepulauan Aru	0.9	80.3	18.8	0.5
8106 Seram Bagian Barat	2.2	86.5	11.2	17.4
8107 Seram Bagian Timur	3.6	94.3	2.1	0.0
8108 Maluku Barat Daya	8.0	84.1	8.0	7.3
8109 Buru Selatan	15.6	83.1	1.3	1.3
8171 Ambon	26.7	73.3	0.0	1.6
8172 Tual	0.0	96.3	3.7	7.2
MALUKU	**13.8**	**79.9**	**6.3**	**3.6**
8201 Halmahera Barat	28.7	61.7	9.6	3.7
8202 Halmahera Tengah	16.4	73.8	9.8	0.0
8203 Kepulauan Sula	19.2	76.9	3.8	4.0
8204 Halmahera Selatan	30.8	59.9	9.3	0.0
8205 Halmahera Utara	43.9	53.1	3.1	3.1
8206 Halmahera Timur	21.6	63.7	14.7	2.7
8207 Pulau Morotai	47.7	50.0	2.3	5.9
8208 Pulau Taliabu	19.7	67.7	12.7	0.0
8272 Tidore Kepulauan	16.3	73.5	10.2	0.0
MALUKU UTARA	**30.3**	**61.7**	**8.0**	**2.1**

Source: (1) Village Potential Statistics 2018; (2) Susenas 2018

Approximately one-third of the villages in Maluku Utara have the majority of their households accessing bottled/refilled and tap water; while in Maluku, it is less than one-fifth. Once well/spring sources are included, over 90 percent of villages in both provinces have access to relatively clean water for drinking. However, upon closer examination, it becomes evident that some districts in Maluku still have over ten percent of villages where the majority of households lack access to clean water. In addition, Table 14 illustrates that a higher number of impoverished individuals in Maluku need to spend some money to obtain drinking water compared to their counterparts in Maluku Utara. This situation hampers the chances of these poor people improving their economic status. Increased accessibility to clean water would enable them to allocate their income to other essential needs, ultimately facilitating their journey out of poverty.

To some extent, access to clean water has a similar impact on public health as sanitation. Therefore, understanding the accessibility of clean water can be connected to the proportion of the population reporting health complaints, as presented in Table 13. Considering the more favorable progress in achieving clean water access compared to sanitation in relation to public health in both regions in question, stakeholders must effectively allocate more resources towards establishing adequate sanitation facilities. This is especially crucial in districts where over one-fifth of the villages have a majority of households without proper sanitation. At the same time, stakeholders also need to keep improving the quality of clean water that the majority has access to.

3.4.4 Access to Middle School

Higher education attainment increases the likelihood of individuals getting jobs and decent earnings, ultimately contributing to their journey out of poverty (Jones, 2016). More than merely providing accessible education facilities, stakeholders must pay attention to the quality of education because

education inequalities exacerbate the divide among different social groups, ultimately leading to further impoverishment among the less privileged (Bonal, 2016). The poor quality of education in Indonesia can be attributed to four main factors: (1) government spending on education levels; (2) the quality of Indonesian teachers; (3) reward/incentive systems that discourage high-quality teaching; and (4) poor management of public educational institutions (Karim, 2021; Rosser, 2018). Unfortunately, not all those components are easily measured over time. At the village level, the most feasible approach is to measure the accessibility of schools and assess their impact on village performance.

Law No. 20/2003 concerning the Indonesian National Education System, further elaborated by Government Regulation No. 47/2008 concerning the implementation of Compulsory Education, is the basis for implementing the nine-year primary education framework. This framework mandates that children aged 7 to 15 must attend elementary and middle schools, underscoring the essential nature of ensuring accessibility to both institutions. In 2018, villages in Maluku with convenient access to middle school facilities had 2.195 times higher odds of becoming developed villages compared to villages where most families lacked such access. Villages in Maluku Utara had 3.048 times higher odds of becoming developed villages. Again, it is evident that access to middle school education in Maluku Utara has a more significant effect on the village's development status compared to Maluku.

Table 15. Percentage of Villages by Middle School Access and Population Graduated from Middle School, 2018

Districts	Villages with middle school [1]	Villages without middle schools have difficulty accessing the nearest middle school [1]	Aged > 24 y.o who graduated from at least Middle School [2]
8101 Kepulauan Tanimbar	68.4	12.7	30.8
8102 Maluku Tenggara	26.1	23.4	30.3
8103 Maluku Tengah	61.4	10.3	29.1
8104 Buru	62.2	7.3	24.7
8105 Kepulauan Aru	29.9	42.7	22.4
8106 Seram Bagian Barat	56.2	5.6	26.2
8107 Seram Bagian Timur	32.0	20.6	20.8
8108 Maluku Barat Daya	46.9	30.1	21.9
8109 Buru Selatan	63.6	9.1	19.0
8171 Ambon	60.0	0.0	40.7
8172 Tual	66.7	7.4	32.0
MALUKU	**46.9**	**18.4**	**30.2**
8201 Halmahera Barat	42.5	10.2	23.5
8202 Halmahera Tengah	57.4	3.3	25.5
8203 Kepulauan Sula	73.1	6.4	21.3
8204 Halmahera Selatan	56.5	18.6	18.6
8205 Halmahera Utara	42.3	9.7	24.0
8206 Halmahera Timur	48.0	6.9	21.6
8207 Pulau Morotai	53.4	8.0	18.1
8208 Pulau Taliabu	49.3	25.4	16.9
8272 Tidore Kepulauan	53.1	6.1	33.9
MALUKU UTARA	**51.2**	**11.6**	**25.1**

Source: (1) Village Potential Statistics 2018; (2) Susenas 2018

Generally, the percentage of villages with middle school institutions in Maluku Utara is higher than in Maluku, even though the distribution varies across districts. The dispersion of villages with middle schools among districts in Maluku Utara appears to be more evenly spread than in Maluku. Table 15 indicates that the lowest percentage of villages with middle schools in Maluku is 26.1 percent, while in Maluku Utara, it is 42.3 percent. Connecting this information with the fact that Maluku Utara performs better in poverty reduction clearly underscores the significant influence of education on poverty. Furthermore, examining the data for individuals over 24 years old who have graduated from at least the middle school level presents a nuanced picture. Maluku's achievement surpasses that of Maluku Utara,

potentially complicating our understanding of the relationship between education and poverty. To some extent, that information offers a new understanding of education's role in poverty alleviation. While access to formal educational institutions is pivotal, the provision of high-quality education holds even greater importance. Explaining that phenomenon is beyond the coverage of this study and, at the same time, offers an opportunity for further research. However, the main focus of stakeholders in this matter should be on enhancing the quality of education services to mitigate disparities in human resources.

3.4.5 Public Transportation

Public transport is essential for facilitating access to healthcare and education, providing jobs, boosting the rural economies, and counteracting the urbanization process (Šťastná & Vaishar, 2017), which contribute to the improved prospects that disadvantaged individuals, especially the poor, can achieve over time. The development of transportation networks in rural areas brings added value to agricultural products, mitigates spoilage and wastage, motivates farmers, enhances productivity, alters migration patterns, and in due time elevates the quality of life (Olagunju, 2022; Šipuš & Abramović, 2017).

In Maluku, villages with regular public transport routes exhibit 2.080 times higher odds of becoming developed villages compared to villages without such access. The same situation happens in Maluku Utara, even with a larger magnitude. Villages in Maluku Utara that have public transport with regular routes show 3.632 times higher odds of becoming developed villages compared to villages without such connectivity. This fact implies that the presence of public transport has a more significant effect on village development in Maluku Utara than in Maluku.

Compared to Maluku, Maluku Utara has more villages accessible by land and fewer villages accessible via water. This distinction is understandable, considering that Maluku Province has more archipelagos than Maluku Utara (Badan Pusat Statistik, 2019). However, considering the relatively low percentage of villages in Maluku with access via water, despite more than 90 percent of its area being water, it underscores the imperative for robust development of water-related public infrastructure in Maluku. Regarding land roads between villages that cannot be passed by 4-wheeled or larger motorized vehicles throughout the year and villages lacking public transport, Maluku also has a higher percentage of such villages.

Table 16. Percentage of Villages by Type of Transport Traffic, 2018

Districts	Traffic from/to the village by land	Traffic from/to the village via water	Land roads between villages cannot be passed by 4-wheeled or more motorized vehicles throughout the year	No public transport
8101 Kepulauan Tanimbar	49.4	15.2	15.2	36.7
8102 Maluku Tenggara	60.9	9.8	19.6	17.4
8103 Maluku Tengah	82.1	1.6	7.1	15.2
8104 Buru	86.6	2.4	7.3	13.4
8105 Kepulauan Aru	1.7	72.6	21.4	17.1
8106 Seram Bagian Barat	86.5	2.2	12.4	16.9
8107 Seram Bagian Timur	33.0	3.1	32.0	29.9
8108 Maluku Barat Daya	34.5	15.9	25.7	52.2
8109 Buru Selatan	53.2	2.6	29.9	19.5
8171 Ambon	96.7	0.0	0.0	0.0
8172 Tual	29.6	22.2	3.7	44.4
MALUKU	**53.8**	**13.1**	**18.5**	**23.7**
8201 Halmahera Barat	77.2	5.4	12.0	14.4
8202 Halmahera Tengah	65.6	0.0	1.6	27.9
8203 Kepulauan Sula	57.7	10.3	9.0	5.1
8204 Halmahera Selatan	30.0	31.6	22.8	17.3
8205 Halmahera Utara	78.6	5.1	8.2	9.7
8206 Halmahera Timur	79.4	1.0	1.0	21.6
8207 Pulau Morotai	77.3	10.2	1.1	3.4
8208 Pulau Taliabu	39.4	19.7	16.9	59.2
8272 Tidore Kepulauan	79.6	4.1	22.4	12.2
MALUKU UTARA	**62.4**	**12.2**	**11.7**	**17.0**

Source: Village Potential Statistics 2018

Transportation development serves as an intermediary service that contributes to poverty reduction by enhancing the well-being of poor individuals. To some extent, the data pertaining to Maluku's land and water transportation development, which is outperformed by its neighbouring province, addresses the query regarding its elevated poverty levels. It also offers insights to its stakeholders about people's needs for improved public transport services.

3.4.6 Access to Credit

Microcredit helps reduce poverty by mitigating financial exclusion, helping poor people to resist economic shocks and making them out of poverty in the long term (Yu et al., 2020). The provision of credit to rural households has yielded an increase in their aggregate income, consequently leading to a rise in per capita income (Luan & Bauer, 2016). However, it is noteworthy that the impact may depend on people's specific socio-economic background in certain instances (Ganle et al., 2015). In a nutshell, ensuring that poor people have adequate access to financial services is vital because it can potentially offer them better prospects for economic development and poverty alleviation. Incorporating this variable into a village-level analysis would be a good starting point.

The difference between the odds of villages where most families have access to credit facilities is relatively minor when considering the village status in Maluku and Maluku Utara. In Maluku, villages with most families having access to credit facilities had 2.562 times higher odds of becoming developed villages compared to villages where most families lack such access. At the same time, in Maluku Utara, it takes 2.015 times. This observation suggests that the impact of households' credit access on village development is more pronounced in Maluku compared to Maluku Utara.

Table 17. Percentage of Villages by Bank Availability and Accessibility

Districts	Villages with Bank	Villages without Bank and have difficult access
8101 Kepulauan Tanimbar	6.3	58.2
8102 Maluku Tenggara	2.7	56.0
8103 Maluku Tengah	6.0	25.0
8104 Buru	2.4	50.0
8105 Kepulauan Aru	0.9	85.5
8106 Seram Bagian Barat	5.6	55.1
8107 Seram Bagian Timur	2.1	74.2
8108 Maluku Barat Daya	2.7	84.1
8109 Buru Selatan	2.6	80.5
8171 Ambon	16.7	0.0
8172 Tual	3.7	63.0
MALUKU	**3.7**	**59.8**
8201 Halmahera Barat	3.6	34.1
8202 Halmahera Tengah	8.2	49.2
8203 Kepulauan Sula	5.1	67.9
8204 Halmahera Selatan	3.0	66.2
8205 Halmahera Utara	2.0	35.2
8206 Halmahera Timur	3.9	49.0
8207 Pulau Morotai	4.5	56.8
8208 Pulau Taliabu	7.0	78.9
8272 Tidore Kepulauan	4.1	28.6
MALUKU UTARA	**3.9**	**51.1**

Source: Village Potential Statistics 2018

Table 17 presents a seemingly contradictory portrayal compared to the outcomes derived from the logistic regression analysis. Despite being only a slight difference, the percentage of villages in Maluku with banks is lower than that in Maluku Utara. Similarly, the proportion of villages lacking banks or facing challenges in accessing banking services is higher in Maluku compared to Maluku Utara. These statistics collectively underscore the more accessible nature of banking services in Maluku Utara. In contrast, the logistic regression results imply a distinct pattern where access to credit facilities significantly affects the village development status in Maluku more than in Maluku Utara. This discrepancy raises the question: could the limited access to banking services in Maluku contribute to this disparity? The answer lies beyond this study's objectives and opens a new topic for future research. Nevertheless, the lower presence of banks in Maluku could signify reduced funding accessibility. This could potentially explain why household credit access has a more pronounced influence on village development in Maluku. Regarding poverty reduction, restricted access to banking services might impede individuals' efforts to achieve economic autonomy, consequently affecting their overall quality of life. This finding could be a reference for the local government to broaden and enhance the accessibility of banking services. Such efforts could play a pivotal role in advancing household and micro-entrepreneurial economy.

3.4.7 Crime

Some economists place criminal activity in the formal labor market as a substitute for employment (Sharkey et al., 2016). This view sees illegal activity as an alternative, if not supplementary, source of income when individuals struggle to secure work or fair wages. Consequently, crime becomes one of the central roles in poverty (Gaitán-Rossi & Guadarrama, 2021). On one hand, poor people are vulnerable to engaging in criminal activities (Sugiharti et al., 2023). On the other hand, poor people are also at risk of being victims of crime (Webster & Kingston, 2014). To this point, the ambiguous relationship between crime and people's welfare status necessitates cautious analysis, given that it can exhibit variations across regions, communities, and time periods. However, understanding its importance in any specific context is essential. By knowing that, stakeholders may have influential information for effectively reducing poverty.

Among the independent variables employed in this study, crime stands out due to the unique direction of its influence on the dependent variable. In the context of this study, the variable "crime" signifies that villages in Maluku with no reported crimes during the past year had 0.594 times higher odds of becoming developed villages compared to villages with reported crimes. Similarly, in Maluku Utara, villages without any crimes during the past year had 0.675 times higher odds of becoming developed villages than those with reported crimes. In the context of logistic regression analysis, coefficients that are exponentiated and fall below 1.0 represent negative relationships. Therefore, the absence of crimes in villages in Maluku and Maluku Utara contributes to reduced odds of achieving developed village status.

By referring to the data in this study alone, one might align with the perspective that crime and village development progress share a linear relationship, a viewpoint supported by several previous studies. A developing village is an attractive and promising market, attracting individuals from diverse backgrounds, albeit accompanied by an increase in criminal activities. However, this finding needs more elaboration and data for a conclusive assessment, considering that the crime-related variable employed in this study is limited to the presence of crime. This study also conducts the Fisher's Exact Test to examine the correlation between people who experienced crimes and their monetary poverty status, using data from the National Socio-economic Survey. The outcome of this analysis demonstrates a statistically significant association between these variables, with a p-value of less than 0.05.

3.4.8 Access to Police Station

To some extent, crimes are intertwined with police accessibility. For effective community-level management, proper security is essential. Considering that police services access is scarce in welfare-related research, even at the village level, this study put that into the analysis. It is essential to understand that the presence of police stations may not accurately correlate with their impact on poverty. For example, there are police stations that do not operate 24 hours and seven days a week, due to various

reasons. Also, access to the police station depends on the willingness and ability of villagers to travel to that location (Stassen & Ceccato, 2021).

Villages in Maluku with convenient access to a police station— whether located within or outside the villages, as long as they are easily reachable—had 2.217 times higher odds of achieving developed status compared to villages without such access. In Maluku Utara, villages with easy access to a police station demonstrate 1.570 times higher odds of becoming developed compared to villages without easy access. This data implies that the impact of accessible police stations on village development status is more pronounced in Maluku compared to Maluku Utara.

Easy access to police stations indicates a high level of progress in village development. On the other hand, data concerning the efficacy of police services, including the responsiveness of officers, was limited, rendering the use this variable in this study preliminary. Nevertheless, to this point, it is evident that for a developing village to mitigate the repercussions of crimes, robust security is imperative to safeguard the social and economic well-being of its residents.

Conclusions

The variables used in this study exerted a notable influence on the probability of a village being categorized as developed in Maluku and Maluku Utara. They supported the existing idea that infrastructure plays a significant role in developing villages and enhancing people's welfare, aligning with the government's integral effort to alleviate poverty. The possession of defecation facilities (toilets) by households in both provinces has the most considerable likelihood and a significant correlation with a village being categorized as developed. However, the effects of the remaining variables exhibited variability.

Regarding electrification, housing defecation facilities, drinking water, access to middle school, public transportation, and crime rates, Maluku Utara's performance is better than Maluku, as evidenced by its more pronounced and significant impact on village development. On the other hand, regarding access to credit and police stations, the likelihood of a village being classified as developed in Maluku is more significant than in Maluku Utara.

The result of this study cannot be separated from the fact that Maluku Utara ranks among the top-performing provinces in Indonesia with regard to its low poverty rate. Therefore, knowing that developed villages in Maluku Utara are strongly influenced by toilet ownership, improved accessibility of public transport, higher electrification rates, and convenient access to middle schools serves as a valuable lesson for its neighboring province, Maluku. Enhanced electrification leads to an improved quality of life, better educational outcomes, and effective public service delivery. In addition, the more significant influence of housing defecation facilities and access to clean drinking water, closely related to healthcare, alongside well-functioning village-level public transportation, correlates with more substantial reductions in poverty and advancements in development, mirroring the achievements seen in Maluku Utara.

An interesting topic for further investigation lies in understanding the substantial influence of crime on village development in both regions, despite its relatively lesser impact compared to other variables. Exploring this avenue of research necessitates more refined and comprehensive crime-related data than what is provided by this study. Nevertheless, it remains evident that criminal activities contribute to the advancement of village development.

As it provides the situations of infrastructure at the village level, the result of this study could also be a valuable reference for the assessment and evaluation of the effectiveness of *Dana Desa* program. This utilization aims to ensure that the program brings its optimal benefit in improving people's welfare.

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Research Paper

Risk Perception in Facing Post-Disaster of 'Rob' Flood in North Jakarta Coastal Using Social Network Approach

Heni Marta Diana Matita Putti[1*], Osmar Shalih[2], Andri N.R. Mardiah[3], Fransyudha Abandhika[4]

Amcolabora Institute, Depok, Indonesia[1]
National Board for Disaster Management (BNPB), Jakarta, Indonesia[2]
National Development Planning Agency (Bappenas), Jakarta, Indonesia[3]
Amcolabora Institute, Depok, Indonesia[4]

***) Corresponding author**: heni.marta@amcolabora.or.id*

Abstract

In recent times, most global disaster studies have primarily focused on protecting vulnerable groups with characteristics that pose a high risk of threat. In this study, we aim to further this research by utilizing social network analysis to study vulnerable groups in Rob Flood. Data were gathered from primary surveys (observations and in-depth interviews) and secondary sources (Internet and digital documentation) and then analyzed by field notes and content analysis using Nvivo 12+ Application. The findings demonstrated that despite being at risk of tidal flooding, they were comfortable remaining in their homes due to the ample support they received during disaster response, recovery, and adaptation. As a result, many of them were not concerned and disregarded potential future risks from the effects of tidal floods. These findings are significant for decision-makers in developing disaster risk reduction policies and strategies.

Keywords: Rob flood; Risk Perception; Social Network; Social Capital; Resilience Community

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Fax: +62 21 31928281
E-mail: journal.pusbindiklatren@bappenas.go.id

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1. Introduction

Many studies suggest that climate change will have destructive consequences, such as rising temperatures, sea level increases, and changes in rainfall patterns (Byers et al., 2018). Since 2012, the Intergovernmental Panel on Climate Change (IPCC) has warned that extreme weather events and their associated hazards are one of the most pressing threats facing the world, with the potential to cause significant harm in the coming decades (IPCC, 2012). In early 2020, Jakarta received heavy rainfall. According to the Meteorology, Climatology and Geophysics Agency (BMKG), this rainfall broke a new record for the highest amount since rainfall data was first recorded in Jakarta since 1866. While some news outlets at the time speculated about the link between this heavy rainfall and climate change, it is important to note that objective evaluation of this link requires further data. Many now expect an increase in flooding events in Jakarta in the future. Moreover, Jakarta is one of the cities in the Southeast Asia region that is considered very vulnerable to the impacts of climate change (Lechner et al., 2020; Matthews et al., 2017; Mora et al., 2017).

Rob Flood is a consequence of climate change. Sea level rise resulting from extreme weather events has led to the flooding of community settlements, particularly those inhabited by people. According to a study by Climate Central (2019), an estimated 300 million people around the world will be impacted by floods caused by rising sea levels within the next thirty years. The study revealed that Indonesia and five other Asian countries would face the greatest impact due to their coastal location and large population residing in these areas. North Jakarta in DKI Jakarta is the most vulnerable area to Rob floods due to its proximity to the sea. Meanwhile, global warming and ongoing coastal land subsidence in Jakarta can lead to an elevation in sea level rise, carrying the possibility of flooding in the North Jakarta coastline. Jakarta's flood risk is projected to rise even further in the future, given the cumulative impact of urban expansion, land subsidence, sea level rise, and climate change-related precipitation shifts (Budiyono et al., 2016; Hallegatte et al., 2013; Rahmawati Hizbaron et al., 2017). The 2007 Rob flood incident, which affected 70% of Jakarta, was the worst in history, with North Jakarta bearing the brunt of the damage. This catastrophic event had severe consequences for the coastal communities, with many residents having to evacuate and abstain from daily activities, including school and work. As documented by VICE News, some residents were traumatized by the Rob flood (VICE, 2018). The centrality of coastal areas for community activities, including trade, transportation, settlements, and industrial sector development, results in considerable losses and damages. In recent times, the government and community have implemented measures to reduce the risk of flooding. The government has constructed seafront barriers to inhibit the overflow of seawater onto the mainland. The construction of the North Jakarta wall began in 2016 and it stands at a height of 3.8 meters. The building of the Giant Seawall (GSW) is expected to prevent flooding. But the reality is that the barrier's structure only prevents seawater from entering the temporary apartment until sea levels rise again due to global warming and land subsidence. In addition to its high cost, Apart from being expensive, GSW is expected to have various negative impacts on biodiversity and ecosystem services (Kawata, 2022). In addition, Heri Andreas, the Head of the Geodesy Laboratory at ITB, analogized the barrier to painkillers because the wall being constructed collapsed due to land subsidence, while the sea level continued to rise.

The Rob flood in North Jakarta has had a significant impact on the physical, economic, and social conditions of the affected population. The disaster has the potential to directly influence the resilience of the region, which can result from various forms of endogenous tensions or exogenous pressures. The importance of affirmative policy from multiple levels of government, assistance disbursement, financial access partnership and community participation, and local culture and networks in facilitating the economic recovery process following a disaster (Mardiah & Lovett, 2021). In the case of the Rob flood, the pressure is an exogenous force originating from outside the system (Asrofi et al., 2017). Resilience is a necessary attribute of any community. Community resilience stems from its ability to adjust to external pressures. Multiple investigations have indicated that social networks, social capital, and cohesion are the key elements to boost community resilience (Aldrich, 2012; Aldrich & Meyer, 2015; Cai, 2017). Particularly significant is the robustness of social networks as they allow communities to rapidly mobilize and utilize resources both during and after a catastrophe, based on their capacity to adjust to the situation. Most studies have primarily focused on protecting vulnerable groups who are at high risk of harm during a disaster. However, there has been little examination of vulnerability based on social capital dimensions in the aftermath of a disaster, which has a close relationship with the basic needs that arise.

The objective of this research is to investigate the community's risks perception associated with post-tidal flood disasters. By utilizing social networks, this study aims to comprehend how social networks can impact individuals' choices of whether to stay or move. Various factors may influence an individual's decision-making process (Babanawo et al., 2023; Costas et al., 2015). However, this study strives to examine solely how social networks might influence people's perceived risk, ultimately affecting their decisions. Risk perception is a critical component of disaster risk management and plays a key role in determining the success of vulnerability reduction efforts (Bubeck et al., 2012). However, through communication exchanges, these perceptions eventually converge toward similarity over time. Trust is a crucial component of social networks, where individuals place their trust in others as a binding factor. The correlation between trust and risk perception is a significant topic of debate in risk perception research. Ge et al., (2021) study, surveyed participants in four European countries (Sweden, Spain, UK, and France) in 1996 to examine the relationship between trust and perceived risk, concluding that trust is a reliable predictor of perceived risk. Still, the strength of the correlation ranged from weak to moderate across different countries. According to Lechowska, (2018), factors that intervene and mediate the influence of personal experiences on risk perceptions of floods include time elapsed since the last disaster and level of trust in flood protection facilities. Factors such as communication, media networks, personal interactions, indirect experiences, and social capital can alter the effect of knowledge on risk levels.

Common aspects of social support relevant to research on disasters include exchange, reciprocity, and help-seeking (specifically informational, emotional, and tangible/material support), as well as the types of support and the individuals who provide consent (such as family members, friends, and neighbors). Disasters are closely associated with overwhelming feelings of distress. However, it is also noted that shared adversity inspires those impacted to become active and support one another. Social capital refers to the characteristics of a group, such as social networks, trust, mutual understanding, shared values, and behaviors that bind the members, while facilitating coordination and cooperation toward achieving specific goals (Jovita et al., 2019). Social capital in society is divided into three types: social capital bonding, social capital bridging, and social capital linking. Social capital bonding is typically demonstrated through the values, cultures, perceptions, and traditions or customs present within a community. The strength of an interpersonal tie can be defined as a linear combination of the amount of time, emotional intensity, closeness (mutual confiding), and reciprocal services that characterize the tie (Krämer et al., 2021).

Network analyses of disasters aim to address the patterns of relationships that either facilitate or hinder the ability of individuals, groups, or organizations to prepare for, manage, adapt to, resist, or recover from hazards, risks, and disasters (Jones & Faas, 2016). Woodcraft, (2015) reports that residents residing in social or affordable housing exhibit higher rates of neighborly conduct when compared to private residents. They have a greater propensity to communicate regularly with other neighbors, possess local support networks that cater to everyone, and believe that the community can be trusted. This phenomenon reflects the possibility of previous residents returning. Ultimately, neighborhoods with higher levels of social capital can effectively communicate and engage with authorities. Social Network Analysis (SNA) is a technique that maps and measures relationships and communications between individuals and non-human elements involved in information processing (Ujwary-Gil, 2020). SNA can be utilized to build disaster resilience within communities throughout the different stages of the disaster cycle. The implementation of SNAs possesses the capability to fundamentally transform the performance of organizations and societies at large regarding both preparation for and response to particular catastrophic events (Duchek, 2020; Kim & Hastak, 2018).

2. Methods

2.1 Study Design

This qualitative study employs in-depth interviews and secondary data collection methods to investigate the vulnerability of populations residing in tidal flood-prone areas at risk of losing their homes due to potential sea level rise and land subsidence leading to Jakarta's sinking. The research focuses on risk perception and is founded on the assumption that such changes will occur in Jakarta by 2050, as determined by existing studies.

2.2 Participant

The researcher utilized purposive sampling to conduct in-depth interviews with key respondents. The two groups consisted of 32 key respondents categorized as follows: 1) The community in RW 22, comprising 30 individuals who have resided in Pluit for a minimum of five years, and 2) the community leaders which included the Head of RW 22 and the Head of Section for Community Development and Empowerment, selected for their understanding of the community's conditions in RW 22.

2.3 Data Collection and Data Analysis

Data collection took place between June and July 2022. All informants were included in the sample. Each interview with the 32 informants lasted between 30 and 50 minutes. Data collected from informants was recorded during interviews, while interview information was recorded using a mobile phone after obtaining approval. To organize and make sense of the data collected and generate realistic conclusions, text data analysis utilizes field notes (which may prove beneficial in later studies) and content analysis (Bengtsson, 2016; Phillippi & Lauderdale, 2018). For this study, content analysis was conducted through the utilization of Nvivo 12+, a software application designed to facilitate the creation, maintenance, and control of qualitative data analysis projects. The data results and field notes, recorded as text or stories/events, are are processed using Nvivo 12+. Technical terms are defined upon first use. Each specific word or sentence is coded by researchers in a construct representing the attributes and interpretations of data for pattern detection, categorization, and theory development. In this case, the researcher categorized the words and sentences from interviews into three codes: Disaster Response, Recovery, and Adaptation. The purpose was to study the interrelationships between the actors involved in each process. The resulting relationships were analyzed to determine their impact on people's risk perception in RW 22. The researcher formulated several main questions for data collection. The primary inquiries directed toward activity participants pertain to their risk perception while handling post-disaster floods caused by Rob. These include: 1) Who are the typical parties aiding residents in constructing Rob flood? 2) How frequently do you receive support from these parties? 3) What sort of assistance is typically provided? The data collected aim to gauge public perception of the dangers posed by Rob flood disasters. For triangulation, we conducted a joint analysis by collecting and reviewing all data with previous informants. In this paper, we report the results descriptively.

3. Results and Discussions

The results can be classified into three categories: 1) The role of social networks in disaster response, recovery, and adaptation; 2) Risk perception when facing the Rob flood. Before examining the core findings, it is important to comprehend the Rob flood incident at the research site to acknowledge the disaster as it is perceived by the public.

3.1 Case of *Rob* flood in RW 22

Rob Floods occur annually on the North Jakarta coast, including in RW 22 Pluit Village, which is divided into four areas: Blok Empang, Tembok Bolong, Eceng, and Kampung Kerang Ijo. The mention of RW 22 first surfaced in 2011 when the area was still a swamp. Many residents constructed floating homes; over time, the community performed backfilling to improve road access. Until now, the region has seen the development of permanent residences, and the former swamp has been transformed into a plain and a designated location. However, despite the change in land use, the area surrounding RW 22 remains vulnerable to flooding caused by Rob. The coastal location makes it susceptible to annual floods, given its previous use as a swamp. Moreover, this area ranks among the locations with notable land subsidence in North Jakarta (Ramadhanis & Prasetyo, 2017).

3.2 Social Network in Disaster Response, Recovery and Adaptation

Risk perception in this study was evaluated through the use of social networks. In this instance, the social network is viewed across several phases following a disaster, including disaster response, recovery, and adaptation. The data collected in the field was coded using Nvivo with grouping codes across three phases to identify actors with relationships. The form of the relationship was also noted to better understand how social networks can impact risk perception and influence people's decisions to stay or move.

3.2.1 Social Network in Rob Flood Response

The flow of water from the sea to RW 22 in Pluit Village at times lasts for an extended period while at others for short periods, posing risks to the residents of RW 22. When the flow of water is high-speed, some inhabitants require additional time to transport their electronics and avoid submersion in the Rob flood waters. Consequently, residents may incur losses due to damaged electronics. During the RW 22 disaster in Pluit Village, the social network manifested as neighbors assisting in the transportation of belongings to safety. Avoiding subjective evaluations, the text provides a clear, concise, and necessary explanation in simple terms, using common sentence structure and consistent technical terms. Neighbors without electronic devices or residing in single-story homes would readily aid those with electronic equipment that required transportation to avoid damage. This supportive behavior is observed in individuals who regularly engage in friendly activities, such as gathering during the day to talk, to develop a sense of community and mutual support. The process of social interaction, in which individuals seek information and share resources, builds trust within social networks. Simultaneously, trust is incorporated into social networks, contributing to their development (Gong et al., 2020).

Figure 1. Documentation of residents gathering with neighbors

Source: Authors' Documentations

Meanwhile, 4 out of 30 families who seldom socialize with neighbors need to evacuate. Some of those households cannot anticipate assistance from neighbors, thus they receive aid from families residing in distinct neighborhoods or transporting their belongings to a secure location. This symbiotic relationship between neighbors and the environment engenders greater reluctance to relocate. Some individuals reported returning to their hometowns but subsequently returned to RW 22 due to its social comfort. Additional informants corroborated this by confirming that individuals who had previously left to return home ended up coming back to the community.

In addition, temporary mutual assistance is provided among neighbors in case of house evacuation needs. When the Rob flood occurs at night, evacuated residents are offered help by families with two-story houses that can accommodate up to ten neighbors. However, some households might refuse to evacuate due to discomfort in asking their neighbors for help and may only evacuate themselves with their children if necessary. This phenomenon occurs among individuals who seldom cross paths on the stairs, but families with adjacent homes will still offer aid due to camaraderie. Such neighborly assistance falls under the category of bonding. As previously defined, bonding social capital pertains to relationships with individuals who share certain demographic features, such as familial ties and kinship.

3.2.2 Social Network in Rob Flood Recovery

The impact of the Rob flood is evident in lots of debris both inside and outside the affected homes. During the recovery phase, neighborhoods around the world work together to clean up the waste left by the flood. External aid during this phase typically comes from community organizations, private institutions, and government agencies. However, assistance may not always arrive immediately following a Rob flood, with aid often being proportional to the severity and duration of the flood. Assistance from the government typically takes the form of temporary refugee tents provided by BPBD to prepare for severe Rob floods predicted by the BMKG. Assistance from the government typically takes the form of temporary refugee tents provided by BPBD to prepare for severe Rob floods predicted by the BMKG. This government initiative aims to proactively offer assistance before any adverse event occurs. Additionally, residents affected by the Rob flood, usually from the village, will receive aid in the form of necessary supplies and other essentials. Help from non-formal institutions or communities typically targets families in fishing communities where the breadwinners work in the fishing industry. Conversely, families with a trading background often seek assistance from the Poor community.

Linking social capital is integrally linked to vertical connections of power, whereas bonding social capital is made up of horizontal links. The strength and scope of people's interpersonal relationships have a significant impact on how much bonding capital exists in a society. Therefore, interactions between community members are the only place where bonding social capital may occur (Rubin, 2016). Meanwhile, Bridging social capital networks are looser and weaker networks that frequently include individuals from multiple networks as well as individuals with diverse origins and cultural, social, and economic resources that bring together people from other networks and people with different qualities, making them more inclusive (Vannebo & Ljunggren, 2021). Based on that, the social network serves as a source of support from formal institutions, which represents a link in social capital. In contrast, the connections between citizens and non-formal institutions create a bridge in social capital.

3.2.3 Social Network in Rob Flood Adaptation

Several adaptations to protect against flooding were made to the house of Rob Flood by residents of RW 22. These include raising the floor to prevent tidal water from entering, building a balek or bed with high legs to keep the mattress above water during a flood, and installing a high table to keep electronic items safe. The adaptations were carried out either by Rob Flood individually or by each family.

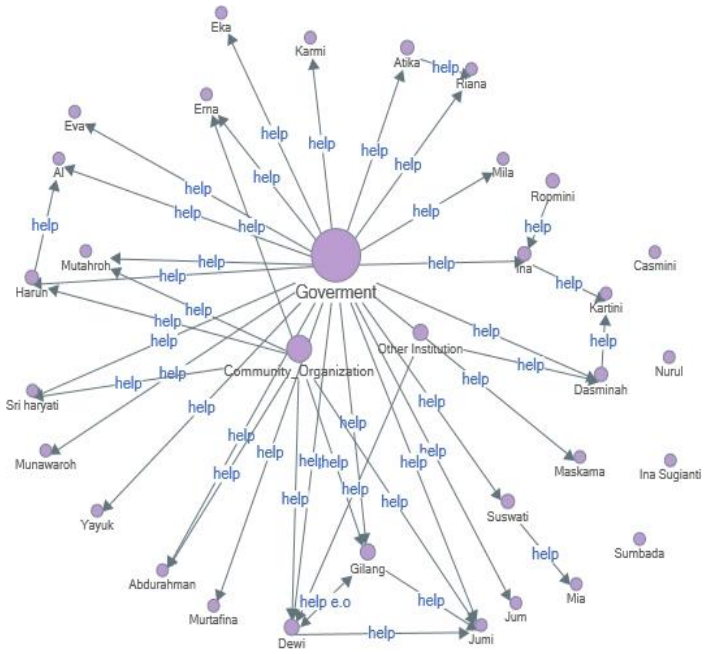

Figure 2. Network Sociogram in Rob Flood Adaptation

Source: Author's analysis using Nvivo 12+

The above figure illustrates the RW 22 community's interconnectedness. The edges represent relationships and the arrows denote the direction, showing "who helps whom." Mutual help interactions occur among those living nearby. Knots without edges represent families that have never received help, such as Casmini, Nurul, Ina Sugianti, and Sumbada. Nurul and Sumbada originate from a similar environment. According to the interview results, their surroundings have seldom received external assistance, and aiding their neighbors is also rare due to shared circumstances. Simultaneously, Ina Sugianti and Casmina hail from distinct environments, yet still receive assistance from their immediate neighbors. Gillang, Dewi, and Jumi are examples of informants originating from a common background. Gilang and Dewi have a reciprocal aid relationship during the disaster response phase. Dewi's house has a sufficiently elevated floor, allowing Gilang and Jumi to temporarily seek shelter at Dewi's place when high tidal floods occur at night. If the flooding persists during the day, Gilang assisted Dewi in moving the refrigerator, which is used to sell beverages in front of the house, to a higher location to prevent it from being submerged in tidal floodwater. In addition to the disaster response phase, they also participate in disaster adaptation efforts by cleaning up the remaining debris after the tidal flood recedes.

Table 1. Sociogram Centrality Measures processed by Nvivo 12+

Case	Degree	Degree In	Degree Out	Betweenness
Government	**23**	**0**	**23**	**672.327**
Community_Organization	**8**	**0**	**8**	**28.333**
Other Institution	**2**	**0**	**2**	**2.007**
Dewi	5	4	2	33.797
Gilang	4	3	2	4.458
Jumi	4	4	0	4.458
Dasminah	3	2	1	47.392
Ina	3	2	1	77.608
Harun	3	2	1	6.458
Suswati	2	1	1	54.000
Abdurahman	2	2	0	4.458
Al	2	2	0	0.000
Erna	2	2	0	4.458

Table 1 (cont.)

Case	Degree	Degree In	Degree Out	Betweenness
Mutahroh	2	2	0	4.458
Sri haryati	2	2	0	4.458
Atika	2	1	1	0.000
Riana	2	2	0	0.000
Murtafina	1	1	0	0.000
Eka	1	1	0	0.000
Eva	1	1	0	0.000
Karmi	1	1	0	0.000
Jum	1	1	0	0.000
Maskama	1	1	0	0.000
Munawaroh	1	1	0	0.000
Mila	1	1	0	0.000
Yayuk	1	1	0	0.000
Kartini	2	2	0	3.333
Ropmini	1	0	1	0.000
Mia	1	1	0	0.000
Casmini	0	0	0	0.000
Ina Sugianti	0	0	0	0.000
Nurul	0	0	0	0.000
Sumbada	0	0	0	0.000

Source: Authors' analysis

The table above presents the Sociogram Centrality Measures processed through Nvivo 12+. The Betweenness measure indicates the number of times a vertex lies on the shortest path between two other vertices. This provides insight into which cases serve as communication paths between different issues, which can aid in determining the points where the network would break apart. In this case, the Betweenness measure indicates how frequently a person or organization assists or is assisted during disaster response, recovery, and adaptation. In this case, betweenness is demonstrated by how frequently a person or organization provides or receives aid during disaster response, recovery, and adaptation. To evaluate the value, we have divided it into two categories: relief organizations and the community. When we examine the aid providers, the government's betweenness value is significant. This indicates that government aid is distributed almost equally among all recipients.

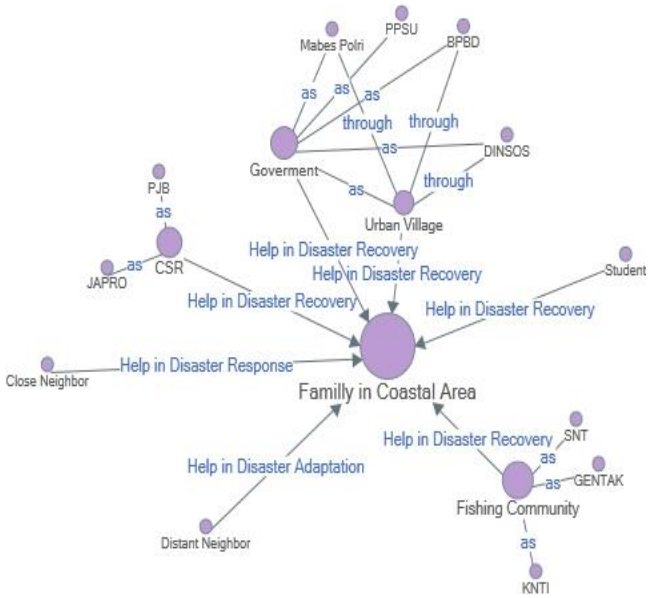

Figure 3. Network Sociogram in All Phases (Disaster Response, Recovery, and Adaptation)

Source: Author's analysis using Nvivo 12+

The analysis in Figure 3 utilized the Network Sociogram feature in Nvivo 12+ and employed the "Help" relationship type in a generalized manner to demonstrate relationship patterns. The analysis reveals that aid was provided during all phases of the disaster. Service during the disaster recovery phase involves numerous support actors, including the Regional Disaster Management Agency (BPBD), the Department of Social Services (DINSOS), the Public Infrastructure and Facilities Handling Officer (PPSU) as government agencies, the Kali Adem Traditional Fishermen Movement (GENTAK), Indonesian Traditional Fishermen Union (KNTI), Traditional Fishermen Union (SNT) as community and CSR, and students. Assistance during the disaster adaptation phase is received from the nearby RW 22 area, which is more significant than that of immediate neighbors. They assist one another provided they have sufficient funds for road backfill dues and drainage construction. A social network is formed during the disaster response phase where financial aid is provided by neighbors who reside closer to the affected homes as tidal floods arrive quicker and immediate assistance is needed.

Table 2. Social Capital in Facing Rob Flood

Form of Social Modal	Actor of Social Support	Form of Society	Type of Ties
Linking	BPBD, Police Headquarters, Social Service Volunteer, Sub-district functionary	Disaster Recovery: Food Aid and Refugee Places	Weak
Bonding	Close Neighbor and Distant Neighbor	• Disaster Response: Help move things when the flood comes fast and the tradition of *gotong royong* (Mutual assistance) to clean up trash after the tidal flood • Disaster Adaptation: Help in backfilling the roads and construction of drainage	Strong
Bridging	Non-formal institutions and fishing communities	Disaster Recovery: Food aid and money donation	Weak

Source: Authors' analysis

The social capital relationship description in RW 22 concludes with the table presented above. This paper examines the types of ties based on the presence of relationships across three phases (response, recovery, and adaptation). Weak ties are present in only one phase, strong ties in two phases, and very strong ties in all three phases. The connections established in RW 22 may need to be strengthened as the government, acting as a source of social support, only assists the community during the disaster recovery phase. Despite the strong bond between the two during the adaptation phase, field data suggests that government aid is only given during the recovery stage, resulting in an overall weak relationship. If disaster victims are unable to independently cope with their difficulties, they typically rely on their social network for assistance. Formal service providers are usually only considered as a last resort. Furthermore, a tradition of gotong royong exists within the community, which involves cleaning up the garbage left by tidal floods to aid in recovery efforts. This bonding can be categorized as strong because it often occurs in multiple phases, such as during disaster response and disaster adaptation. Additionally, the word cloud image results further support the robustness of this bond.

Figure 4. Word Cloud Based on NVivo 12+ Analysis of Coded Nodes

Source: Authors' analysis

The term 'neighbor' is frequently cited by informants regarding who provided aid during flooding. Furthermore, bridging ties form through non-formal institutions and communities, strengthening assistance in times of severe floods."

3.3 Risk Perception in Facing *Rob* Flood

Disaster is the convergence of a threat (hazard) and vulnerability, signifying that the threat need not necessarily manifest if vulnerable elements are absent. When regarding flooding, irrespective of the inundation's height, if the water resides on a suitable plain (such as a swamp), it would not qualify as a disaster since inundation is a natural occurrence in such an area. Problems arise only when the water recedes or dries up, causing the plains to be appropriated and repurposed for human activities such as settlements. This occurred with regards to RW 22, which had previously been a swamp area, about a decade ago (at the time of this writing). Many residents initially constructed floating houses before converting them to non-floating structures. Their choice to remain in the area was not due to ignorance of the risk of flooding from the Rob River but was influenced by several factors, including an inability to secure land for construction through the 'first come, first served' system, low rent rates, and proximity to their means of livelihood. Most of the participants were unaware of any research indicating that the northern region would sink due to land subsidence and rising sea levels. This lack of knowledge is likely due to their low educational background and limited access to information.

Flood risks present a significant and increasing danger to the health and well-being of individuals residing in urban and rural areas worldwide (Fox Gotham et al., 2017). However, they differ from the Rob Flood in RW 22, as the residents of RW 22 are accustomed to and opt to reside alongside the floods, despite knowing that the area will eventually submerge.

Figure 5. Word Cloud for 'reasons to stay' based on NVivo 12+ Analysis of Coded Nodes

Source: Authors' analysis

The term 'comfortable' is consistently mentioned by each informant concerning their work. Here, comfort refers to the overall environment. One informant reported attempting to relocate to their hometown but quickly returned to reside in RW 22 due to feeling more comfortable there. This supports the assertions of multiple other interviewees who reported feeling more lonely due to a lack of social interaction and activities in their hometown. They feel more comfortable socializing with their neighbors in their current residence due to its proximity. Moreover, this is further facilitated by the numerous cooperative activities among neighbors as previously described. However, their responses and behaviors during the robbery contradicted their self-perception as weak victims. Remove subjective evaluations unless marked as such.

In conclusion, the residents of this flood-prone area acknowledge the risk associated with Rob Flood and place-based memory, recognizing that their location is vulnerable to inundation. They draw comfort from their community's shared experiences, as well as assistance from external parties during severe flooding caused by Rob Flood. Although they are aware of the potential sinking of Jakarta in the future, it is not their primary concern. This is a common occurrence in flood-prone regions, as shown by the residents' focus on seeking logistical aid instead of dwelling in their flooded houses In most severe cases, some communities have expressed dissatisfaction over the delay in receiving logistical assistance rather than the actual extent of damage caused by flooding or loss of property (Akuntono, 2013; Simarmata, 2018). This indicates that risk perception is closely linked to disaster preparedness and place attachment (Putti et al., 2022). In the context of post-disaster recovery efforts, the function of social capital at the community level is highly significant. To reduce future disaster risk, efforts should focus on disaster mitigation and adaptation that are well-suited to local factors. Social networks, social trust, and systems all contribute to enhanced resilience and disaster risk reduction (Shalih et al., 2020). There is proof that values and norms, trust, networks, knowledge-sharing, and commitment that naturally developed in society have affected improved public awareness, social solidarity, and community understanding of the post-disaster (Mardiah et al., 2022).

Conclusions

According to the study's findings, the community's perception of the risk of flood in RW 22 is linked to the role of social capital in residents' lives. The bonding, bridging, and linking associations among RW 22 residents influence their decision to remain because they perceive a social support mechanism that aids their livelihoods as long-term residents. This leads individuals to consider that "it doesn't matter if they will lose their homes after the flood," since they are not alone and there are people who can help them when needed. Even if the community's bonding and bridging relationships are weak, the community can still benefit significantly from the social support system provided by bonding connections during the response and adaptation phases of the flood. Therefore, residents are unwilling to move and accept the constant possibility of flooding. The community does not necessarily view the Rob flood as a high-risk

event. Despite several impacts from the Rob flood, they can continue to live because they are not alone and some individuals will assist in the event of losing their dwelling due to the Rob floods.

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Research Paper

Analysis of Nuclear Energy for Future Power Plants in Indonesia

An Assessment for Sustainable Energy Development

Handrata Roy Josia

School of Electrical Engineering and Informatics Bandung Institute of Technology, Bandung, Indonesia

marbunhandrata@gmail.com

Abstract

Indonesia has been investing in expanding its power generation capacity to meet increasing needs. There is an ongoing demand for a new source of energy that is reliable, affordable, safe, and clean. This research has assessed the feasibility on implementing nuclear power plants in Indonesia using systematic literature review based on a comprehensive SWOT analysis, IFE/EFE matrix analysis, and TOWS analysis. The obtained result is that the impacts of internal and external factors are assessed as moderate-positive and positive, respectively. The research implies that strategies regarding investments, benefits, waste management, and collaborations with other alternative energy sources can significantly maximize the benefits and overcome challenges. This study contributes to the understanding of nuclear energy implementation in Indonesia and provides insights for policymakers, stakeholders, and researchers seeking to explore and promote sustainable energy solutions in an urgent need regarding increasing energy demand.

Keywords: SWOT analysis; IFE/EFE matrix; TOWS analysis; nuclear energy; sustainable energy

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Fax: +62 21 31928281
E-mail: journal.pusbindiklatren@bappenas.go.id

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1. Introduction

Electrical energy is vital for the world, playing a crucial role in advancing societies, economies, and technological progress. It is the backbone of modern economies, driving industrialization and the economy's growth (Nti et al., 2020). It improves the quality of life for people across the globe. Access to electricity enhances living conditions, particularly in rural and remote areas, by providing better healthcare, education, and communication services. It enables modern technologies, such as computers, internet connectivity, and mobile devices, facilitating information access, e-commerce, and social connectivity. Furthermore, electrical energy is a critical enabler of clean water supply and sanitation systems, contributing to public health and hygiene (Capodaglio & Olsson, 2020). Overall, electrical energy is instrumental in promoting human development social progress, and enhancing the well-being of individuals and communities worldwide.

Ensuring access to reliable, affordable, and clean electricity addresses global development challenges, including poverty alleviation, healthcare, education, and environmental sustainability (Moristanto & Setiandanu, 2020). It also applies in Indonesia, where the need for reliable and sustainable electrical energy is increasing yearly. Electricity demand is expected to grow at an annual average of 2.5% from 2021 to 2025 and then by 5% until 2029 (Kanugrahan et al., 2022). There are some reasons behind its continuous increase, which are explained as follows.

Electrical energy is essential for economic development in Indonesia. It powers various sectors, such as manufacturing, industry, commerce, and services. Reliable and affordable power enables businesses to operate efficiently, stimulates industrial growth, and attracts investment. Access to electricity boosts productivity, job creation, and overall economic prosperity (Saputra & Ali, 2021). Technological advancements and the proliferation of electrical appliances and devices contribute to the rising demand for electrical energy. The increasing use of electronic devices, household appliances, communication technologies, and industrial machinery requires an excellent electricity supply (Saudi et al., 2019). Various sectors' growing digitalization, automation, and electrification further amplify this trend.

As the population grows, electricity and energy consumption demand also increase. More households, businesses, and industries require access to reliable and affordable energy (Romadhoni, 2020). It places a tremendous strain on the existing power plant infrastructure and necessitates the development of new power generation facilities to meet the rising demand. Indonesia has also been experiencing rapid urbanization and infrastructure development. As more people migrate to cities and urban areas, expand, the demand for electrical energy increases. Urban areas require electricity to power residential buildings, commercial establishments, transportation systems, and essential infrastructure such as hospitals, schools, and public facilities (Bashir et al., 2021).

The Indonesian government has been actively promoting electrification efforts to increase access to electricity nationwide. It includes extending the electricity grid to remote areas, providing electricity to rural communities, and electrifying previously off-grid islands (Wibisono et al., 2023). These initiatives aim to improve the quality of life and support social development. As a result, expanding electricity access leads to an increase in overall electrical energy consumption.

Economic development will also lead to rising standards of living. As living standards improve, there is an increased demand for electrical energy to power modern amenities and comforts. People now rely on electricity for lighting, refrigeration, air conditioning, entertainment, and other daily activities. The desire for a higher quality of life and increased energy consumption contribute to the continuous growth in electrical energy demand (Hill, 2021).

To meet the growing demand for electrical energy, Indonesia has been investing in expanding its power generation capacity, upgrading transmission and distribution infrastructure, and diversifying its energy mix (Tambunan et al., 2020). These efforts aim to ensure a reliable and sustainable electricity supply to support economic growth, improve living standards, and drive socio-economic development. The significance of new power plants is based on factors such as strain on existing power plants, environmental impact, and energy security.

The increasing population can stress existing power plants more, leading to potential overloading and inefficiencies. Power plants may operate at maximum capacity for extended periods, increasing the risk of equipment failures and decreasing reliability (Behbahaninia et al., 2022). Adequate maintenance and upgrades become crucial to ensure existing power plants' continued performance and reliability.

Meeting the energy demands of a growing population can have significant environmental implications. Traditional power plants, especially those relying on fossil fuels, contribute to greenhouse gas emissions. The need for increased power generation can lead to higher carbon emissions, affecting air quality and contributing to climate change. As a result, a growing need exists to explore cleaner and more sustainable energy sources, such as renewable energy, to mitigate the environmental impact (Sasana & Aminata, 2019).

A larger population increases the importance of energy security. The stability and reliability of the power supply become critical to supporting economic growth, social development, and daily activities. Adequate power generation capacity, diversified energy sources, and robust energy infrastructure ensure an uninterrupted energy supply, reduce import dependency and enhance energy self-sufficiency (Sambodo & Novandra, 2019).

As a solution to overcome the electricity crisis, the construction of a nuclear-based power plant (Indonesian: *Pembangkit Listrik Tenaga Nuklir*) was proposed. However, public acceptance is shallow due to concerns about its safety, even though nuclear power development has made significant advancements in safety and technology, with its maturity continuously growing (Sugiawan & Managi, 2019). Moreover, from an environmental standpoint, nuclear power plants are considered the cleanest option (Pata & Kartal, 2023). From an economic perspective, they are more economical than other power plants (Jensen-Eriksen, 2022), especially when addressing electrical energy supply rather than nuclear weapons development.

However, adopting nuclear energy in Indonesia is a complex decision that requires careful consideration of various factors. A comprehensive assessment of nuclear energy, including a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis, is necessary to understand the potential benefits, challenges, and risks associated with implementing nuclear power plants. This research aims to conduct a thorough SWOT analysis of nuclear power plants in Indonesia, evaluating the internal and external factors that influence the deployment and operation of such facilities.

By conducting a SWOT analysis, the study will analyze the internal and external factors that influence the adoption and development of nuclear power plants. It will evaluate the strengths and weaknesses of nuclear energy, such as its potential to provide a stable and reliable power supply and its associated environmental risks and concerns. Additionally, the study will identify the opportunities and threats of integrating nuclear energy into Indonesia's energy mix, considering factors such as policy frameworks, safety regulations, public acceptance, and international cooperation. This analysis will encompass various dimensions, including technological, economic, environmental, social, and political, ensuring a comprehensive assessment of the nuclear power plant's feasibility and compatibility with Indonesia's unique context.

Research on implementing nuclear plants in Indonesia is significant because it can address the country's increasing energy demand and contribute to sustainable development. Understanding the strengths, weaknesses, opportunities, and threats associated with nuclear power implementation enables policymakers and stakeholders to develop strategies that optimize benefits and mitigate risks. Such research can pave the way for the safe and efficient deployment of nuclear energy, ensuring long-term energy security, reduced carbon emissions, and economic growth while addressing environmental concerns and fostering public acceptance. The study will also contribute to the broader discourse on sustainable energy development and the transition to low-carbon energy sources in the global context.

2. Methods

The methodology employed in this study aims to comprehensively assess nuclear energy's potential for future power plants in Indonesia, considering its viability as a sustainable energy source. This assessment will involve a rigorous and systematic analysis of various technical, economic, environmental, social, and policy-related aspects. This research methodology is illustrated as a flowchart in Figure 1.

Figure 1. Research Flowchart

1.1 Data Collection and SWOT Aspects Determination

Data collection will include literature reviews from journals, policy analyses, investigations from previous surveys, and analyses of existing case studies from other countries that have implemented nuclear power plants. Table 1 presents the journal sources used in this literature study, identifying 20 aspects of strengths, weaknesses, opportunities, and threats in implementing nuclear power plants in Indonesia.

Table 1. SWOT Variables

Component	Aspect	Sources
Strength	Lower Operation and Maintenance Cost	Laleman, Balduccio, & Albrecht (2023) Roth & Jamarillo (2017) Reyseliani & Purwanto (2017)
	Skilled Workforce	Surya et al. (2021) Jafarinejad et al. (2021)
	High Suitability Area	Susiati et al. (2022) Abdullah et al. (2023)
	Attractiveness to Foreign Investors	Kim (2020) Terlikowski et al. (2019)
	Strong Government Support	Kim (2020) Narinda, Sudibyo, & Prakoso (2021)
Weakness	High Initial (Upfront) Investment	Kan, Hedenus, & Reichenberg (2020) Mari (2014)
	Lack of Sociopolitical Acceptance	Sugiawan & Managi (2019) Ho et al. (2022) Wang & Kim (2018)
	Limited Power Infrastructure	Maulidia et al. (2019) Bragg-Sitton et al. (2020)
	Nuclear Waste Management Challenges	Wisnubroto et al. (2021) Alwaeli & Mannheim (2022)
	Potential Safety Concerns	Jang & Park (2020) Xu & Zhang (2021)
Opportunity	Increasing Energy Demand	McNeil et al. (2019) Kanugrahan et al. (2023)
	Reduction in Carbon Emissions	Pata & Kartal (2023) Sun et al. (2023)
	Maximization of Energy Utilization	Bragg-Sitton et al. (2020)
	Technological Advancements	Locatelli, Mancini, Todeschini (2013) Terlikowski et al. (2019)
	Opening of New Jobs	Cho et al. (2021) Kenley et al. (2009)
Threat	Other Alternative Energy Sources	Timilsina (2021) Suman (2018)
	Geopolitical Risks	Palle (2021)
	Public Opposition to Nuclear Power	Ho et al. (2022) Karfopoulos et al. (2015)
	Natural Disasters	Susiati et al. (2022) Wu, Wu, & Gao (2020)
	Political Instability	Neumann et al. (2020) Ho et al. (2022)

While nuclear energy holds considerable potential, carefully considering strengths, weaknesses, opportunities, and threats is necessary to make informed decisions regarding its implementation. SWOT analysis will be the strategic planning methodology used to evaluate the internal strengths (S) and weaknesses (W) of a project, as well as the external opportunities (O) and threats (T) it faces (Alamanda et al., 2019). The determination of SWOT aspects requires the following steps.

a. Identify Strengths (S): Recognize the internal factors or capabilities that provide an advantage to the case. These can encompass resources, skills, competitive advantages, or other internal strengths.
b. Identify Weaknesses (W): Identify the internal factors or limitations that place the case at a disadvantage. These can involve deficiencies, gaps, constraints, or other internal weaknesses.
c. Identify Opportunities (O): Identify the external factors or favorable circumstances that benefit the case. These can include market trends, regulatory changes, or external opportunities.
d. Identify Threats (T): Identify the external factors or challenges that can negatively impact the case. These can involve competition, political risks, environmental factors, or other external threats.

The analysis helps identify critical factors that can influence the success or failure of the entity under consideration. The selected sources are based on relevant and credible academic journals offering a thorough analysis. Each analysis aspect must also be supported by at least one source published within the last five years.

1.2 IFE and EFE Matrix Analysis

In the context of utilizing an Internal Factor Evaluation (IFE) and External Factor Evaluation (EFE) matrix, SWOT analysis provides a structured approach to assess the strategic position of the entity (Alamanda et al., 2019). The IFE and EFE matrix focus on evaluating the internal strengths and weaknesses of the entity, as well as external opportunities and threats, considering factors such as resources, capabilities, and operations. Weighted ratings are assigned to each internal factor based on its importance and the entity's performance. The ratings typically range from 0 to 4, with higher numbers indicating better performance or greater importance. These weighted ratings are then multiplied by the assigned weights to calculate a score for each factor using Equation (1):

$$Total\ Score = \sum_{i=1}^{n} W_i I_i \quad (1)$$

Where Wi represents the weight of each SWOT aspect, I_i denotes the rating of each SWOT aspect, and n signifies the total number of aspects.

Once the IFE and EFE matrices are developed, they can be used with the SWOT analysis to understand the entity's strategic position comprehensively. The strengths and weaknesses identified in the IFE matrix are aligned with the opportunities and threats identified in the EFE matrix, creating a matrix that highlights the strategic implications of these factors.

1.3 TOWS Analysis

The TOWS Analysis is a strategic planning tool that integrates the external opportunities and threats identified in the SWOT analysis with the internal strengths and weaknesses of the research subject. It aids in recognizing strategic insights and formulating suitable strategies to leverage strengths, address weaknesses, capitalize on opportunities, and mitigate threats. The name TOWS was created by reversing the order of the SWOT acronym. The process of conducting a TOWS Analysis is as follows.

a. Combine Strengths and Opportunities (SO): Analyze how internal strengths can be leveraged to capitalize on external opportunities. Identify strategies to maximize the benefits of strengths in exploiting opportunities.
b. Combine Strengths and Threats (ST): Analyze how internal strengths can mitigate or overcome external threats. Identify strategies to minimize the impact of threats by leveraging existing strengths.
c. Combine Weaknesses and Opportunities (WO): Analyze how internal weaknesses can be addressed or overcome by taking advantage of external opportunities. Identify strategies to minimize weaknesses by capitalizing on available opportunities.
d. Combine Weaknesses and Threats (WT): Analyze how internal weaknesses can be minimized or mitigated in the face of external threats. Identify strategies to overcome weaknesses and reduce the impact of threats.
e. Develop Actionable Strategies: Based on the insights gained from the TOWS Analysis, develop specific, actionable strategies and action plans that align with the goals and objectives.

2. Results and Discussions

Nuclear energy is a form of energy generated through nuclear reactions, specifically nuclear fission. It involves splitting atomic nuclei, typically uranium or plutonium isotopes, releasing substantial energy in heat. This heat is then harnessed to produce steam, which drives turbines connected to generators, ultimately generating electricity. Nuclear power plants utilize this process to produce electricity on a large scale.

Nuclear reactions occur in a nuclear power plant in the reactor core, where fuel rods containing enriched uranium are arranged. These reactions generate intense heat, which is transferred to a coolant, usually water or a gas, circulating through the reactor. The heated coolant then flows through a heat exchanger, transferring its thermal energy to a secondary water loop, producing steam. The steam drives turbines, which rotate the alternator to generate electric power (Sun et al., 2023). The electricity generated is then fed into the power grid for distribution to consumers. This nuclear thermoelectric conversion process is illustrated in Figure 2, depicting the conversion from thermal energy to mechanical energy and then from mechanical energy to electrical energy.

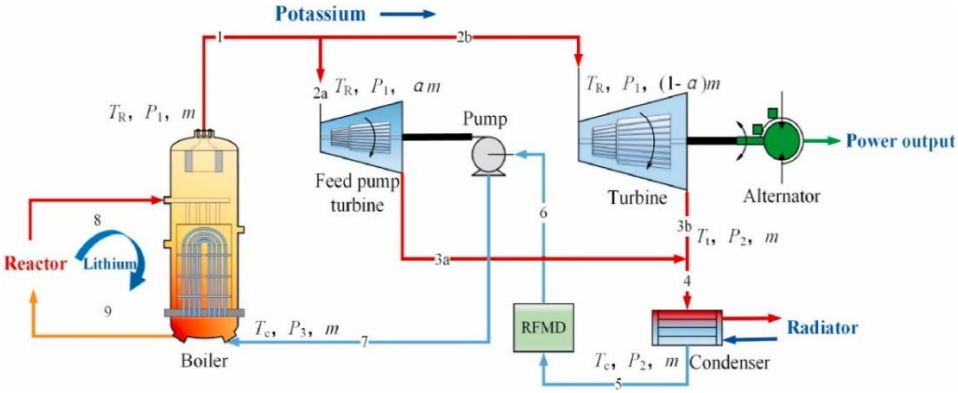

Figure 2. Nuclear Thermoelectric Conversion Scheme

Source: Sun et al. (2023)

One of the significant advantages of nuclear energy is its capability to generate electricity without emitting substantial amounts of greenhouse gases or air pollutants. Nuclear power plants do not produce carbon dioxide (CO2), sulfur dioxide (SO2), or nitrogen oxide (NOx), which are significant contributors to global warming and air pollution. As a result, nuclear energy has the potential to considerably reduce carbon emissions and alleviate the impacts of climate change.

However, nuclear energy does pose environmental challenges related to nuclear waste and the potential for accidents. The spent fuel rods and other radioactive waste generated by nuclear power plants are highly hazardous and demand careful management. Furthermore, the risk of accidents, such as meltdowns or radiation leaks, can lead to environmental consequences and threaten public health (Ohba et al., 2021).

Despite these challenges, there are reasons why nuclear power plants should be considered in Indonesia. As shown in Figure 3, Indonesia is experiencing a rapid increase in energy demand due to economic growth and population expansion, although the rise in electricity demand has slightly slowed due to the COVID-19 pandemic. Nuclear energy can offer a reliable and consistent electricity supply, aiding in meeting this escalating demand and supporting industrial and infrastructural development. The subsequent SWOT, IFE/EFE matrix and TOWS analyses will further explain these aspects.

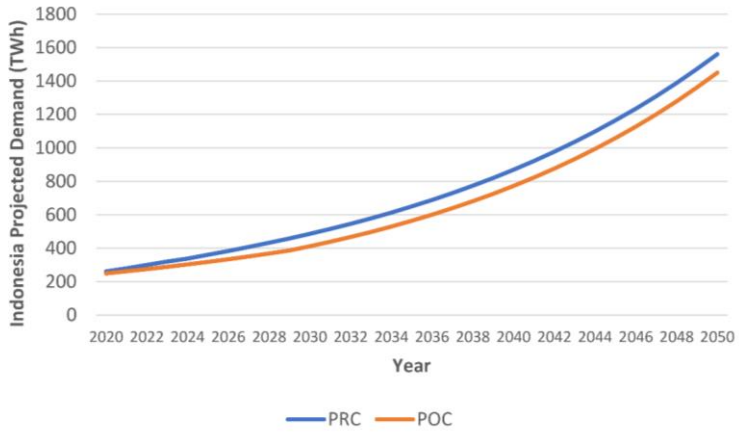

Figure 3. The pre-COVID-19 (PRC) and post-COVID-19 (POC) Electricity Demand Prediction

Source: Kanugrahan et al. (2023)

2.1 Strength Analysis

The strengths of nuclear energy in Indonesia underscore its potential benefits and advantages. One of the strengths of nuclear power plant implementation is the potential for lower operation and maintenance costs compared to other forms of power generation. Although the upfront capital costs of building a nuclear power plant can be high, nuclear plants can experience relatively low operational fuel costs, as stated in the research by the University of Gent, Belgium, shown in Figure 4 (Laleman, 2023).

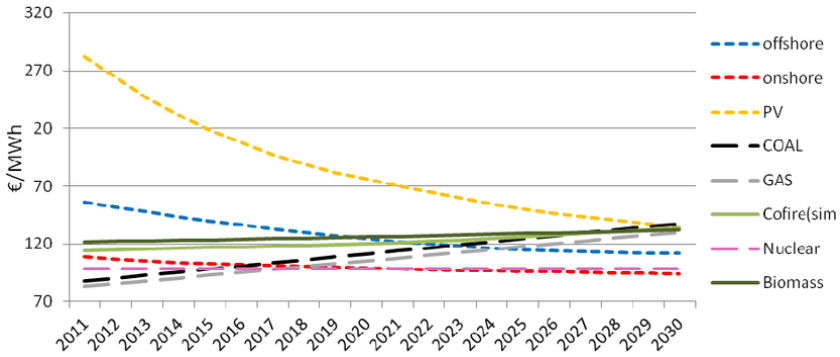

Figure 4. Levelized Cost of Electricity Comparison for Different Energy Sources

Source: Laleman et al. (2023)

The University of Indonesia has also conducted similar research to gain an Indonesian perspective. The cost of producing power using 100% renewable energy versus 100% renewable energy (without nuclear), focusing on the base case demand scenario, is depicted in Figure 5. The cost of power production does not show a significant change from 2020 to 2030. However, in the long run, the cost of producing 100% electricity without nuclear energy is predicted to exceed that of producing 100% with nuclear energy (Reyseliani & Purwanto, 2021).

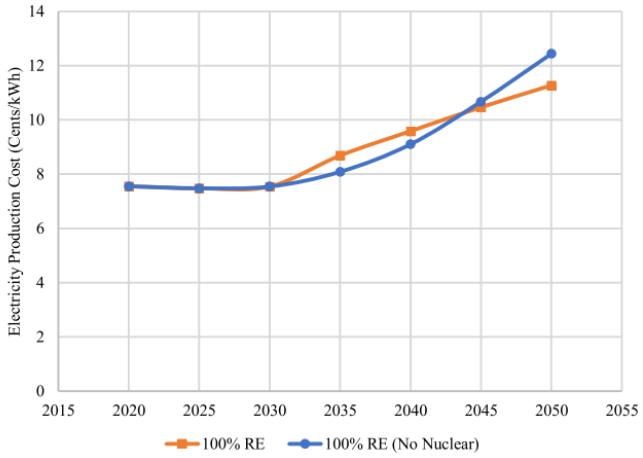

Figure 5. Electricity Production Cost for 100% Renewable Energy (With and Without Nuclear)

Source: Reyseliani & Purwanto (2021)

Nuclear fuel, such as uranium or thorium, is highly energy-dense (Layton, 2008), meaning a small amount can generate significant electricity. It leads to reduced fuel consumption and lower fuel costs over the operational lifetime of the plant. Moreover, advancements in nuclear technology, such as improved reactor designs and operational efficiencies, can further contribute to lower operating and maintenance costs.

The second strength of nuclear power plant implementation in Indonesia is its skilled workforce. The successful establishment of nuclear power plants demands a highly skilled workforce, encompassing engineers, technicians, nuclear physicists, and safety experts. Indonesia has the advantage of having a substantial and well-educated workforce that can be trained and employed in the nuclear industry. According to PII (Indonesian Engineers Association) calculations, by 2015, Indonesia had 211,124 engineers, predicted to rise to 546,075 engineers by 2025 (Handayani, 2015). The existing pool of skilled professionals can be further enhanced through specialized training programs and collaborations with countries possessing well-established nuclear energy initiatives. The growth of a skilled workforce will correlate positively with energy production and consumption (Surya et al., 2021).

Indonesia's geographical characteristics also render it highly suitable for implementing nuclear power plants. A geological analysis in Figure 6 demonstrates that West Kalimantan has a very high nuclear suitable area (Susiati et al., 2022), encompassing 25.81% of the unrestricted area in the province. This discovery is further substantiated by the Fuzzy Analytic Hierarchy Process (FAHP) method (Abdullah et al., 2023). The region features many coastal areas and large river valleys, positioning power plants near potential raw water sources for coolants, industrial zones, and a well-developed power grid. Additionally, the area is geologically stable, boasting a relatively low risk of severe seismic activities and natural disasters that could endanger nuclear facilities. This stability diminishes the likelihood of accidents or damage stemming from external factors.

Developing nuclear power plants in Indonesia is also highly appealing to foreign investors. Nuclear energy projects generally entail significant investments, and foreign investors can contribute financial resources, technical expertise, and experience in nuclear power plant construction and operation. Indonesia's stable economic growth further enhances this attractiveness (Kim, 2020). A robust regulatory framework, government support, and transparent policies can establish a favorable investment climate, encouraging foreign entities to engage in the development of nuclear energy projects.

Strong government support is a crucial advantage for implementing nuclear power plants. The Indonesian government's commitment to nuclear energy, as demonstrated through clear policy frameworks and regulations like Act No. 10/1997 on Nuclear Energy and Government Regulation No. 2/2014 on the Licensing of Nuclear Installation and the Utilization of Nuclear Materials, creates a stable and supportive environment for nuclear energy projects. Government support encompasses establishing regulatory bodies, formulating national energy plans involving nuclear power, and allocating resources and funding for research, development, and infrastructure. This support can expedite the development of nuclear power plants in Indonesia and serve as a means to achieve defense diplomacy (Narinda et al., 2021). It can simultaneously enhance energy security in the face of climate change and synergistically affect Indonesia's defense capabilities.

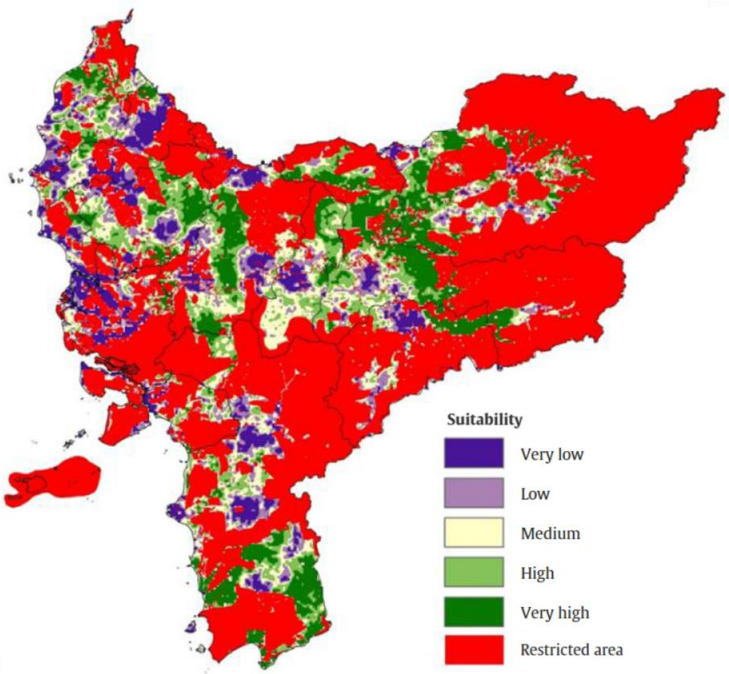

Figure 6. Geological Analysis of Suitable Locations for Nuclear Power Plants in West Kalimantan

Source: Susiati et al. (2022)

2.2 Weakness Analysis

The weaknesses associated with implementing nuclear energy in Indonesia emphasize the challenges and limitations that must be addressed. One of the significant weaknesses of nuclear power plants is the substantial initial (upfront) investment required for construction and commissioning, amounting to $7000/kW (Kan et al., 2022). It is corroborated by the data presented in Table 2.

Table 2. LCOE Decompositions by Percentage

LCOE	Nuclear	Coal	Gas
Initial Investment	61.24%	38.97%	14.40%
Taxes	17.37%	9.63%	2.55%
O&M	13.66%	16.32%	5.78%
Fuel	7.60%	35.08%	77.27%
Decommissioning	0.13%	0.00%	0.00%

Source: Mari (2014)

Building a nuclear power plant entails a substantial initial investment, as indicated in Table 2. The initial investments encompass engineering, procurement, and construction expenses. These costs can pose a barrier, especially for developing nations like Indonesia, where allocating significant amounts of money may present financial challenges. Adequate financial planning, access to funding sources, and meticulous cost-benefit analysis are essential to address this weakness.

Implementing nuclear power plants necessitates sociopolitical acceptance from the public, stakeholders, and policymakers. This acceptance is a pivotal element in successfully establishing nuclear power plants. The absence of acceptance can stem from safety concerns, fear of accidents, and misconceptions about the potential risks linked to nuclear energy (Sugiawan & Managi, 2019). Building public trust and awareness through transparent communication, education, and public engagement initiatives is crucial to addressing these apprehensions (Ho et al., 2022). Failing to secure public acceptance can result in opposition, regulatory obstacles, and even the abandonment of nuclear projects.

Implementing nuclear power plants necessitates a sturdy and comprehensive power infrastructure to distribute the generated electricity efficiently. Developing countries like Indonesia might lack power infrastructure or encounter difficulties incorporating nuclear power into the existing grid (Maulidia et al., 2019). Upgrading and expanding the power infrastructure, encompassing transmission lines, substations, and distribution networks, may be imperative to accommodate the supplementary power supply from nuclear facilities. This weakness underscores the requirement for thorough planning and coordination with other energy sectors to guarantee the seamless integration of nuclear power into the national grid.

Nuclear power generation produces radioactive waste that demands meticulous management and disposal. Effective waste management practices are crucial to mitigate environmental and health risks linked to radioactive materials. Establishing secure storage facilities, implementing efficient waste management strategies, and adhering to international safety standards are pivotal in addressing this weakness (Wisnubroto et al., 2021). Radioactive waste management involves several steps: collection, characterization, sorting, processing, storage, and disposal. These steps are further detailed in a flowchart illustrated in Figure 7.

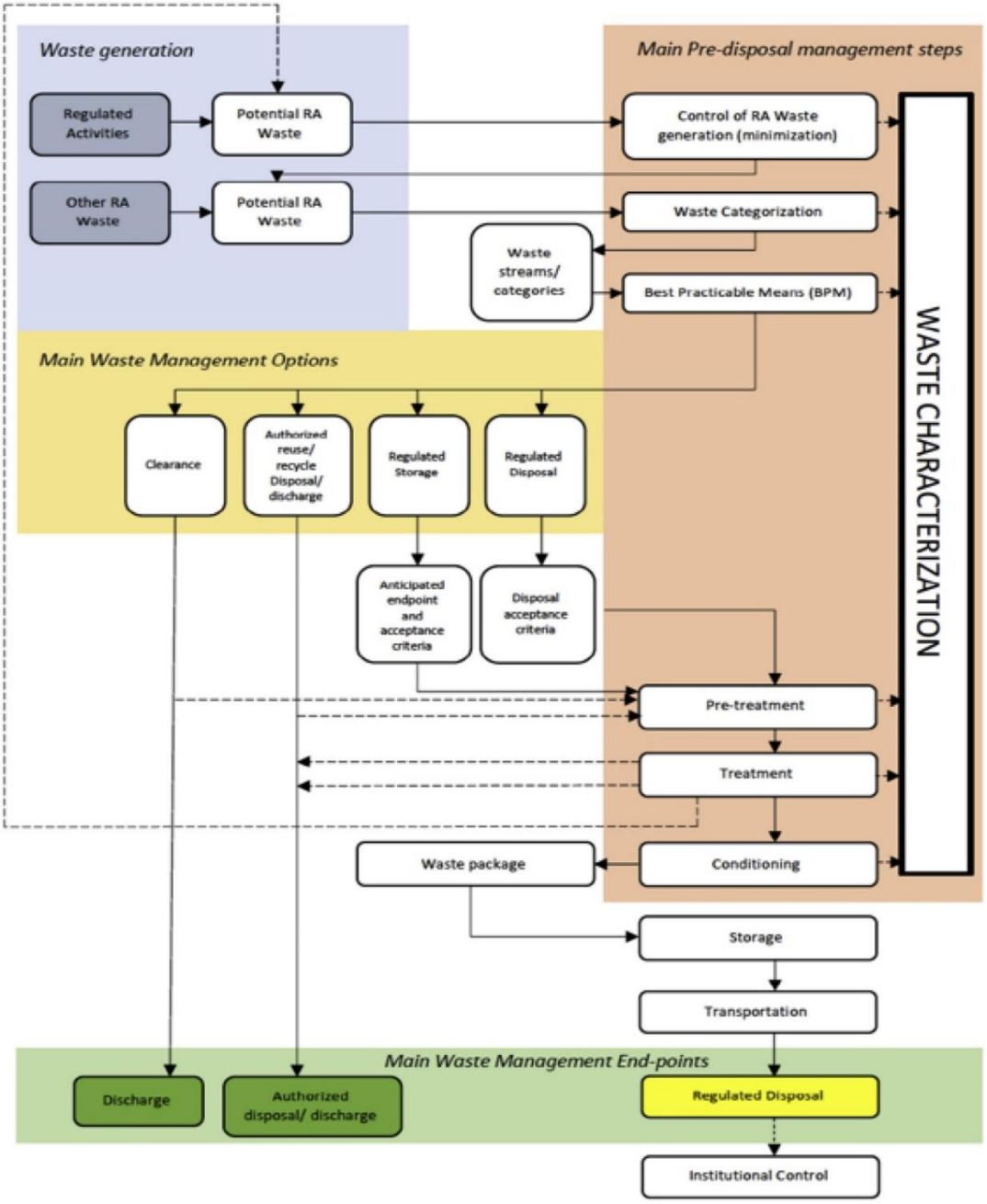

Figure 7. Radioactive Waste Management Steps

Source: Wisnubroto et al. (2021)

Safety concerns linked to nuclear power plants present the most substantial weakness. Despite modern reactor designs and stringent safety measures that mitigate risks, accidents and incidents can still transpire (Jang & Park, 2020). Nuclear power plants must adhere to rigorous safety protocols, maintain emergency preparedness, and provide ongoing training for personnel to ensure the secure operation of facilities. Regulatory frameworks must be in place to enforce safety standards and oversee compliance. Addressing safety concerns is pivotal for upholding public confidence and reducing potential risks of nuclear power generation.

2.3 Opportunity Analysis

The opportunities linked to nuclear energy in Indonesia underscore the potential benefits and positive outcomes that can be realized. One of the significant opportunities for nuclear power plant implementation is the capability to fulfill the escalating energy demand sustainably. As economies flourish and populations expand, the need for electricity rises, as depicted in Figure 8.

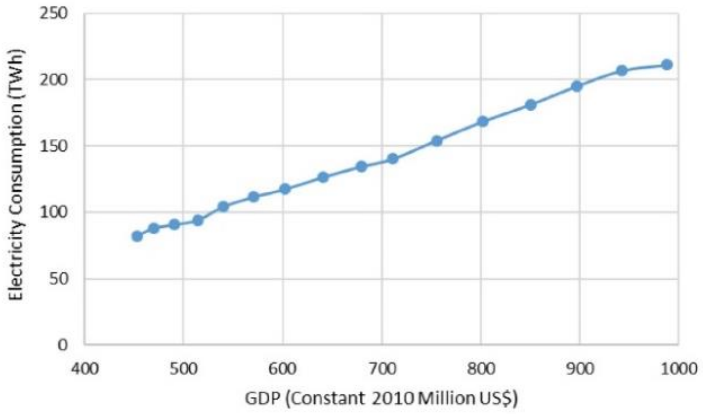

Figure 8. Indonesia's Electricity Consumption in Respect to GDP

Source: Susiati et al. (2022)

Nuclear power can offer a large-scale, continuous, and reliable electricity source, effectively addressing the escalating energy demands of a country like Indonesia. By diversifying the energy mix and integrating nuclear power into the generation capacity, Indonesia can ensure a stable and secure energy supply to bolster economic development. Nuclear power plants can also contribute to reducing carbon emissions, being regarded as a low-carbon energy source due to their lack of greenhouse gas emissions during electricity generation (Pata & Kartal, 2023). The implementation of nuclear power can aid Indonesia in reducing carbon emissions and combating climate change. By substituting fossil fuel-based power generation with nuclear energy, the nation can make substantial progress toward achieving emission reduction goals and aligning with international commitments such as the Paris Agreement. This transition would not only enhance the stability and sustainability of electricity but also reinforce environmental sustainability.

Nuclear power plants can offer high energy utilization efficiency. The energy density of nuclear fuel is significantly higher than conventional fossil fuels. Consequently, a small amount of nuclear fuel can generate substantial electricity over an extended period. This efficiency enables the optimal utilization of available resources, reduces fuel consumption, and minimizes waste generation. Nuclear energy plays a vital role in the global clean energy supply, functioning as a primary energy source and complementing and enabling other clean energy sources (Bragg-Sitton et al., 2020). There is an increasing necessity to approach energy resource utilization that maximizes effectiveness in meeting all energy needs.

The implementation of nuclear power plants presents opportunities for technological advancements and innovation. As the global nuclear industry continues to evolve, ongoing research and development efforts aim to enhance safety, efficiency, and sustainability in nuclear power generation. By embracing and adapting advanced reactor designs, such as Generation IV reactors (Locatelli et al., 2013), Indonesia can tap into the latest technological breakthroughs in the nuclear energy sector. It encompasses enhancements in reactor safety, waste management, energy utilization, and even the potential utilization of thorium-based reactors. Furthermore, this can facilitate technology transfer and knowledge-sharing among countries with well-established nuclear energy programs. This exchange of expertise holds the potential to contribute to the growth of Indonesia's nuclear industry and bolster local capabilities.

One of the significant opportunities for nuclear power plant implementation is the creation of new job opportunities across various sectors (Kenley et al., 2009). Development, construction, and operation

of nuclear power plants demand diverse skilled professionals, technicians, and support staff. Specific job opportunities from nuclear power plant implementation include engineering, construction, operation, maintenance, research, development, and safety positions.

2.4 Threats Analysis

The threats associated with nuclear energy in Indonesia identify the challenges and potential risks that must be mitigated. One of the primary threats to nuclear power plant implementation is competition from other alternative energy sources. The rapidly evolving renewable energy sector, such as solar and wind power, poses a challenge to expanding nuclear power. As different renewable energy resources advance in technology, there may be a shift in focus towards these alternatives, potentially reducing the demand for nuclear energy.

Secondly, nuclear power plant implementation is subject to geopolitical risks that can impact the availability of resources, technology, and expertise. The global nuclear industry heavily relies on international collaborations and transferring knowledge, materials, and equipment across borders (Palle, 2021). Geopolitical tensions, conflicts, trade restrictions, or changes in international agreements can disrupt the smooth flow of these resources and affect the progress of nuclear projects.

Public opposition and concerns about the safety, environmental impact, and nuclear waste management associated with nuclear power can pose significant threats to its implementation. Misinformation, lack of awareness, and fear of accidents or radiation leaks can lead to strong public opposition and protests against nuclear energy projects. This opposition can hinder the development of new plants, delay regulatory approvals, and create significant challenges in gaining social acceptance for nuclear power.

The potential impact of natural disasters on nuclear power plants is a significant threat that must be carefully considered. Indonesia is prone to earthquakes, tsunamis, and volcanic eruptions. While modern nuclear power plants incorporate stringent safety measures, including robust design features and multiple safety systems, extreme natural events can still pose risks to plant safety (Susiati et al., 2022). Ensuring that nuclear facilities are located in appropriate areas to mitigate the effects of potential natural disasters is crucial to addressing this threat.

Political instability and changing government priorities can threaten the implementation nuclear power plants. Nuclear energy projects require long-term planning, consistent policy support, and regulatory stability. Changes in government, shifts in energy policies, or the lack of a clear long-term commitment to nuclear energy can create uncertainties and deter investment in the sector (Neumann et al., 2020). Political stability and continuity in energy policies are essential to ensure nuclear power plants' successful implementation and operation.

2.5 IFE and EFE Matrix Analysis

To analyze the Internal Factor Evaluation (IFE) of the SWOT aspects related to internal strengths and weaknesses of nuclear power plants, ratings and weights will be assigned to each factor. The evaluation of the internal matrix pertains to how strong or weak each aspect is. The numbers range from 4 to 1, where 4 indicates a significant strength, 3 indicates a moderate strength, 2 indicates a minor weakness, and 1 indicates a significant weakness. Strengths are only given ratings of 3 and 4, while weaknesses are only given ratings of 2 and 1. Each key factor should also be assigned a weight from 0.0 (low importance) to 1.0 (high importance). This number signifies how crucial that factor is for ensuring the successful implementation of nuclear power plants in Indonesia. The assignment of weights and ratings, along with the calculations, is presented in Table 3.

Table 3. IFE Matrix

Component	Aspect	Weight	Rating	Score
Strength	Lower Operation and Maintenance Cost	0.1	4	0.4
	Skilled Workforce	0.05	3	0.15
	High Suitability Area	0.2	3	0.6
	Attractiveness to Foreign Investors	0.1	4	0.4
	Strong Government Support	0.15	3	0.45
Weakness	High Initial (Upfront) Investment	0.05	1	0.05
	Lack of Sociopolitical Acceptance	0.05	2	0.1
	Limited Power Infrastructure	0.1	1	0.1
	Nuclear Waste Management Challenges	0.1	2	0.2
	Potential Safety Concerns	0.1	2	0.2
Total		1.0		2.65

Similar to the Internal Factor Evaluation (IFE), the External Factor Evaluation (EFE) also involves analyzing ratings that range from 4 to 1. However, the assessment focuses more on the positive or negative impact of opportunities and threats the country may encounter while implementing nuclear power plants. In this context, a rating of 4 indicates an excellent effect, 3 signifies an above-average effect, 2 represents an average effect, and 1 indicates a poor effect. Opportunities are only assigned ratings of 3 and 4, while threats are exclusively given ratings of 2 and 1. Each key factor should also be assigned a weight ranging from 0.0 to 1.0. The assignment of weights and ratings, along with the subsequent calculations, is presented in Table 4.

Table 4. EFE Matrix

Component	Aspects	Weight	Rating	Score
Opportunities	Increasing Energy Demand	0.2	4	0.8
	Reduction in Carbon Emissions	0.15	4	0.6
	Maximization of Energy Utilization	0.2	4	0.2
	Technological Advancements	0.15	4	0.6
	Opening of New Jobs	0.1	3	0.3
Threats	Other Alternative Energy Sources	0.05	2	0.1
	Geopolitical Risks	0.05	1	0.05
	Public Opposition to Nuclear Power	0.05	2	0.1
	Natural Disasters	0.15	1	0.15
	Political Instability	0.05	2	0.1
Total		1.0		3.00

An IE matrix can be constructed to visualize the evaluated IFE and EFE better. On the x-axis of the IE matrix, the value of the IFE is 2.65, and on the y-axis, the value of the EFE is 3.00. The results of the IE matrix indicate that the implementation of nuclear power plants in Indonesia falls within quadrant II of the final IE matrix, as shown in Figure 9.

IE MATRIX		IFE		
		Strong	Average	Weak
		(4.0 - 3.0)	(3.0 - 2.0)	(2.0 - 1.0)
EFE	Strong (4.0 - 3.0)	I	II	III
	Average (3.0 - 2.0)	IV	V	VI
	Weak (2.0 - 1.0)	VII	VIII	IX

Figure 9. Final IE Matrix

The IFE score of 2.65 suggests that the impact of internal strengths and weaknesses on implementing nuclear power in Indonesia is moderately positive. It indicates the presence of notable strengths alongside areas of weakness that require attention. The score signifies room for improvement and further enhancement of internal factors. The EFE score of 3.0 implies that the external opportunities and threats related to nuclear power implementation in Indonesia have a positive influence. It suggests the availability of opportunities and potential threats demanding management and resolution. The score underscores external factors supporting nuclear power implementation alongside challenges that need thorough consideration. In ideal scenarios, these threats could potentially be surpassed by the benefits of opportunities. It underscores the need for strategic planning, investment, and stakeholder involvement to capitalize on strengths, address weaknesses, leverage opportunities, and mitigate threats to nuclear power implementation in Indonesia.

The initial steps to enhance the obtained IFE and EFE scores involve refining aspects with lower ratings. Regarding internal factors, the IFE score can be boosted by securing additional government support, such as enacting laws that favor nuclear power plant construction. Moreover, establishing electricity infrastructure before implementing nuclear power plants can ensure grid reliability and stability. Concerning external factors, elevating the EFE score can be achieved by collaborating with alternative energy sources and transforming threats into new opportunities. Additionally, public education is crucial to counter opposition towards nuclear energy usage.

2.6 TOWS Analysis

To create a more streamlined approach, one can undertake a TOWS analysis. Engaging in a TOWS analysis offers a holistic grasp of the internal and external factors linked to the introduction of nuclear power plants in Indonesia. It facilitates the identification of strategic alternatives for policymakers, stakeholders, and industry participants, encompassing weakness rectification, strength utilization, opportunity exploitation, and threat alleviation. The analysis is a foundation for devising impactful strategies and policies to foster Indonesia's prosperous and sustainable integration of nuclear energy. The TOWS analysis for implementing nuclear power plants in Indonesia follows.

Table 5. TOWS Matrix

Strengths-Opportunities (SO) Strategies: • Leverage the advantage of lower operation and maintenance costs and a skilled workforce to optimize energy utilization and meet the growing demand. • Capitalize in the high suitability area and foreign investment potential to drive advancements in nuclear technology, thereby reducing carbon emissions. • Exploit strong government support and the creation of new jobs to promote nuclear energy as a solution to energy demand while fostering economic growth.	**Weaknesses-Opportunities (WO) Strategies:** • Address the high initial investment by seeking foreign investments and partnerships to alleviate financial burdens and facilitate technological progress. • Overcome challenges related to sociopolitical acceptance and limited power infrastructure by emphasizing nuclear energy's benefits in reducing carbon emissions and maximizing energy efficiency.
Strengths-Threats (ST) Strategies: • Mitigate potential safety concerns through rigorous safety measures, research, and development, highlighting nuclear energy's safety advantages over alternatives. • Utilize strong government support and a skilled workforce to manage geopolitical risks, public opposition, and concerns related to natural disasters through stringent regulations and safety protocols.	**Weaknesses-Threats (WT) Strategies:** • Develop comprehensive plans for nuclear waste management, incorporating technological innovations and international best practices to minimize environmental and safety risks. • Collaborate with alternative energy sources to explore hybrid solutions, mitigating geopolitical risks, public opposition, and political instability.

Table 5 presents the comprehensive TOWS matrix, serving as the foundational framework for devising strategies to implement nuclear power plants in Indonesia. This matrix encompasses the alignment of strengths and opportunities, weaknesses and opportunities, strengths and threats, and weaknesses and threats. It ensures the optimization of positive attributes and the mitigation of negative factors. Succinct elaborations of the provided solutions are detailed below.

Strengths-Opportunities (SO) Strategies:

a. Leveraging the lower operation and maintenance cost and skilled workforce to maximize energy utilization and meet the increasing energy demand:

b. By capitalizing on the cost efficiency of nuclear power plants' operations and maintenance, Indonesia can achieve cost-effective energy production, as demonstrated in the practices of the United States (Roth & Jamarillo, 2017). The country can harness its skilled workforce within the energy sector to optimize nuclear power plant operations, thus enhancing energy utilization. A pathway to achieving this is by enhancing the development of distinct professional standards recognized through national qualification frameworks to validate the acquired qualifications formally (Jafarinejad et al., 2021). This strategy empowers Indonesia to address escalating energy demands driven by economic expansion and population growth, thus ensuring a sustainable energy supply.

c. Capitalizing on the high suitability area and attractive foreign investment to drive technological advancements in nuclear energy and reduce carbon emissions:

d. Indonesia's highly-suited regions, such as coastal zones like West Kalimantan, can serve as ideal locations for constructing and operating nuclear power plants (Susiati et al., 2022), benefiting from favorable conditions for safety and efficiency. Foreign investments can be appealed through incentivizing policies and favorable investment environments, thereby nurturing progress in nuclear energy technology (Terlikowski et al., 2019). This strategy positions Indonesia to curtail carbon emissions by substituting fossil fuel-based power generation with nuclear power, aligning with its environmental sustainability commitments.

e. Utilizing strong government support and the opening of new jobs to promote nuclear energy as a solution to energy demand and create economic opportunities:

f. Strong government backing is pivotal in providing regulatory frameworks, policies, incentives, and long-term visions for advancing nuclear power while cultivating new employment avenues. Research indicates that adopting nuclear energy can foster job creation within the construction, operation, and maintenance of nuclear power plants, ultimately invigorating economic growth (Cho et al., 2021). This strategy positions nuclear energy as a pragmatic solution for meeting energy demands and concurrently generating socio-economic advantages.

Strengths-Threats (ST) Strategies:

a. Mitigating potential safety concerns through robust safety measures, research, and development, demonstrating the safety advantages of nuclear energy over alternative sources:

b. To effectively alleviate potential safety apprehensions tied to nuclear power, rigorous safety protocols, thorough risk assessments, and ongoing monitoring must be implemented. Concurrently, investment in research and development is crucial to enhance safety technologies, thereby bolstering the safety benefits of nuclear energy compared to other energy alternatives (Xu & Zhang, 2021). Facilitating transparent communication with the public and stakeholders is vital to amplify comprehension and confidence in nuclear power plants' safety measures and risk management.

c. Using strong government support and a skilled workforce to address geopolitical risks, public opposition, and concerns related to natural disasters by implementing stringent regulations and safety protocols:

d. Collaborative initiatives involving the government and international partners can effectively address geopolitical risks linked to importing nuclear technology and materials (Terlikowski et al., 2019). This collaborative effort can be supplemented by comprehensive communication campaigns and inclusive public consultations, facilitated through education and training, aimed at countering public opposition and cultivating trust in the safety and merits of nuclear power (Karfopoulos et al., 2015). Concurrently, stringent regulatory frameworks and safety protocols, guided by expert input, must be established to tackle concerns about natural disasters and ensure the resilience of nuclear power plants against such adversities.

Weaknesses-Opportunities (WO) Strategies:

a. Addressing the high initial investment by seeking foreign investments and partnerships to reduce the financial burden and promote technological advancements:

b. Indonesia can attract foreign investments and foster collaborations with international organizations or corporations to alleviate the challenges posed by the high initial investment. These partnerships can secure the requisite funding for constructing and operating nuclear power plants. Engaging with foreign entities brings expertise and technology transfer and alleviates financial strain on Indonesia's budget. This approach mirrors the successful case of South Korea, which, despite being a developing nation, effectively harnessed nuclear energy for power generation by engaging in strategic partnerships (Sung & Hong, 1999). Through such collaborations, Indonesia can surmount the financial hurdle of the substantial upfront investment required for nuclear power plants.

c. Overcoming the lack of sociopolitical acceptance and limited power infrastructure by emphasizing the benefits of nuclear energy in reducing carbon emissions and maximizing energy utilization:

d. Comprehensive public awareness campaigns and educational initiatives are essential to address the challenges stemming from societal acceptance and inadequate power infrastructure. Underlining nuclear energy's pivotal role in curbing carbon emissions and combating climate change can garner more comprehensive public support. A study across 27 nuclear energy-utilizing nations revealed that increased nuclear energy acceptance correlated with heightened perceived benefits and knowledge, lowering perceived risks (Wang & Kim, 2018). Concurrently, prioritizing investment in power infrastructure development can fortify the grid, ensuring seamless integration of nuclear power and consistent electricity supply. By effectively highlighting nuclear energy's advantages—such as its potential to optimize energy utilization and foster sustainable development—Indonesia can effectively surmount challenges related to public acceptance and infrastructure limitations.

Weaknesses-Threats (WT) Strategies:

a. Developing comprehensive plans for nuclear waste management, incorporating technological advancements and international best practices to minimize environmental and safety risks:

b. To effectively address nuclear waste management, Indonesia can invest in research and development to advance technologies for handling nuclear waste. Prioritizing recycling and reprocessing methods can minimize waste volume and enhance safety. Collaborating with experienced international organizations and countries in the realm of nuclear waste management is essential to adopting global best practices and ensuring adherence to international standards and regulations (Alwaeli & Mannheim, 2022). Through such concerted efforts, Indonesia can proactively mitigate potential environmental and safety risks linked to implementing nuclear power plants.

c. Collaborating with other alternative energy sources to explore hybrid energy solutions and mitigate geopolitical risks, public opposition, and political instability:

d. Indonesia can facilitate collaboration between nuclear power and other renewable sources like solar and wind energy to foster a resilient energy landscape. This approach aligns with the positive outcomes of the United States' comparable initiatives (Bragg-Sitton et al., 2020). Indonesia can diversify its energy portfolio by cultivating hybrid solutions, mitigating the vulnerabilities of relying solely on one energy source. Engaging stakeholders vested in alternative energy resources can help alleviate geopolitical risks and promote stability amid political fluctuations. Embracing hybrid nuclear-renewable systems bolsters energy security and enhances public acceptance (Suman, 2018).

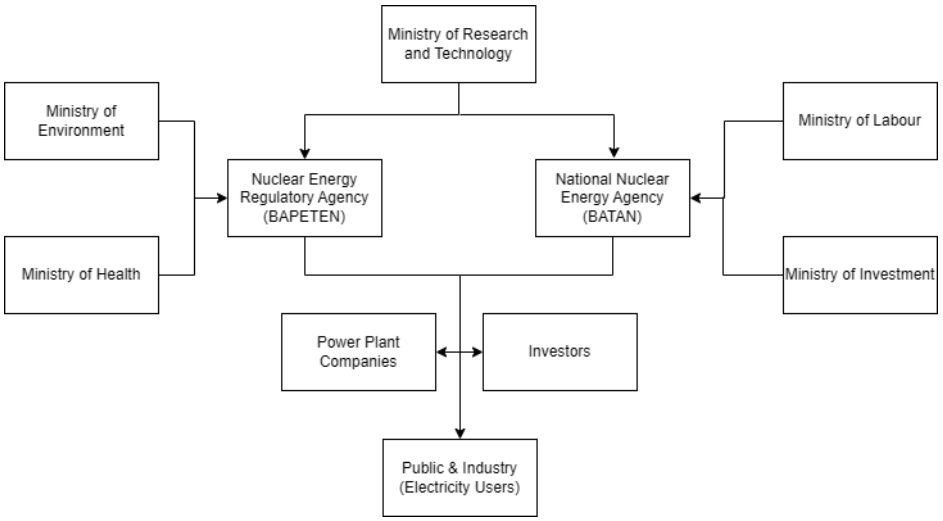

Figure 10. Proposed Stakeholders Structure

Collaboration among diverse stakeholders is paramount to ensure the successful implementation of nuclear power plants in Indonesia. An illustrative stakeholder structure is presented in Figure 10. By engaging and coordinating the efforts of government bodies, industry representatives, academic experts, investors, and the public, the challenges can be effectively addressed, risks mitigated, and the advantages of nuclear power plants maximized.

Conclusions

This research has assessed the feasibility of implementing nuclear power plants in Indonesia through a systematic literature review and comprehensive analysis. Based on the analysis, it is evident that the internal strengths and weaknesses of nuclear power implementation in Indonesia have a moderate positive impact. It suggests the presence of notable strengths alongside weaknesses that require attention. Additionally, the external opportunities and threats related to nuclear power implementation in Indonesia exhibit a positive impact. It implies that the opportunities available in implementing nuclear power plants can outweigh the associated threats.

By capitalizing on opportunities and addressing challenges, Indonesia can effectively realize the implementation of nuclear power, meeting energy demands, reducing carbon emissions, enhancing safety, and creating economic prospects. Strategies such as seeking foreign investments, accentuating the advantages of nuclear energy, formulating comprehensive waste management plans, and collaborating with alternative energy sources can ensure success and maximize the advantages of nuclear power implementation in Indonesia.

One limitation of this study stems from potential constraints in the availability and accuracy of data, particularly given that nuclear power plants have not yet been fully implemented in Indonesia. Additionally, restricted access to proprietary or classified information could be hampered by research accuracy and depth, leading to an incomplete understanding of complex factors. In addition, due to the rapidly changing nature of technology and geopolitical dynamics, the results may have a limited lifespan, requiring continual updating to remain relevant and applicable to the development context nuclear energy adoption in the country.

These limitations underscore the urgency for Indonesia to expedite research on the implementation of nuclear power plants. Future research topics concerning nuclear energy for power plants in Indonesia may encompass safety and risk assessment, human resource development, socio-economic impacts, energy planning, policy frameworks, environmental impact assessment, and perception assessment.

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Research Paper

Soft Infrastructure in Smart Sustainable Cities

A Literature Review

Ridwan Sutriadi

Urban Planning and Design Research Group, Bandung Institute of Technology, Bandung, Indonesia

readone@itb.ac.id

Abstract

Learning from the cases in Indonesia, the proliferation of advanced technologies has engendered a burgeoning interest in smart city promotion as a dominant developmental theme, and this has an association heavily with physical infrastructure development, while there are other things that need to be thought about. The methodology entails the scholarly works, procurement of data, classification of data, and integration of resultant discoveries. The objective of this article is to furnish a thorough and intricate comprehension of the soft infrastructure that upholds crucial infrastructure systems. Qualitative assessments scrutinize outcomes within multiple frameworks to gauge the efficacy of the supple infrastructure in promoting resilience. As a result, the occurrence of the theme of soft infrastructure in smart sustainable cities poses a novel challenge to continuously enhance their skills and expertise. The soft infrastructure in smart sustainable cities addresses business-spatial, cultural-political, and humane-innovation issues. Such resources can effectively address integrated regional challenges and well-conceived planning for cities.

Keywords: soft infrastructure; disrupted cities; smart city; sustainability; SDGs

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Fax: +62 21 31928281
E-mail: journal.pusbindiklatren@bappenas.go.id

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1. Introduction

The article discusses the concept of creating smart sustainable cities, which involves improving modern cities, including those in Indonesia, by building things like roads and buildings to make them grow faster. The main objective is to create well-arranged and organized cities. However, cities can become disrupted for various reasons, such as environmental impact, overuse, functional problems, and difficulties with management. The study provides evidence that urban and regional development requires more than just building infrastructure. Other important factors need to be considered and addressed as well.

These factors are very significant for the creation of a smart sustainable city development theme, where these factors relate to efficiency and socioecological issues as criticism of excessive physical infrastructure development; appropriate and justice issues as criticism of physical infrastructure development that excludes marginalized groups; the comprehensive and inclusive concept of infrastructure as a critique of infrastructure development in a peace meal manner without looking at the wider context of sustainability; rooted development theme issues as criticism of imported development theme; prevent infrastructure failure as a criticism of the existence of a "copyrighted work monument" (the physical infrastructure that is only used as a monument, not utilized); considering the soft infrastructure concept as a criticism of infrastructure development that overrides the role of stakeholders, local culture, and community cohesiveness.

The elucidated factors hold great significance in the establishment of a theme for developing a smart and sustainable city. These factors pertain to the domains of efficiency and socio-ecological concerns, which expose the loopholes in the prevalent unbridled physical infrastructure development. The inappropriate and unjust infrastructural systems, which exclude marginalized communities, also require attention. Additionally, a comprehensive and inclusive infrastructure development approach is imperative, which should be viewed holistically in the context of sustainability, instead of being implemented piecemeal. The notion of rooted development is also critical and relevant, highlighting the drawbacks of an imported development theme. The need to prevent infrastructure failure, specifically in terms of the existence of publicly funded infrastructure, which falls into disuse and becomes a mere 'copyrighted work monument,' is equally significant. Finally, it is pertinent to consider the essentiality of soft infrastructure, which emphasizes the role of stakeholders, local culture, and community cohesiveness in infrastructure development, thus critiquing the existing notion of infrastructure that ignores these fundamental aspects.

Firstly, the author quotes Rushton's classical book about the optimal location of facilities in the era leading up to the 1980s, he explains that planning for public facilities is not only related to physical development and the supporting population who need it, but also the existence of other measures that can be the key to the success of the implementation of the public facilities. Specifically, he said that within the period sometime recently computers became by and large available to analysts and understudies, the standards of the area were understood, and were taught by the component of building speculative situations with basic characteristics and hypothesizing rules of behavior to run the show in that (Rushton, 1979).

Buildings and structures that support city life are very important, but we often don't notice them because we think they are normal. They are really important for the non-stop and moving life in cities in many different ways. This process works in many different places, from inside our bodies to the whole world. It includes things like how food and water get to the city, and how we travel and communicate with people in other countries. It also involves dealing with different kinds of waste. The process of globalization is talked about a lot, but it depends on very big and complicated systems of things like roads and buildings. Cities are the most important parts of these systems because they use the most energy, food, water, transportation, and communication. But cities also cause the most pollution and waste (Graham, 2010).

When things go wrong with buildings, roads, or technology, it can teach us about how cities work and the government policies that govern them. We can learn more about this when things are not working properly than when everything is running smoothly. When things go wrong in transportation systems, we can learn about how people and things move around in society. Sometimes when traffic stops or something breaks in a city, we can see that the infrastructure (like roads and buildings) isn't just made by engineers who only care about efficiency. Instead, it's influenced by politics, the environment, and society,

and it helps keep global capitalism going. When we closely examine infrastructural problems, we can gain insight that goes beyond just figuring out ways to prevent them from happening again or lessening their impact. The changes also give us a chance to think about and understand modern city living in new ways (Graham, 2010).

On the opposite end of the spectrum, Graham posits that maintaining a functional, sustainable infrastructure related to energy, communications, water, or transportation necessitates persistent efforts to ensure its seamless operation. Infrastructure networks have become ubiquitous in contemporary society, leading some individuals to overlook their significance. Additionally, the author referenced the statements of Jane Summerton, a sociologist, who asserts that there is a widespread tendency to overestimate the competence and dominion of infrastructure networks. It is postulated that the growth trajectory of the aforementioned entities will persist in a specific direction. However, it should be noted that these systems exhibit discernible weaknesses in terms of strength, stability, and predictability, ultimately challenging preconceived notions regarding their effectiveness. They exhibit a heightened susceptibility and are capable of unpredictable transformations.

Infrastructure networks may appear permanent and stable at times, but they are always at risk of being unstable or fragile. The connections between computer points need to be taken care of regularly to stay working properly. For a lot of people who live in cities, especially in poorer areas in countries in the Southern Hemisphere, getting access to electricity, water, or communication services is a struggle they face every day. They have to find ways to make it work. For city people, infrastructure networks are not mysterious boxes that magically bring electricity, Internet, water, or food to any place. Instead, these groups of things and actions are very influenced by politics. People in these groups might try to resist or take control, and this could allow them to customize services in ways that go beyond what's normally allowed by laws or the market (Graham, 2010).

The importance of infrastructure development, as well as the role of computer technology today, is illustrated by Graham's explanation below. Slowly but surely based on the process, this phenomenon is also happening in Indonesia. Infrastructure networks, despite their appearance of permanence and stability, are innately vulnerable to potential instability or fragility. The regular maintenance of interconnections among computer points is imperative to sustain optimal functionality. Obtaining access to essential amenities such as electricity, water, and communication services, constitutes a significant challenge for numerous urban dwellers, particularly in impoverished regions of countries located in the Southern Hemisphere. This reality poses an ongoing daily struggle for affected populations. Efforts must be made to devise strategies to ensure its efficacy. For urban residents, infrastructure networks are not enigmatic compartments that mysteriously provide electricity, Internet connectivity, water, or sustenance to any given location. However, it can be observed that these collectives of entities and behaviors are highly influenced by the intricate interplay of political factors. Individuals belonging to such factions may exhibit a proclivity towards defiance and appropriation, thereby allowing them to tailor services beyond the confines of regulatory statutes or typical market practices (Graham, 2010).

The present study emphasizes conducting a thorough review of the literature to address inadequacies in the discourse surrounding the significance of infrastructure in urban development, as highlighted by previous scholars such as Rushton (1979) and Graham (2010). By doing so, the study aims to prevent any potential shortcomings in the utilization of infrastructure in urban contexts. One aspect addressed in this paper pertains to the inclusion of soft infrastructure in the development of city infrastructure, as underscored by Turner (2020). With the contemporary trend of smart city development, there is an increasing emphasis on the advancement of technology, highlighting the necessity for soft infrastructure to be seamlessly integrated into the overall development strategy. The perspective of urban planners regarding the smart city concept should encompass a broader range of considerations, including the diverse stakeholders, their respective roles, and competencies.

2. Methods

The utilization of qualitative methodology in the assessment of literature on soft infrastructure encompasses a process of analyzing and interpreting non-numeric information, including text, images, and videos, as a means of obtaining insights into the attitudes, perceptions, and experiences of individual

persons or groups. However, in practice, video data was not used as the main consideration in writing this paper. This approach proves to be highly advantageous in conducting a comprehensive analysis of literature relevant to the subject matter of soft infrastructure, encompassing an array of cognitive, emotional, social, and relational assets that reinforce the capacity of the community to withstand and recover from adverse circumstances. Qualitative data analysis tools, exemplified by processes such as content analysis, thematic analysis, and narrative analysis, may be employed to extract patterns, themes, and meanings from a given body of literature. The methodology entails the identification of pertinent scholarly works, procurement of data, classification of data through coding, and integration of resultant discoveries. The objective of this study is to furnish a thorough and intricate comprehension of the soft infrastructure that upholds crucial infrastructure systems. Qualitative assessments scrutinize outcomes within multiple frameworks to gauge the efficacy of the supple infrastructure in promoting resilience. The manuscript aims to present a structured and methodical synthesis of prior research, employing a predetermined search protocol that distinguishes it from conventional literature reviews. In general, utilizing the qualitative approach to evaluate the literature about soft infrastructure leads to a comprehensive and meticulous comprehension of the intricate and evolving characteristics of the soft infrastructure that reinforces crucial infrastructure systems. In practice, there are several tools used for writing this paper, such as a website to map, classify, and see trends in scholarly works.

2. Result and Discussions

This section discusses the findings ascertained through an in-depth scrutiny of the scholarly works concerning the discourse on soft infrastructure in smart sustainable cities. The present section is a reflection of the outcomes obtained from the literature review discussed in the preceding section. It is observed that six distinct sub-discussions have been identified, including Soft Infrastructure Issues, Smart Sustainable Cities Issues, the Relationship between Soft Infrastructure and Urban Development, Smart Sustainable Cities and Sustainable Development Goals, Clustering Research on Soft Infrastructure in Smart Sustainable Cities, and the concluding discussion on the Components of Soft Infrastructure in Smart Sustainable Cities.

Optimal Location of Facilities

In the early stages of formulating the principle of optimal facility location, the decisive factor in providing public facilities was perceived to be the geographic proximity and strategic positioning of said facilities. In this instance, there exists a correlation between the physical distance element and the expenses associated with the construction of hard infrastructure. Concurrently, the prioritization of public infrastructure development is directed towards physical public facilities.

The matter of efficiency concerning the provision of public facilities has recently gained the attention of erudite professionals. This can be observed in the discourse about a genetic algorithm intended for the identification of optimal locations for mining facilities, as put forth by Kumral (2004). In a different scenario, it is said that Witzgall has made noteworthy contributions to the fields of applied mathematics and operations research, with a particular emphasis on the optimization of facility location. During the period leading up to the 2010s, research about the ideal placement of public amenities began to incorporate the consideration of soft infrastructure, including the utilization and deployment of technology to enhance and improve public services. Thus, the study conducted by Shiode et al. (2012) delves into the significance of customers in the context of facility utilization.

It can be deduced that from the outset of the progress of the optimal facility location theory, paramount importance has been given to the notion of advancing a system of urban expansion hubs that depend on infrastructural components and technological advancements. Concurrently, the aspect concerning the evaluation of the level of efficacy of the network and growth centers toward enhancing the quality of life within the community has yet to be given deliberate consideration.

Disrupted Cities

A key issue in the debate around disrupted cities is the lack of investment in physical infrastructure for public amenities, as noted by Graham (2010). A thorough analysis of public amenities with a focus on geography and sociology is exemplified in the exploration of the development of a supermarket in Harlem which saw active involvement from the community leading to its triumph. The significance of local knowledge in designing public amenities post-2010s is highly valued, particularly in the context of traditional urban models that have the potential to promote social inclusivity and long-term sustainability within cities (Steinbrückner & Lewerentz, 2012). To increase effectiveness, it is possible to systematically observe the expansion of cities by utilizing specialized software. The previously mentioned study was conducted by a group of researchers in 2012. In the post-2010 era, hives for the development of smart cities have also become the subject of discussion in disrupted cities in the era after the 2010s. A study of world-class cities using a smart city approach in the form of runtime conflict detection and resolution challenges shows how projects with 'world-class cities' ambitions are speculative and will worsen issues like spatial inequality and environmental damage (Ma et al., 2016). Finally, innovative efforts are needed in managing urban development as the increasing population and climate emergency (Glass, 2012; Graham, 2010) are influential, as well as Allam and his colleagues (Allam et al., 2022).

Optimizing Optimization and Engineering Optimization

About the discourse surrounding the most suitable positioning of facilities, there exists a cohort of professionals who offer insight into this facet of optimization from a quantitative and engineering perspective. These insights often serve as technical considerations for optimization implementation in the field, encompassing matters such as the optimal positioning of facilities. At present, there exist no less than two scholarly publications that delve into the topic, these being Optimizing Optimization (Satchell, 2010) and Engineering Optimization (Rao, 2009). In the present discourse concerning the optimization of optimization, antecedent literature has underscored the importance of maximizing efficiency, leveraging resources, managing portfolios, and employing effective methods. Subsequent scholarly works have placed greater emphasis on optimizing efficiency and forecasting future estimations. In the discourse about engineering optimization, former literary works have underscored the significance of functions, algorithms, reduction, and the formulation of methodologies. Subsequent publications have placed greater emphasis on enhancing optimization through the development of methodologies and algorithms.

In general, Satchell explained that the comprehensive evaluation of optimization rarely encompasses a worldwide and impartial perspective on its practical components. Stephen Satchell has presented a sophisticated compilation of technical discussions related to optimization packages offered by developers, as well as current optimization practices and theories posited by scholarly researchers. This comprehensive assembly provides a valuable source of practical solutions that can be applied to the current economic landscape, which has been impacted by the aftermath of the liquidity bubble. The commercial sections of the discourse place emphasis on the algorithmic components in a manner that abstains from any sales-oriented approach, while the academic segments establish relevant frameworks and investigate potential avenues for advancement. Collaboratively, they proffer a perspicacious outlook that extends toward novel products, innovative methodologies, and original solutions within the realm of quantitative finance (Satchell, 2010).

Newer book on engineering design optimization (Martins & Ning, 2021), engineering optimization (Rao, 2009) provides a comprehensive guide for readers seeking to swiftly comprehend and implement a host of crucial optimization techniques utilized today throughout various industries. This academic text comprehensively addresses contemporary and traditional optimization techniques, commencing with fundamental concepts and systematically augmenting the reader's understanding with advanced principles and practical implementations. This exhaustive treatise encapsulates a comprehensive range of programming techniques encompassing nonlinear, linear, geometric, dynamic, and stochastic methodologies. It also delves into more specialized approaches, including multi-objective programming, genetic algorithms, simulated annealing, neural networks, particle swarm optimization, ant colony optimization, and fuzzy optimization. Each method is elucidated clearly and straightforwardly, thus rendering the more advanced techniques comprehensible even to novice readers. In addition,

engineering Optimization is a highly suitable course for advanced undergraduate and graduate students in mechanical, civil, electrical, chemical, and aerospace engineering due to its focal point on problem-solving and practical applications. Furthermore, the textual material serves as a valuable resource for practicing engineers across diverse industrial sectors by providing insights into the design of enhanced and cost-effective systems.

Soft Infrastructure

The discussion of soft infrastructure is relatively new, the following is his review according to Colin Turner in Chapter 6 in the book The Infrastructured State. Territoriality and the National Infrastructure System (Turner, 2020). As Turner interpreted from Niskanen's presentation in 1991, soft infrastructure, was regarded as the fundamental institutional structure that forms the basis for the functioning of an economic, political, and/or social system. With time, the conception of soft infrastructure has undergone refinement to emphasize its function as a facilitator for the implementation and utilization of hard infrastructure. The domains of transportation, energy, and information are closely intertwined, with the former providing a foundation and structure for the latter's development, progression, and utilization. In recent years, the importance of soft infrastructure within national infrastructure systems (NISs) has become increasingly prominent. This is because NISs have evolved into complex polycentric systems with a combination of state and non-state ownership, and as such, shifts in the form and magnitude of flows within and between NISs have significantly influenced their utilization.

Smart Sustainable Cities

The Case of the United Nations Economic Commission for Europe (UNECE) defines smart sustainable cities as innovative city that uses ICTs and other means to improve quality of life, efficiency of urban operation and services, and competitiveness while ensuring that they meet the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects (The United Nations Economic Commission for Europe [UNECE], n.d.). Through an examination of global publications accessed via the online platform www.lens.org, about the subject area of intelligent and sustainable urban centers, a visual representation in the form of a word cloud is hereby presented herein. The analysis of the word cloud suggests that smart sustainable cities are associated with the concept of innovation, which leads to the production of products that compete with one another. The results indicate that the majority of the keywords pertain to business (8,587), followed by engineering (6,160), as it pertains to the efficient and effective resolution of innovative challenges. The forthcoming keyword under consideration is 'smart city', which possesses a frequency of 5,043. The presence of this keyword indicates that the discourse surrounding smart cities is intertwined with that of smart sustainable cities. However, it should be noted that the conceptualization of smart cities has not necessarily incorporated thorough inquiries into sustainability. It may be posited that the discussion centering on smart sustainable cities is more closely aligned with the domains of business and engineering, in comparison to that of smart cities. An alternative inference that may be posited is that smart cities tend to conduct individualized analyses of cities in a specific context, whereas smart sustainable cities take into account a broader spatial framework that encompasses regional constellations. The topic of smart sustainable cities is intricately linked to the field of political science (4,584), due to its focus on the participation of relevant stakeholders and the governance policies at play. Subsequently, the secondary most salient term, with a count of 4,503, is sustainability. This tally suggests that the discourse about smart sustainable cities extends beyond the confines of individual cities within the regional grouping, and encompasses aspects of sustainability, governance, business, and engineering.

Soft Infrastructure in a Smart Sustainable City

The significance of soft infrastructure lies in its impact on the accomplishments of smart cities. Although hard infrastructure, such as roads, buildings, and utilities are critical components of urban development, it is the soft infrastructure that enables the smooth integration of technological advancements and the effective provision of services. Soft infrastructure comprises a diverse array of

elements, involving education, governance, social welfare, and community participation. To comprehensively reap the advantages of a smart city, municipalities are required to prioritize the development of both tangible and intangible infrastructure. Investing in soft infrastructure is regarded as imperative by cities to facilitate the development of a sophisticated workforce equipped with the requisite skills to harness cutting-edge technologies for addressing intricate issues. Furthermore, soft infrastructure plays a crucial role in ensuring equitable provision of resources and services to all individuals, irrespective of their socioeconomic status. In light of the rapid urbanization trend observed worldwide, it is imperative that modern cities put significant emphasis on the incorporation of soft infrastructure within their smart city planning endeavors. Furthermore, the improvement of soft infrastructure has the potential to augment the involvement and engagement of citizens in urban decision-making procedures. In order to effectively address the complicated challenges of the present world, the establishment of sustainable and resilient smart cities necessitates the paramount importance of soft infrastructure. Soft infrastructure is a crucial element within the context of smart cities in that it facilitates harmonious integration of technological advancements and enables proficient administration of services. The allocation of resources towards education, governance, social services, and community involvement has the potential to cultivate a proficient workforce that possesses the ability to employ sophisticated technologies for the purpose of tackling issues, while simultaneously guaranteeing just and equal access to resources and services for all members of society.

The implementation of this planning strategy holds the potential to bolster citizen participation and engagement in urban decision-making processes, ultimately paving the way toward the development of smart cities that are sustainable, resilient, and capable of effectively addressing multifaceted challenges. The integration of soft infrastructure with hard infrastructure has the potential to exert a substantial influence on the achievement of smart city initiatives.

Through prioritization of investment in hard and soft infrastructure, smart cities can capitalize on the most modern technological advancements to enhance their economic, environmental, and social efficiency. Consequently, municipalities are called to direct their efforts towards the enhancement of not only their tangible infrastructure but also towards the advancement of academic institutions, healthcare amenities, and other crucial provisions that can effectively augment the standard of living for their entire populace. The complete potential of smart cities can only be achieved with the existence of a sturdy and durable soft infrastructure. Thus, municipal planners and policy makers must accord topmost priority to the development of physical and non-physical infrastructure components for the efficient establishment and implementation of intelligent cities. The enhancement of the infrastructure in smart cities must be supplemented by the adequate preparation of human capital, given their crucial role in the implementation and utilization of sophisticated technologies to enhance societal well-being. To conclude, the implementation of a smart city approach focused on the welfare of its inhabitants and emphasizing the strengthening of intangible infrastructure can potentially drive a rise in citizen participation, enhance economic productivity, and improve overall standards of living across all resident groups. The integration of both tangible

Figure 1. World Cloud on Smart Sustainable Cities

Source: Analysis through www.lens.org (04/05/2023)

and intangible components of infrastructure is crucial for the effective development of intelligent urban areas. Moreover, urban centers need to pursue the establishment of an open data ecosystem that fosters intelligent mobility and facilitates other catalysts of intelligent city undertakings. In regard to the advancement of intelligent cities in the future, the establishment of energy-efficient smart cities is currently experiencing noteworthy traction. Integrating renewable energy sources with smart technologies represents a viable approach for mitigating energy-related challenges and decreasing carbon emissions in urban environments. By embracing a comprehensive and strategic planning approach, intelligent urban centers possess the capacity to effectively tackle the multifaceted issues that currently confront them. The strategic approaches towards developing smart cities may exhibit significant differences, stemming from various factors such as the level of governance - national or local, as well as concerning the type of city - new or existing. Furthermore, there exists variance between hard and soft infrastructure-oriented strategies, in addition to the choice between sector-based or geographically based strategies. To succeed, a smart city must attain equilibrium among all constituent parts of its ecosystem and adopt a comprehensive approach toward infrastructure development. Furthermore, it is imperative to uphold a worldwide outlook on the advancement of intelligent urban areas, particularly in light of their increasing size and intricate nature.

The acknowledgment of the current neoliberal rationale underlying the development of smart cities, which prioritizes technological consumption and the optimization of profits, is crucial. This line of reasoning has the potential to perpetuate inequalities and impede accessibility for specific segments of the populace. Henceforth, it is of pivotal significance to contemplate equity and inclusion as fundamental constructs in the advancement of smart cities. In the context of urban development, it is widely acknowledged that pedestrians occupy a crucial position in the spatial ecology of a city. Therefore, the provision of lucid information and signage for pedestrians is deemed imperative for the successful implementation of sophisticated infrastructure projects that cater specifically to their needs.

Infrastructure development relates to strategic activities with broad impact to encourage economic growth and infrastructure financing, as well as businesses related to consumers and producers. Therefore, it is not only the physical development of infrastructure that is focused but also the preparation of human resources that are relevant to needs. Another important thing is the discussion about the importance of government governance in ensuring the activities of its citizens so that they run more smoothly and with quality. The government's role cannot be separated from encouraging the creation of sustainable development with the support of the active participation of its citizens. The following are some relevant recent publications. Study by Portugal-Perez and his colleagues estimates the impact of aggregate indicators of “soft” and “hard” infrastructure on the export performance of developing countries. Although public infrastructure plays a critical role in attracting Foreign Direct Investment (FDI), identifying the effect remains a challenge largely due to the econometric challenges involved in cross-country analyses (Portugal-Perez & Wilson, 2012). Meanwhile, Chakrabarti and his colleague identified this effect by employing a unique dataset of FDI at the district level in India, which has become one of the largest destinations of FDI in recent years. Arguably, countries with good infrastructure will have lower trade costs and aim at shedding light on the role of infrastructure towards trade costs by grouping infrastructure into four types. These spaces provide support (moral, emotional, professional, financial) and facilities (infrastructure) to enable entrepreneurs to start and grow their businesses (Ramli & Ismail, 2014). Related to innovation in the field of business, Fuzi wrote a publication that aims to provide an empirical exploration of whether co-working spaces can promote entrepreneurship in regions with sparse entrepreneurial environments by creating the hard infrastructure particularly designed in such a way that the soft infrastructure necessary for entrepreneurship can also emerge (Fuzi, 2015). Because soft infrastructure is related to the business side, there are also related publications that discuss demand-side solutions, as a crucial class of mitigation options that go beyond technological specifications and cost-benefit analysis (Creutzig et al., 2016). Likewise the discussion on the government's role in promoting economic growth and the availability of resources, this is illustrated in the following publication. Lin and his colleagues explore the ideas of development and the role of the state in economic development and institutional change from the New Structural Economics perspective. Utilizing participatory action research methods at the intersection of industrial ecology and design (Lin & Wang, 2017). Other publications are about resources in a broader context, as written by Nogueira et al. (2020). He and his colleagues developed a new framework and a model for considering and allocating the variety of resources that organizations utilize when creating value for themselves, society, and the planet.

Sustainable Development Goals

The Sustainable Development Goals (SDGs) comprise a worldwide framework of 17 primary objectives and four pillars aimed at promoting sustainable development. The attainment of this objective necessitates concerted efforts from diverse stakeholders, encompassing governmental bodies, local communities, and commercial enterprises. In contemporary business practices, diverse corporations commonly adopt the Sustainable Development Goals (SDGs) as a pragmatic framework to guide their social responsibility initiatives. Numerous enterprises have utilized the Sustainable Development Goals (SDGs) as a framework to govern their business operations. In order to facilitate comprehension of the Sustainable Development Goals (SDGs), four overarching pillars have been identified to encompass the 17 distinct agenda points.

- Pillars of Social Development. This pillar includes points (1) No Poverty, (2) No Hunger, (3) Healthy and Prosperous Life, (4) Quality Education, and (5) Gender Equality. In essence, the goal is to achieve fair and equal quality fulfillment of basic human rights to improve welfare for the entire community.
- Pillars of Economic Development. This pillar covers (7) Clean and Affordable Energy, (8) Decent Work and Economic Growth, (9) Industry, Innovation, and Infrastructure, (10) Reducing Inequalities, and (17) Partnerships for Goals. In essence, the aim is to achieve quality economic growth through sustainable employment and business opportunities, innovation, inclusive industries, adequate infrastructure, affordable clean energy, and supported by partnerships.
- Pillars of Environmental Development. This pillar includes points (6) Clean Water and Adequate Sanitation, (11), Cities and Settlements, (12) Responsible Consumption and Production, (13) Climate Change Management, (14) Marine Ecosystems, and (15) Ecosystems Land. In essence, the aim is to achieve sustainable management of natural resources and the environment as a support for all life.

Pillar of Law and Governance. This pillar includes points (16) Peace, Justice, and Strong Institutions. In essence, the aim is to create legal certainty and governance that is effective, transparent, accountable, and participatory to create security stability and achieve a state based on law.

Soft Infrastructure Issues

The present study aims to analyze Colin Turner's scholarly contributions on the concept of soft infrastructure, as outlined in his 2020 publications, in the context of related research findings. In order to achieve this, an analytical tool provided by "Connected Papers" has been utilized to establish the interrelationships between various academic journals. The outcomes of this endeavor help in delineating the salient themes of the pertinent literature germane to soft infrastructure, alongside the sub-theme of derivative works concerning Turner's latest theoretical accounts on this subject.

- The literature from Prior Works spanning the years 1999 through 2010 demonstrates that during the initial phases of discourse surrounding soft infrastructure, attention was directed towards studentification, particularly in urban centers. Subsequently, attempts were made to draw connections between studentification and gentrification. The provided literature suggests that the primary apprehension regarding soft infrastructure pertains to competencies, agents of change, spatial configurations, and their representation, efficacy, and management of urban municipalities.
- Scholarly journals derived from soft infrastructure expound upon the correlation between a stakeholder, namely the phenomenon of studentification, and the revitalization of the locale in a deliberate and enhanced manner, initiated at the neighborhood level. In this instance, the discourse concerning soft infrastructure may be linked to the enduring notion of the neighborhood unit as well as planned unit development. This is due to the fact that it strives to effectuate change at the micro-level, to transform the locale. A variety of cases has been discussed, encompassing regions such as Latin America (specifically Chile), Asia (in particular Malaysia), and Canada. The present study infers that the derivative works shed light on the phenomenon of regional transformation, which can be attributed to the proactive and

affirmative endeavors of stakeholders in establishing an innovation ecosystem. This innovation ecosystem is considered to yield favorable implications, including but not limited to the optimization of benefits and efficacy in the process of regional development planning.

Meanwhile, based on the results of an analysis of recent publications on soft infrastructure, it can be interpreted that there are the following important points:

- Discussions on soft infrastructure are becoming increasingly significant in countries in Asia that have limited records of providing infrastructure, especially in terms of management models and opportunities for cross-country infrastructure development to promote regional economic growth in a more equitable manner. Not only road infrastructure, but also telecommunication, energy, and air traffic infrastructure (Setunge & Kumar, 2010). In addition, other publications explain that specifically for the ASEAN context, infrastructure development is inseparable from business considerations, namely in the case of ASEAN in terms of global direct distribution and integration (Bhattacharyay, 2010), where there are market and global supply chain factors in it (Su et al., 2011).
- Discussions about infrastructure are not only in the realm of technical engineering such as road construction, improving public services, and business development opportunities (Ghosal, 2013), but there are also broader considerations because infrastructure development is closely related to urban economies, the strategic side planning and cultural policies are important factors for finding systemic problems (Raymond & Falk, 2018) or even better implementation of infrastructure planning (Chen et al., 2011), Another related matter is the about under-utilized infrastructure to bring benefits to a region, such as the case of under-utilized power which considers the information to enhance the Asian tourism sites and attractions (Pearce & Wu, 2015).
- Soft infrastructure touches on the power role of community members, especially in understanding the characteristics of citizens and encouraging empowerment, not only in urban areas but in rural areas with the main activity being agriculture (Nesamvuni et al., 2016). Another side of power that is closely related to soft infrastructure is related to conflicting policy preferences, resource allocation, and administrative tensions (Dolšak & Prakash, 2018). This can also be input in the use of technology, especially the development of computer technology, due to the fact that soft computing techniques are tolerant of imprecision, intended on approximation, focus on uncertainty, and are based on partial truth (Rath & Pati, 2020).

Smart Sustainable Cities Issues

The discourse of smart sustainable cities is a manifestation of the dialogue pertaining to smart cities, which posits that a city imbued with a smart ethos can progress autonomously in relation to its surroundings. Additionally, the terminology of "smart" is ordinarily assumed to encompass a sustainable disposition. The correlation between the growth and advancement of a city and its interaction with the encompassing region is unequivocal. Such interdependence arises because a city cannot suffice its citizens' necessities solely from within its boundaries, nor can it autonomously produce by-products resulting from urban development, such as waste and garbage. In the event that a city's development is executed without considering the interactions with its proximate environs, for a comprehensive and far-reaching outlook, it is a judicious decision to employ the terminology "smart cities" in reference to the interconnected surrounding areas, rather than "smart city" as individual entities. The proliferation of technology, stemming from the advent of "smart city" initiatives, often necessitates considerable financial resources and can impose significant strain on energy consumption, surpassing available capacity. The inclusion of the term "sustainable" in relation to smart cities underscores the assurance that contemporary advancements in products, enabled by technology, are conscientious of sustainability throughout the entirety of the modeling, development, implementation, maintenance, and monitoring processes while taking into consideration the unique societal circumstances.

As an illustration of the latest discussion on smart sustainable cities, several important points can be drawn, including:

- The development of the smart city concept should be in accordance with the planning process, consideration of the environment, as well as environmental technologies (Gabrys, 2014). In addition, it is appropriate for the smart city concept to be explained more clearly (Höjer & Wangel, 2015) through indicators and development sectors and their impacts, thus choosing the smart city concept will be more valuable when it is selected as one of the urban development scenarios (Ahvenniemi et al., 2017).
- The development of the concept of smart sustainable cities is relevant for anticipating future cities, so it requires the involvement of various fields of knowledge (interdisciplinary), including research at higher education (up to the doctoral level) regarding research gaps that have not been studied on the theme of smart sustainable cities, especially the broad research the field of sustainability transition and sustainability science where ICT is seen as a salient factor given its transformational, disruptive, and synergetic effects as an enabling, integrative, and constitutive technology. The research idea to fill in the gap is to investigate and analyze how to advance and sustain the contribution of sustainable urban forms to the goals of sustainable development with the support of ICT of pervasive computing (Bibri, 2018b). The next research Bibri is to develop state-of-the-art sensor-based big data applications enabled by the IoT for environmental sustainability and related data processing platforms and computing models in the context of smart sustainable cities of the future (Bibri, 2018a).
- The gap regarding sustainability is still interesting to talk about in the realm of smart cities, especially when formulated in computer modeling because the smart theme is very closely related to the theme of modern city development (Yigitcanlar et al., 2019). Therefore, it is appropriate that the smart city concept can provide guidance for city managers and policy makers to select the indicators and standards that best correspond to their assessment needs and goals, and align with their stage in Smart sustainable city implementation (Huovila et al., 2019).

Soft Infrastructure and Urban Development

General information about the relationship between soft infrastructure and urban development can be found in the writings of Brian H. Roberts from the University of Canberra in one of the Cities Alliance reports entitled Connecting Systems of Secondary Cities. The report contains a description of the roles and functions of secondary cities in regional constellations, in which there are inter-regional urban linkages. In this publication, advancements in the physical accessibility domain, attributable to the augmentation of transportation infrastructure systems, do not ensure a concomitant rise in local and regional populace, nor do they necessarily lead to ameliorated economic performance, as evidenced by the ESPON report of 2016. The importance of establishing physical connectivity cannot be overstated; however, the complementary soft infrastructure of social and digital networks also holds great significance. The dichotomization of connectivity into discrete hard and soft components, though valuable, fails to acknowledge the criticality of interdependence existing between the two. These two concepts are not mutually exclusive. The scope and dimension of both rigid and pliant infrastructure ought to be ascertained in consideration of eventual exigency, technological advancement, vulnerability, and other foreseeable transformations. The improvement of connectivity as a means of aiding the economic growth of secondary cities and larger urban centers requires policy-makers to grasp the interdependence between hard and soft connectivity components. Effective facilitation of the development of these elements by governments is critical to the integration of said components. In addition, soft infrastructure has a broader meaning than just software, because soft infrastructure touches the physical side, it also anticipates the city of the future by including the virtual side in it. Another interesting thing about this soft infrastructure is that there is attention to the side of people in general, but an increase in the innovation ecosystem and the competence of community members.

In the context of the latest academic journals, there are several highlights that connect soft infrastructure and urban development, here are some important points:

- Soft infrastructure relates to efforts to improve urban problems not only from the physical side but touches on the financing side, such as urban infrastructure issues such as environmental

improvement, also relates to the adequacy of basic infrastructure services, such as water in developing and the developed countries (Hiraishi & Tadenuma, 1998).

- Soft infrastructure encourages the development of models, including the agent-based model to formulate innovations in terms of efficiency in the provision of public services and related actors, as well as innovation management model tools for the adequacy of infrastructure provision (Setunge & Kumar, 2012).
- The discussion on soft infrastructure is relevant to the role of technology in improving the quality of life of city residents, such as telecommunication networks and trends in convergence technology (Yigitcanlar & Han, 2010).
- The discussion on soft infrastructure also relates to the realm of policy as well as the need to analyze a framework to measure soft assets (Grigg, 2012).

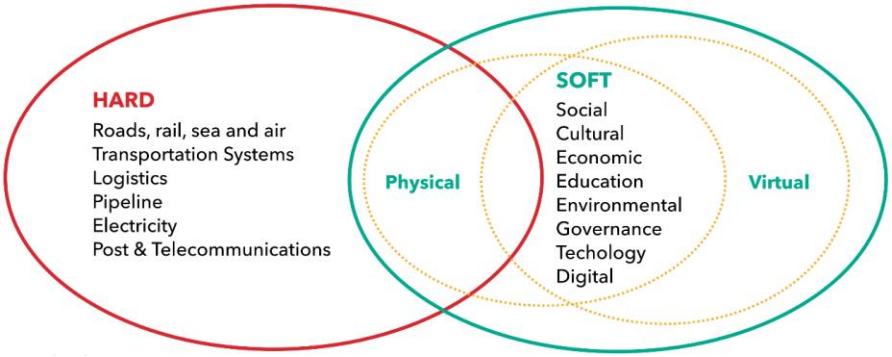

Figure 2. The framework of the interrelationship between hard and soft connectivity and network infrastructure

Source, Cities Alliance, 2019.

Smart Sustainable Cities and Sustainable Development Goals

As stated in the literature review, the SDGs in Indonesia are grouped into four pillars, namely the pillars of social development, the pillars of economic development, the pillars of environmental development, and the pillars of law and governance. Based on the grouping of SDGs in Indonesia, the author proposes the following framework. Social development is very contextual to the condition and diversity of natural and human resources in Indonesia along with various problems that must be resolved. Meanwhile, economic development places more emphasis on innovative efforts to increase economic added value, both comparative and competitive advantages to solve challenges and various kinds of social problems that exist in the pillars of social development. Meanwhile, environmental development places more emphasis on various innovations to improve the quality of human life, especially efforts to fulfill basic needs without damaging the environment. Meanwhile, law and governance development are binding for all pillars because sustainable development must be agreed upon in an appropriate legal framework and governance.

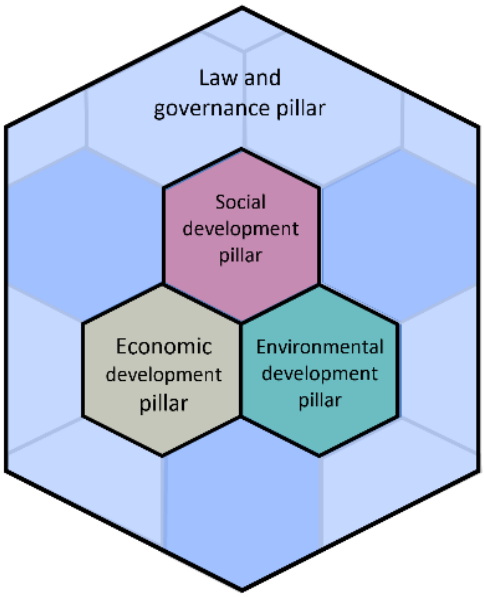

Figure 3. Smart Sustainable Cities and Four Pillars Sustainable Development Goals

Source: Analysis, 2023

Taking a cue from Europe, UNECE has directed its focus towards smart cities and has conceived the idea of sustainable and intelligent urban settlements for people of

all generations. The Indonesian context can be enhanced by the combination of this concept with the four pillars of the SDGs. The ECOSOC (United Nations Economic and Social Council) established the UNECE (United Nations Economic Commission for Europe) in 1947. The primary goal of UNECE is to facilitate economic integration across Europe as a whole. The UNECE encompasses 56 countries throughout Asia, North America, and Europe as its member states. Nevertheless, the UNECE welcomes the participation of any United Nations member countries who express interest in their activities. More than 70 professional organizations and NGOs from around the world are involved in the operations of UNECE. For the case in Europe, UNECE is not like Indonesia which previously grouped the SDGs into four pillars, They immediately chose certain SDGs (eight selected SDGs) to be included as the essence of sustainable and smart cities for all ages, namely: SDGs 03, good health and well-being; SDGs 06, clean water and sanitation; SDGs 07, affordable and clean energy; SDGs 08, decent work and economic growth; SDGs 09, industry, innovation and infrastructure; SDGs 11, sustainable cities and communities; SDGs 12, responsible consumption and production; and SDGs 13, climate action;

The interpretation that can be drawn from the selection of the SDGs when compared to conditions in Indonesia is that the effort to create a better quality of life by carrying out the theme of sustainable and smart cities for all ages, is an inclusive side in solving urban problems, in addition to trying to solve problems These are based on strategic basic points, such as relating to public health (SDG 03) because they are influenced by the experience of a pandemic, provision of basic needs in the form of clean water (SDG 06) as well as energy (SDG 07). Interventions on these three things are expected to create a better working ecosystem so that it has a positive impact on economic growth (SDG 08), as well as various innovations that can increase the problem of providing innovative infrastructure and have a positive impact on the growth and development of environmentally sound industries (SDG 09). Cities are considered engines of growth and agents of change as centers of civilization, so that smart, inclusive, and sustainable efforts can start in urban areas and spread to the surrounding areas as a reflection of equitable development (SDG 11). One more SDG that was chosen was for reasons of urgency because it is to anticipate climate change and various kinds of disasters, namely climate action (SDG 13). In addition, it seems that because Europe already has adequate law and governance, and there is also an agreement to jointly carry out a partnership in resolving common problems, SDGs 16 and 17 were not selected.

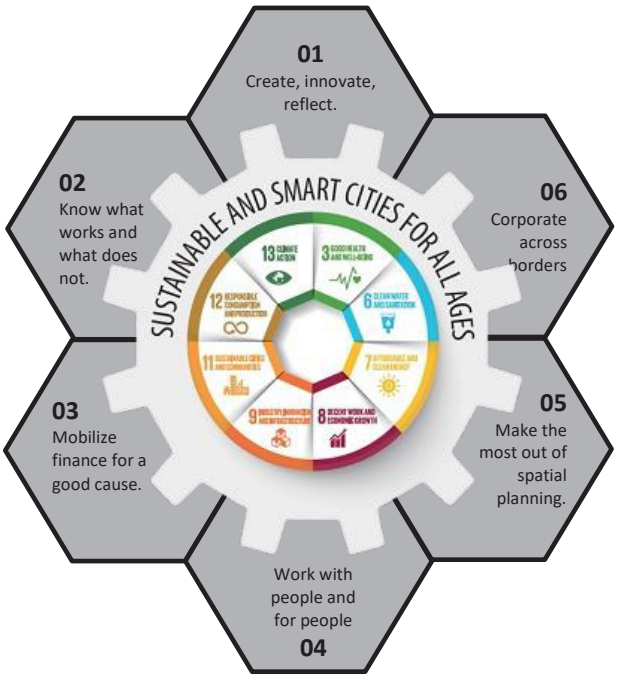

Figure 4. The Challenge in Developing Sustainable and Smart Cities for All Ages

Source: UNECE, and Analysis, 2023

Although the national development planning system policy does not mention the obligation to use smart city terms, the idea of a smart city is becoming more popular in Indonesia because it uses technology to solve problems. Urban planners need to redefine the idea of what a smart city is. They should focus on supporting citizens to learn and come up with new ideas to solve problems in Indonesian cities. A sustainable city needs to focus on three important things: sustainability, inclusiveness, and resilience. Based on this, there will be eight suitable chosen SDGs. Adding the word sustainable to a smart city to make it a smart sustainable city is important to show that it is not just about technology, but also about taking care of the environment and serving the public's needs. This includes eco-consciousness and eco-friendliness, viability, continuity, feasibility, and maintainability. The UNECE publication uses the term

"smart sustainable cities" which aligns with eight specific goals. To achieve these goals, the following steps can be taken:

- Create, innovate, reflect. This first step shows that the assumption of a smart city is not one city as a single entity, but a complex urban system that is represented in a metropolitan area. Metropolitan areas are compelled to establish a robust facilitating circumstance. The process of innovation entails a degree of uncertainty and risk, leading to a state of indeterminacy whereby it becomes impracticable to predict with certainty the outcome of a particular endeavor. The aforementioned statement denotes a significant deviation from the conventional approach to governance, which is primarily founded upon the formulation of quinquennial plans, regulatory frameworks specific to technology, banking on the status quo of the existing economic landscape, and adherence to the entrenched legal, institutional, and cultural heritage. Such a paradigm shift warrants closer scrutiny and analysis. Cities are encouraged to shift their approach from a hierarchical framework to a decentralized one, emphasizing innovation. In this new paradigm, the city conceives of itself as a facilitator, overseeing ongoing developments, and proactively intervening when beneficial. Additionally, it assumes responsibility for monitoring and assessing the outcome of its interventions in a thorough and ongoing manner. Despite the prevalence of "best practices," it remains uncertain whether they are universally applicable or viable in disparate contexts, particularly in situations where the motivating factors that undergird their success are absent.
- Know what works and what does not. It is of notable significance that policies ought to be formulated to facilitate comprehensive evaluation. This evaluation ought to deliberate upon the efficacy of measures implemented, shortcomings in their implementation, and the capacity to discontinue unsuitable ones, thus circumventing unprofitable and perpetual situations. In the process of deliberating potential avenues for urban development, it bears equal significance for cities to identify and navigate routes to be avoided. It is imperative to refrain from adopting fresh major decisions solely based on past practices and prevailing infrastructure. The phenomenon frequently arises whereby maintaining established customs perpetuates an ineffective state of affairs and facilitates the reinforcement of unsustainable methodologies.
- Mobilize finance for a good cause. Public procurement drives sustainable development by creating demand for innovative solutions. Local policies can encourage sustainable activities and discourage unsustainable ones, such as transport fees, parking charges, congestion fees, taxes, and development costs. City responses to sustainability challenges are limited by fiscal capacities and autonomy. Although smart-city technologies are cost-effective, comprehensive policies require significant capital. Cities need sustainable revenue sources and can seek private sector help through partnerships for energy projects. National governments must provide sufficient resources for local and regional governments through effective taxation work with people and for people.
- Work with people and for people. People-smart cities prioritize consistent and purposeful interactions with citizens, the private sector, and stakeholders. To achieve Sustainable Development Goals, governance should prioritize fostering urban centers as hubs of idea propagation through adaptive multi-stakeholder approaches. Promote transformative thought and investment, empower and engage stakeholders in decision-making. This message aims to inform and work with the local community to ensure the successful implementation of new strategies. The main question regarding civic engagement is whether people can initiate change and shape cities according to their wishes, leading to empowerment and a sense of accomplishment. The inquiry is about whether residents have access/control over the urban environment or if these rights are monopolized by a select group. Make the most out of spatial planning.
- Make the most out of spatial planning. Spatial planning integrates sectors and urban systems into a localized SDG strategy. Planning is the one academic discipline that integrates specialized knowledge and provides a holistic context for society, and this context in Indonesia can be seen in Law no 25 of 2004 concerning the national development planning system. There is planning at the macro level to the micro level, there is also sectoral and spatial planning. Planning systems vary by country, but they usually have spatial planning instruments that are organized

hierarchically at different levels: national plans, regional plans, city plans, and building plans. National planning is crucial for reducing regional inequalities and improving connectivity, Regional planning guides land use, infrastructure, connectivity, and environmental management. Not only for the context of European countries, this is similar to what happened in Indonesia. Urban planning is vital for sustainable cities and involves considerations such as design, aesthetics, transit, services, and infrastructure. This is also similar to what happened in Indonesia Indonesia has new laws and regulations after the issuance of the Omnibus Law, not only regulations regarding the implementation of spatial planning but also how to guide the preparation and evaluation, as well as planning licenses.

- Corporate across borders. Cities face externalized issues that demand multi-level and horizontal cooperation. This includes coordinating territorial regions across municipal borders, transboundary cooperation among cities, exchanging information and learning, and standardization of product requirements and technological protocols. Various initiatives, projects, and processes transcend administrative boundaries (e.g. infrastructure or public transport). Geneva has a cross-border administration with a delegate from Swiss and French municipalities. They oversaw the Leman Express, Europe's widest cross-border regional railway network. The same thing happened in Indonesia, even during the era of President Joko Widodo There has been massive infrastructure development to expand connectivity between regions so that activities and logistics systems can be more competitive which in turn can accelerate national economic growth. Infrastructure development is no longer monopolized by Java Island but also by other regions in Indonesia, including plans to relocate the nation's capital to East Kalimantan Province.

Clustering Research on Soft Infrastructure in Smart Sustainable Cities

This section illustrates the clustering of research by analyzing worldwide publications about soft infrastructure in cities that are smart and sustainable. It is worth noting that while there is some discourse surrounding smart sustainable cities and their support systems, the amount of attention given to soft infrastructure pales in comparison to that of the former. When the analysis is compiled to classify studies on soft infrastructure in smart and sustainable cities, the amount of research remains significantly lower compared to the classification of research on smart and sustainable cities. Furthermore, this section introduces a suggested framework for the implementation of soft infrastructure in smart sustainable cities. As an initial description, with the support of www.lens.org (accessed on 05/05/2023), there are five keywords from the discussion on soft infrastructure in smart sustainable cities, followed by the number of publications: Political science (658), business (624), engineering (512), sociology (428), and geography (307). Meanwhile, to cluster research on soft infrastructure in smart sustainable cities, it is carried out using the open knowledge website (www.openknowledgemaps.org). Due to the limited number of publications on this theme, the grouping was made in two stages, the first with the theme of soft infrastructure and the second on smart sustainable cities.

- Categorizing topics on soft infrastructure. The six main research clusters that emerged were the city region model (including mainland and coastal cities), planning and development (including non-motorized vehicles), urban development and employability, political science and international relations; civil and structural engineering, including science and technology studies; as well as research on Asian tourism and autonomy.
- Categorizing topic on smart sustainable cities. The six main research clusters that emerged were a smart city, smart governance; data-driven smart sustainable cities, compact cities, ecocities; sustainable smart city, sustainable urban development; contextual participatory approach, intelligent transport, smart city; smart tourism city; as well as sustainable urbanism, urban computing, urbanism.

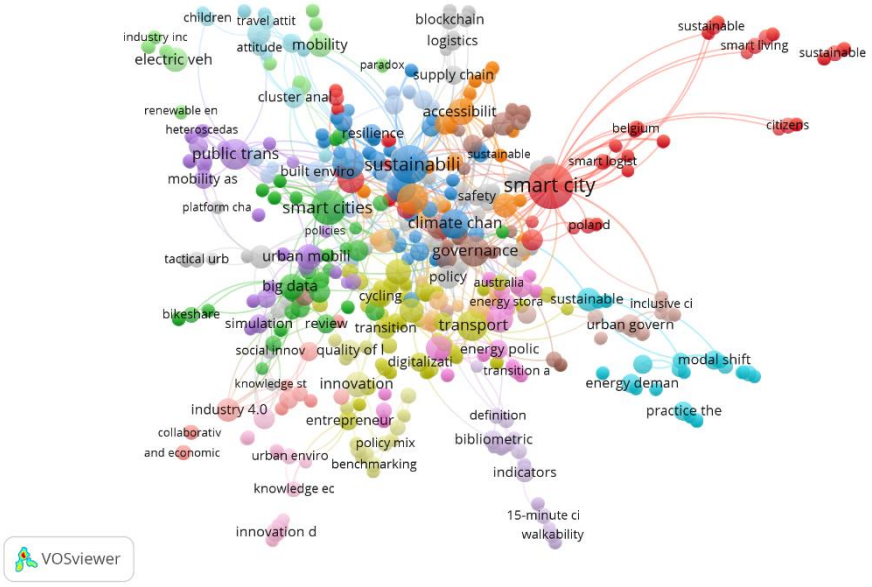

Figure 5. Mapping of publications about soft infrastructure in smart sustainable cities

Source: Analysis, 2023

To provide more adequate results, analysis is also carried out through the Vos viewer software, especially in mapping international publications with the theme of soft infrastructure in smart sustainable cities. The analysis was carried out by publications from 2010-2023 (there were 1,847 articles), which covered six scientific points of view: social sciences (330), decision sciences (95), environmental science (88), engineering (27), as well as economics, econometrics, and finance (16). The results of the analysis can be seen in the graph above. Based on these graphs, it can be concluded that the soft infrastructure in the smart sustainable cities theme cluster includes at least a discussion of (1). Smart city; (2). Sustainable development, (3). Bibliometrics, (4). Industry 4.0, (5). Big data, (6). Public transportation, (7). Sustainability, (8). Accessibility, (9). Climate change, (10). Smart cities, and (11). Logistics.

Components of Soft Infrastructure in Smart Sustainable Cities

The author recalled how the way people thought about managing land use changed in the mid-1990s. This was discussed in a book by Stuart Chapin and his colleagues called Urban Land Use Planning, 1995. The author thought about this while conducting a literature review on soft infrastructure in smart sustainable cities. The writer read a book about managing changes in how we use land because of new technology in the 2010s (Sutriadi, 2010). The book also introduced the term "smart city." In general, the management of land use change pertains to the handling of human activities that cause alterations to the natural environment. Addressing food security and climate change are enormously significant concerns to overcome on a global scale. Different data-driven resources can be utilized to measure and monitor alterations in land usage throughout time. Continued endeavors are being made to standardize worldwide information on alterations and maintenance of land, to comprehend the fundamental trends and changes more effectively. A recent publication focuses on the necessity for efficient management tactics to tackle the worldwide divide instigated by alterations in land use, emphasizing the significance of managing such changes.

In the fourth edition of the urban land use planning book (Kaiser et al., 1995) it is stated that there are three pillars in land use change management, namely social values, market values, and ecological values. This is an improvement from a new concept that has not been discussed in the third edition of urban land use planning (Rushton, 1979). In this land use change management concept, physical considerations (such as benchmarks for building public facilities based on the carrying capacity of the population) are not made independently but are included in social values, which can be interpreted that these physical factors must be able to give meaning to social side in an inclusive manner to create a higher quality of life. In short, social values are related to urban form, activity system, and neighborhood context; market value is related to redistribution of wealth and power, correcting market failure, public public-private partnership; Ecological values relate to environmental assets, environmental integrity, and preservation of nature. For the record, when there is a shift from space of place to space of flow, there will be a new variant of the details of each of these pillars (Sutriadi, 2010). This is what then makes the author relate the experience of exploring the concept of land use change management to the digital era with a discussion of soft infrastructure in smart sustainable cities. The author's experience as a city planner who pays attention to smart cities has changed several urban planning concepts, as well as the Pandemic Covid 19 era, The author seeks to propose the development of the concept of land use change management for city planners more extensively, including seeing groupings which discusses a combination of social values and market values, namely business-spatial concerns; a combination of market values and ecological values, namely cultural-political concerns; as well as a combination of ecological values and social values, namely humane-innovation concerns. This idea can be seen in the following figure.

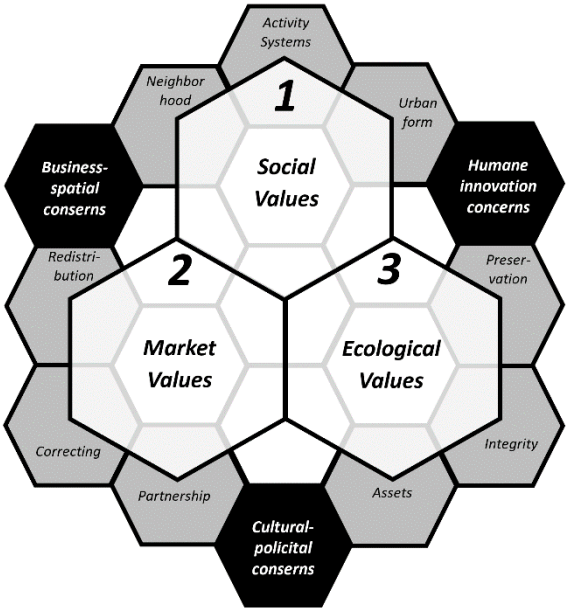

Figure 6. Proposing Soft Infrastructure in Smart Sustainable Cities

Source: Analysis, 2023

The analysis that produces the keywords from soft infrastructure in smart sustainable cities in the previous description both with the help of open knowledge and vos viewer, can then be regrouped into three keywords derived from the concept of land use change management in the post-pandemic era. The results of the new grouping can be seen in the following table.

Table 1. Re-Clustering Keywords in the Context of Soft Infrastructure in Smart Sustainable Cities

Mapping Method	Business and spatial concerns	Cultural and political concerns	Humane innovation concerns
Soft Infrastructure (open knowledge)	Civil and structural engineering	City region model Planning and development Political science and international relation Asian tourism	Urban development and employability
Smart Sustainable Cities (open knowledge)	Sustainable smart city, sustainable urban development Sustainable urbanism, urban computing, urbanism.	Smart city, smart governance Data-driven smart sustainable cities, compact cities, eco-cities Smart tourism city	Contextual participatory approach, intelligent transport, smart city.

Table 1 (cont.)

Mapping Method	Business and spatial concerns	Cultural and political concerns	Humane innovation concerns
Soft Infrastructure in Smart Sustainable Cities (vos viewer)	Sustainable development Smart city Industry 4.0 Accessibility Logistic	Big data Bibliometric Public transportation	Sustainability Climate change Smart cities

Source: Analysis, 2023

In addition, here are some keywords that emerged from the discussion on soft infrastructure in smart sustainable cities related to scientific fields: covid-19, internet of things, and public health (4); climate change, policy, well-being (3), active travel, capacity cloud computing, environmental governance, environmental monitoring, epidemiology, GIS, governance, health systems, nutrition, pandemic, physical activity, risk, security, smart cities, smart city, telemedicine, trust, urban planning (2); UK, 3d Ray Launching, abatement, action research, active filtration, advanced oxidation, affordance, age in place, agent-based simulation, aging, AI, air quality, ammonia emission, artificial synthetic pitches, assessment, attention, autonomous maritime vehicles, autopoiesis, baby pram, bayesian causal inference, bbmri.se, bias bicycle-sharing, big data, big data analysis, bike sharing biobanking, biobot, biocomposite, biodesign, biodiversity, bioeconomy, bioenergy, bioengineering, biohybrid, biomass potential, biometrics, biosensors, biotechnology, blind, blue exercise, breast cancer, built environment, carbon nanotubes, causal loop diagram, cavitation, change management, child, child health, child survival, children, cholesteric liquid crystals with spherical topology, cities, climate policy, cloud -based bim, coastal armouring, coastal management, coastal zone management, cognition, collection, community, commuters, complex systems thinking, complexity theory, computing methodologies, construction, construction and demolition waste (Cdw), construction components, consumption, cooperative vehicles coronavirus , cost, croplands (1).

Based on the keywords that appeared, it appears that the latest publications were influenced by the Covid-19 pandemic so discussions about health appeared in several keywords and were among the dominant ones. Other emerging knowledge is related to technological developments such as IoT and its derivatives. Meanwhile, representation related to urban planning is not the dominant keyword that appears, but when it is related to the discussion of urban planning, the dominant keywords such as COVID-19, IoT, public health, climate change, policy, and well-being are very relevant. with urban planning. There is also a non-physical side of the discussion or towards soft infrastructure, including starting to have many variations, especially those related to computer technology, and also related to well-being, policy, environmental governance, and environmental monitoring, as well as planning support systems such as IoT, cloud computing, GIS, smart cities, and smart cities.

Conclusions

This paper analyzes the role of urban planning in the 21st century which is influenced by various technologies as a form of innovation. This is a new challenge for increasing the competence of stakeholders in utilizing limited resources towards developing inclusive, intelligent, and sustainable cities.

According to the extant literature, the prevalent observation suggests that the quantity of scholarly work available concerning soft infrastructure in smart sustainable cities is relatively scarce, in contrast to the available abundance of publications elucidating diverse urban planning themes. Amidst the proliferation of technological advancements and the sweeping modifications to everyday lifestyles engendered by the global COVID-19 pandemic, discourse on soft infrastructure within the context of smart and sustainable cities has assumed a more diverse and interdisciplinary character. This discourse extends beyond the purview of engineering and advanced technological infrastructure and encompasses domains such as political science, business studies, and sociology. Indonesia's efforts to expedite development through infrastructure development across multiple regions necessitates a comprehensive comprehension of infrastructure for policymakers to devise efficacious policies, plans, and programs that address regional challenges and facilitate targeted growth.

Based on identifying keywords and grouping discussions about soft infrastructure in smart sustainable cities, it appears that regrouping can be done to enrich existing theories, such as land use change management theory (Kaiser et al., 1995), where land use change theory has also attempted to transform the classical approach which previously emphasized physical planning, to be based on three main pillars, namely social values, market values, and ecological values. The denser the urban population, the development of innovation, especially in the field of technology, which is reflected in research related to soft infrastructure in smart sustainable cities, the enrichment of the three pillars of land use change management can be carried out by adding a discussion which is an intersection between social values and market values, namely business-spatial concerns; intersection between market values and ecological values, namely cultural-political concerns; as well as the intersection between ecological values and social values, namely humane-innovation concerns.

Regarding the SDGs initiative, UNECE has created the idea of sustainable and smart cities for all ages to inclusively tackle urban issues. These are based on strategic basic points, such as relating to public health (SDG 03) because they are influenced by the experience of a pandemic, provision of basic needs in the form of clean water (SDG 06) as well and energy (SDG 07). Interventions to improve these factors will boost economic growth (SDG 08), Innovations can boost infrastructure and eco-friendly industries (SDG 09). Cities are catalysts for growth, change, and equitable development (SDG 11).

The occurrence of the theme of soft infrastructure in smart sustainable cities poses a novel challenge for urban planners to continuously enhance their skills and expertise. The UNECE, with its emphasis on spatial planning and its use as a measuring tool, is a pertinent entity for the development of planning resources that are capable of addressing business-spatial, cultural-political, and humane-innovation issues. Such resources can effectively address regional challenges and promote integrated and well-conceived planning for cities.

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Commentary

Gender Dynamics Analysis: Uncovering the Roles and Identities of Bugis-Makassar Women

Rezky Juniarsih Nur*[1] and Siti Komariah[2]

Indonesia University of Education, Bandung, Indonesia

*) Corresponding author : rezkyjuniarsih@upi.edu

1. Introduction

Gender refers to the socially created assumptions, duties, opportunities, and relationships associated with the female or male sex. Gender is society's differentiation in terms of position, rank, and division of labor based on sex. Gender analysis can also be used to examine situations in order to better understand the cause-and-effect relationships that shape reality. Gender is a social and cultural construction that differentiates the treatment between men and women, which may tend to benefit both men and women, so gender is not a fundamental issue. In Bugis society, gender identification is divided into five categories, each of which serves a specific purpose. They are identified as female (*Makkunrai*), male (*Orowane*), feminine male (*Calebai*), masculine female (*Calalai*), and mute (a mix of male and female). These are developed based on initial characteristics and environmental influences (Nurohim, 2018).

The focus of this study is on women (*Makkunrai*). Since women are generally seen and treated as 'second class', it sometimes is misinterpreted that gender studies are exclusively directed toward women. This construction is no longer just based on biological or sex differences that individuals have. Through a strong socialization process, gender ideology is formed and internalized in society. Within the gender ideology that is formed, there are stereotypes or images attached to the roles of men and women. For example, women are often connoted as being gentle, beautiful, emotional, and having a motherly nature.

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Fax: +62 21 31928281
E-mail: journal.pusbindiklatren@bappenas.go.id

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On the other hand, men are often perceived as strong, rational, powerful, and manly. These social stigmas and expectations of gender roles can influence the behaviors, attitudes, and expectations accepted by individuals in society. Although common, the position of men and women in discourses that are usually explored through gender studies is still important today. There are still gaps that need to be filled with new analyses to color the treasures and dominance of gender analysis so far.

This paper examines how gender dynamics shape the contribution of human networks to research and uses gender differences to explain why gender should be considered in sociology (Kent, et al 2019). However, many of these approaches are not tested through a gender lens, leading to a gender gap in empowerment in the agricultural sector. Considering the current understanding of gender dynamics within households (Brearley et al., 2020), the article discusses the theory of gender identity development (a dynamic system framework for gender identity development). It suggests critical aspects of pre-symbolic gender (Sterling, 2019). By reflecting on multiple experiences, individuals can learn and grow. Similarly, when examining the stratification of the Bugis-Makassar community, sociologists have identified three distinct categories. These cultural patterns and heritages can also be traced and studied sociologically (Ahmadin, 2021). The shift in cultural values and gender relationships reveals the impact of various forms of inequality that influence and are reflected in society. For example, women may face difficulties or conflicts in traditional marriages when their roles require them to work outside of the home (Sassler et al., 2020).

The influence of the feminist movement on sociology has encouraged sociology to focus on issues of gender relations and women's lives. Many sociological theories have recently addressed this issue. Macro social functionalism theories, conflict analysis theories, and neo-Marxian world system theories all explore households in political systems. Marxian world system theory explores the household in the political system as a way to explain the socially subordinated position of women. Interactionism and ethnomethodology (two micro-social theories) examine how gender differences are created and recreated in individual relationships (Hedriyanti & AB, 2021). These social constructions can shape individuals' mindsets and actions, both consciously and unconsciously. It is important to remember that gender ideology is socially constructed and can vary across cultures and contexts. This understanding opens up space to question existing gender stereotypes and strive for more inclusive and equitable gender equality. In general, there is an assumption that in South Sulawesi, especially in some tribal cultures, there are social patterns and traditions that emphasize women's limited roles and positions. This can include restrictions in access to education, economic opportunities, political participation, and decision-making. Women may face pressure to conform to conservative social norms and have higher expectations to take on domestic roles and support other family members.

However, a historical perspective of Sulawesi reveals that the Bugis-Makassar tribe has a very respectful and protective attitude towards women. They recognize the important role of women in society and provide opportunities for them to occupy strategic positions (Ilyas, 2019). Many ancient documents, although in short fragments, describe the differences in rank, duties, and functions between men and women in Bugis society throughout its historical and cultural evolution. As these ancient works were not designed to provide such answers, contemporary gender discourse is unthinkable, hence the explanation is more about social, cultural, political, economic, and other values (Kesuma, 2019). The *Lontarak* used in this study has many *Pappaseng* covering virtues, but it has minimal discussion of the roles of men and women in household, political, and cultural roles. These ancient writings are essential for understanding gender relations in Bugis culture in South Sulawesi, both in understanding the intricacies and dynamics of the past and in weaving a red thread to provide color in living life now.

In terms of the status, roles, and functions of women in social constructions, both normatively and empirically, there are different historical dynamics to women's rights in the archipelago. Even in the 18th century, when there was still practically a stereotype against women throughout the archipelago, this was not the case in Bugis society. In his book, History of Java (cited by Mantik, 1817 in Rosdiana, 2020), Thomas Stanford Raffles noted his admiration for Bugis women's role in his society.

> *"The women are held in more esteem than could be expected from the state of civilization in general, and undergo none of those severe hardships, privations or labors that restrict fecundity in other parts of the world"*

It is told in literary works included in *La Galigo* or *Sure'galigo*. The presence of women in these literary works cannot be ignored as they are an important aspect in the historical development of Bugis society at that time. The presence of Bugis women in La Galigo, such as *We' Opu Sengngeng, We' Tenri Abeng,* and *We' Cudai*, colored the style of government and the development of independent Bugis women, which became the starting point for the emergence of Bugis women as partners of their husbands in running the wheels of government (Ilyas, 2019). In the *Lontaraq* texts, it was found that the position of Bugis women in this tradition was not only a domestic symbol or caregiver for their husbands and children, but also controlled the social and political institutions of the community.

This shows an understanding of the values of gender equality in Bugis culture. Gender equality is a position where a person's sex does not determine their opportunities, possibilities, freedoms, and significance in life (Jahan, 2021). The bilateral kinship system in Bugis culture also plays an important role in demonstrating equal gender relations for women. In this system, women are equal to men in terms of family rights, responsibilities, and inheritance rights. This demonstrates the principle of equality in the relationship between women and men in Bugis society. Thus, it is not appropriate to attribute assumptions about 'women's oppression' to Bugis culture in general. Each culture has its own dynamics and complexities, and gender equality can be found in many different cultural contexts. Therefore, it is important to avoid generalizations and respect cultural diversity and a more holistic understanding of the role of women in Bugis society.

In a socio-historical context, the people of South Sulawesi generally accept the presence of women as leaders and play a role outside the home, as long as these roles do not neglect their duties as head of the household. In fact, many national figures who came from South Sulawesi were dominated by women. Brave women, movement, political figures, and educational figures have surpassed male dominance in South Sulawesi. Some examples of figures recorded in history are Opu Daeng Risaju and Salawati Daud from Luwu, Emmy Saelan from North Sulawesi, Andi Depu from Mandar, and many other female figures. Bugis egalitarianism also applies to gender equality. Not only in daily social institutions, but Bugis women are also placed on an equal level with men, even in the political system. The chronicles of several Bugis kingdoms, such as Luwu, Bone, Tanete, Soppeng, and Wajo in several times record kings from the women's side. Bugis women who became kings in their kingdoms were not just decorating genealogies (*Lontaraq*) but also actively contributing to the progress of their people.

In South Sulawesi society, women's successes and contributions in various fields have been recognized and appreciated. Local communities have accepted the idea that women have the same capabilities and abilities to lead and achieve in their fields. South Sulawesi's women leaders have inspired the young generation and proven that women can play a significant role in social, political, and educational transformations. Their presence illustrates a cultural shift and an increased awareness of the importance of gender inclusion in community development. In the context of South Sulawesi, women have successfully broken through male dominance and demonstrated that they can become leaders, drivers of change, and valuable contributors in various aspects of life. The roles and achievements of these female figures not only enrich the local history of South Sulawesi, but also provide inspiration and motivation for other women to take an active role in society and realize their full potential.

However, some Bugis-Makassar families still adhere to a patriarchal culture. Growing up in a patriarchal-agrarian culture, Bugis women are often said to have dominant roles in the kitchen, well, and bed. In the study of gender and feminism, patriarchal discourse is a violent discourse because it traps women in a low/inferior position by allowing men to determine standards for women on how to see, feel, think, and act in society (Alam & Alfian, 2022). Women are often placed in unfavorable positions (Akbar, 2022). Although patriarchal traditions still play a role, Makassar women have important roles in family life, economy, and customary institutions. With ongoing social change, Makassar women are increasingly demonstrating their abilities, aspirations, and contributions to achieving gender equality and women's empowerment. Thus, it is exciting to study more deeply from the sociology side related to the analysis of gender dynamics in the Bugis-Makassar tribe in South Sulawesi to understand the dynamics of social change and the role of tradition in influencing the position and welfare of women in the community.

2. Makassar Bugis Women's Identity

2.1 *Makkunrai Intan Permata Keluarga* (Women as Diamond Jewels in the Family)

In Bugis-Makassar society, women are considered as precious gems and must be kept pure. Therefore, Bugis-Makassar women have an identity consisting of four main components, namely *siri'*, *sipakatau*, *sipakalebbi*, and *sipakainge* (Fitriani & Siscawati, 2021). These four elements form an integral part of Bugis women's identity and also reflect the overall identity of Bugis society. *Siri'* is a tradition and custom that has a powerful influence on the culture and daily life of the people of South Sulawesi, especially the Bugis. *Siri'* encompasses norms, customary rules, and values that are passed down from generation to generation. *Siri'* plays an important role in shaping the identity of Bugis women, both in terms of gender roles, involvement in social activities, and family responsibilities.

Bugis-Makassar women not only play a role as holders of this identity, but also have a responsibility to maintain and continue the traditions and customs embodied in *siri'*. Bugis women's identity not only encompasses gender roles and family responsibilities, but it is also closely linked to social life and the norms upheld in Bugis society. In a broader context, it comprises understanding and appreciating Bugis women's identity, including *siri'*, *sipakatau*, *sipakalebbi*, and *sipakainge*'. Thus, Bugis-Makassar women must maintain chastity in the form of virginity. Sexual intercourse before marriage is considered forbidden and can lead to divorce. Bugis women who have sexual relations before marriage will be described as a broken woman (*Makkunrai* masolang), a dirty woman (*Makkunrai marota*'), a cheap woman (*Makkunrai masémpo*), something rotten (*Agaga makebbong*), or a woman without *siri'*/shame (*Makkunrai déggaga siri'na*) (Idrus, 2023).

2.2 *Alebbireng*: Bugis women are seen as symbols of glory

Alebbireng is a form of modesty from Bugis women. One example of *alebbireng* is the high value of customs regarding the culture of *siri'* (Shame). The term *siri'* is closely related to the self-esteem of a person or family. For the name of a person and his family to be maintained, *siri'* must be respected (Agus, 2018). Women in Bugis culture are known as *alebbireng*, which means women who are guarded and defended by Bugis men until the end of their lives. The actions of women who defend their *siri'* or honor are considered a form of virtue that is highly valued in Bugis society. The concept of *'mate ri santangngi'* is used to describe a woman who died in a noble state because she defended her honor. According to Idrus in (Fitriani & Siscawati, 2021), in Bugis custom, women are considered as 'glory' (*alebbireng*) because they bear more *siri'* than men. It is like a woman bears 99 *siri'* and a man bears 1 *siri'*.

In this context, Bugis women are considered the guardians of family and community honor. They are expected to maintain attitudes, behaviors, and images that are in line with traditional values known in Bugis culture. The honor and integrity of Bugis women are considered very precious and men are responsible for protecting and guarding them. This understanding of women's role as *alebbireng* in Bugis culture demonstrates the importance of values such as honor, integrity, and primacy in maintaining family identity and dignity. However, it is important to remember that cultural interpretations and practices can vary between groups and individuals, as well as the influence of social and cultural changes that occur over time.

2.3 *Panai'* money as a Symbol of Respect

Dui' menre' (in Bugis) or *Panai'* money (in Makassar) refers to the amount of money given by the groom's family to the bride's family in the context of a marriage proposal ritual. This money is significant in determining the social status of both parties involved. In Bugis and Makassar traditions, the giving of *Dui' menre'* or *Panai'* money is an important part of the engagement or marriage proposal process. The amount of money given can vary depending on the agreement between the two families, as well as factors such as social status, economics, and traditions prevailing in the community. The giving of the money is not only a token of affection or appreciation, but also a symbolic meaning in building a relationship between the two families. By giving *Dui' menre'* or *Panai'* money, the groom's family shows their seriousness and ability to fulfill their responsibility in guiding and protecting the bride-to-be.

The research from Djabbar and Winaudri examines "Buginese Women's Attitude Toward Uang *Panai'* as One of the Wedding Cultures in Buginese". This research focuses more on Buginese women with their confessions about the *Panai'* money. And the results of the study revealed that not a few women (respondents) admitted to feeling happy if they married a man who could provide *Panai'* money as requested even though they did not know the man before. Therefore, Bugis women have a great tendency to fully agree with the high determination of the *Panai'* money (Djabbar & Winaudri, 2020). *Panai'* money is defined as spending money, and *Panai'* money is different from the dowry at the time of marriage because the dowry is shared between the bride and groom while the *Panai'* money is given to her family, which is determined according to the social status and education level of the woman. Because in the decision-making, the amount of *Panai'* money is the decision of the woman's family (Yansa, 2019).

In addition, this money also reflects the social and economic status of the groom's family. The larger the amount of *Dui' menre'* or *Panai'* money given, the wealthier and more prestigious the groom's family can be shown, which can affect the perception and social position of both parties in the community. *Dui' menre'* or *Panai'* money is one of the traditions rich in meaning and cultural value in the context of marriage in Bugis and Makassar communities. However, it is important to remember that practices and interpretations can differ between families and regions, and are subject to change in line with social and cultural developments. If a man wants to get married, in addition to the dowry, an obligation must be carried out, namely *Panai'* money. *Panai'* money is defined as spending money. And this *Panai'* money is given to the family of the prospective bride he wants to marry. *Panai'* money is different from the dowry. *Panai'* money is spending money for a woman's wedding reception offered by the man who proposed to her. Meanwhile, a dowry is a gift given by a man to a woman, and it belongs entirely to the woman (Almaida, 2023).

The giving of *Panai'* money from a man to a woman was originally an expression of gratitude, respect, and pride of the man towards the woman and was not a form of squandering money used for the needs of the woman's party from start to finish, even though the man afterward gave money. Men are the full property of women and are only used during the wedding ceremony, but the meaning and value of *Panai'* money remains as a sign of a man's admiration and respect for the woman he loves (Rinaldi et al., 2022). The *Panai'* tradition is a hereditary tradition that originated from the ancestors of the Bugis tribe. This tradition aims to teach the importance of women's dignity and remind the community that women deserve to be respected and valued. In the *Panai'* tradition, the main role is to give respect to women and recognize their value in society. This is done through the gift of money or other assets from the man's family to the woman's family as a form of appreciation and gratitude of the woman's worth. This tradition reflects the Bugis community's concern and interest in women and their efforts to maintain women's dignity and integrity. Through the giving of *Panai'*, Bugis society teaches values such as respecting, valuing, and protecting women in various aspects of life.

To this point, research on *Panai'* money (spending money) in Bugis Muslim family marriage law has focused on two main topics. First, research that examines that from a philosophical point of view the high level of *Panai'* money in the Bugis tribe is a form of a man's seriousness if he agrees to the agreement of both families to marry his prospective wife and as a form of motivation to realize desires related to the selection of prospective life companions (Fitriyani, 2022). Secondly, a study looking at the sociological features of *Panai'* money in the Bugis tribe found that the amount is not small, it is determined by education level, race/caste, economic level, physical condition, maiden status, and hajj title (Kadir, 2017). The *Panai'* tradition also has a deep symbolic meaning. The gift is not only material, but also symbolizes the attention, love, and support given by the man's family to the woman's family. It is also a way to establish good relations between the two families and strengthen social ties within Bugis society. By keeping and maintaining the *Panai'* tradition, the Bugis community continuously reminds and teaches the importance of respecting women as individuals with high self-esteem. This tradition is an effort to strengthen the role and position of women in Bugis society and to promote gender equality and respect for women at large.

2.4 Mother in Family and Society

Women's identity as mothers in the Bugis-Makassar tribe reflects the rich culture and diverse roles in the community. The identity of Bugis-Makassar women can be understood through several aspects,

including gender roles, customs, economic life, and religion. First, in the context of gender roles, Bugis-Makassar women are responsible for protecting and maintaining the family. They play the role of mothers, wives, and caregivers of children. Makassar's women also have roles in public life, including in social and political activities. They can participate in community forums and have a voice in decision-making that affects their community. This is in accordance with "Bugis women in *Lontaraq* manuscripts, it was found that the position of Bugis women in the tradition played a role not only as a symbol of domesticity or caretaker for her husband and children but also dominated the social institutions of society and politics. Bugis women in the Bugis *Lontara* are called *materru na' malampe nawa-nawa* (dare to have a vision and mission) (Ilyas, 2019).

Second, customs play a central role in the identity of Bugis-Makassar women. Traditions and social norms passed down through generations form the basis for women's roles and actions. Makassar's women are involved in maintaining and continuing cultural traditions, including in traditional ceremonies, dances, music, and art that are unique to the Bugis-Makassar tribe. Third, in economic life, Bugis-Makassar women have a significant contribution. They are involved in various types of work, such as farming, trading, and managing home businesses. Makassar's women are often the backbone of the family economy, with their skills and knowledge. Fourth, religion also plays a role in the identity of Bugis-Makassar women. The majority of Makassar's adhere to Islam, and women play an important role in daily religious activities. They are involved in religious ceremonies, and traditional rituals, and support other religious activities within their community.

The identity of Bugis-Makassar women reflects the diversity of their roles and contributions in community life. Although patriarchal traditions still influence some aspects of life, Makassar's women also demonstrate their abilities, aspirations, and contributions in achieving gender equality and women's empowerment. Recognition and appreciation of Bugis-Makassar women's identity is important to promote gender equality, cultural diversity, and women empowerment in an inclusive and harmonious society.

3. The Role of Women in the Tradition of the Bugis-Makassar Tribe

The role of women in the Bugis-Makassar tradition has depth and diversity that reflects rich and complex cultural values. Makassar's women play an important role in various aspects of life, including in the social, cultural, and religious context. The following are some of the roles women play in the Bugis-Makassar-Makassar tribe tradition:

a. Role as custodians of custom and culture: Makassar women have an important responsibility in maintaining and spreading their customary and cultural values. They play a role in maintaining and continuing the traditions, traditional ceremonies, dances, music, and arts that are typical of the Bugis-Makassar tribe. Women are also often the guardians and maintainers of the cultural heritage of families and communities.

b. Role in the kinship system: Makassar women have a central role in a complex kinship system. They are often responsible for maintaining family relationships and bonds, including maintaining relations with the extended family, facilitating family gatherings and events, and playing an important role in marriage and birth ceremonies.

c. Role in economic life: Makassar women also play an active role in economic activities, both at the household level and in the market. They are involved in various types of work, such as farming, trading, managing home businesses, and handicrafts. Women are also involved in the process of production and distribution of agricultural products and traditional crafts.

d. Role in religion and spirituality: Makassar women have an important role in the context of religion and spirituality. They are involved in religious ceremonies, traditional rituals, and daily religious activities. Women are often the successors of spiritual knowledge and religious practices passed down from generation to generation.

e. Role in education and learning: Makassar women also have an important role in education and learning in their community. They are responsible for educating children in local cultural values, customs, and knowledge. Women also play a role as caregivers and companions in formal and non-formal education.

Through these roles, women in the Bugis-Makassar tradition play a very important role in maintaining and continuing their cultural identity. Acknowledgment and appreciation of the role of women in the Bugis-Makassar tradition are important for promoting gender equality, empowering women, and preserving a diverse and highly valued culture.

4. Gender Dynamics

Gender is a novel concept to society. Gender indicates a part of responsibilities between husband and wife in the family, for example, the husband earns a living while the woman works to take care of the household. Bugis people believe in gender roles that are influenced by local culture and customs. The notion of gender lies in the term of disposition, which can be separated into two characteristics, namely, the disposition of natural characteristics and the disposition that can be changed to be interchanged (Taufik et al., 2022).

Changing gender dynamics in Bugis-Makassar society refers to shifts and transformations of the roles, norms, and relations between men and women within Bugis-Makassar tribes in a modern context. Traditionally, in Bugis-Makassar culture, there is a distinctive pattern of gender roles, where men have a dominant role in the economy and public life, while women have a role that is more focused on household and family matters. However, with social and economic changes and times, gender dynamics in Bugis-Makassar society have also shifted. Bugis-Makassar women are increasingly and actively involved in various aspects of social, political, economic, and cultural life. They can take on roles as leaders, entrepreneurs, and professionals, and are active in community organizations and social activism. These changes were driven by factors such as more equitable education, easier access to information, awareness of women's rights, and changes in social views of gender roles. Bugis-Makassar women are increasingly aware of their potential and contribution to society and are taking the initiative to strive for gender equality and overcome barriers to their participation. Gender dynamics also face challenges and conflicts with traditional values and social expectations that still influence Bugis-Makassar society. Conflicts between traditional values that emphasize women's roles as homemakers and modern demands for gender equality can occur.

Gender dynamics in Bugis-Makassar society are a complex and evolving process. This requires a deeper understanding of the social, cultural, and contextual factors that influence such changes, as well as collaborative efforts from various parties to create a supportive environment for gender equality and women's empowerment in Bugis-Makassar society. Despite women being given opportunities to work, they are still often expected to fulfill traditional gender roles as caretakers of the home. This expectation is rooted in the historical view of women as housewives and caregivers, and it is often challenging for women to balance their career and family duties, especially when companies do not have sufficient support systems in place for them to manage unexpected family emergencies. In essence, women are expected to fulfill the roles of a wife and a mother within the household. However, this expectation is not profitable for women who work outside the home and must juggle multiple responsibilities (Muis et al., 2021).

Women try to use modern ways of dealing with many traditional role expectations, expecting women to become housewives, although most women work full-time outside the home (Gui, 2020). The involvement of women in domestic work has had a beneficial effect on their fertility rates. The extent of their participation in household chores is likely to differ depending on the educational level of the wife. There is a correlation between women's educational achievements and their engagement in domestic tasks (Cheng et al., 2020). In gender roles, these women handle household and work responsibilities, so there is gender inequality (Parlak et al., 2021). Women spend more time at home and do more work (Briscoe et al., 2019). In addition, the presence of women in various public spaces and social media is obvious today (Varshney, 2019). Mothers are overwhelmed by domestic tasks, childcare, and homeschooling assignments. Most mothers' professions have suffered due to an increase in housekeeping and childcare/online schooling. This is not usually true for fathers who emphasize their office careers. During this period, what happened in Bugis-Makassar society consistently placed second-class women behind males and treated them unfairly, resulting in discriminatory behaviors and unjust treatment (Muhammadong, 2020). Men and women who are in a marriage relationship in the Bugis-Makassar kinship system, are ruled by blood and marriage (Kesuma, 2019). Furthermore, there are other

traits in the Bugis-Makassar history and culture where mothers' status, title, and occupation are highly revered. A mother's purity, piety, and wisdom must be preserved. A mother's information must be kept up to date at all times (Kesuma, 2019). The participation of women in the world of entrepreneurship is still minimal compared to men (Pandang et al., 2022).

The existence of rapid social changes such as urbanization, modernization, and economic development also has the potential to affect the dynamics of gender relations in Makassar society. Makassar women are increasingly exposed to formal education, employment opportunities outside the household, and greater access to information and technology. These changes can affect the role of traditions and norms in gender relations in society. The lifestyle changes, particularly in agricultural households in South Sulawesi, with gender subtleties. Household livelihood methods, namely men and women, must play a role without restricting each other's access, control, participation, and rewards. Economic transformations have risen to different alternative employment, both farm and off-farm, in relation to the development of workspace in the formal and informal sectors, and driven changes in roles and time allocations (Suhaeb et al., 2020). For household livelihoods in fishing communities in South Sulawesi, stating that the involvement of fishermen's wives is an actualization of the Bugis-Makassar community (Idrus et al., 2022). Women in the Bugis-Makassar tribe have a very important role in improving the family economy. They are actively involved in various economic activities, such as farming, trading, or managing a home business. Bugis women possess a wide range of skills and knowledge in this field, and they contribute significantly to the family's future income. Bugis women often become the financial managers in the family as well.

5. Empowerment of Women in the Bugis-Makassar Tribe

Women's empowerment in Bugis-Makassar refers to the efforts made to increase the independence, participation, and influence of Bugis-Makassar women in various aspects of life. Women's empowerment aims to eliminate gender inequality, increase women's access to resources, and strengthen their roles and contributions in society. In the Bugis-Makassar context, women's empowerment focuses on providing women with equal opportunities for education quality, access to employment and economic opportunities, and active participation in decision-making that affects their lives. These involve raising awareness of women's rights, eliminating gender discrimination, and strengthening women's capacity in various fields.

Empowerment of Bugis-Makassar women also involves revitalizing and strengthening cultural values that value women and acknowledge their contributions to society. This can be done through education and a better understanding of the Bugis-Makassar tribe's cultural and historical heritage, as well as increasing awareness of women's role in maintaining and continuing the tribe's noble traditions and values. Empowering women in Bugis-Makassar also involves addressing barriers that prevent women from reaching their full potential, such as gender violence, gender stereotypes, and limited access to resources and opportunities. These involve collaboration between the government, civil society organizations, and other institutions to develop policies and programs that support women's empowerment in Bugis-Makassar.

In addition, women's empowerment also involves a holistic approach, considering the interrelated social, economic, and political dimensions. These include social change, policies that support gender equality, increasing access to education, improving health conditions for women, and eliminating structural injustices that affect women. Overall, women's empowerment aims to create an inclusive, just, and equal environment for women, where they have the autonomy, freedom, and opportunity to reach their full potential and contribute significantly to social and economic development. By strengthening the position and role of women in society, Bugis-Makassar women's empowerment contributes to sustainable, equitable, and inclusive development. This not only benefits individual women, but also positively impacts their families, communities, and society as a whole.

Conclusion

Analysis of gender dynamics in the Bugis-Makassar tribe in South Sulawesi found several important things related to identity, role, social change, and women's empowerment. Gender identity in the Bugis-Makassar tribe is formed through social construction that depicts women as holders of the traditional role of housewives who are respected and defended by men. However, it is important to note that this gender identity continues to change in the context of social change and increasingly strong external influences. The role of women in the Bugis-Makassar tribe is not limited to being housewives, but also has roles in social, economic, political, and cultural life. Bugis-Makassar women have significant involvement in decision-making and contributions in various aspects of community life, both at the family level and in the wider community.

Social changes affect gender dynamics in the Bugis-Makassar tribe. Factors such as modernization, globalization, and economic development, have brought about changes in gender roles and identities. Bugis-Makassar women are increasingly involved in the world of work, education, and other social activities, changing the existing traditional order. Women's empowerment plays an important role in empowering Bugis-Makassar women. Efforts to raise women's awareness of their rights, provide equal access to education, skills, and other resources, and strengthen women's participation in decision-making and leadership, have contributed to women's role and influence improvement in society. Analysis of gender dynamics in Bugis-Makassar tribes shows that social changes, gender identities, women's roles, and women's empowerment are interrelated. Bugis-Makassar women have significant societal roles and experience changes in their identities and roles in response to social change. Women's empowerment efforts are important in increasing women's roles and contributions to developing a more inclusive and equal society.

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Book Review

Territorial Conflicts Minus the Fear of Secession

Nino Viartasiwi

President University, Bekasi, Indonesia

nino.viartasiwi@president.ac.id

Introduction

Does Indonesia's provincial proliferation incite conflict? According to Istania, regional proliferation at the provincial level escalates the conflict at the district level (2023). (Istania, 2023) is a lecturer at the Polytechnic School of Administration (STIA LAN), Jakarta. She finished her PhD at Loyola University Chicago, USA, and developed her dissertation into a book published by Routledge under the Contemporary Southeast Asia Series. The book, titled "Territorial Change and Conflict in Indonesia: Confronting the Fear of Secession," analyzes Indonesia's territorial autonomy strategy for the establishment of new provinces. The 2020-page book comes with a very simple cover that pulls the reader's attention solely on the title. The title suggests that the book will discuss territorial change that has incited secession conflict in Indonesia. For those interested in the interplay between territorial change and the secession movement in the context of local political contestation, the book is very compelling. The book is important for a deeper understanding of Sustainable Development, particularly in lessening the impact of development. Territorial change is believed to be effective in shortening bureaucracy to a better service delivery. However, the possibility of conflict is worth the calculation. The book offers a lesson learned from the case.

The book discusses the nexus between regional proliferation and socio-political conflict. Particularly, it discusses the district-level conflict, as districts are the force behind regional expansion at the provincial level. The objective is to identify the impact of the new province's aspirations on the conflict situation in the supporting districts. The author suggests that to analyze the dynamics of regional expansion at the provincial level, it is valuable to first look at the district-level political contestation and expansion process.

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Address: Jalan Proklamasi 70, Central Jakarta, Indonesia 10320
Phone: +62 21 31928280/31928285
Fax: +62 21 31928281
E-mail: journal.pusbindiklatren@bappenas.go.id

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Then, zoom in on the policy-making process and its level of potential conflict at each stage, namely the district, provincial, and national levels.

Since the reform era 1998, Indonesia has been undergoing regional proliferation by dividing the existing provinces or regencies into new provinces or regencies with smaller territories. In the period 1999–2012, Indonesia established eight new provinces. After a period of postponement, in 202, four more provinces were established as a proliferation of Papua Province and Papua Barat Province. The book's publication is timely in light of the establishment of Papua Tengah Province, Papua Pegunungan Province, Papua Selatan Province, and Papua Barat Daya Province. Coincidentally, the two mother provinces, namely Papua Province and Papua Barat Province, are located in the Papua region, the most conflict-prone region of Indonesia and plagued with secession issues.

This review pays attention to four main chapters of the book: chapters five, six, seven, and eight. It will be followed by a short critique and a conclusion with a rating.

Writing Style and the Data

Taking examples from the cases of four districts in three provinces as the supporting administration for the provincial level of proliferation, the book dwells on the plan to establish a new province. Those districts are Bima Regency in West Nusa Tenggara Province, Cirebon Regency and Purwakarta Regency in Jawa Barat Province, and Tana Toraja in South Sulawesi Province. In these chapters, the author takes the reader through her fieldwork experience in a first-person story-telling style.

The data to calculate the conflict incidents as the basis of the study is from a political violence dataset from a national violence data collection known as SNPK or NVMS (Sistem Nasional Pemantauan Kekerasan; the National Violence Monitoring System Indonesia) during 2000–2014. As a note, the NVMS collects the data from local newspaper reports (The Coordinating Ministry for Human Development and Culture, n.d.). The data is available to the public on the website.

Political Conflict in Proliferation Planning

In chapters five and six, the book illustrates the cases of Bima and Cirebon regencies, which still need to claim new provinces.

From interviews, the book shows that when ethnic-based local elites cannot reach a consensus on power-sharing in Bima, their aspirations to form a new province fail. Because the ethnically based political groups were equally powerful, they were caught in a protracted conflict that thwarted the political consolidation they needed to claim the new province. The author also claims that "the high level of conflict in Bima can be causally related to economic marginalization and the lack of ethnic power-sharing in the West Nusa Tenggara Provincial government's top executive positions" (p. 115). The Cirebon case illustrates that groups' high diversity adds difficulties to political consolidation through ethnic identification, resulting in weak political power. The variety of ethnic groups unable to reach a consensus due to a lack of political consolidation means that violent conflict is less likely to occur, but at the same time, it also means that they are less likely to claim a new province successfully.

The study argues that the plan for proliferation accelerates conflicts during the initiation of a new province stage in the supporting districts due to group competitions supported by the local elites. It focuses on groups in the four regencies that utilize their identities to gather support for competition among them and against the national government for the new province campaign.

How Conflict is Developed

In chapters seven and eight, the cases of Tana Toraja Regencies and Purwakarta Regencies, the author presents a different angle to show that the conflict persisted even though there was no intention to claim a territorial change in the two districts. The case of Tana Toraja illustrates that the intention to form a new province was absent when local elites were busy securing local political authority in their newly established districts. The conflict is based more on local contestation based on intra- and inter-

ethnic relations. The case of Purwakarta as a null case shows that the district elites had no intention of secession in either the claim of a new district or a new province. However, small conflicts still erupted in Purwakarta's social setting. In conclusion, the author highlights that the absence of regional expansion cannot be equated with the lack of violence in the region.

Conflict Mechanism

The author concludes the book by describing the mechanisms between elite contestation during the new province campaign and the conflict. Those conflict mechanisms were first introduced in the early stages, introducing the idea of a new province to the public. Second, at the start of the campaign for a new province, groups use their ethnic identity for political support, which triggers conflict and a bargaining process between various groups. Third, the possibility of a failure of consensus among ethnic identity-driven groups will start a more intense battle, especially when the claim to a new province is rejected by the national government or mother province.

Finally, the author suggests that to ensure the smooth process of the necessary new provinces' development, "if a federal arrangement is not an option, the national government must tackle the situation most sensibly and strategically possible to maintain its unity" (p. 197).

Critics to Consider

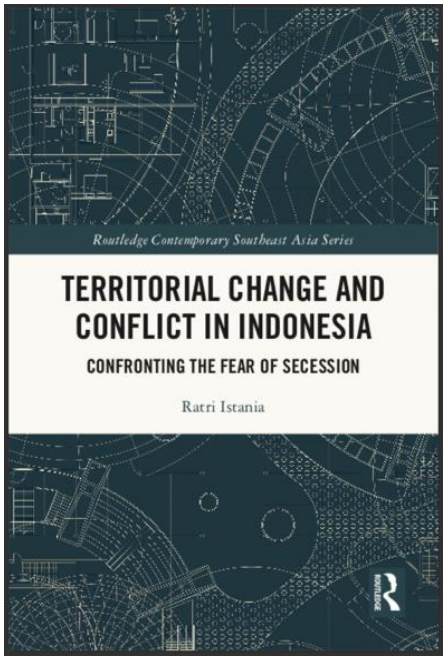
The book's attractiveness starts with its title, which aims to "confront the fear of secession." The title suggests that the book encourages the readers to face their fears of secession. However, the elaboration does not clearly explain what fears must be confronted. When reading the title, readers might expect that the book will discuss the risks of secession and self-determination in the sense of an independence movement or insurgency that threatens the territorial integrity of the state or its sovereignty. However, the introduction chapter explains that the book intends to explain secession in a more government-organizational sense—the withdrawal from one administrative entity to develop a new organizational entity. From a mother province to a new area. But then, in the conclusion chapter, chapter nine, the author returns to the hope of connecting the proliferation-related conflict with secession in the sense of the self-determination movement by briefly mentioning West Papua's independence ambition. The book is satisfactory in explaining the linkage between the development of new provinces and social-political conflict. However, the author's desire to link the proliferation-related conflict with nationalism and secession is the book's weakness since it is not proven throughout the discussion.

Second, presenting a null case by taking the Purwakarta case needs to be clarified since neither the intention for territorial change nor the fear of secession, as the main idea stated in the title, are present in the Purwakarta political sphere. The authors need to explain the reasoning behind explicitly choosing Purwakarta as the null case among other conflict-free and no proliferation aspirations districts in Indonesia, as conflict based on cultural modernization is not exclusive to Purwakarta, as a study (Kinseng,2021) shows.

Conclusion and Rating

Overall, with the mentioned flaws, the book deserves an A-rating, as it is a meticulous work that deserves the attention of anyone interested in decentralization, conflict, and democracy. As a contribution to scholarship, the book sheds light on understanding decentralization strategy through regional autonomy in Indonesia.

Cover Book



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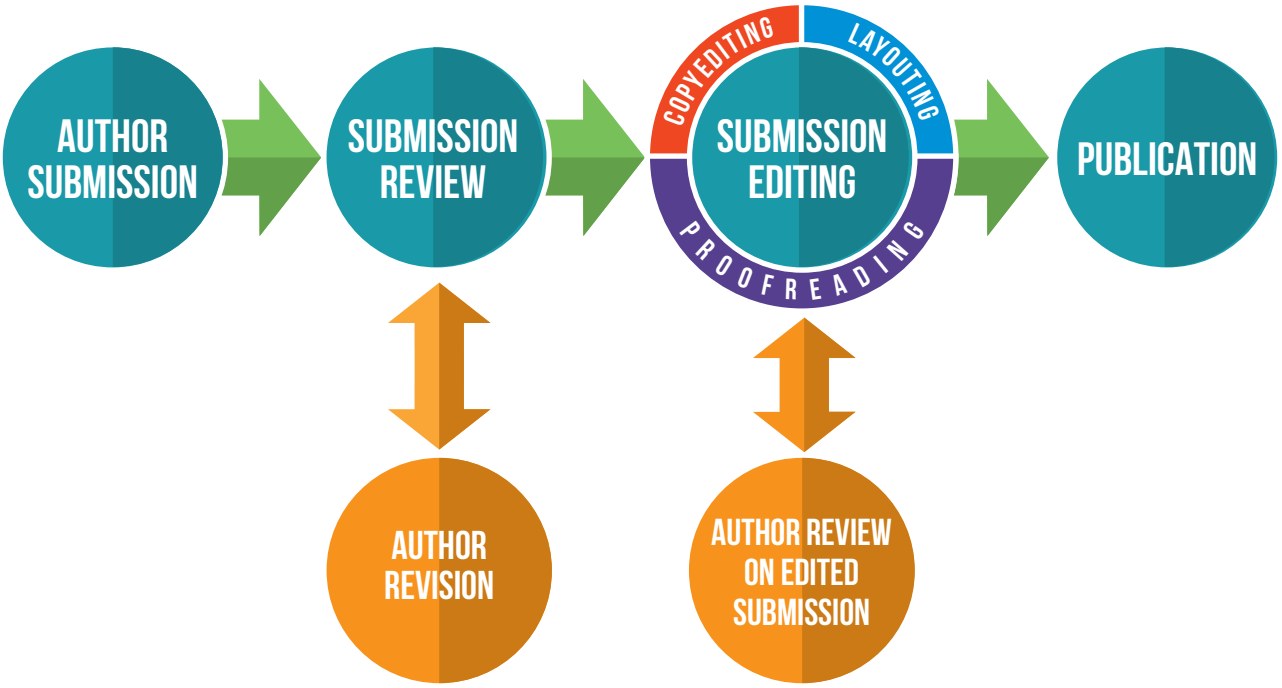

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