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Study of Social, Economic, and Environmental Impacts of Inter-Island Bridge Construction in Belakang Padang and Mat Belanda

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ABSTRACT

The research examines the social, economic, and environmental impacts of constructing an inter-island bridge between Belakang Padang and Pulau Mat Belanda. The findings reveal that the bridge has significant social benefits, enhancing inter-island access and improving the quality of life for local communities. Additionally, it brings positive economic impacts, including increased trade activities and improved distribution efficiency. However, responsible management must address potential environmental effects during construction and operation. The construction of the inter-island bridge provides substantial social advantages by facilitating improved accessibility and connectivity. It allows for smoother movement of people, goods, and services, thereby enhancing the quality of life for residents of Belakang Padang and Mat Belanda Island. The bridge fosters closer relationships, cultural exchange, and the development of vibrant inter-island communities. Furthermore, the bridge contributes to economic growth and prosperity. Enhanced inter-island connectivity stimulates trade activities and opens new markets, benefiting local businesses and the economy. The efficient transportation of goods and services leads to increased commerce, generating economic opportunities for both islands. While acknowledging the positive aspects, it is essential to address potential environmental impacts. Proper management measures must be implemented during construction and operation to mitigate adverse effects. Environmental considerations include habitat disruption, water pollution, and noise pollution. By adopting sustainable practices and responsible operation, the potential environmental risks can be minimized, ensuring the preservation of the ecosystem. In conclusion, the construction of the inter-island bridge in Belakang Padang and Pulau Mat Belanda brings significant social and economic benefits. It improves accessibility, strengthens social bonds, fosters economic growth, and enhances trade activities. However, responsible environmental management is crucial to mitigate potential negative impacts. By incorporating sustainable practices, this development can positively impact the lives of local communities while preserving the environment.

1. Introduction

Good infrastructure has been a significant development indicator, especially among developing countries [1]. Bridges are critical to every country's infrastructure [2]. Several aspects must be prioritized in designing it: safety, security, convenience, smoothness, system integration, comfort, and attractiveness [3] . Bridges also have a significant social, economic, and environmental impact on the region. Bridges function to connect one area to another. Bridge's structural characteristics, location, pedestrian perception, and attitudes may affect their use behaviour [4]. With the construction of

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bridges, it can facilitate access and transportation between connected areas. Even bridges with small spans would still significantly impact many factors.

Indonesia itself is a country that has thousands of islands. It is necessary to build infrastructure such as bridges to connect one area to another to facilitate access for the residents. The existence of this inter-island bridge will certainly significantly impact the social, economic, and environmental factors of the residents in the area. With the bridge, people can get education, jobs, and other daily needs. Another impact given by the bridge's construction can undoubtedly support the economic income of the people in the area.

Kepulauan Riau consists of 2408 large islands; the other 30% are unnamed and inhabited. With so many islands, people usually travel from one island to another using ferries and speedboats, and some even use pom-pom boats for trips between islands that are pretty close. In one of the cities in the Kepulauan Riau, namely Batam itself [5]. There is an iconic bridge known as the Barelang Bridge. The attractiveness of a place can be viewed from the aspects of geology, topography, and historical value [6]. Barelang Bridge stands for Batam, Rempang, and Galang because it connects these islands and the small islands around them. This bridge was built to expand the Batam authority's working area and help the communities on these islands regarding social, economic, and environmental factors. The development is often oriented to the transportation system too [7].

Cities have become the residence of humans until now, and for that, cities are a huge deal, and because of that, it needs a design that is well thought out [8]. Cities have various functions, such as a place to live, commercial activities, education, work, and others. Belakang Padang District itself has six sub-districts consisting of 108 small islands. Mat Belanda Island is one of the islands located in the Belakang Padang District. Mat Belanda Island is separated by sea, which can be crossed at low tide, but not at high tide. Therefore, one way to cross the island is by pom-pom boat. However, this made it difficult and hindered the people living on Mat Belanda Island from crossing.

One way to help access from island to island is to build crossing bridges between islands. Crossing bridges between islands will be one of the infrastructures that can support people's lives. With that in mind, it is necessary to analyze the social, economic, and environmental impacts of the construction of this pedestrian bridge in the Belakang Padang District. By doing the analysis, we can find out how this bridge can tangibly affect people's lives.

2. Literature Review

In civil infrastructures, a bridge requires profound insight into its security, resilience, and sustainability [9]. Bridge engineering involves many stages throughout its life cycle; each step comprises multiple complex processes with large project teams and relies on the efficient exchange of information [10]. The bridge connects separate transport routes/routes by rivers, swamps, lakes, straits, canals, highways, railways, and other crossings [11]. Bridge construction impacts sustainability, including social, economic, and environmental factors [12]. Bridge structural planning must be well designed to be used for a long time with maintenance that is relatively inexpensive.

Humans are social creatures. Humans would suffer big time if they lived alone without others. Thus humans would, or should, socialize with one another to their advantage. That way, a human could survive and lead more quickly and efficiently. The construction of a pedestrian bridge impact on social factors in the region. It certainly would help to increase the life quality of each individual. With the construction of access in the form of a pedestrian bridge, the people on Mat Belanda Island can easily

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access Belakang Padang. With a pedestrian bridge, it can help people to connect and socialize with one another.

The existence of this bridge will produce a tremendous impact. Because the island of Mat Belanda can be said to be relatively small, the facilities there are only partially available. Therefore, the people living on Mat Belanda Island must cross the sea by pom-pom boat to use the required facilities. Many young children living on Mat Belanda Island attend school in Belakang Padang. Because of that, they have to cross the sea by pom-pom boat to go to school. Many people who are sick or have died must get on a pom-pom boat first and cross the island to use facilities such as hospitals and cemeteries. It is an unfortunate and hurtful thing to witness. With this bridge, it is expected to increase the effectiveness and efficiency of people's lives.

From this research perspective, the economy is viewed as a sub-system of human-social needs within an institution, with the social dimension itself being a sub-system of the environmental system, hence, the interrelationship between the three pillars of sustainability [13]. Similar to the social effects, the construction of the pedestrian bridge will also affect the economy on a big scale. The increase in the trading activity between buyers and sellers will surely increase the economic state of the region. Because each region produces different things, it will also help to keep the balance of supply and demand. When the balance is stabilized, then both of the areas will flourish.

Economic factors in an area can develop if access is expanded. With inter-island access, sending materials and purchasing goods can be done quickly between sellers and buyers. The shipping cost will also drop by a lot. So the buyers can easily have access to the materials they need. Because of the easy access, the time needed for each transaction will shorten considerably. The supply and demand requests will also be balanced out. So, the relationship between the buyers and the seller will happen frequently. And because of that, it will increase the productivity between the two parties. However, constructing a bridge will undoubtedly cost mone. It will have an impact on monetary funds in the region. With the construction of this bridge too, it can disrupt residents whose livelihood is operating pom-pom boats. But this can be overcome by finding alternative jobs that are relatively available in the area.

Aside from the social and economic effects, the environment in the region will indeed be affected too. When building a bridge, of course, it will also have an impact on environmental factors. Environmental effects are divided into five pollution types: air, water, soil, noise, and light. Each of the pollutants will undoubtedly be affected. But the most to be affected is air pollution. Building a bridge will also cause a lot of pollution in the air because of the utilization of heavy machinery. Heavy machinery is needed to ensure the construction process. It will affect the water that surrounds the region too. The water could be dangerous if the workers are not cautious.

The construction will affect the soil too. Because it is built above the ground, workers should be cautious not to spill any hazardous liquid that could affect the soil condition. Construction will cause a lot of noise pollution too. The main cause is also the operation of the heavy machinery itself. And for the light pollution, it doesn't really affect as much as the others. The construction project should consider the environment surrounding it [14]. Therefore, the construction of bridges must be as environmentally friendly as possible by applying recycling methods and designed with the least potential risk of contamination [15]. They should also prevent waste as much as possible. That way, it can protect the environment in the development area.

3. Method

The methodology collects data to produce an article [16]. Data is one of the main strengths in developing research [17]. The methodology for writing this article uses qualitative data. This qualitative data is

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obtained directly through observation, which makes this data the primary data (Rifai & Isradi, 2022). Primary data is created by researchers for the specific purpose of solving problems being handled by researchers [7] [18]. The article's author interviewed the people living on Pulau Mat Belanda to discover the impacts. Data collection includes the opinions and expectations of the population from a social, economic, and environmental perspective [19] [20] [21].

Figure 1. Location of Research

Figure 2. Article's Writer Conducting an Interview with Locals

4. Result and Discussion

This chapter presents and discusses the results of observations, interviews, and research on the Social, Economic, and Environmental Impacts of Inter-Island Bridge Construction in Belakang Padang and Mat Belanda. The study was conducted in the Belakang Padang district by engaging informants who were residents of the research area. The research involved several stages, including the formulation of interview questions used to collect data, which were then analyzed to understand the information provided by the informants. This research aimed to explore the studied area's social, economic, and environmental issues.

4.1 Social Difficulties

Based on a survey involving 25 respondents, most expressed that access to community facilities such as schools and hospitals was the biggest challenge regarding social factors. This situation becomes even more difficult because Mat Belanda Island is separated from the main island, making it challenging for the community to access healthcare facilities promptly. To reach the hospital, they must cross the sea using pom-pom boats and then be transported by pedicabs. Difficulties are also experienced by children who go to school on the main island but live on Mat Belanda Island. They must return the pom-pom boats to their homes every morning and after school.

In addition, some respondents also mentioned their difficulties in accessing basic needs such as food, clothing, and shelter in their daily lives. To buy these items, they must take the pom-pom boats to the main island to get what they need. This limited access becomes a natural barrier to fulfilling the basic needs of the Mat Belanda Island community. Although there might be a few shops on their island, the options and availability of goods may be limited, thus increasing the difficulty in accessing the necessary items.

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Furthermore, some respondents expressed difficulties visiting family and relatives who live on different islands. The separation of Mat Belanda Island from the main island hinders the mobility of the population. It makes it difficult for them to maintain relationships with their separated family and relatives. Traveling by pom-pom boats is the only option to visit their loved ones, which may require extra time and effort. This lack of social interaction contributes to feelings of isolation among the residents of Mat Belanda Island.

4.2 Economic Difficulties

In the survey involving 25 respondents, most faced difficulties purchasing daily necessities on Mat Belanda Island, such as fresh meat, vegetables, and other food items. Accessibility limitations were the main factor influencing this issue. The island's residents have to take pom-pom boats and pay transportation costs to go to the main island and buy essential goods. It creates an imbalance between supply and demand on Mat Belanda Island, as the supply of goods may need to meet the local community's needs.

In addition to difficulties meeting food needs, some respondents also mentioned their struggles in finding employment to sustain their daily lives. Mat Belanda Island may have limited job opportunities and economic prospects that can result in high unemployment rates and difficulties for the local population in finding suitable jobs. The inability to secure adequate livelihoods can lead to financial problems and affect their overall quality of life.

4.3 Environmental Difficulties

During the interview sessions, nearly half of the respondents expressed concerns about the pollution caused by the motor engines used to operate the pom-pom boats. They were aware that using motor engines could result in exhaust emissions that could harm the air quality in the area. These individuals were concerned about the potential negative impacts on the environment and their health due to air pollution caused by motor engine emissions. They advocated for environmentally friendly alternatives, such as using more efficient motor engines or transitioning to renewable energy sources.

However, some other respondents believed no significant environmental disturbances resulted from using motor engines for the pom-pom boats. They argued that the motor engines were used on a limited scale and did not pollute the environment significantly. They might believe that the pollution impact generated by the pom-pom boats was not significant enough to be a primary concern or that the local climate had sufficient capacity to handle the existing pollution. This difference in opinions indicates a variation in perceptions regarding the pollution impact caused by the motor engines of the pom-pom boats.

4.4 Can the Construction of the Bridge Provide a Solution?

All respondents who participated in the interviews agreed that the bridge's construction could improve impacts. The majority stated that the bridge structure could be one potential solution to address several issues faced by the community of Mat Belanda Island, including accessibility problems, mobility issues, and the environmental impact caused by using motorized pom-pom boats. Several benefits can be achieved with a bridge connecting the island to the mainland.

Almost all respondents mentioned that constructing the inter-island crossing bridge would improve the accessibility of the Mat Belanda Island community to essential facilities such as schools, hospitals, and economic centers on the mainland. The district would no longer rely on pom-pom boats to cross the sea, which may involve additional costs and longer travel times. Thus, access to critical facilities and services can be enhanced, helping to address the difficulties faced by the community in meeting their daily needs.

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Some respondents also pointed out that the bridge's construction could also reduce the use of motor engines and the related pollution impact. With the bridge in place, land transportation becomes more accessible and more efficient, eliminating the dependency on fossil fuel-powered pom-pom boats. Reducing motor engine usage would help mitigate exhaust emissions that degrade air quality and the surrounding environment of Mat Belanda Island.

4.5 Challenges Hindering the Construction of the Inter-Island Crossing Bridge

In the interview results, it was revealed that the bridge's construction also faces challenges in terms of economic and environmental factors. One major factor is the economic aspect, as the bridge's construction requires a significant budget. This aspect can pose a barrier in the bridge construction process, as adequate financial resources may be challenging to obtain. Additionally, the bridge's construction may disrupt the livelihoods of individuals currently providing ferry services using pom-pom boats. These service providers may experience a decline in income if the bridge is built, as the demand for pom-pom boat crossings could significantly decrease.

Apart from economic factors, environmental considerations are also crucial in bridge construction. The bridge's construction can cause severe environmental pollution if not carefully planned. Using heavy machinery in bridge construction can generate harmful gas emissions, which can degrade the air quality in the surrounding area. Additionally, without proper control measures, the bridge construction also has the potential to pollute the surrounding seawater. Marine pollution can negatively impact the marine ecosystem and the livelihoods of the local community, especially those relying on seaweed cultivation. Although social factors were not directly mentioned as difficulties in bridge construction, the interview results indicate that the community did not perceive significant problems in terms of social factors. The results can be interpreted as the community not feeling socially disrupted by the construction of the bridge.

5. Conclusion and Recommendation

The construction of the inter-island crossing bridge at Belakang Padang and Mat Belanda Island has significant social, economic, and environmental impacts on the region. The analysis of these impacts reveals the following key findings. For the social impacts, the bridge's construction will significantly improve the area's social conditions. It will provide better access to community facilities such as schools and hospitals, reducing the challenges faced by residents in accessing essential services. The bridge will also enhance social interactions and connections between residents living on different islands, promoting a sense of community and reducing feelings of isolation. As for the economic impacts, the bridge will have positive economic effects by improving the accessibility and mobility of goods and services. It will facilitate trade activities between regions, reducing transportation costs and increasing efficiency in the supply chain. The bridge will also create employment opportunities, particularly in transportation, trade, and tourism sectors, contributing to the area's overall economic development. While for the environmental impacts the construction process of the bridge may have temporary negative environmental impacts, such as air and water pollution, caused by the use of heavy machinery. However, these impacts can be mitigated by implementing environmentally friendly practices, such as proper waste management and efficient, low-emission machinery. In the long term, the bridge will reduce the pollution caused by the operation of pom-pom boats, leading to improved air quality and a healthier environment.

Based on the analysis, the following recommendations are suggested. The design and planning of the bridge should prioritize the local community's needs. Consideration should be given to ensuring easy access to essential facilities, such as schools, hospitals, and markets. Engaging with the community and

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incorporating their input in planning is crucial to address their needs and concerns. During the construction phase, measures should be taken to minimize the environmental impacts, including using environmentally friendly construction techniques, proper waste management, and reducing pollution caused by heavy machinery. Adhering to sustainability standards and guidelines will help preserve the natural environment and protect the ecosystem. Alongside the bridge construction, comprehensive economic development plans should be implemented to maximize the financial benefits, like include promoting local industries, attracting investments, and providing training and skills development programs to enhance employment opportunities for the local population. Collaboration with relevant stakeholders, such as government agencies and private sector organizations, is essential to implement effective economic development strategies. Regular monitoring and evaluation should be conducted to assess the bridge's social, economic, and environmental impacts. Monitoring will identify potential issues or challenges and allow timely interventions and adjustments. The feedback from the community should be actively sought and considered in the monitoring and evaluation process. In conclusion, constructing the inter-island crossing bridge at Belakang Padang and Mat Belanda Island will significantly impact the region's social, economic, and environmental aspects. By addressing the identified recommendations, the bridge project can be effectively implemented to improve the quality of life for the local community while ensuring sustainable development and environmental protection.

References

[1] M. C. Torrentira Jr, "Critical Evaluation on the Social, Economic, and Environmental Impacts of the Tagum City Flyover Project, Philippines: A Perception from Affected Stakeholders," *About AADN,* vol. 162, 2019.

[2] M. C. Tang, "Forms and aesthetics of bridges," *Engineering,* vol. 4, no. 2, pp. 267-276, 2018.

[3] I. Pangesti, A. I. Rifai and J. Prasetijo, "The Horizontal Curved Geometric Planning Using the Autocad® Civil 3D Method on Tanah Merah Road, Banjarbaru City, South Kalimantan," *Indonesian Journal of Multidisciplinary Science,* vol. 1, no. 1, pp. 265-287, 2022.

[4] M. Saadati, A. Dorosti, M. Dahim, E. Hemmati, M. Edalatzadeh, T. Hosseinpor and A. J. Biparva, "Listening to pedestrian; What are the influential factors on bridge use," 2020.

[5] D. Pratama, A. I. Rifai and S. Handayani, "The Passenger Satisfaction Analysis of Commuter Line in the New-Normal Period," *Indonesian Journal of Multidisciplinary Science,* vol. 1, no. 1, pp. 409-418, 2022.

[6] A. Mufhidin, D. A. Febriansyah, A. I. Rifai and M. Isradi, "Toll Gate Capacity Analysis:(Case Study: Sentul Toll Gate 2)," *WORLD JOURNAL OF INNOVATION AND TECHNOLOGY,* vol. 3, no. 1, pp. 15-21, 2022.

[7] A. W. Rahmadhani, A. I. Rifai and S. Handayani, "The Perception of Travel Behavior on Public Transport Mode Choice: A Case of Depok-Jakarta Route," *Citizen: Jurnal Ilmiah Multidisiplin Indonesia,* vol. 2, no. 5, pp. 896-905, 2022.

[8] Y. Immanuel, A. I. Rifai and J. Prasetijo, "The Road Performance Analysis of the Tuah Madani Roundabout, Batam-Indonesia," *Indonesian Journal of Multidisciplinary Science,* vol. 1, no. 1, pp. 27-36, 2022.

Receieved 20 April 2023
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Published by Fakultas Teknik Sipil dan Perencanaan UIB

Civil Engineering and Architecture Journal Vol 1 No 1 (2023) E-ISSN
DOI 10.37253/leader.v1i1.8078

[9] J. Górecki and P. Núñez-Cacho, "Decision-Making Problems in Construction Projects Executed under the Principles of Sustainable Development—Bridge Construction Case," *Applied Sciences,* vol. 12, no. 12, p. 6132, 2022.

[10] J. Wei, G. Chen, J. Huang, L. Xu, Y. Yang, J. Wang and A. M. Sadick, "BIM and GIS applications in bridge projects: A critical review," *Applied Sciences,* vol. 11, no. 13, p. 6207, 2021.

[11] M. Safri, "Feasibility and impact of Muara Bulian Bridge construction on the economy of Batang Hari Regency," *Jurnal Perspektif Pembiayaan dan Pembangunan Daerah,* vol. 5, no. 2, pp. 81-90, 2017.

[12] V. Penades-Pla, D. Martinez-Munoz, T. García-Segura, I. J. Navarro and V. Yepes, "Environmental and social impact assessment of optimized post-tensioned concrete road bridges," *Sustainability,* vol. 12, no. 10, p. 4265, 2020 .

[13] W. Gachie, "Project sustainability management: risks, problems and perspective," *Problems and perspectives in management,* vol. 17, no. Iss. 1, pp. 313-325, 2019.

[14] F. Yavuz, U. Attanayake and H. Aktan, "Economic impact analysis of bridge construction," *Transportation Research Record,* vol. 2630, no. 1, pp. 95-102, 2017.

[15] N. Bertola, C. Küpfer, E. Kälin and E. Brühwiler, "Assessment of the environmental impacts of bridge designs involving UHPFRC," *Sustainability,* vol. 13, no. 22, p. 12399, 2021.

[16] N. Ulchurriyyah, A. I. Rifai and M. Taufik, "The Geometric Redesign of Horizontal Curved Using AutoCAD Civil 3D®: A Case Jalan Garuda–Jalan Moh. Hatta, Tasikmalaya West Java," *Indonesian Journal of Multidisciplinary Science,* vol. 1, no. 1, pp. 288-303, 2022.

[17] T. Resinta and A. I. Rifa'i, "The Traffic Jam Phenomenon at Traditional Village: A Case of User Perception in Batam, Indonesia," *LEADER: Civil Engineering and Architecture Journal,* vol. 1, no. 1, pp. 36-43, 2023.

[18] A. Setiawan, A. I. Rifai and J. Prasetijo, "The Phenomena of Local Public Transportation Service: A Case Oplet in Pontianak, Indonesia," *Citizen: Jurnal Ilmiah Multidisiplin Indonesia,* vol. 2, no. 5, pp. 916-923, 2022.

[19] E. O. Joice, A. I. Rifai and M. Taufik, "The Link Road Design of Jalan Plupuh Tanon And Jalan Gabugan Section 1, Sragen Indonesia," *Indonesian Journal of Multidisciplinary Science,* vol. 1, no. 1, pp. 211-223, 2022.

[20] R. A. Agustino, A. I. Rifai and S. Handayani, "A Comparative Effectiveness Analysis of The Users of Public Transportation and Private Transportation for Employees: A Case of Cinere-Lebak Bulus Route," *Indonesian Journal of Multidisciplinary Science,* vol. 1, no. 1, pp. 178-188, 2022.

[21] R. B. Nugroho, A. I. Rifai and A. F. Akhir, "The Geometric Design of Horizontal Alignment: A Case of Bojonggede-Kemang Area Route, West Java Indonesia," *Indonesian Journal of Multidisciplinary Science,* vol. 1, no. 1, pp. 331-343, 2022.

Receieved 20 April 2023
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