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The Impact of Industrialization on Changes in Spatial Structure and Access to Livelihoods in Teluk Mata Ikan, Nongsa

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Abstract
Industrialization in coastal settlements located in Kepulauan Riau triggers spatial transformation and physical barriers, yet its impact on micro-community livelihoods is often overlooked. The main issue addressed in this study is the emergence of physical barriers and micro-scale environmental degradation resulting from industrial expansion, which has led to spatial conflicts and the marginalization of local communities. Therefore, this study aims to analyze the impact of industrialization activities on changes in the physical spatial structure and its influence on the limited access to livelihoods for traditional communities in Teluk Mata Ikan, Nongsa, Batam. A qualitative approach using the case study method was applied in this study. Data were collected through field observations and semi-structured interviews with four informants representing various local professions. Data analysis utilized the interactive model of Miles and Huberman through the stages of condensation, data presentation, and drawing conclusions. The study results indicate a double-edged impact, positive impacts are felt by informal sector vendors and retailers, who gain daily revenue due to the arrival of industrial workers during specific hours. Conversely, severe negative impacts were experienced by fish farmers and small-scale farmers. Landfill activities without adequate drainage triggered sediment flows that damaged aquaculture ponds, while the installation of project fences created enclaves that restricted the community's socio-economic mobility. The significance of this study lies in providing empirical evidence regarding the marginalization of traditional communities due to the spatial transformation in coastal areas that experience spatial conflicts between industrial zones and traditional settlements.

Keywords: Coastal settlements; Industrialization; Spatial conflicts

Introduction

Both globally and nationally, coastal areas are considered strategic regions that are currently experiencing tremendous development pressure along with the accelerations of industrial activities. The developments of industrial areas along the coast triggers spatial changes in a very intense scale, most of it comes in the form of conversion of productive lands, reduction of open green spaces, and the shrinking of conservation areas that are turned into built-up areas (Argarani et al., 2025).

Empirically, the phenomenon of converting coastal spaces does not merely change the physical landscape but also brings a chain effect on the socio-economic structure of local communities. This phenomenon aligns with the findings of Saputra et al., (2025) which asserted that the conversion of coastal land and degradation of coastal ecosystems directly reduces the productivity of marine products, which in some cases creates economic vulnerability and erodes the social stability of certain communities that relies in the sectors of traditional maritime for their livelihood. The structural pressure resulting from this expansion forces local communities to face the loss of primary living spaces, thereby triggering a forced shift in coastal livelihood structures (Sherina et al., 2025; Saputra et al., 2025).

Coastal communities, particularly traditional fishermen, are the groups that are most vulnerable towards these impacts because of their living spaces and fishing areas that conflicts directly with the interests of corporate expansion (Anab et al., 2023; Argarani et al., 2025). This statement aligns with research from Wahyudi et al., (2025) which asserts that a socio-spatial approach shows high tension and segregation when corporations or private parties begin to restrict and dominate access to coastal spaces that originally served as the livelihood base for local communities. This phenomenon is also consistent with the spatial trend analysis by Fedriansya & Rahman (2025), which indicates that massive expansions of the industrial sector in coastal areas could drive and converse the communal spaces into private built-up areas, triggering spatial inequality and marginalization of living spaces throughout the local community.

The pressure conditions in the area due to industrial expansion are clearly visible in Batam City, especially in the coastal area of Nongsa District. Historically, Batam's designation as a center for large-scale industrial activity began with its role as a logistics base for offshore oil exploration, which was then accelerated through the Free Trade Zone and Free Port (FTZ) policy) Hutasoit et al., (2023). This aligns with research of Iood et al., (2022) which shows that Batam City's Government continues to promote the integration between Nongsa as the Special Economic Zone (SEZ), the developments of community-based economic potential, and tourism based on local wisdom. In line with this, Nensi Lapotulo et al., (2026) affirms that the acceleration of tourism in Batam is currently focused on sustainability and strengthening the digital capacity of local business actors.

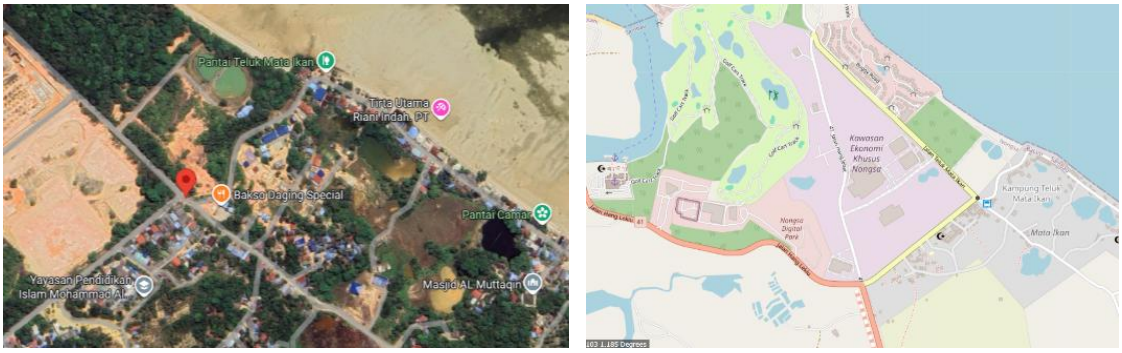
Based on previous research in Kabil Village, Nongsa, the presence of industrial activities has been proven to degrade the socio-economic conditions of the local community due to the shrinkage of fishermen's catch areas and forced shifting in livelihoods to the formal or informal sector (Sherina et al., 2025). Although studies on the

impact of industrialization on fishermen in Nongsa have been conducted (Sherina et al., 2025), and the socio-economic impacts on coastal fishermen at the national level have also been extensively discussed (Anab et al., 2023), an analysis that integrates changes in the physical spatial structure with restrictions on livelihood access in Kampung Tua Teluk Mata Ikan has not yet been addressed. Previous research generally analyzed the impact of industrialization from a macro socio-economic perspective descriptively (Anab et al., 2023; Sherina et al., 2025) or focused only on trends in spatial land-use changes through remote sensing data (Argarani et al., 2025).

Therefore, this study aims to analyze the impact of industrialization on changes in the physical spatial structure and its effects on the limited livelihood access of fishing communities in Teluk Mata Ikan, Nongsa. This study is expected to contribute scientifically to the development of urban architecture and coastal spatial planning, particularly regarding the mitigations of spatial conflicts between industrial areas and traditional settlements. In addition, the research findings can be used as a consideration for local governments in considering a more inclusive formulation in spatial planning regulations that protects the living space rights of local communities in Batam City.

Research Method

This research was conducted in the Teluk Mata Ikan area, Sambau Village, Nongsa District, Batam City (Figure 1). The main observation's focus was directed at the perimeter boundary area of the industrial zone that directly borders to the traditional residential areas. The location selection used purposive sampling techniques based on the characteristics of Teluk Mata Ikan as one of the coastal settlements in Batam that experiences direct interaction with industrial zone and most respresentative area. This step was based on the theory Tajik et al., (2024) which states that the deliberate selection of research sites is very crucial to filter complex phenomena so that researchers can focus on the location that is richest in information and has the deepest problem urgency.



(a) (b)

Figure 1. *Teluk Mata Ikan, Sambau Village, Batam*
Source: (a) Google Maps, (b) GISTARU, 2025

This study used a qualitative approach with a case study method. According to Merriam (2009), qualitative research is oriented towards natural observation in order to deeply understand the context of a phenomenon. In line with this, Sugiyono (2020)

emphasizes that the qualitative method operates in natural conditions of the object with the researcher as the key instrument. A case study design by Creswell & Poth (2018) is applied to limit the analysis to a single spatial area in Nongsa, so that the researcher can explore the meanings, perceptions, and survival strategies of the local community as a result of changes in space from public function to private industrial area.

Types of data collection include observation, interviews, and documentation.

a) Field Observation

Referring to Sugiyono (2018), the researcher conducts a transect walk without intervention. The aspects observed include changes in land use, the spatial distance between the factory boundaries and residents' homes, as well as economic activities in existing communal public spaces. Documentation from the field that has been observed is attached in (Figure 2).



Figure 2. *Observation area documentation*

b) Interviews with Local Residents

Conducted with four informants selected based on a variety of occupations. With the durations of 10–15 minutes per person, researchers obtained an audio recording with the informants' permission. The informants' profiles are presented in Table 1.

Table 1. *Informant Profile*

Informant Code	Profession / Occupation	Estimated Duration of Stay at the Location	Focus of Information / Qualitative Information Explored
R-01	Food Stall Merchant (Former Fishpond Worker)	> 15 years	Positive economic impact, the intensity of consumer crowds from industrial workers, fluctuations in daily income, and the pattern of peak visiting hours of factory workers (afternoon and evening).

R-02	Grocery Store / Retail Owner	> 20 years	Positive economic impact, the intensity of consumer crowds from industrial workers, fluctuations in daily income, and the pattern of peak visiting hours of factory workers (afternoon and evening).
R-03	Fish Farming Farmer	> 20 years	Chronology of landfilling, pond damage due to sediment, and project transparency issues.
R-04	Gardener	> 20 years	Chronology of land accumulation (landfill), pond damage due to sediment, and project transparency issues, narrowing of free exploration space in coastal areas, and installation of project activity boundary wire fences.

c) Documentation

According to Sugiyono (2019), documentation is a method used to obtain data and information in the form of books, archives, documents, writing, numbers, and images in the form of reports as well as explanations that can support research. Documentation is used to collect data and then examine it. The documentation used in this research includes the conditions of the location and the profile of the informants. Based on the opinions of experts that have been cited, it can be understood that data analysis in qualitative research is a series of systematic activities aimed at processing raw data (from interviews, field notes, and documentation) into meaningful and easily understood information. This process includes organizing data into categories, elaborating into smaller units, synthesizing, arranging patterns, selecting important data, and drawing conclusions.

According to Sugiyono (2019), data analysis in qualitative research aims to process raw data into meaningful information. There are 4 stages in the analysis, as follows.

a) *Data Collection*

The data collection process in this qualitative research is carried out comprehensively by relying on three main instruments, namely field observation, in-depth interviews, and documentation studies. In practice, all of this dynamic data is collected progressively and simultaneously through a series of periodic visits to Mata Ikan Bay. The researchers deliberately adopted this step to map out

socio-spatial dynamics thoroughly within their actual ecosystems. They systematically categorized and filed all field notes, informant transcripts, and visual media to eliminate any potential bias. To lock in data quality and keep it accountable, the study relies on source triangulation. This method of cross-confirmation serves as a vital filter, verifying authenticity and securing the objectivity of the field findings.

b) *Data Condensation*

To align with Sugiyono (2019), reducing or condensing data is a critical step to summarize, isolate key insights, and zero in on what truly matters to the study. This elimination phase does more than just clean up data; it uncovers hidden themes and structural patterns within the phenomenon. For this project, piles of raw field notes and interview transcripts were carefully sifted to prioritize high-relevance data. Sharpening the dataset this way is crucial to prevent the manuscript's narrative from wandering, keeping it firmly anchored to spatial structure dynamics and their direct impact on local livelihoods. To provide a clear overview, the entire methodological sequence is illustrated in Figure 3.

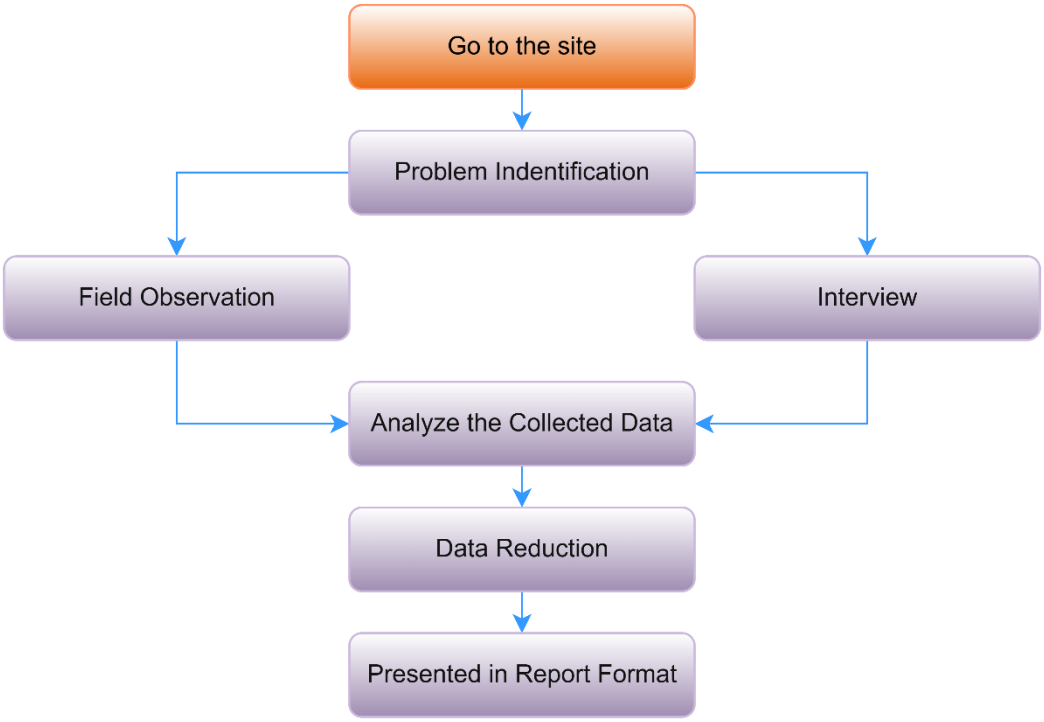


Figure 3. *Flowchart of the Data Collection Process*

Grounded in the flowchart sequence, the study began by analyzing and identifying key issues across various coastal communities in Batam City for an initial comparative assessment. Teluk Mata Ikan in Nongsa was eventually selected as the main study site. The researcher then moved forward with follow-up fieldwork, equipped with more comprehensive tools like structured interview guidelines and field observation logs. Instead of letting the collected raw data pile up, the information was promptly filtered, cross-referenced, and refined into dense, context-heavy qualitative data. This systematic processing forms the backbone of the narrative analysis in this paper.

c) *Data Display*

After passing the reduction stage, the next crucial step that must be taken is the presentation of data. If referring to the thinking of Sugiyono (2019), the format of data presentation in the realm of qualitative research is actually very flexible; Data can be packaged in the form of tables, graphs, flowcharts, and pictograms. Through this neat visualization or grouping, the data stack that initially looks complicated can be well organized. This not only makes it easier for researchers to map meaningful relationships between variables but also makes the overall content of the material much easier for readers to understand.

d) *Conclusion Drawing and Verification*

The final step is drawing conclusions. According to Sugiyono (2019), conclusions in qualitative research are new findings that have not existed before, which can be in the form of a description of an object that was previously unclear but becomes clear after being studied.

Researchers began to look for patterns or themes that recur and configurations between categories. The results of the analysis are presented in a systematic interpretive descriptive narrative, from thematic description to theoretical interpretation regarding changes in structure and spatial conflicts in Nongsa. To ensure the conclusions are accurate, verification is carried out by comparing interview results among respondents and matching them with observational findings.

Results and Discussions

Based on the results of field observations, a match was found between the real conditions and the interview data. Positive impacts are significantly felt by culinary and retail traders. Their income has become more stable since the industrial sector developed.

> *"Yes, they (the workers in the industrial sector) often sit here, have lunch, and snack. So, it has become busier since they started coming. I ended up getting more income." (R-01)*

On average, the peak hours of economic activity are concentrated during lunchtime from 12.00 – 13.00 and in the late afternoon 16:00 - 17:00. This temporary economic activity, which centers on critical hours, shows that the new livelihood rhythms of the local community are heavily dependent on the activity cycle of the industrial area. In addition, positive responses also emerge because the industrial sector is able to absorb labor from the surrounding community who meet the criteria, as laborers or unskilled workers.

> *"You can also work there (in the industrial sector), even if you can't, then at an office, you can do rough jobs. My neighbor works there as a laborer, it's not bad, you also get money." (R-02)*

This spatio-temporal adaptation phenomenon aligns with the concept of hybrid economy-mobility spaces from Annisa et al., (2026) which states that the informal sector has characteristics of flexible and dynamic space utilization, where commercial spaces are formed temporarily following the convergence points of mass mobility flows and consumer break times. This finding is also relevant to Meliala Sekolah Tinggi Ilmu Ekonomi Ottow, Serui -Papua, (2022), which states that the presence of industrial activities has a positive correlation in stimulating the economic growth of surrounding communities. Furthermore, positive responses also emerge because the industrial sector is capable of absorbing labor from the surrounding community.

This spatio-temporal adaptation phenomenon aligns with the concept of hybrid economic-mobility space that the informal sector has characteristics of flexible and dynamic space utilization, where commercial spaces are formed temporarily following the meeting points of mass mobility flows and consumer break hours. This finding is also relevant to the view that the presence of industrial activities has a positive correlation in stimulating the economic growth of the surrounding community. In addition, a positive response also arises because the industrial sector is able to absorb labor from the local community.

> *"It's quite fortunate that this place has become busy since the factory (industry) was built, it can at least provide a little income for the family." (R-01)*

Broadly speaking, the development of industrial areas produces an economic domino effect on two paths: the formal sector through employment absorption and the informal sector through the growth of spontaneous trading spaces. A summary of the interrelation of these two dimensions of positive responses is presented in the following table.

Table 2. *Matrix of Positive Response Synthesis and Economic Adaptation of the Teluk Mata Ikan Community*

No	Dimensions of Positive Impact	Type of Activity / Absorption	Spatial Elements Involved	Measurable Success Indicators
1.	Formal Sector (Employment)	Local residents who meet the criteria are recruited as factory workers and manual laborers in the industrial sector.	Main circulation routes and entrance gates to the industrial project site.	The unemployment rate at the village/subdistrict level is gradually decreasing.

2.	Informal Sector (Spontaneous Economy)	Residents have opened food stalls, coffee shops, and retail kiosks in a flexible manner to meet the needs of workers.	Porch, front yard of a residential home, and the outer perimeter of the project.	There is a steady increase in daily sales during the lunch break and in the afternoon.

In practice, the daily income of local vendors fluctuates in sync with factory shifts and corporate calendars. This economic interdependence highlights a worrying structural fragility. Without a diversified market, the informal sector near the zone is caught in an acute reliance on industrial enclaves, making peripheral livelihoods highly sensitive to both internal corporate decisions and external global market shocks (Ariffianti et al., 2025).

Furthermore, the negative fallout on fishpond operators and local planters cannot be overlooked. Large-scale land clearing and landfill operations, executed without proper drainage systems or transparent administration, remain the root cause of local complaints. This spatial friction heavily impacts the area's primary production sector, especially inland aquaculture. According to local accounts, land reclamation continues despite a lack of clear waterway planning and bureaucratic transparency. The decision to withhold technical data has caused widespread anxiety, as heavy rains repeatedly wash soil and sediment from construction sites into residents' productive fishponds, clogging and damaging their main source of livelihood.

Empirically, patterns of material accumulation that ignore transparency of environmental impact information and spatial planning calculations like this have been proven to disrupt hydrological balance, trigger massive sedimentation, and destructively reduce the carrying capacity of surrounding aquatic ecosystems (Augustina et al., 2024). As a result, water quality has drastically declined, fish commodities have died in mass, and land that used to be a source of livelihood has now turned into dead areas that cannot be cultivated again. This imbalance ultimately eliminates the social and economic values of local communities in order to prioritize merely the normative legality of development.

> *"Our fishponds are all gone, we already tried to communicate with the person in charge, but there was no response." (R-03)*
> *"Our garden was affected too, we suffered losses. But there wasn't any good intention at all." (R-04)*

These findings are in line with the argument from Augustina et al., (2024) that patterns of material accumulation that ignore information transparency have been proven to disrupt the hydrological balance, trigger massive sedimentation, and reduce the carrying capacity of aquatic ecosystems. This is also consistent with Adyatama et al., (2025) that reclamation activities that disregard AMDAL procedures provide negative externalities in the form of sediment mud pollution.

Physical degradation is exacerbated by the emergence of spatial barriers in the form of physical boundaries (project zinc fences) that create closed areas (enclaves), reducing the public roaming space of residents. This condition aligns with the territoriality theory of Grace Halim et al., (2024) that aggressive physical configurations trigger psychological barriers and a sense of alienation. This practice reflects a form of the contemporary enclosure movement in coastal areas. The practice of fencing living spaces reflects in coastal regions, where the privatization of maritime areas, or ocean grabbing, is carried out manipulatively through the isolation of physical access (Muh. Syaiful & Zulkifli, 2025)

Spatial analysis shows that corporations carry out the privatization of coastal areas without synchronizing with existing spatial uses by indigenous communities. These zinc fences not only restrict physical space but also sever the cultural and historical attachment of the communities to their ancestral lands. The preliminary conclusion affirms the occurrence of structural spatial marginalization, where the right to space for local communities is sacrificed for the acceleration of formal industrial infrastructure.

Identification of physical degradation and movement space restrictions at the location is presented in the following (Table 3).

Table 3. *Identification of Physical Degradation and Restrictions on the Range of Traditional Communities*

No	Affected Communities	Changing Physical Elements	Field Observations	Perceptions / Impact on Residents
1.	Fish Farmers & Planters	Aquaculture ponds and productive crop areas.	Sedimentation of sludge from industrial landfills was found.	Fish are dying en masse, and farmland is becoming barren.
2.	Traditional Communities / Fishermen	Land ownership boundary (Public Area → Private).	Installation of a solid metal fence around the perimeter of the construction site.	Public spaces are shrinking; residents have to take a detour on foot around the outer perimeter of the fence.

This spatial imbalance confirms that rapid land transformation without effective and adaptive regional regulations tends to compromise the long-term sustainability of local communities (Baihaqi et al., 2025).

In the end, changes in spatial structure bring economic stimulus to the service sector, but at the same time create spatial inequality. The informal sector grows spontaneously, while the living spaces of traditional communities are marginalized.

Table 4. *A Comparison of the Impacts of Industrialization Based on Residents' Testimonies and Field Observations*

Sector	Testimonials from Residents	The Actual Conditions Observed in the Field
Stall / Vendor	Revenue has increased because construction workers often come to shop, have lunch, and buy snacks.	The warung is crowded with people in uniforms from 12:00 to 1:00 p.m. and from 4:30 to 5:00 p.m.
Fish Farmer	The fishpond was buried under soil from a land development project, the fish died, and the owner suffered a loss.	What remains is a shallow, dirty pool caused by soil and debris washing in from above.
Community Room	The land, which used to be open to the public, has now been fenced off by the project team, and residents are prohibited from entering.	A metal fence stands around the property, but residents can still walk past it on the outside.

Facing that pressure, the community develops adaptation strategies (coping mechanisms). For fish farmers and fishermen, changing professions becomes an inevitable choice, such as becoming daily laborers or opening a small retail business.

> *"Yesterday I worked there (fishpond), but the owner could no longer afford to pay, so I changed my profession to what I do now. Thank God I can have a job in today's times." (R-01)*

However, this shift in livelihoods does not automatically solve the problem but rather creates new vulnerabilities due to unstable income compared to when they still had self-owned production assets (fishponds).

This statement aligns with the research Sari et al., (2025) that radical changes in profession to casual daily laborers trigger new vulnerabilities in the form of income uncertainty, which results in the accumulation of psychological stress and physical fatigue. This prolonged pressure forces the local community to develop emergency coping mechanisms that are often maladaptive.

This statement is in line with research that radical changes in profession to daily casual labor trigger new vulnerabilities in the form of income uncertainty, which ultimately leads to the accumulation of psychological stress and physical fatigue. This prolonged pressure forces the local community to develop emergency coping mechanisms that are often maladaptive.

Meanwhile, spatial adaptation manifest clearly at the community level, where residents creatively repurpose the remaining public spaces untouched by the project's zinc fences into hubs for social interaction. This spontaneous transformation demonstrates that the people of Teluk Mata Ikan do not simply accept their circumstances passively. Instead,

they actively negotiate the remaining confined spaces to sustain their daily routines. This organic survival strategy exemplifies spatial resilience in action. Within spatial theory, this concept highlights how local communities often resist the rigid boundaries of formal urban planning by reclaiming and converting marginal or leftover spaces into adaptive environments. This tactical intervention successfully preserves community cohesion, preventing social fragmentation amid rapid industrialization (Protomastro, 2022). To illustrate the complete causal logic of these industrial impacts, the empirical findings are mapped out in the flowchart in figure 5.

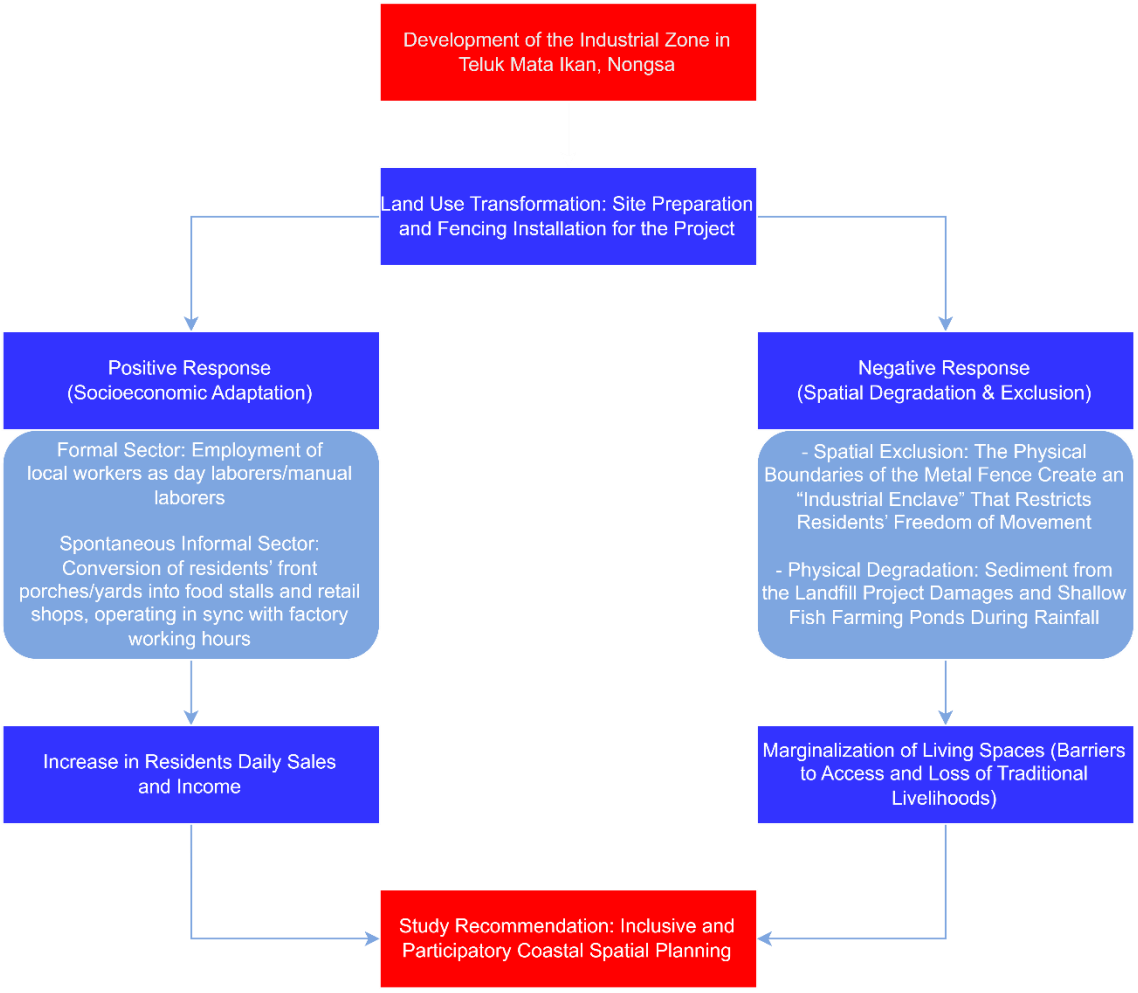


Figure 5. *Flowchart of the Impacts of Structural Changes in Teluk Mata Ikan*

Ultimately, industrial expansion in Nongsa has introduced shifting dynamics that offer mixed benefits, as economic gains fail to reach all segments of society equitably. This structural imbalance reveals that urban spatial planning cannot be separated from questions of social access and the future sustainability of the population. For development to be genuinely inclusive, active community participation must be integrated into every planning phase. This shift guarantees that structural changes prioritize livelihood stability and social equilibrium rather than focusing solely on economic growth.

Conclusion

This study demonstrates that the massive industrial expansion in Teluk Mata Ikan, Nongsa, has driven a structural spatial transformation that deeply alters local livelihood accessibility. Broadly, this industrialization acts as a double-edged sword. Informal vendors, such as small food stall and grocery owners, experience a positive economic boost, seeing higher daily revenues from factory workers during operational shifts. Conversely, aquaculture farmers and planters face an entirely different reality; these vulnerable groups suffer severe losses due to the drastic shrinkage of their traditional productive land.

Unregulated land reclamation, combined with poor drainage networks, triggers heavy sedimentation during rainy periods, causing mass die-offs in fishponds and degrading agricultural soil fertility. This physical disruption is compounded by the installation of corrugated zinc fences around the project sites, creating an isolated industrial enclave. This spatial restriction compromises the community's social fabric and severs physical access to the ancestral natural resources they historically relied on.

Theoretically, these findings reinforce the sustainable livelihoods framework by providing empirical proof that coastal industrialization compromises natural capital while failing to provide inclusive formal employment for indigenous populations. Practically, a fundamental review of Batam's industrial development policies is urgently needed, as current frameworks heavily favor macroeconomic targets at the expense of long-term coastal community sustainability. Ultimately, this study contributes to architectural and regional planning discourse by blending field observations, interviews, and visual records into a rigorous qualitative methodology that maps the micro-level spatial conflicts and community marginalization.

As a foothold for the development of science in the future, there are several crucial follow-up research recommendations to be explored. First, a quantitative study is needed that focuses on concrete measurements of how much of the nominal decrease in income experienced by pond farmers and planters due to industrial penetration in the Nongsa area. Second, comparative research that compares the characteristics and spatial impacts between coastal areas in the Riau Islands, such as Nongsa, Sekupang, and Batu Ampar, will provide a more complete regional picture.

Finally, a longitudinal study of the long-term adaptation strategies of local communities after the loss of access to traditional livelihoods will be a valuable input for the study of social resilience. Departing from the reality of this unequal space, this study formulates several strategic policy recommendations for the Batam City Government.

Local governments are required to be more actively involved in local communities in every stage of spatial planning from the beginning so that the development process runs more democratically. In addition, the government needs to enact strict regulations that require an environmental accessibility impact analysis before issuing permits for the construction of new industrial estates in coastal areas. As a concluding step that is a solution, the provision of skills training programs designed according to the real needs of the local industry becomes very important, so that traditional communities have the capacity to compete and do not end up as alienated spectators in their own homeland.

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While recognizing the inherent limitations of this study, constructive feedback and critiques are welcomed. Hopefully, these findings offer useful insights for Batam City's urban planners to ensure industrial growth respects the fundamental rights of its coastal communities. Thank you.

Competing Interest

The authors clarify that there are no competing financial or personal interests that could influence the publication of this manuscript.

Generative AI Statement

In developing this manuscript, AI models including Gemini, DeepSeek, and ChatGPT were utilized strictly for brainstorming, structural discussions, and obtaining critical feedback on the academic content. Following these initial stages, the authors meticulously examined, edited, and cross-checked all material to ensure scientific precision and compliance with academic ethics. The authors maintain full accountability for the integrity of the final text. These AI technologies served purely as secondary writing aids and hold no authorship status, with all primary data interpretation remaining entirely under direct human supervision.