International Journal of Sustainable Development & World Policy
2024 Vol. 13, No. 1, pp. 1-13.
ISSN(e): 2305-705X
ISSN(p): 2306-9929
DOI: 10.18488/26.v13i1.3969
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Dynamic transition to a sustainable waterfront development in Penang, Malaysia

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Article History
Received: 23 October 2023
Revised: 8 October 2024
Accepted: 21 October 2024
Published: 1 November 2024

Keywords
Development
Ecological systems
Preservation
Socio-Economic
Sustainability
Sustainable development goals
Waterfront.

ABSTRACT

The interactions between human with land and water in realizing economic dynamism and sustainability with vast diversity human usage and needs is a great challenge that often with the resultant of rising tensions among stakeholders and the users. While the right to development is an absolute human right, along the development pathway should at least preserve or sustain the ecological systems for the future generations while maintaining the socio-economy balance. This paper firmly positions its study on Penang and applying the mixed mode research methods to reveal the underlaying elements to examine the sustainable waterfront development goals that will benefit the stakeholders and users of Penang. These underlaying elements plays a pivotal solution in addressing the rapid development with land and water. It emphasizes the proactive measures that can be undertaken to restrain economic, social and ecological systems risks, cultivating an improved and congruent environment for both the stakeholders and users of Penang. The mixed mode method used in this paper was the quantitative approach that collects data from questionnaires surveys and qualitative approach covers interviews where the analysis point of interface converged the results producing a constructive good health, quality education and deserving a quality living place as a sustainable inference to address the land and water mixed application challenges in Penang.

Contribution/Originality: This mixed mode method approach showcases the harmonious assimilation of quantitative and qualitative techniques to extract the underlaying elements that underscores and bolstering sustainable waterfront development in Penang.

1. INTRODUCTION

Waterfront has always connected human with land and water use (Lopate, 2008; Lopez, 2012) where the established facts are that the land and water are fundamental to human in the pursuit for survival and development (Niemann & Werner, 2016; Salina & Abdul, 2009). This can be supported with the early civilizations that were founded on waterfront (Algaze, 1993; Gates, 2011; McIntosh, 2008; Stuart-Fox, 2003) and transformed into affluent cities around the world (Nordin, 2007; Ragheb, 2017). Settlements on waterfront transited to the inner part land due to exploration for food cultivation, mining, deforestation, and comfort (Chapman, 2005) but with land inadequacy, the return to waterfront (Dong, 2004; Van, 2022) is preordained as land expansion is only possible beyond water edge and not inner land. The conventional waterfront develops on land abutting water or the water edge, but this has progressed over the decades with the land reclamation (Dong, 2004). While this may seem like a solution to land

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inadequacy and echoing the rights to development, the sub-sequent questions poke to ask on perseverations and sustainability. For each development, there are potential effect and impact on the economic, social, and ecological systems where the development scale may potentially determine the magnitude of the effect and impact. An undeniable fact about waterfront development is job opportunities (Lv & Wang, 2018; Saad, 2021) that contribute to economic vitality and reaches out to multiple layers of benefactors. The initial and apparent impact is the labor workforce and building material demands that open the doors and entails to benefit many. This will circuitously impact the labor workforce, food supply chain, building materials, tourism, and the real estate's industry (Edge, 2011; Lv & Wang, 2018; Speake & Kennedy, 2019; Tan, 2019; Van, 2022). A revitalized or new waterfront development boosts the real estate with its substantial improved prospect ability to lure investors (Lv & Wang, 2018; Van, 2022). Albeit economic vitality, a place identity may change or under threat of vanishing from massive physical transformation without preservation or sustainability. This may possibly lead to affected income source occupants to evade and replaced with new communities. The area of Penang South Reclamation and the Clan jetties prime income relies on the marine harvesting and through waterfront development sees a transformation from a fishing village to tourist business hub in the Clan jetties that witnesses the occupants moving out with influx of new faces marking a place identity change (Balvin, 2019). On the contrary, the occupants of Penang South Reclamation project (Woo, 2020) receive aids such as skill enrichment to keep up to the waterfront development pace and as an inclusion effort. Freedom of movement may be a fundamental right but the choice to interact or seclude (Seta, Biswas, Khare, & Sen, 2015) depends on the occupant and this can be influenced by the built environment aspects that enticingly encourage interactions or seclusions. The waterfront development is often perceived as luxury (Edge, 2011; Speake & Kennedy, 2019) that sets the boundary to many. Acknowledging land reclamation as a method to land inadequacy does not equate to acceptance because depending on the development scale and concept results to a varying effects and impacts. Coastline changes (Sekaran, 2020) shoreline erosions (Butler, 2005) and marine life are few concerned parameters of such effect and impacts. The process of creating land on water changes the coastline and if not properly constructed, it may lead to shoreline erosions from diverted ocean waves. Preservation of certain level must be set to avoid severe damage to the seabed and marine life. These are part of the food and income sources. An interrupted marine life equates to income source lost to those relying on marine life harvesting while the building industry experiencing income surge. This is explained as a shift of wealth distribution. Penang is a state within Malaysia that is remarkably captivating that consist of two parts, an island, and the mainland. The strait of Malacca separates these two parts while enveloping the island with the Andaman Sea making waterfront development in Penang inescapable. The water serves not only as human necessity but also a water way as logistic means since the early civilizations to presence. These are the interlocked reasons to civilization established and develop around waterfront. It is supported by the founding of Penang in 1786 by Captain Francis Light and thriving as an entrepot (Andaya & Andaya, 1991). Penang has moved and developed immensely since then from entrepot to semiconductor industry resonant (Koay, Wong, Singh, & Rasiah, 2019) and with the current list of waterfront development encircling the island, including the riverfront development as subdivision of waterfront. These terms are used interchangeably by some including city port, harbor front, riverside, water edge, and river edge (Razali, Yassin, Mastor, & Zainudin, 2014). Establishing the inescapable fact of Penang waterfront development, this paper seeks to examine the sustainable goals for waterfront development sustainability in Penang.

2. WATERFRONT AND SUSTAINABILITY IN PENANG

For periods spanning over centuries, the waterfront cities in southeast Asian holds a strategic maritime intersection route for trading and cultural exchange and these appearances can be classified into four periods of the Emerging period, the Early Colonial period, the Prosperous Colonial period, and the Modern/Transitional period (Han & Beisi, 2016) as illustrated in Figure 1. This metaphor explains the periods beginning with the early first millennium A.D with key coastal and river mouth emergence rising from foreign western and eastern Asian regions

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trade and exchange. The early colonial period attracts European voyagers and merchants' consequence from the international trading hub activities while the prosperous colonial period sees the entire city re-planned and rearranged heavily influenced by the colonizers to the extent of ethnic group segregation to various part of the city. The modern/transitional period realizes a new era of independence with commercial transformation structure. Penang has developed steadily since independence seeing it progressed and expanded from entrepot to semiconductor manufacturing and an overall waterfront city development. The rapid development is unmistakably apparent over the decades from the flashy hotels to gurney drive on northeast district encircling towards southwest district on the island and various locations on the mainland along the straits of Malacca. The Gurney Wharf sits on 131 acres reclamation is a state development that prioritizes public space access concept with public park, children's park, food and beverages, leisure area and includes mangroves and casuarina trees along the shoreline. This reflects the elements of United Nation (UN) sustainable development goals (SDGs). Over to the southwest district of Penang Island, the Penang South Reclamation (PSR), a 3 reclamation islands claims to embrace 11 out of the 17 UN SDGs by regrouping it into 3 themes of 'People', 'Planet' and 'Prosperity' (Woo, 2020) which literally associates to socio-economic and the ecosystems. It is believed that the impetus for a sustainable building is to develop a responsible and virtuous response towards the ecosystem deteriorations in relation with the population and consumption massive increments (Kibert, 2016). Table 1 list the 17 UN SDGs and its description adopted by the PSR development. Figure 2 illustrates the Gurney Wharf masterplan along the gurney costal while Figure 3 shows the proposed Penang South Reclamation project of 3 mini-islands.

Figure 1. Four waterfront development morphological stages.

Source: Han and Beisi (2016).

Figure 2. The Gurney Wharf Masterplan.

Source: Tanjung Pinang development.

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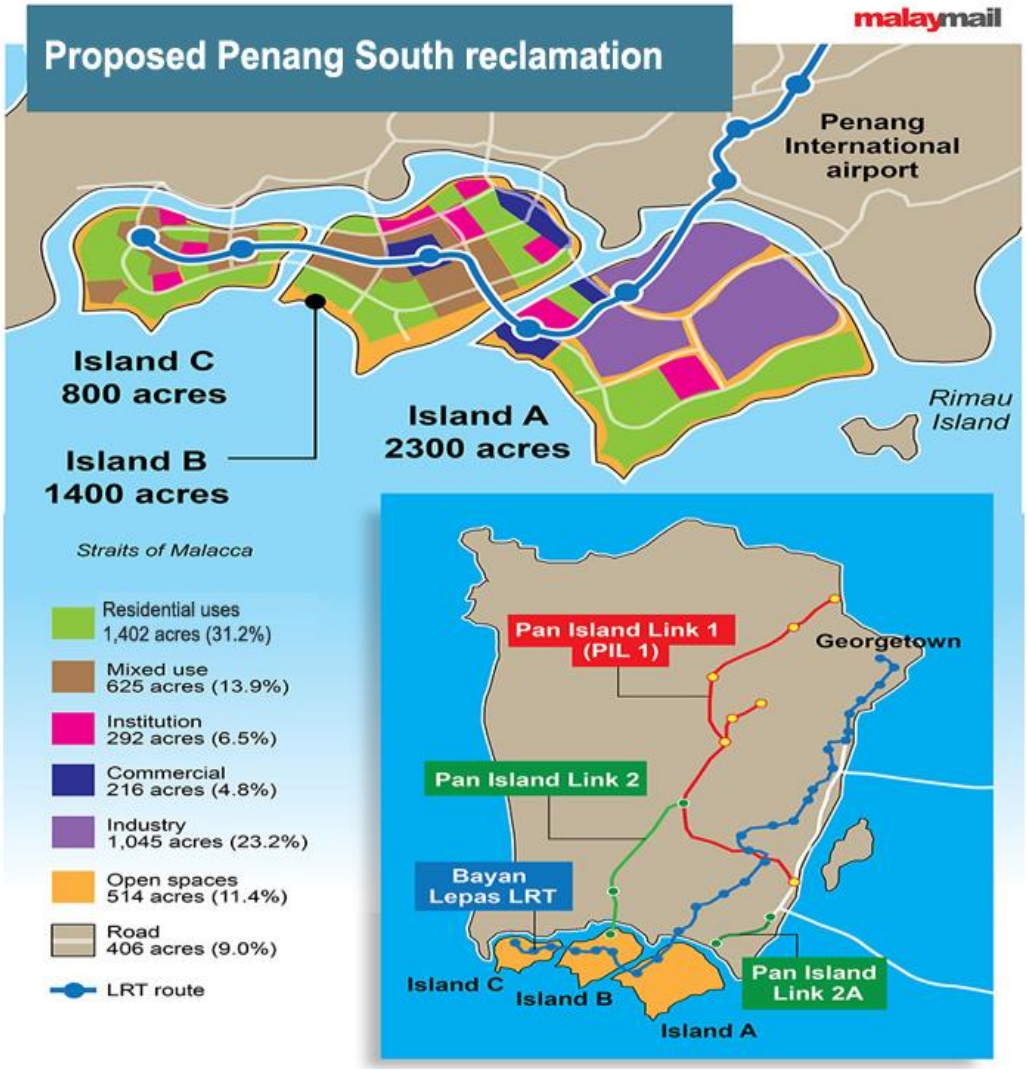

Figure 3. Penang South reclamation (PSR) waterfront.
Source: Penang state government.

Table 1. The 17 UN SDGs and PSR 11 adoption.

UN SDGs	Description	PSR
1	No poverty	✓
2	Zero hunger	
3	Good health and well-being	
4	Quality education	
5	Gender equality	
6	Clean water and sanitation	
7	Affordable and clean energy	
8	Decent work and economic growth	✓
9	Industry, innovation, and infrastructure	✓
10	Reduce inequalities	✓
11	Sustainable cities and communities	✓
12	Responsible consumption and production	✓
13	Climate action	✓
14	Life below water	✓
15	Life on land	✓
16	Pease, justice, and strong institutions	✓
17	Partnerships	✓

Note: * PSR = Penang South reclamation.**✓ = PSR adopted UN SDGs.

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In focusing people, the PSR development aims to create new economic and opportunities (Tan, 2019; Woo, 2020) in reducing inequalities and to sustain the local community with the development to avoid the younger generations from migrating. The current PSR surrounding occupants with the absence of a proper sewage filtration system is a localized environmental (Woo, 2020) and hygiene concerns that correspond with 'Clean water and sanitation' (UN SDG 6) and with a holistic development that generates better jobs and in respect to recovery time could potentially experience an eventually improved livability area according to the Environmental Kuznets Curve hypothesis (Stern, 2018). The southeast Asian cities often experience complex urban problems that leads to disparities and there is a need to respond to these problems (Yap, 2013). Hence, the response to the enormous population growth and consumption is a sustainable development in maintaining the planetary ecosystem and addressing the socio-economic challenges that will affect and impact the human population and development. The 17 UN SDGs is a complete and well-defined sustainability parameter that envelopes the interlinked issues of economic, social, ecological and governance of the waterfront development.

3. METHODOLOGY

In this paper, the 17 UN SDGs are adopted as the waterfront development sustainability fundamentals and positioning Penang as the area of study to examine the sustainable waterfront development goals for Penang by applying the mix method data collection. Reviewing the literature allows observation of the Penang's waterfront development evolvement to fine-tune the mix method data collection approaches as the research progress. The quantitative method is a scientific and statistical method with a larger scale survey to collect factual data for analysis and study on its interaction with theories and the literature reviews discovery. Contrariwise, the qualitative approach can extract an in-depth and thorough data from the interviewing process of 2-way communications (Bryman & Bell, 2011; Eden, Ackermann, & Cropper, 1992). It is a narrative and phenomenological investigative research. This interview process enables the author to collect data by applying 3 possible methods of audio recording, audio-visual recording, and note taking while using comprehensible languages with the interviewees. Audio or audio-visual recordings are only with the interviewee's consent.

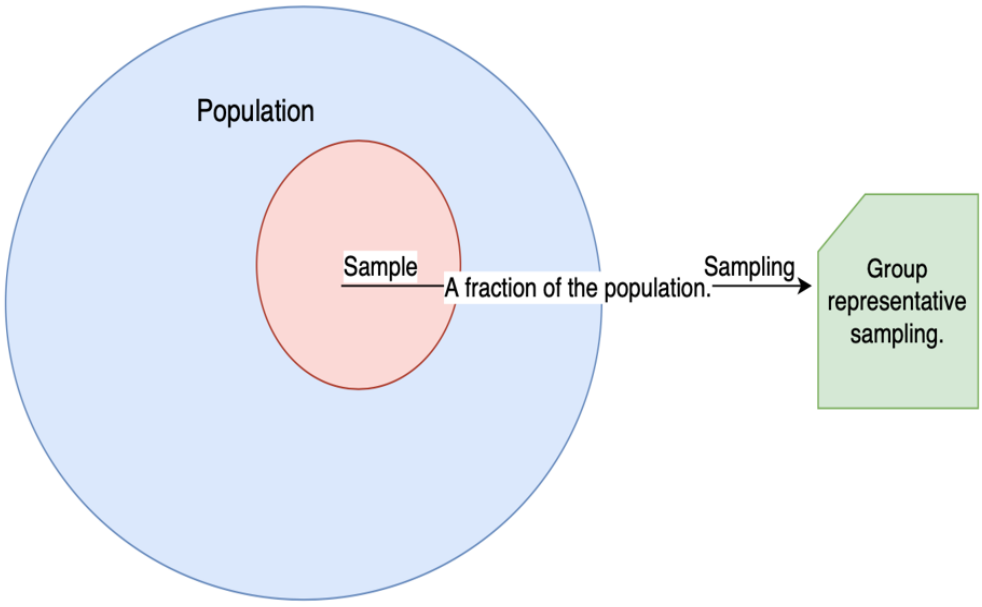

Figure 4. Group representative sampling.

Source: Stockemer (2019).

Figure 4 illustrates the group representative sampling method that extracts a sample from the population of Penang into group representative of authorities, professionals, developers, contractors, and the users (Stockemer, 2019). The reliability analysis is applied to confirm the collected data are consistent and precise by achieving a value

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of ≥0.700 to be putative while the relative importance index *(RII)* signifies the relativeness and top 3 utmost important or desired sustainable goals for Penang. A quantitative normality test will determine the data distribution with the Skewness and Kurtosis z-scores indication. The relative importance index *(RII)* formula equation was applied on the Microsoft Excel (Iyer & Jha, 2005; Tholibon et al., 2021) in determining the degree of importance ranking as shown below:

$$RII = \frac{\sum W}{A * N}$$

Where:

$W = Respondent's\ weightage\ to\ each\ factor.$

$A = Highest\ weightage.$

$N = Total\ respondents.$

Keywords relative to sustainable waterfront development are extracted from the qualitative data collected and coded in the 1st cycle of the document text analysis. The 2nd cycle sees a code pattern identification that abbreviates it into categories as thematic (Miles, Huberman, & Saldana, 2014; Saldana, 2013). Applying the mixed mode methods bonds the best of both while eliminating the setbacks if conducted separately. Collectively, the quantitative and qualitative analyzed results are triangulated to associate the positivism and constructivism polarizing them into a new paradigm, interpretivism. It is a process of comparison and convergence of the data triangulation and relationships.

4. RESULT AND DISCUSSION

The study was conducted on the population sampling of Penang with a total respondent of (N=508) for the quantitative approach with 21 sustainable waterfront development goals items and 12 interviewees for the qualitative approach with 10 sustainable waterfront development goals interview questions. It has applied a bricolage approach that construed literature review findings with the substantiation of scientific statistical, narrative, and phenomenological research to examine and explore the sustainable goals for Penang's waterfront development. Table 2 list the quantitative approach's 21 attributes items that corresponds with the 17 UN SDGs with some overlapping parameters and to avoid having 2 parameters in a questionnaire question, 21 attributes were used while Table 3 reveals the reliability analysis result for the Sustainable Development Goals scale of 21 items (α=0.920) which is greater than 0.700 (Hair, Black, & Anderson, 2010). In determining the data distribution (Kim, 2013; Mayers, 2013) for sample size above 300, Table 4 reveals the z-Skewness lower than 2 and z-Kurtosis lower than 3 as suggested by Kim (2013).

Table 2. Sustainable Development Goals (SDGs) Attributes.

Item	Attributes	UN SDG corresponding
SDG1	Waterfront development can reduce poverty.	1 – No poverty.
SDG2	Waterfront development can reduce hunger.	2 – Zero hunger.
SDG3	Good health is important.	3 – Good health and well-being.
SDG4	Quality education is important.	4 – Quality education.
SDG5	Waterfront development can improve gender equality.	5 – Gender equality
SDG6	Everybody deserves a quality living place.	6 – Clean water and sanitation. 10 – Reduced inequality.
SDG7	Renewable energy must be prioritized.	7 – Affordable and clean energy
SDG8	Waterfront development helps economic growth.	8 – Decent work and economic growth.
SDG9	Green building technology must be incorporated into waterfront development design.	9 – Industry, innovation, and infrastructure.
SDG10	Sustainable criteria are important in city planning.	11 – Sustainable cities and communities
SDG11	Well-being is important in place of living.	3 – Good health and well-being.
SDG12	The population statistic survey must be carried out properly before any waterfront development.	11 – Sustainable cities and communities.

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Item	Attributes	UN SDG corresponding
SDG13	Material wastage must be reduced in waterfront development.	12 – Responsible consumption and production.
SDG14	Climate effect must be considered in development planning.	13 – Climate action
SDG15	Marine life must be preserved in waterfront development.	14 – Life below water.
SDG16	Environmental Impact Assessment report must be obtained prior to any waterfront development.	6 – Clean water and sanitation. 14 – Life below water. 15 – Life on land.
SDG17	Environmental impact assessment report must be made public prior to any waterfront development.	6 – Clean water and sanitation. 14 – Life below water. 15 – Life on land.
SDG18	The existing regulations and guidelines are not sufficient to manage waterfront development.	11 – Sustainable cities and communities. 16 – Peace and justice strong institutions. 17 – Partnerships to achieve the goal.
SDG19	The authority should make sustainable development goals compulsory as prerequisite to waterfront development.	11 – Sustainable cities and communities. 16 – Peace and justice strong institutions. 17 – Partnerships to achieve the goal.
SDG20	The united nation sustainable development goals (UN SDGs) are important to transform our world.	17 – Partnerships to achieve the Goal.
SDG21	Implementing sustainable development goals can improve Penang's living environment.	17 – Partnerships to achieve the goal.

Table 3. Summarized reliability analysis results.

Variable	Frequency (N)	No. of items	Alpha (α)
Sustainable development goals (SDGs)	508	21	0.920

Table 4. Normality Test's z-Skewness and z-Kurtosis.

	Frequency (N)	Skewness Statistic	Kurtosis Statistic
Sustainable development goals (SDGs)	508	-0.856	1.604

Table 5. Sustainable development goals attributes relative importance index *(*RII*)*.

Attributes	Frequency						Total	Missing	RII	Ranking
	1	2	3	4	5	6				
SDG1	62	43	98	154	101	50	508	0	0.534	19
SDG2	62	45	105	158	88	50	508	0	0.524	21
SDG3	1	4	17	50	91	345	508	0	0.897	1
SDG4	0	4	19	51	107	327	508	0	0.889	2
SDG5	59	49	109	150	90	51	508	0	0.524	20
SDG6	2	5	15	77	131	278	508	0	0.858	3
SDG7	2	2	16	90	182	216	508	0	0.832	11
SDG8	14	11	45	146	170	122	508	0	0.720	18
SDG9	3	4	33	99	169	200	508	0	0.804	14
SDG10	1	1	29	71	159	247	508	0	0.844	6
SDG11	3	1	25	78	160	241	508	0	0.839	8
SDG12	3	1	33	79	176	216	508	0	0.822	12
SDG13	4	3	21	83	160	237	508	0	0.834	10
SDG14	2	1	25	78	174	228	508	0	0.835	9
SDG15	3	3	18	85	134	265	508	0	0.848	5
SDG16	0	3	21	80	147	257	508	0	0.850	4
SDG17	2	2	28	78	143	255	508	0	0.842	7
SDG18	4	7	45	159	155	138	508	0	0.742	17
SDG19	0	1	31	112	153	211	508	0	0.813	13
SDG20	3	2	49	133	157	164	508	0	0.766	16
SDG21	3	2	29	107	184	183	508	0	0.800	15

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From Table 5, the relative importance index *(RII)* analysis on the respondents' responses to strongly agree with the 6-point Likert scale of 1 (strongly disagree) to 6 (strongly agree) positions SDG3 (Good Health is Important) on the highest rank with (N=345) followed by SDG4 (Quality Education) with (N=327) and SDG6 (Everybody Deserves a Quality Living Place) with (N=278). These scientific and statistical results support the literature review findings that a sustainable and livable place prioritize the people needs with good health and quality education interconnected in building a holistic development that responses to the enormous population growth and consumption. Quality education has the potential to reduce or eradicate poverty. It molds and creates people with better skills and ability to narrows job and income disparities and promote equalities. A sustainable waterfront development should consider the existing communities' socio-economic needs with efforts to maintain and not disregard them. As witnessed in the Penang South Reclamation (PSR), there are efforts to assist the affected fishermen to diversified with the education and entrepreneurship support. The development somehow elevated the current living conditions with proper sewage system that meets the UN SDG 6, clean water, and sanitation. This will address most of the urban and social disparities problems. Table 6 summarizes the sustainable development goals importance ranking for Penang based on the *RII* results while Figure 5 illustrates the interviewees' responses that have been summarized, coded, and themed to the adopted 17 United Nations' Sustainable Development Goals.

Table 6. Relative importance index attributes summary.

Ranking	Attributes
1	SDG3 – Good health is important.
2	SDG4 – Quality education is important.
3	SDG6 – Everybody deserves a quality living place.

Note: * SDG = Sustainable development goals.

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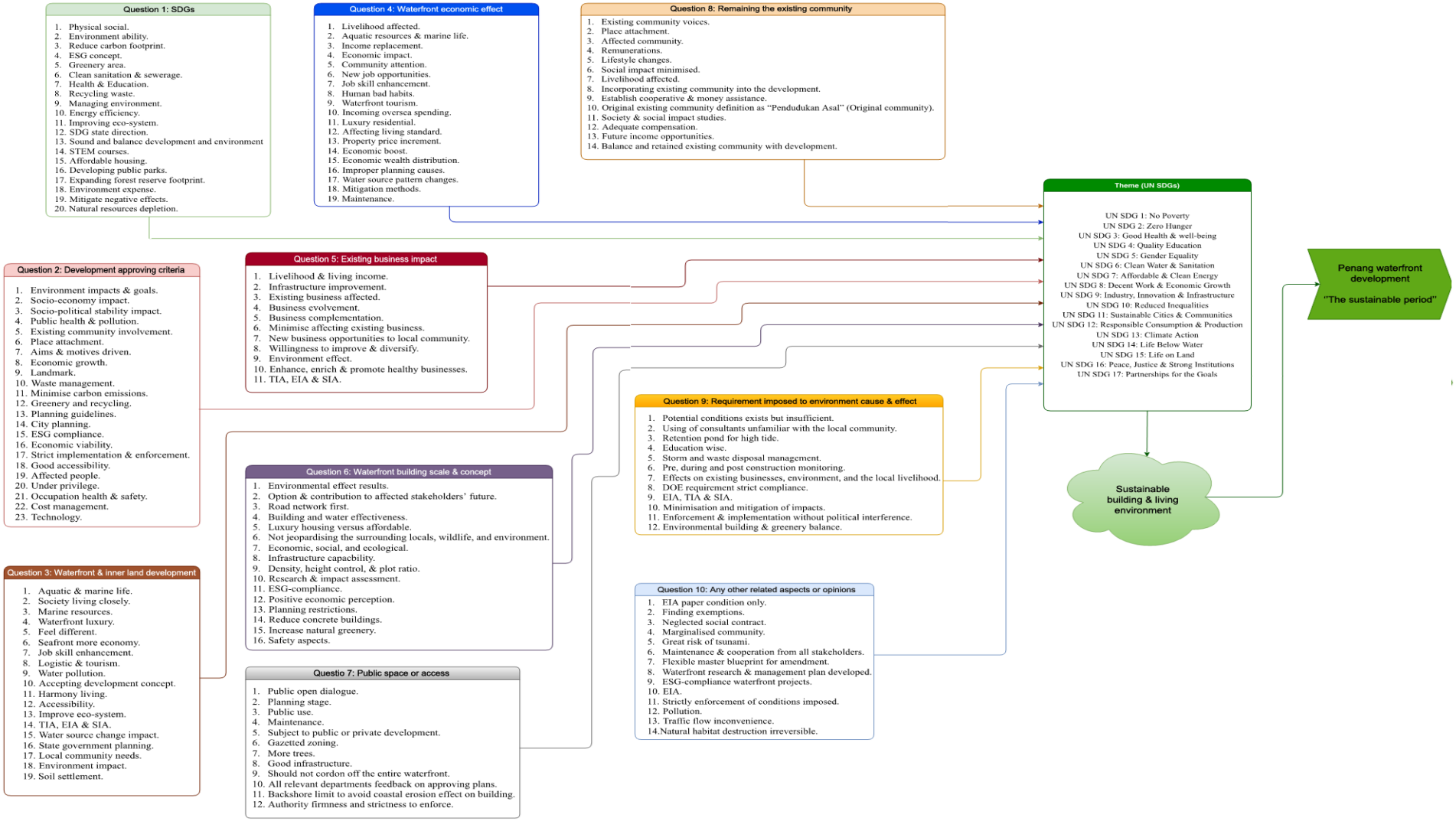

Figure 5. Sustainable development goals thematic by qualitative data analysis.

Note: * Q = question (Q1 = Question 1)
** ESG + Environment, Social & Governance, EIA = Environment impact assessment,TIA = Traffic impact assessment, SIA = Social impact assessment.
*** DOE = Depart of environment, JPS (Water) = Jabatan Pengairan dan Saliran.
**** PSR = Penang South reclamation

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Table 7. Highest SDGs attributes' RII with thematic coding (UN SDGs) relation.

SDGs RII	Thematic coding	UN SDGs
SDG3 Good health is important.	Physical social. Environmental ability. Reduce carbon footprint. Greenery area. Clean sanitation & sewerage. Improving eco-system. Expanding forest reserve footprint. Public health & pollution. Water source pattern changes. Occupation health & safety.	UN SDG 3 good health and well-being. UN SDG 6 clean water and sanitation. UN SDG 13 climate action. UN SDG 14 life below water. UN SDG15 life on land.
SDG4 Quality education is important.	Health & education. Sound & balance development & environment. STEM courses. Existing community involvement. Job skills enrichment. Human bad habits. SIA. Willingness to improve & diversify. Original existing community definition as *"Pendudukan Asal"* (Original community).	UN SDG 4 quality education. UN SDG 5 gender equality. UN SDG 9 industry, innovation, and infrastructure. UN SDG 10 reduced inequalities. UN SDG 11 sustainable cities and communities.
SDG6 Everybody deserves a quality living place.	Physical social. Clean sanitation & sewerage. Managing environment. Energy efficiency. Affordable housing. Socio-economy impact. Waste management. Minimize carbon emissions. Greenery and recycling. Harmony living. Accessibility. Road network first. Density, height control, & plot ratio. Good infrastructure. Place attachment. Public use. Adequate compensation.	UN SDG 5 gender equality. UN SDG 6 clean water and sanitation. UN SDG 7 affordable and clean energy. UN SDG 10 reduced inequalities. UN SDG 11 sustainable cities and communities. UN SDG 13 climate action. UN SDG 14 life below water. UN SDG15 life on land.

Note: *SDGs = Sustainable development goals, UN SDGs = United Nations sustainable development goals.
** SIA = Social impact assessment.
*** STEM = Science, technology, engineering, mathematics.

Table 7 reveals that quantitative data collection analysis top 3 highest ranking for sustainable waterfront development goals are relative with the thematic coding extracted from the qualitative data collection analysis. A distinct response from r (508), N=345 strongly agrees that good health is important and N=327 strongly agrees that quality education is important parallels with the 12 interviewees to healthy living conditions and environment with multiple suggestions to improve the education system. A quality education can also potentially address the vandalism of public amenities problems where an educated and socially adequate person are more likely to think analytically and rationally. The top 3 ranked sustainable development goals that corresponds to the interviewees thematic coding interweave relates back to several other sustainable development goals as illustrates in Table 7 while Table 8 summarizes the quantitative and qualitative triangulation. Consequently, a quality living place envelopes a wide parameter of equalities, clean water and sanitation, affordable and clean energy, life on land and below water, and sustainability among others that matters to people, land, and water.

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Table 8. Research objectives methodological triangulation.

Research objectives	Quantitative (Highest 3 RII)	Qualitative (Interview summary)
To examine the goals of a sustainable waterfront development in Penang.	SGD3 SDG4 SDG6 (See Table 6)	The first question on SDGs draws a collective response emphasizing aspects and factors to physical social, environmental ability, carbon footprint reduction, good health and well-being, clean sanitation and sewerage systems, affordable housing, public parks, and negative effects mitigation. All subsequent questions receive responses agreeing that affordable and quality living should be considered as well as quality education.

5. CONCLUSION & RECOMMENDATION

The waterfront development sequence and transitions from the emerging to colonials and modern periods have taken place, and presently, there is a need to response to the immense population growth and increased consumption. Inducing sustainability with economic vitality is a great challenge where human interactions with land and water often results to a high potential stakeholders and users' tension but it will reap a beneficial socioeconomic outcome for Penang. Developing, governance and the users have interlapping interest and some possible conflict. One common is the maximization of land and water use but conflicting on the return for revenue or public use. It can also potentially detach the environmental degradation elements of production and consumption deriving from waterfront development and safeguarding the ecological sustainability for the future generations. Henceforth, the need to strike a balance between development and sustainability is attainable with the 17 UN SDGs, a complete sustainable development goals that can analyze and designate the economic, social, ecological and governance of the waterfront development to navigate a dynamic transition for Penang's waterfront development into the 5th stage, 'the Sustainable Period' as illustrated in Figure 6.

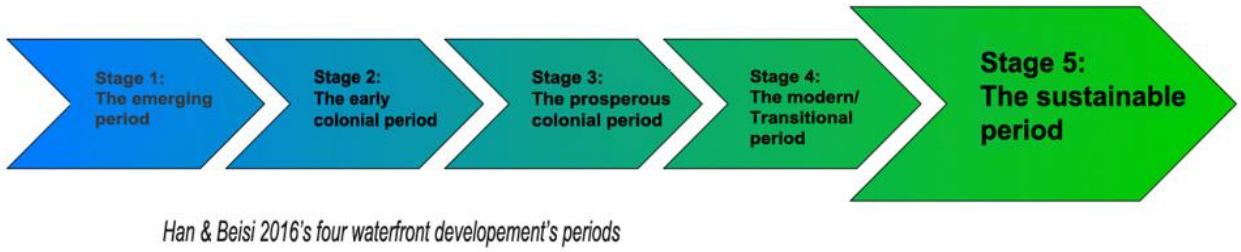

Figure 6. The sustainable period.

Source: Han and Beisi (2016) (Stage 1 to 4).

Funding: This study received no specific financial support.
Institutional Review Board Statement: The Ethical Committee of the Tunku Abdul Rahman University of Management and Technology, Malaysia has granted approval for this study on 8 December 2022 (Ref. No. Minutes of Ethics Committee, 8th December 2022).
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Data Availability Statement: The corresponding author can provide the supporting data of this study upon a reasonable request.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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