05

SOFT-SHELL CRABS ECO-TOURISM CENTRE IN KUALA GULA, PERAK

Nur Farahadlin Adlan and Zeenat Begam Yusof *
Kulliyyah of Architecture and Environmental Design,
International Islamic University Malaysia, Jalan Gombak, 53100, Kuala Lumpur

ABSTRACT

The depletion of mud crab population within mangrove areas in Malaysia is primarily due to over-catching, and a lack of breeding centre. The core issue in Kuala Gula Mangrove area in Perak is the depletion of mud crabs, leading to a reduction in soft-shell crab numbers despite their high demand as a seafood source. Soft shell crab is an authentic food delicacy in Perak. Consequently, there is an opportunity to establish an a centre that becomes breeding facilities for soft shell crab and mud crab plus research facilities that increase the production of species and related products. This centre will also become tourists attraction to see the breeding process, tour at mangrove area, and taste the delicate soft shell crabs' cuisine. The objective of this thesis is to design an ecotourism centre focused on soft-shell crab production and mud crab breeding, while simultaneously promoting tourism and aquaculture. Specific goals include offering workshops on soft-shell crab processing for fishermen nationwide, breeding and releasing significant numbers of mud crabs to restore ecological balance in the estuary and establishing appropriate dining and tourism facilities to enhance soft-shell crab production. Data collection methods employed include literature reviews, site studies, in-depth interviews, precedent studies, and case analyses. Findings suggest that the site's proximity to mangrove forests, the natural habitat of mud crabs, makes it suitable for the construction of an ecotourism centre.

Keywords: Aquaculture, Breeding, Ecotourism, Mud crab and Soft-shell crabs.
*Corresponding author: zeensoni@iium.edu.my

INTRODUCTION

Aquaculture, also known as aquafarming, is the practice of farming aquatic plants and animals, including fish, mollusks, crustaceans, and seaweed, in controlled environments such as tanks, ponds, and cages located in both fresh and salt water (FAO, 2018). The goal of aquaculture is to produce food, restore wild populations, and conserve biodiversity (National Oceanic and Atmospheric Administration, 2019).Aquaculture provides numerous benefits including increased food security, reduced pressure on wild fish populations, and improved livelihoods for those involved in the industry (FAO, 2018).

However, it can also have negative impacts on the environment, such as the spread of disease and genetic traits among farmed and wild populations, and the release of nutrients and chemicals into surrounding waters (National Oceanic and Atmospheric Administration, 2019).

To mitigate these impacts, many countries have implemented regulations and best management practices for aquaculture operations (FAO, 2018). The industry is also continuously evolving, with advances in technology and research leading to more sustainable and efficient practices (National Oceanic and Atmospheric Administration, 2019). Aquaculture in Malaysia has been growing rapidly in recent years, with the country now ranking as one of the largest producers of aquaculture products in Southeast Asia (Department of Fisheries Malaysia, 2021).

The industry primarily focuses on the cultivation of fish and shrimp, with the majority of production taking place in the states of Penang, Johor, and Sabah (Department of Fisheries Malaysia, 2021). The government of Malaysia recognizes the importance of the aquaculture industry and has implemented various initiatives to support its growth. For example, the Department of Fisheries Malaysia has established training programs to improve the skills and knowledge of aquaculture farmers and provides funding and technical support for the development of new aquaculture sites. Crustaceans, such as shrimp, crab, and lobster, are an important part of the aquaculture industry in Malaysia (Department of Fisheries Malaysia, 2021). The country has been successful in cultivating a variety of crustacean species, both in saltwater and freshwater environments. Mud crab aquaculture is a growing industry in Malaysia, with the country being one of the largest producers of farmed mud crabs in Southeast Asia (Department of Fisheries Malaysia, 2021). Mud crabs are highly valued for their meat, which is considered a delicacy in many countries.

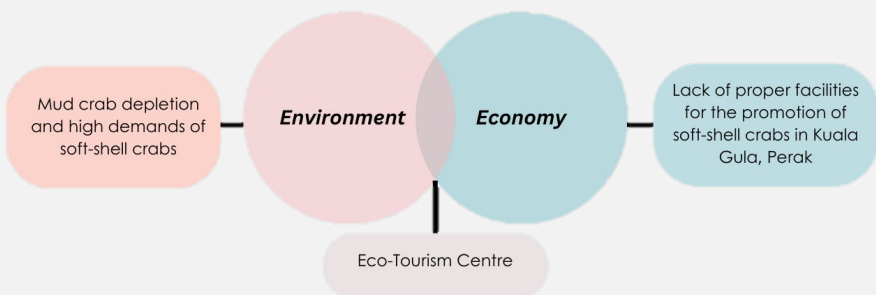

Figure 1: Shows two issues interrelated creates a solution

STUDY ISSUES FRAMEWORK

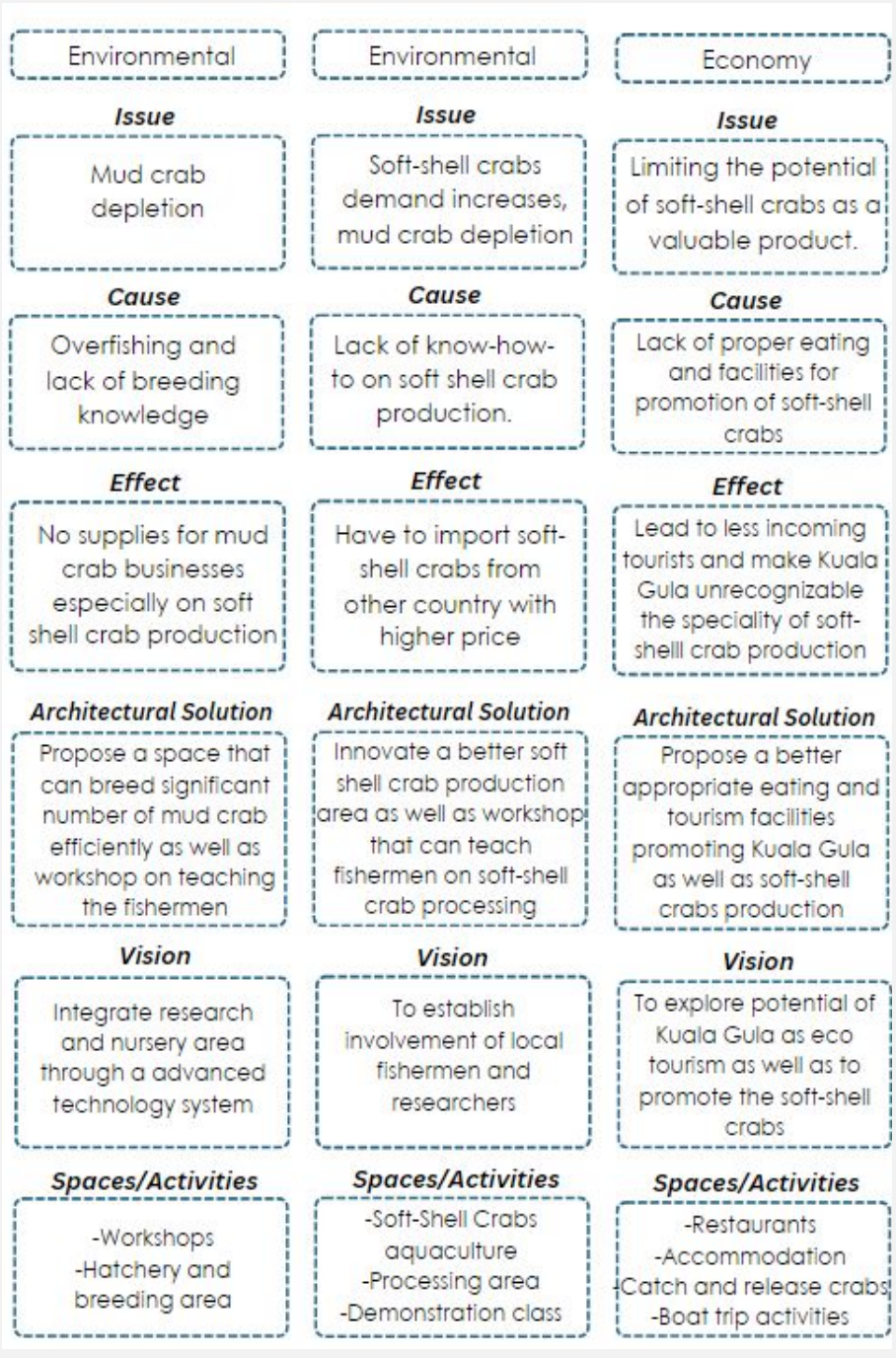

Diagram 1: Showing the design thesis issue framework.

AIM

This study aims to design a soft-shell crabs eco-tourism center for mud crab breeding and soft-shell crabs production as well as tourism to promote soft-shell crabs aquaculture and mud crab breeding process

OBJECTIVES

1. To provide soft-shell crabs production workshops that can teach other fishermen around Malaysia on soft-shell crabs processing.
2. To breed and release significant number of mud crab as well as balancing the ecosystem in this estuary.
3. To determine appropriate eating and tourism facilities to promote soft-shell crabs production.

QUESTIONS

1. How to increase soft-shell crabs production that can meet the market demand and supply?
2. How to balance the marine ecosystem through breed and release significant number of mud crab?
3. What are the appropriate eating and tourism facilities in promoting soft-shell crabs production?

STUDY STATEMENTS

It is imperative to equip local fishermen with the requisite skills, knowledge, and understanding of mud crab breeding and soft-shell crab processing to create broader employment opportunities. The centre will enable researchers to delve into soft-shell crab processing while also positioning Kuala Gula as an ecotourism hub. This initiative would offer opportunities for soft-shell crab production, cultivation, and the provision of fresh seafood delicacies. Moreover, fishermen engaged in mud crab aquaculture across Malaysia could benefit from learning about soft-shell crab production, given its current high demand.

STUDY LIMITATIONS AND SCOPES

Implementing innovative features for the project faces challenges due to the unique characteristics of the site, which necessitate the utilization of modern construction methods to address factors such as fluctuating tides. These conditions also impact aquaculture activities, particularly soft-shell crab farming. Obtaining precise data concerning the site's topography, river depths, and demographics proves challenging, as Kuala Gula is located on the outskirts of the town. The study focuses on understanding the ecosystem of mud crabs, the dynamics of ecotourism, and the characteristics of coastal settlements, along with their respective impacts, in order to ascertain the significance of the design thesis. The research site is located in Kampung Kuala Gula, Perak. Data collection methods include interviews with local fishermen, particularly mud crab catchers, and members of the local communities.

STUDY SIGNIFICANCES

The significance of study are ;

- Increased soft-shell crab production at Kuala Gula
- Increased tourism activities around Kuala Gula area
- Increased local people's economic

By focusing on the design of an ecotourism center centered around soft-shell crab production and mud crab breeding, this research offers a multifaceted solution to the existing challenges. The proposed center not only serves as a tourist attraction but also as a platform for promoting sustainable aquaculture practices and fostering community engagement. Through workshops, educational programs, and hands-on experiences, fishermen can learn about responsible crab processing techniques, while efforts to breed and release mud crabs contribute to the restoration of ecological balance in the estuary. Furthermore, the research underscores the importance of integrating environmental conservation with economic development. By establishing appropriate dining and tourism facilities, the ecotourism center not only enhances the soft-shell crab production process but also creates opportunities for local businesses and entrepreneurs. This holistic approach to ecotourism not only benefits the local economy but also strengthens the resilience of coastal communities in the face of environmental challenges. Overall, this research has significant implications for the aquaculture industry, environmental conservation efforts, and sustainable development initiatives. By addressing the complex interplay between economic, social, and environmental factors, the proposed ecotourism center offers a promising model for fostering sustainable practices and ensuring the long-term viability of coastal communities like Kg. Kuala Gula.

METHODOLOGY

Data is collected from both primary and secondary data collection. Primary data are collected during the data collection phase, while secondary data are collected during the theoretical analysis and literature review phase. The four methods used to complete this research paper are literature review, in-depth interviews, precedent studies, case studies, site studies and observation, as stated;

Table 1: The Study Framework

Thesis Objectives	Thesis Questions	Thesis Methodology	Design Solution
To provide soft-shell crabs production workshops that can teach other fishermen around Malaysia on soft-shell crabs processing.	How to increase soft-shell crabs production that can meet the market demand and supply?	Literature Review, In-depth Interview	Propose a space that can breed significant number of mud crab efficiently as well as workshop on teaching the fishermen
To breed and release significant number of mud crab as well as balancing the ecosystem in this estuary.	How to balance the marine ecosystem through breed and release significant number of mud crab?	Literature Review, Precedent Studies	Innovate a better soft shell crab production area as well as workshop that can teach fishermen on soft-shell crab processing
To determine appropriate eating and tourism facilities to promote soft-shell crabs production.	What are the appropriate eating and tourism facilities in promoting soft-shell crabs production?	Site studies and observation, In-Depth Interview, Case Studies Precedent Studies	Propose a better appropriate eating and tourism facilities promoting Kuala Gula as well as soft-shell crabs production.

SITE

SITE INTRODUCTION

Kuala Gula is located in the Kuala Kurau district. Kuala Kurau is a mukim or district subdivision in Kerian, Perak. The population study on Kerian District and based on My Local STATS Kerian Perak 2020. Kerian District is an administrative district in Perak, Malaysia. It covers the northwestern corner of Perak, bordering the states of Penang and Kedah to the north. According to the 2020 census, the population of the Kerian District was 193,800. The district has a population density of 207 people per square kilometer. The majority of the population in the Kerian District is Malay (74.8%). Other ethnic groups in the district include Chinese (17.3%), Indian (8.1%), and Others (0.3%). The Kerian District covers the northwestern corner of Perak, bordering the states of Penang and Kedah to the north. Among the ecotourism sites promoted in this district are Kuala Gula Bird Sanctuary, which won the “Best Tourist Attraction (Natural Attraction)” title during the Malaysia Tourism Awards, and Bukit Merah Orang Utan Island Foundation.

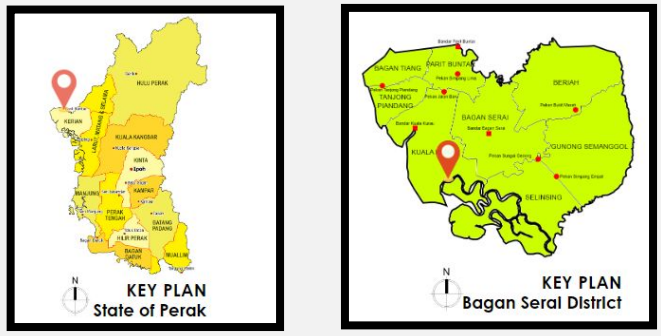

Figure 2: Key and Location plan

The proposed site located at the state of Perak, Malaysia. Situated at Southwest of Bagan Serai District, Perak at the Kuala Gula agriculture territory, 22.5km from Bagan Serai and 15.1km from Kuala Kurau of car ride. The location chose based on several criteria such as;

Figure 3: Shows criteria for a site selection

SITE INFO

Bagan Serai is a mukim or district subdivision in Kerian, Perak. The main activity here is agriculture, be it the various paddy fields and palm oil plantations, or the processing plants for the produce.

The proposed site is located at 40°56'20"N in Kampung Kuala Gula, Perak. The area of the proposed site is located 22.5km from Bagan Serai and 15.1km from Kuala Kurau. Located at the coastal area of Sungai Gula, this proposed site has good view of mangrove forest as well as a soft-shell crab aquaculture.

Land Area: 5 acre
Land use: Agriculture and Commercial
Existing Use: Floating Restaurant and Soft Shell Crab Aquaculture
District: Kuala Kurau

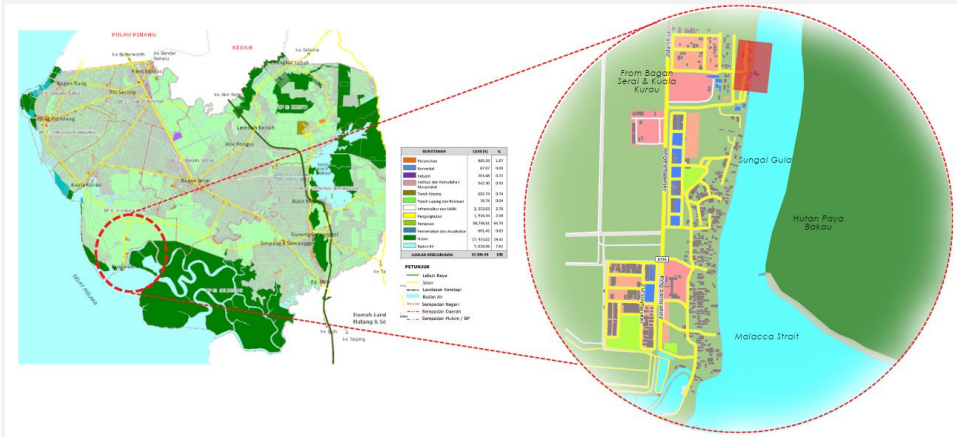

Figure 4: Shows the land use and zoning in Kg.Kuala Gula

Planning standards and guidelines for development in coastal areas in Malaysia are crucial for ensuring sustainable and balanced growth while protecting fragile marine ecosystems and coastal communities. These standards and guidelines typically encompass various aspects such as land use planning, environmental conservation, infrastructure development, and disaster risk management. According to *Jabatan Perancang Bandar & Desa Perak Darul Ridzuan*, development on water and coastline as well as estuarine and river zones consists of; Any construction should be done on stilts, only 20% of the area is mangrove forest can be developed and setback are excluded as well in case of construction on piles.

SITE ANALYSIS

The selected location in Kg. Kuala Gula presents an optimal setting for the center, offering panoramic views and proximity to another local tourist attraction, the *Pusat Konservasi Burung Laut Liar*. Its strategic placement near the estuary coastline, coupled with easy accessibility, high visibility, favorable climate conditions, natural ventilation, and proximity to mangrove forests, enhances its appeal. The site's visibility and accessibility make it an enticing destination for both tourists and local fishermen alike. The establishment of this ecotourism center holds promise for contributing to ecosystem preservation, particularly in bolstering the mud crab population, advancing knowledge in soft-shell crab production, and stimulating tourism-related endeavors. Moreover, its visibility from the Malacca Strait serves as a form of complimentary promotion to tourists engaged in bird watching and mangrove planting activities.

Figure 5: View facing the mangrove forests from the site location

Figure 6: View facing the Malacca Strait from the site location

Figure 7: View facing to the Kuala Gula river from the site location

The tide in Kampung Kuala Gula is calculated based on Bagan Serai river reading. Based on the tide chart, the highest tide of 2.7m was at 12.10am and the lowest tide of 0.6m was at 6.51am. This tidal changes depending by months.

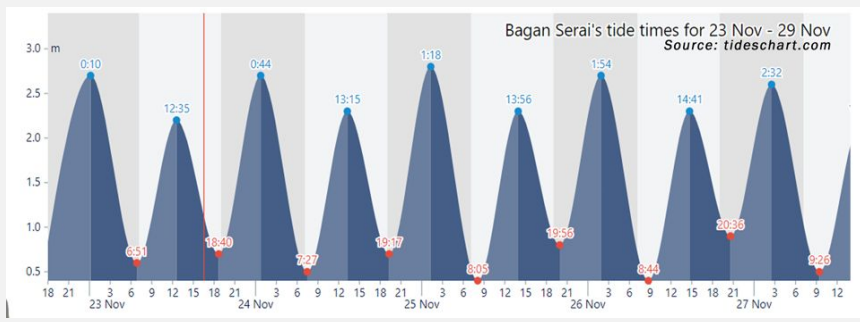

Figure 8: Bagan Serai's Tide Times
(Source: Tideschart.com)

Kuala Gula has a characteristics strong west-wind. Based on interview with En. Wahab (Fishermen of Kg. Kuala Gula), it has been said that the best time to catch mud crab is when the water is high (high tide) and an hour before high tide, the bubu will be lifted.

Other than that, he also stated that during low tide, it is possible that you will not be able to catch even 50kg of mud crab compared to during high tide; 200-400 kg of mud crabs in a day. When the wind is strong and big waves come, these soft-shell crabs cages may overturn and cause losses to the fishermen.

SITE SYNTHESIS

Through the integration of essential facilities, mud crab breeding, soft-shell crab aquaculture, and innovative architectural concepts, the proposed site aims to cater to the needs of both local fishermen and eco-tourists. This comprehensive approach not only ensures the preservation of the depleted ecosystem but also promotes economic development and cultural exchange. Moreover, the Soft-Shell Crab Ecotourism Centre in Kg. Kuala Gula presents a distinctive opportunity to strike a balance between preserving local culture and meeting modern tourism demands. By blending indigenous architectural elements with innovative designs aimed at facilitating aquaculture practices, a holistic and flourishing ecotourism destination can be realized.

DESIGN BRIEF

Tourism and aquaculture are two different sectors that have merge at some area to allow promotion and experience between the producer and consumer. This project is to provide an architectural integration and contribution towards aquaculture especially on mud crab as it will be used to process to be soft shell crabs. Due to overfishing without harvesting faster than the mud crab can be produced, it becomes even more crucial as it can also impacted the ecosystem of the coastal area. This centre will teach the fishermen to balance the marine ecosystem through breed and release significant number of mud crab thereby can produce soft shell crabs to reach the demands.

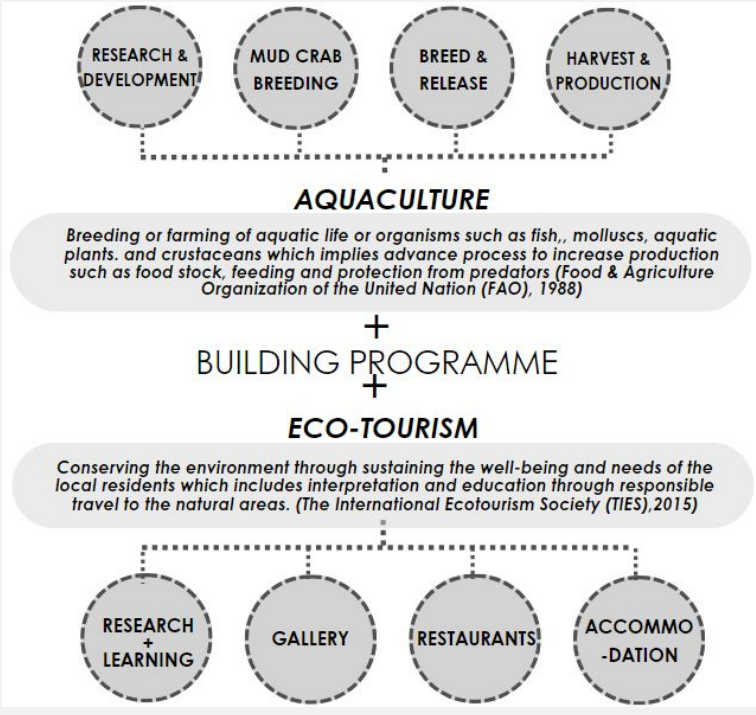

Figure 9: Building program

USERS AND HYPOTHETICAL PROGRAMS

The client for this project is based on interview with the fishermen in Kuala Gula, majority got helped by Jabatan Perikanan Malaysia (JPM), thus, in this case, JPM will provide classes and help regarding businesses related to fisheries. Jabatan Perikanan Malaysia, or the Department of Fisheries Malaysia, is a governmental body dedicated to managing and advancing the fisheries sector in Malaysia.

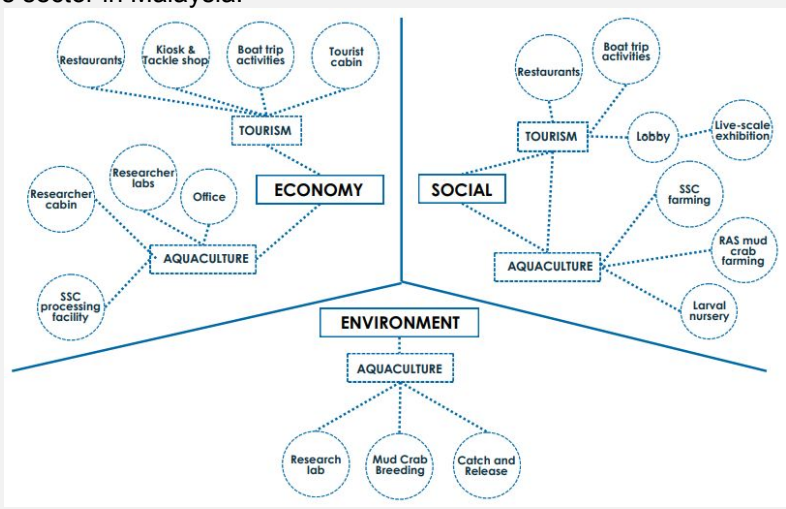

Figure 10: Distribution of building typologies in relation to the issues.

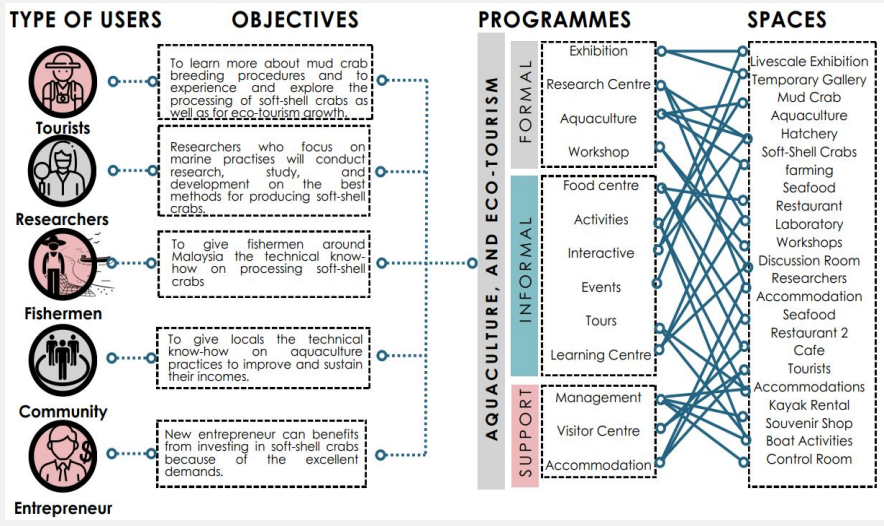

Figure 11: Users and Hypothetical Programs

DESIGN CONCEPT

THE EMERGENCE

The philosophical concept of "emergence" suggests that complex patterns and behaviors can arise from the interactions of simpler components. In mud crab breeding, individual behaviors like mating rituals and nesting activities may seem simple, but when combined within a population and with environmental factors, they create emergent phenomena like population dynamics and ecological impacts. This concept highlights the interconnectedness of organisms and ecosystems, showing how small actions can lead to larger effects.

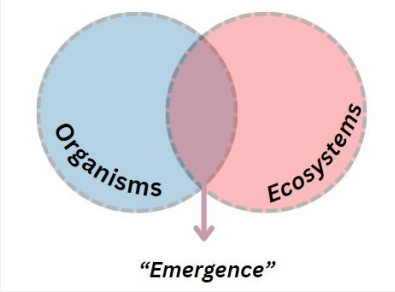

Figure 12: The interconnectedness between organisms and ecosystems.

In designing an ecotourism center, the concept of emergence applied in several ways:

Ecosystem Dynamics: Understanding how different components of the ecosystem interact and give rise to emergent phenomena can inform the design of the ecotourism center. For example, observing how mud crab breeding behaviors contribute to the overall health of coastal ecosystems can influence decisions about which areas of the ecosystem to prioritize for conservation and visitor education.

Visitor Experience: Designing the ecotourism center to showcase emergent phenomena within the ecosystem can enhance the visitor experience. For instance, interactive exhibits or guided tours that highlight how small-scale ecological interactions lead to larger ecological patterns can help visitors appreciate the complexity and beauty of nature.

Education and Outreach: Incorporating the concept of emergence into educational programs and outreach efforts can help visitors understand the importance of preserving natural habitats and biodiversity. By demonstrating how small-scale actions can have significant impacts on ecosystem functioning, the ecotourism center can inspire visitors to become stewards of the environment.

ISLAMIC VALUE

This educational initiative plays a crucial role in raising community awareness about the significance of conservation methods for maintaining a sustainable ecosystem. Therefore, the role and function of this centre is charged to help educate the public to appreciate nature. This coincides with Surah Hud verse 61 which explains about Allah SWT's command to humans to prosper the Earth which is clearly the role of all parties.

وَإِلَىٰ ثَمُودَ أَخَاهُمْ صَٰلِحًا ۚ قَالَ يَٰقَوْمِ ٱعْبُدُوا۟ ٱللَّهَ مَا لَكُم مِّنْ إِلَٰهٍ غَيْرُهُۥ ۖ هُوَ
أَنشَأَكُم مِّنَ ٱلْأَرْضِ وَٱسْتَعْمَرَكُمْ فِيهَا فَٱسْتَغْفِرُوهُ ثُمَّ تُوبُوٓا۟ إِلَيْهِ ۚ إِنَّ رَبِّى قَرِيبٌ مُّجِيبٌ

And to Thamud [We sent] their brother Salih. He said, "O my people, worship Allah; you have no deity other than Him. He has produced you from the earth and settled you in it, so ask forgiveness of Him and then repent to Him. Indeed, my Lord is near and responsive."

Figure 13: Surah Hud, Verse 61.
(Source: Al-Quran)

This explains that the task of raising awareness about the importance of environmental conservation needs to be done. In this regard, the center will offer environmental education programs targeted at the community, including visitors and local fishermen who will play a vital role in ecosystem preservation moving forward.

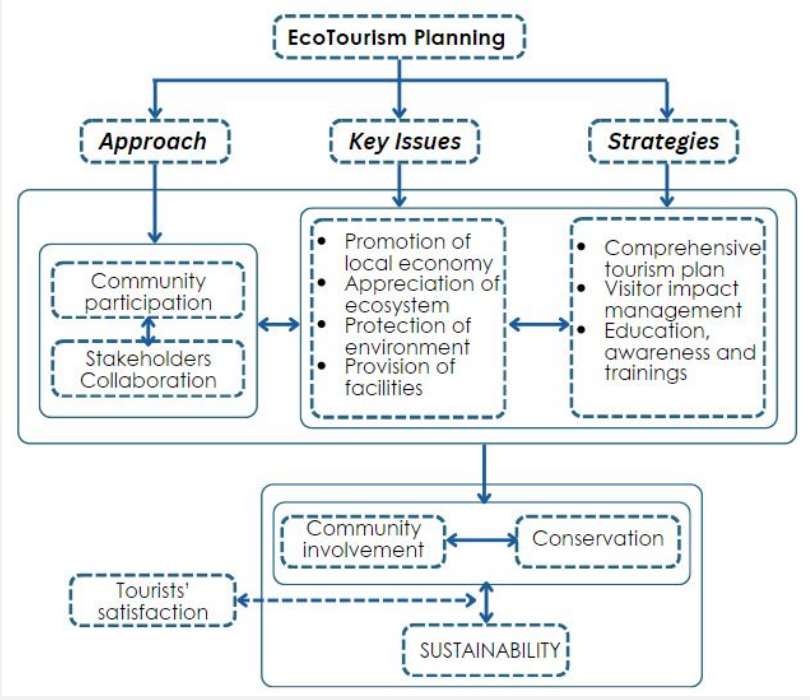

Figure 14: Ecotourism Planning

SITE PLAN

The building's orientation and spatial arrangement are designed in direct response to the site's natural features, including the river and other surrounding landscapes. The design meticulously translates each zone of the soft-shell crab ecotourism facility, serving as conduits for tourism, research, and immersive experiences that foster a deeper connection to the crucial coastal ecosystems.

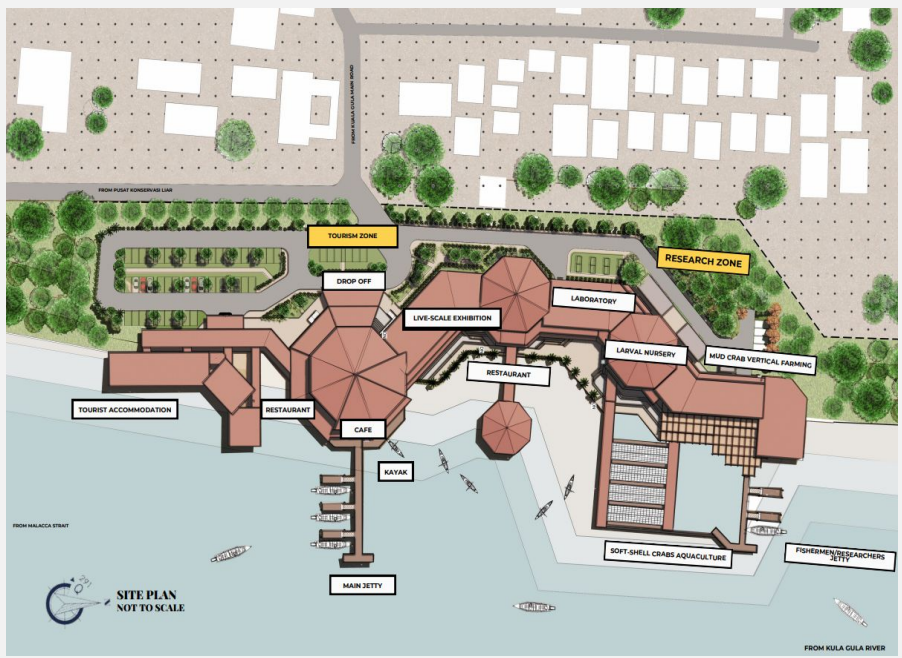

Figure 15: Site Plan

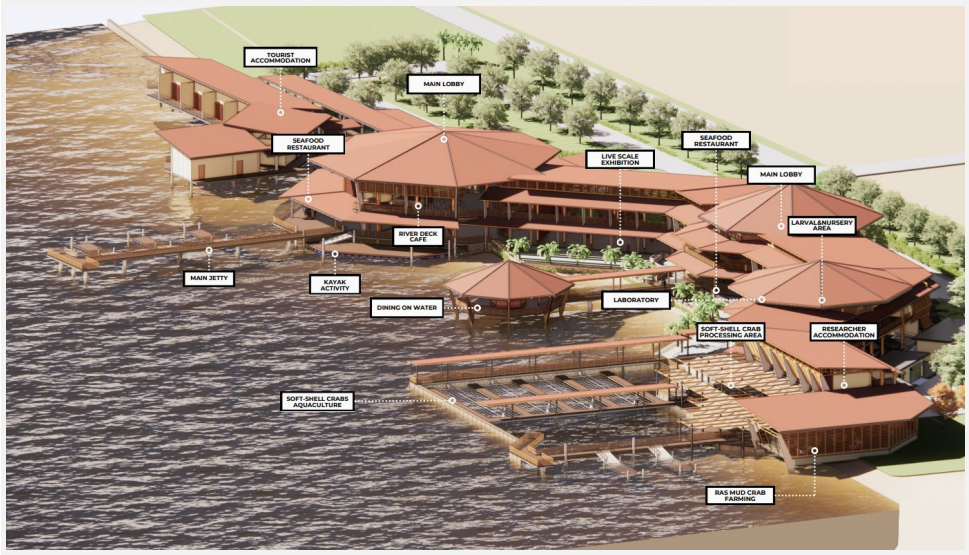

Figure 16: Perspective with building program

GROUND FLOOR PLAN

On the ground floor of the center, the main lobby serves multiple functions: it acts as a reception area, check-in point for tourist accommodations, tackle shop, kayak rentals and a restaurant. Additionally, there are two seafood restaurants offering soft-shell crab cuisine. These restaurants are strategically placed near the main lobby and at the center of the facility, with a connected "dining on water" space. Between these dining areas, there is a large-scale exhibition space designed to educate visitors about the mangrove system, the natural habitat of mud crabs, as well as other historical attractions in Kuala Gula.

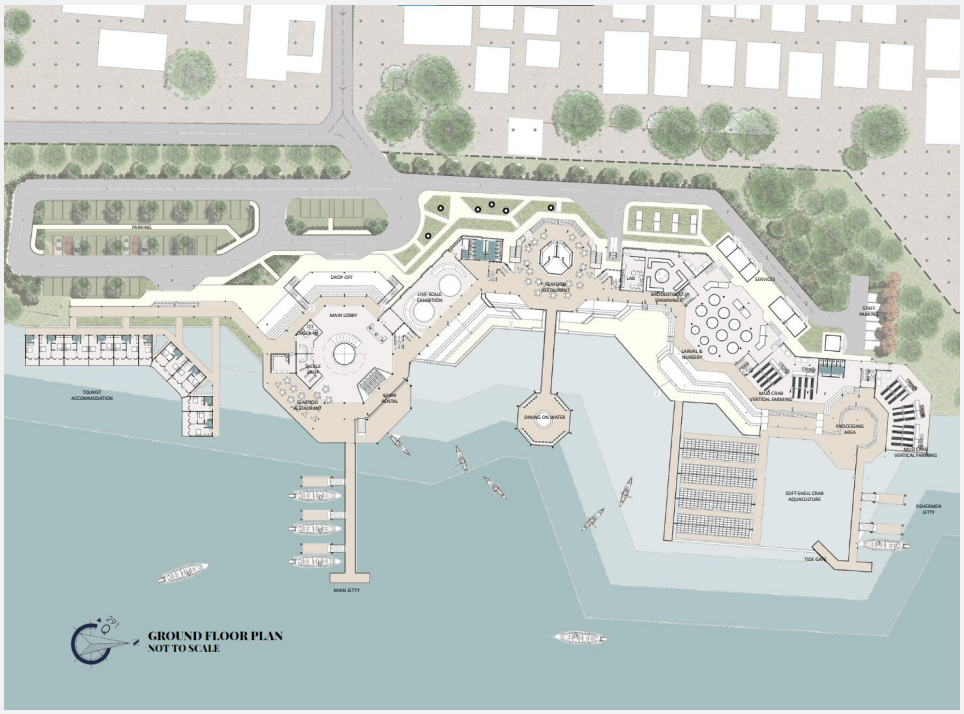

Figure 17: Ground floor plan

Furthermore, the ground floor features tourist accommodations with river and mangrove forest views. The research zone includes larval and nursery areas, vertical mud crab farming facilities, and a laboratory connected to spaces for broodstocks and spawning tanks. This zone is overseen by researchers and is open for tourists to visit. Soft-shell crab aquaculture is situated near the research zone for ease of access, with the location chosen by the river and regulated by a tide gate to ensure the soft-shell crab boxes on pontoons remain above water level.

FIRST FLOOR PLAN

The first floor of the center comprises various spaces, including a management office, musolla (prayer room), river deck café, temporary exhibition area, discussion room, classrooms, and researchers' accommodation. Positioned between the classrooms and researchers' accommodation is a void area, allowing for maximum visibility of the larval and nursery tanks below. This floor also offers enhanced views of the aquaculture activities occurring by the river on the ground floor.

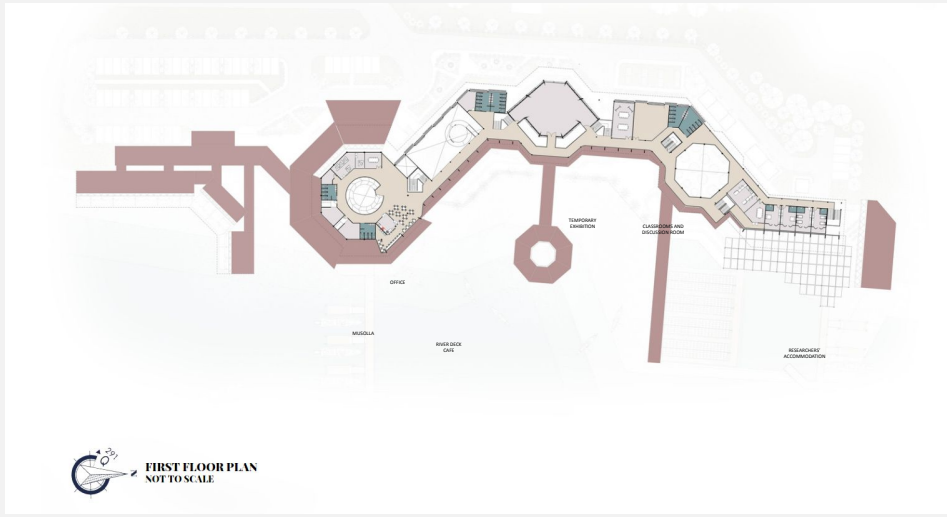

Figure 18: First floor plan

ELEVATIONS

Figure 19: Building North and South Elevations,

Figure 20: Building West and East Elevation.

SECTIONS

Figure 21: Building Section A-A and B-B

PERSPECTIVES

Figure 22: Isometric view from the soft-shell crab aquaculture

Figure 23: Compilation of interior perspectives.

SPECIAL STUDY
MUD CRAB VERTICAL FARMING

Recirculating Aquaculture System (RAS) is an aquaculture farming system in which culture tanks and filters where water is continuously recycled and monitored to maintain optimal conditions throughout the year. Water is treated mechanically to prevent degradation, maintain quality, and remove particulate matter biologically by converting the harmful collected chemicals into non-toxic ones. RAS uses filtration and disinfection technology to clean the water and put it back into tanks or cages to grow the stock in optimal conditions. It helps to buffer against fluctuation in natural brackish water. RAS offer several benefits over traditional aquaculture methods, including reduced environmental impact, improved water quality, and increased efficiency (Aqua Farm,2023).

Due to mud crab nature of cannibalism (if overcrowded in the pond, mud crabs would cannibalize each other), the crab will be separated and placed on each of the shelves.

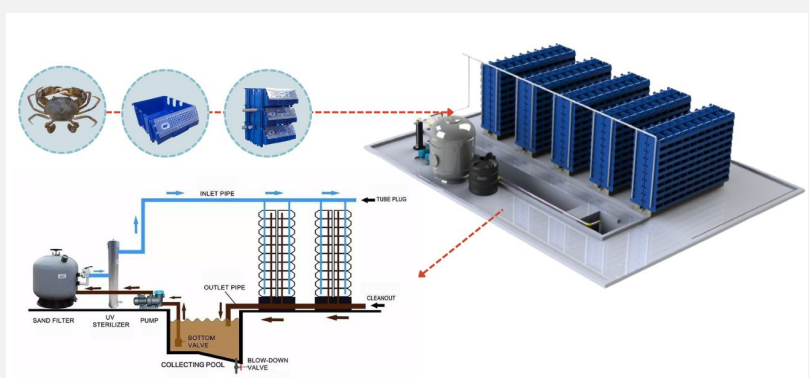

Figure 24: Shows on how RAS work in vertical mud crab farming.
(Source: Author, Yaal AQUA Private Ltd.)

In this centre, there are two spaces for vertical mud crab farming which each can fit the number of mud crab needed in a month. In a month, total of 4,500 mud crab needed for soft shell crabs production also as breed and release. For each space, there will be around 4,500 mud crabs production and the second space will be used to start the cycle prior one month earlier followed by another space to keep on producing 4,500 mud crabs every months. Each vertical crab condo can fit 280 crabs

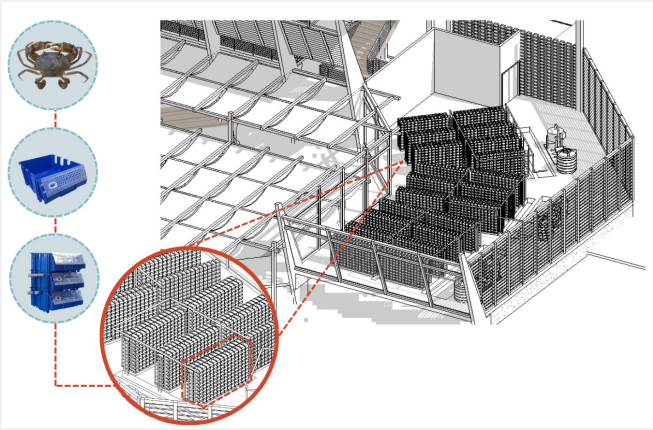

Figure 25: Shows on how RAS work in vertical mud crab farming in the centre.

SEMI-CLOSED SYSTEM FOR SOFT-SHELL CRABS

The major common points among the main systems currently used for soft-shell crab farming are the confinement of the animals in the pre-moult stage and the requirement that the place used to keep the animals allows an easy monitoring of the ecdysis as well as fast removal of the recently molted animals.

Figure 26: Shows molting stages of mud crab.

In this building, it will be used brackish water source directly as an aquaculture pond. Closed system farming represents the most primitive and least technical method to obtain soft-shell mud crabs ,among systems currently used. The semi-closed system was designed with the purpose of improving and easing the management in the production of soft-shell mud crab, with respect to the management problems described for open systems.

This old semi- closed system that have been used in Kg. Kuala Gula put 5-7 mud crabs in one cage caused lower chance of survival rate due to cannibalism between crabs in one cage. Other than that, poor water quality can also caused death to these mud crabs even before it turns into soft-shell crabs. Water quality got affected due to leftovers food for those 5-7 mud crabs in one cage.

THE PONTOONS FOR SOFT-SHELL CRAB BOXES

Quinitio & Lwin (2009) suggest that a conventional brackishwater earthen pond, typically used for fish or shrimp farming, can also serve as a suitable environment for cultivating soft-shell mud crabs. Key considerations for selecting an appropriate pond site include ensuring a consistent and plentiful supply of clean seawater or brackish water. According to Camila et. al (2017), pontoons for soft-shell crab boxes are floating platforms designed to support the storage and cultivation of soft-shell crabs in aquaculture facilities. These pontoons offer several advantages in the management of soft-shell crab production:

Water Quality Management: Pontoons allow for greater control over water quality parameters such as temperature, salinity, and oxygen levels. This control is essential for optimizing the growth and health of soft-shell crabs, as they are sensitive to changes in water conditions.

Enhanced Space Utilization: By utilizing pontoons, aquaculture operations can maximize the use of available water surface area. This efficient use of space allows for higher stocking densities and increased production capacity within a given aquaculture facility.

Ease of Management: Pontoons provide a stable platform for managing soft-shell crab boxes, making it easier for aquaculturists to access and maintain the crabs. This facilitates routine tasks such as feeding, monitoring water quality, and harvesting, ultimately contributing to more efficient operations.

Flexibility in Site Selection: Pontoons offer flexibility in site selection for aquaculture operations. They can be deployed in various aquatic environments, including estuaries, rivers, and coastal areas, allowing aquaculturists to choose locations that are most suitable for soft-shell crab production.

PULLEY SYSTEM FOR SEMI-CLOSED SYSTEM IN THE CENTRE

Pontoons support the crab boxes where crabs are held. This pontoon of polyvinylchloride (PVC) pipes (4 cm in diameter) is constructed with 8 units of 4 m length pipes connected to each other forming 4 columns. Both ends of the pipes are covered with PVC cap to prevent the entry of water. The length of the pontoon depends on the pond size. The cages are installed in long and narrow floating structures arranged side by side. To ease the management of the cages and the identification of mould, a walkway structure similar to a bridge is installed.

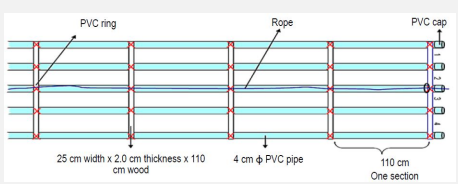

Figure 27: A top-view diagram of a pontoon illustrates detailed measurements, featuring four columns labeled from 1 to 4. (Source: Quinitia & Lwim (2009)

One section can hold 24 boxes arranged in 4 rows, that is 6 boxes in each column. In this centre. one pontoon have 19 sections that can hold 456 boxes. Based on the number of soft shell crabs needed in a month, total of 8 pontoons will be provided to cater the 3,600 soft-shell crabs.

A pulley is a wheel on an axle or shaft that is designed to support movement and change of direction of a taut cable or belt, or transfer of power between the shaft and the cable or belt. In this case, a pulley supported by a frame or shell that does not transfer power to a shaft, but is used to guide the cable or exert a force, the supporting shell is called a block, and the pulley may be called a sheave or pulley wheel. The function of this system is to make the labor force easier to pull the pontoon of the soft shell crabs pontoon. The oar at the pulley wheel is used to move the cable holding the framing closer to the jetty to checking on individual crab.

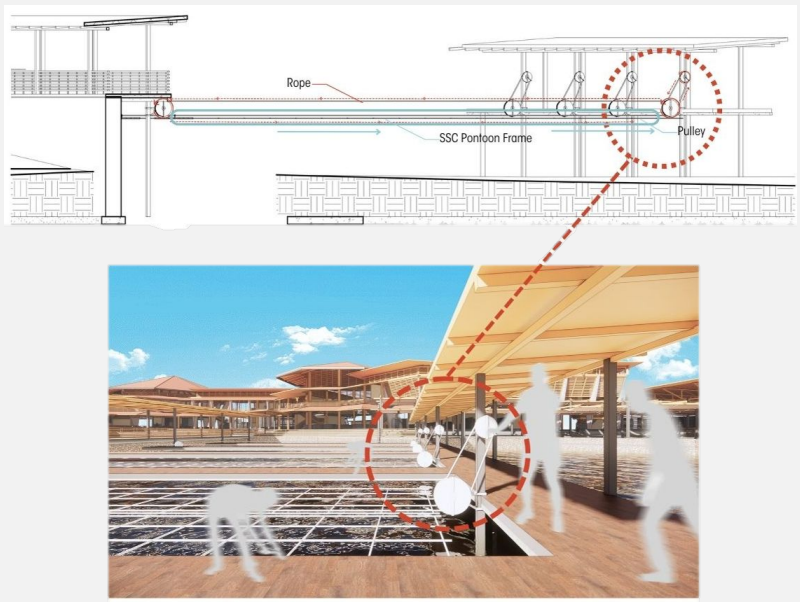

Figure 28: Pulley system for soft-shell crab pontoons.

TIDE GATE FOR SOFT-SHELL CRAB AQUACULTURE

Tide gates control water flow between a tidewater area and a diked-off, drained upland area. A tide gate involves a hinged door at the end of a culvert that connects these areas and a mechanism that controls when and how the door is opened to allow water flow in either direction. Tide gates close during incoming tides to prevent inundation from downstream water propagating inland which will be used for soft shell crabs pontoon farming system.

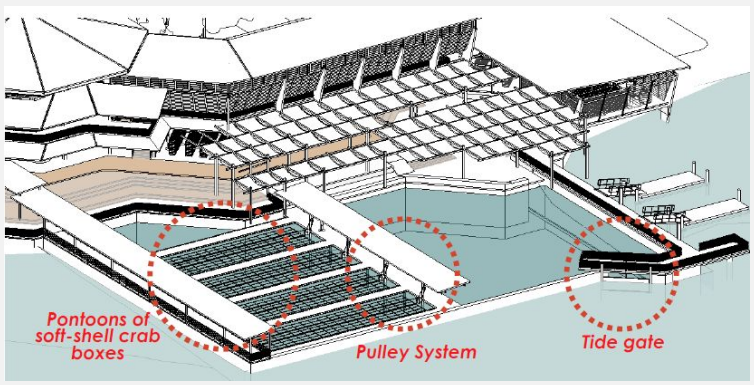

Figure 29: Aerial view focusing the soft-shell crab aquaculture in the centre

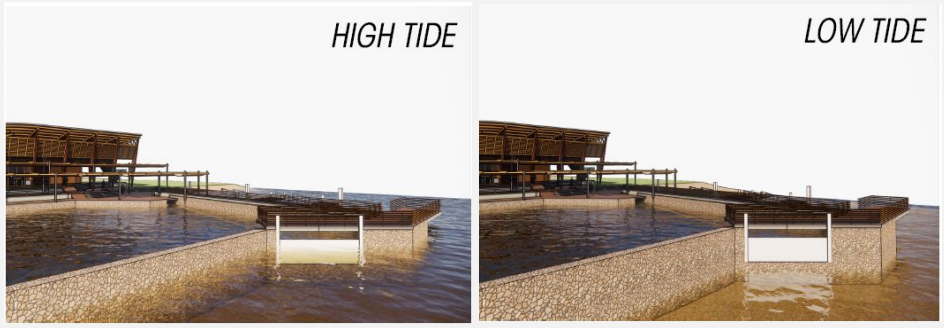

Figure 30: Shows that the water level for soft-shell crab aquaculture remains the same level upon tide changes.

CONCLUSION

The proposal for establishing a Soft-shell Crab Ecotourism Centre in Kg. Kuala Gula, Perak aims to promote sustainable tourism, conserve the mud crab ecosystem, and raise environmental awareness through catch-and-release practices and education. The thesis focuses on balancing visitor experiences with safeguarding the ecological integrity of the mangrove ecosystem. Key design principles prioritize sustainability, environmental sensitivity, and community engagement, with an emphasis on energy efficiency, proper material usage, and low-impact construction techniques. The research zone facilitates environmental education, research, and community engagement, while the tourism zone offers guided eco-tours for visitors to explore Kg. Kuala Gula's mangrove forests. Success depends on active involvement and support from local communities, government agencies, and other stakeholders, highlighting the importance of community engagement and cultural integration in preserving the mud crab ecosystem and promoting responsible tourism. Ultimately, the proposed Soft-shell Crab Ecotourism Centre exemplifies a holistic approach to environmental preservation and sustainable tourism, serving as a potential model for ecotourism initiatives globally.

BIBLIOGRAPHY

Aqua Farm (Ed.). (2023, April 12). Revolutionizing Aquaculture: The Benefits and Functionality of Recirculating Aquaculture Systems.

Department of Fisheries Malaysia (2021). Retrieved from https://www.dof.gov.my

Fisheries, N. (2022, September 15). Aquaculture supports a sustainable earth. https://www.fisheries.noaa.gov/feature-story/aquaculture-supports-sustainable-earth

Food and Agriculture Organization of the United Nation (FAO). (2018).World Fisheries And Aquaculture.

Quinitio, E. T., & Lwin, M. M. N. (2009). Soft-shell mud crab farming. Tigbauan, Iloilo, Philippines: Aquaculture Department, Southeast Asian Fisheries Development Center.

Tavares, Camila & Silva, Ubiratã & Angelo Pereira, Leandro & Ostrensky, Antonio. (2017). Systems and techniques used in the culture of soft-shell swimming crabs. Reviews in Aquaculture. 10. 10.1111/raq.12207.

The International Ecotourism Society (TIES).(2015). What is Ecotourism. Definition, 1-4