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Depth Analysis of Border Security Space Planning for The Malaysia-Thailand Border in Rantau Panjang, Malaysia

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ABSTRACT

This study conducts a depth analysis of the Rantau Panjang border checkpoint between Malaysia and Thailand, recommending the best possible design concept for its improvement. Examining the Malaysia-Thailand border from historical, geopolitical, and economic perspectives, the study reveals the complexities of border management and highlights the need for more robust security measures. The study tackles the urgent issue of porous border checkpoints in Malaysia, particularly at Rantau Panjang, which calls for a critical assessment of the operational and spatial circumstances as they stand. The three objectives are to evaluate the current condition of the Rantau Panjang border facility, find best practices from local and international antecedents, and consider building a new type or upgrading the checkpoint, using a mixed-method study design that includes site visits, case studies, and questionnaires. The investigation reveals deplorable circumstances at Rantau Panjang, including unlawful activity and poor space design. The results recommend wider documentation counters, better direct circulation, and the incorporation of auxiliary programmes to reduce traffic and boost productivity. The importance of a comprehensive and flexible strategy for border security is emphasised in the study's conclusion, which also acknowledges the limitations brought on by financial and schedule constraints. Notwithstanding these drawbacks, the study makes a substantial contribution to the conversation on border security and national security, especially in light of West Malaysia's advantageous location.

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INTRODUCTION

Malaysia, strategically positioned in Southeast Asia, shares borders with Thailand, Indonesia, Brunei, Singapore, and the Philippines (Harun, 2009). The Malaysia-Thailand border stands as a pivotal marker of territorial demarcation and sovereignty. Despite the border's extent, Malaysia faces security challenges from conventional military threats to terrorism and human trafficking, prompting joint efforts with Thailand to enhance border security, notably through the construction of a border wall (Parameswaran Prashanth, 2016). Economically, national borders facilitate trade and regional integration initiatives like the ASEAN Economic Community, fostering economic growth and cross-border tourism (Kadir & Karim, 2012). However, borders can also impede economic activity, particularly in border regions, though they offer unique economic opportunities such as border trade zones (Anderson et al., 2003). The Malaysia-Thailand border serves as a vital conduit for goods transport, tourism, and commercial activities, highlighting its economic significance for both nations.

Rantau Panjang is a vital border crossing point between Malaysia and Thailand. Unlike other areas, the delineation of the border here relies solely on the 50-meter-wide Golok River, without a border fence. Despite being a hub for goods, services, and tourism via road transport, the town faces significant challenges in security. The absence of proper border infrastructure coupled with a single bridge under the jurisdiction of each country's Immigration Department, renders the area susceptible to various illegal activities, including smuggling and undocumented migration. Moreover according to a previous study by Polese et al., in 2011, the community's tolerance and involvement in such illicit practices, compounded by the proliferation of illegal jetties along the Golok River, exacerbate security concerns. Despite being designated as a duty-free zone, Rantau Panjang's unique features, including its integration with pre-existing residential areas, create a mixed impression among tourists. The zone's entry points, controlled by customs officers, further contribute to the challenges, as illegal goods are transported, reducing potential tax revenue (Hussin et al., 2012). Moreover, Thailand accounts for 70% of the supplies in Rantau Panjang's duty-free zone, leading to significant revenue loss through tax evasion. Malaysia has suffered losses of approximately RM5 billion in subsidised goods due to smuggling (Junaidi et al., 2019). These complexities highlight the multifaceted issues facing Rantau Panjang, necessitating comprehensive strategies for addressing security, sovereignty, and economic concerns. Amidst recent advancements in technology whereby technological applications have been adopted in various fields (Zaiki & Wong, 2021). Better infrastructure and technology are also needed to address issues of smuggling and crime as well as corruption at the border.

ISSUES, AIM, OBJECTIVES AND QUESTIONS

Most border checkpoints in Malaysia are considered porous due to a lack of integrity, technology, and planning (Zainol et al., 2019). Despite government efforts to improve security, the Malaysia-Thailand border is ranked 306 out of 313 in its permeability between nations. This is due to the lack of proper transportation and maintenance on the border (Deutschmann et al., 2023). Local communities in Malaysia and Thailand also prefer to use illegal routes along the border (Hussin et al., 2012). Issues such as the smuggling of small arms and light weapons have also been reported (Dahari et al., 2019). Thus, an understanding of the border through literature reviews and site observation is urgently needed to create beneficial solutions. A better understanding of the transportation, circulation, and permeability of Malaysia’s border will also help improve and provide more seamless permeable solutions to the issue.

Research Aim, Objectives, and Questions

This research aims to propose the best design scheme solution for the international Malaysia-Thailand Rantau Panjang border checkpoint facility. This will eventually deepen our understanding of border management.

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Table 1. Research Objectives and Questions

Research Objectives	Research Questions
To evaluate the existing operation and spatial condition employed in the Malaysia-Thailand Rantau Panjang border facility.	What are the existing operational and spatial conditions of the Malaysia-Thailand Rantau Panjang border facility?
To identify best practices of operation and space planning in various case and precedent studies of international and local border facilities.	What does it take to have the best spatial design and to run effective operations in international and local border facilities?
To retrofit or develop a new design for the Malaysia-Thailand Rantau Panjang border checkpoint facility.	How can the existing Malaysia-Thailand Rantau Panjang border facility be improvised based on the case and precedent studies?

Source: Authors (2024)

Research Significance and Limitation

The research explores the relationship between spatial design and border security strategies, shedding light on how effective space planning can contribute to enhancing a nation's security apparatus. This is an important aspect of national security, especially for Peninsular Malaysia which is connected to three continents and located at a key maritime trade route. This study also offers insight into optimising spatial resources through a comparative analysis of international models applied to Malaysia. By identifying best practices and addressing gaps, tailored spatial strategies can be proposed to strengthen border security, safeguard territorial integrity, and combat illicit activities like smuggling and trafficking. This research is particularly relevant given global border crises, underscoring the importance of effective border control. Furthermore, the study's focus on Malaysia's unique geographical, cultural, and socio-economic factors offers valuable insights for policymakers and security practitioners.

LITERATURE REVIEW

Border security plays a crucial role in safeguarding a nation's sovereignty, acting as the first transportation and traffic control between nations, protecting its citizens, and managing the flow of goods and individuals across borders. In Malaysia, a nation with extensive land and maritime borders, ensuring effective border security is paramount.

The Permeability of Border Checkpoints

Studies that look at the ease of border crossing around the world focus on how transportation and traffic flow works at border checkpoints. This section explores the importance of smooth transportation and traffic flow, known as Transportation and Traffic Efficiency (TTE), and the balance between security and ease of crossing, called permeability of checkpoint borders. A comparative study (Deutschmann et al., 2023) to assess the current permeability of nation-state borders worldwide reported that transport infrastructure with national political checkpoints can be used as an indicator of border permeability. The study ascertains that better infrastructure at national checkpoints can increase border permeability while the checkpoints create a safer political capacity for reducing entries (Deutschmann et al., 2023). Fortification or high wall along the border line is the background whereas paths or gaps that cut across it are the foreground The fortification would still be penetrable through a door, gate, or gap. Thus, the number of gaps can tell something about the potential of mobility from one side to another, and the permeability of a border. In another example, the opening of the Kazungula bridge between Zambia and Botswana, the bridge (gap) caused the cars, trains, and pedestrians to cross to the other side more easily. Improvement of border permeability also can be the result of agreements between nations, for example, it can be in the nation's best interest to make an open border policy and allow cross-border mobility of certain goods and persons of interest (Gavrilis, 2008).

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Moreover, the two current paradigms in the study of borders and approach to assessing the permeability of nation-state borders, are the shifting border paradigm and the fortified border paradigm. The shifting border paradigm states that borders are detached from the physical location of the line as seen in the constituting territorial border; to sum up this paradigm is study of border checkpoint area. This paradigm controls the upcoming traffic and mobility usually not at the border checkpoint but at certain places via visa (Rijke, 2021). It is more focused on the legality of mobility while highlighting the intricacy of borders which contain political, social, and cultural aspects. Conversely, the fortified border paradigm proposes that a fortified physical border is still relevant in the current time, and spatial understanding and inquiries of the border still have some standpoints (Vobruba, 2016). This type of paradigm focuses on the study of land border fortification (Gülzau & Mau, 2021). Scholars have argued and put the traffic infrastructure that crosses a border in the limelight. This is due to the maneuverability of people and goods occurring on these routes (Deutschmann et al., 2023). By analysing the infrastructure, one can understand how permeable a border is. Thus, a fortification of the border becomes secondary when examining the permeability of a border. This shows the importance of traffic control and its effect on the permeability of a border checkpoint.

Border Security, Control and Management

Several current literatures on border checkpoints also pay particular attention to the security, control, and management. Zainol et al. (2019) emphasised the challenges and prospects or actions taken by the Malaysian government to curb the issue. In Malaysia, particularly on the Malaysia-Thailand land border, there are two border crossing points, the Legal Crossing Points & Illegal Crossing Points (Zainol et al., 2019). The example of legal crossing points in Malaysia are sea crossing points (ports) and airspace crossing points (airports) while illegal crossing point is a crossing point along a national border where individuals pass without utilizing official border checkpoints or without permission from the appropriate government authorities. With regards to 1) the border security, transnational organised crime has constructed illegal crossing points that have been utilised for smuggling, illegal immigration, and human trafficking along the Malaysia-Singapore border and at border with Thailand. There are unofficial crossing sites between Thailand and Malaysia in developed regions and at the boundary of the jungle. The Malaysian border is crossed at unlawful spots, demonstrating how porous and exposed the Malaysian borders are. Hence, Inefficient threats will increase when vulnerabilities are addressed. The border had evolved into one of the border enforcement agencies' most crucial and contentious challenges. Thus, every Malaysian entry point's border control needs to be strengthened. To safeguard Malaysia's stability from potential threats, border agencies including the Malaysian Department of Immigration, Royal Malaysian Customs Department, Royal Malaysian Police, Malaysia Border Control Agency, and Malaysia Maritime Enforcement Agency must perform their duties. The Malaysian Armed Forces have certain tasks and responsibilities to eliminate threats in their assigned areas of duty (Zainol et al., 2019). Numerous illegal crossing locations along the Malaysian border show that the border was permeable and exposed to dangers. Threats will increase if vulnerabilities are handled ineffectively. The most significant and debatable concerns regarding the effectiveness of border enforcement organisations are the vulnerabilities of the Malaysian border. Furthermore, in relation to border management and control, to safeguard Malaysia's stability from any threats and maintain control of the border, border enforcement authorities at every entrance point must be strengthened and given more authority. Zainol et al., (2019) study also emphasised the ethnic community challenges along the border area. The connection keeps the culture and economy intact despite the fact they are separated by a border. Therefore, when talking about border management security, the non-physical aspect along the border needs to be considered. The border region, where the same community resided before the drawing of national lines, presents unique challenges, including cross-border mobility and the need for specific immigration documentation. The community's belief that they have the right to cross borders even when those borders keep them apart presents the most obstacle. This also explains why the local community along the border allowed illegal and criminal activities in the area (Polese et al., 2011). The local community feels they have the right to do what they want, and it has become part of their cultural community. Furthermore, Zainol et al., (2019) further stated that another challenge faced is the lack of

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authority to the armed forces. The Malaysian Armed Forces were operating in the northern regions of Malaysia and Thailand, particularly in Kedah and Perak, without the legal authority to make arrests, conduct searches, or seize objects. Zainol et al., (2019) also highlighted the Malaysian government's failure to assess the ever-changing threat. He found from a previous study by Navniit (2010) that the notion of security was formerly focused on the military aspect, most notably the elite's assessment of dangers, doctrinal responses, security resources, and ability to counter external threats. The evaluation of danger and the availability of hardware and the security environment were the two clusters of variables that were given more attention in terms of security. The concept of security acquires an operational meaning when a threat is identified.

Another study focused on the security of Malaysia's border checkpoint. Junaidi et al. (2019) investigated the immigration laws and Malaysian policies that were implemented and upheld to guarantee state border security, as well as the difficulties encountered by border security agencies. The enforcers were interviewed about the difficulties they encountered in maintaining security. Findings indicate that border control requires not only an increase in troops but also significant financial commitment and an effective plan. This could relate to good governance, efficient mechanisms, and strategic planning to guarantee humanistic results. AKSEM is staffed by 10,000 officers from a variety of border enforcement organisations, including the military, the police general operation force, and the Smuggling Prevention Unit (UPP). They must protect the borders from criminal operations like TIP and smuggling. Smuggling is currently prevalent in more than 1,200 locations at the peninsular border alone. Currently, the border in Malaysia mostly uses only security fences and integrated surveillance systems. The need for more upgraded and technologically advanced equipment such as biometric systems and More tracking system usage is required, including the use of drones, security cameras, and satellites. Home Ministry discovered that numerous areas had been breached. Unmanned aerial vehicles, or UAVs, will be used in conjunction with the replacement of the electronics system to accomplish this. Junaidi et al. (2019) also found and emphasised the need for collaboration, Malaysia has collaborated closely on capacity-building programmes covering prevention, protection, prosecution, awareness, and related fields with several nations, including the United Kingdom, Australia, and relevant international organisations like the International Organisation for Migration (IOM). Migrants illegal or not strategically utilise bribery to evade arrest and deportation. Reports of corruption among security personnel have occasionally surfaced. For example, the Wang Kelian TIP Camp on the Malaysia-Thailand border showed the revealing systemic corruption and weak border control of Malaysia even before being discovered in 2015. Furthermore, ensuring effective State security can be achieved through regular assessments of border control legislation and practices. Like other ASEAN nations, Malaysia has the right to implement its laws and regulations to stop illegal immigration because it is a sovereign nation. An efficient plan is necessary for border control in addition to new equipment and strategies to combat TIP. For these initiatives to be successful, the government must provide the financial commitment to equip enforcers. For example, Malaysia could adopt and equip border checkpoint enforcers with better equipment and facilities, thus discouraging criminal activity along the border.

Spatial Condition for Border Facility

Proper spatial infrastructure at border areas and checkpoints plays an important role in maintaining border control and security. For example, proper infrastructure will provide better control in the area, reducing transnational crime. Hence, spatial conditions encompassing physical, social, economic, cultural, and environmental components also play a crucial role in shaping the effectiveness of border control measures (Gümüş & Erdönmez, 2021). The importance of spatial configuration is further emphasised in the assessment of spaces, with the need for a common pattern that unifies them (Gabr, 2019). Understanding this is essential for developing informed policies and strategies that address the complex dynamics of border regions. 15 criteria should be considered for border gate site selection (OSCE, 2021; Kabak et al., 2020) (Table 2).

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Table 2. Criteria For Border Gate Site Selection

Criteria	Description
C1	The border gate site should be close to highway to maximise transportability
C2	Border gate site should be close to railway to maximise transportability
C3	Border gate site should be close to airports to maximise transportability
C4	Border gate site should be close to residential area to maximise suitability
C5	Border gate site should be close to police forces to maximise security
C6	Border gate site should be away from current border gates to maximise availability
C7	Border gate site should be constructed on a low slope to present easiness for heavy vehicles
C8	Border gate site should be constructed on places that have high export/import values to maximise the trade
C9	Border gate site should be close to refugee camps to maximise usage and control over refugees
C10	Border gate site should be close to the industry to minimise the transportation costs and environmental damage
C11	Border gate site should be away from forest land to maximise control on vehicles and refugees
C12	Border gate site should be located on places with low altitude to maximise the easiness of transportation
C13	Border gate site should be away from war zones to maintain the trade line flow
C14	Border gate site should be close to free trade zones to maximise the trade
C15	Border gate site should be close to the other border gates with high utilisation density to allocate the density optimally

Source: Kabak et al. (2020)

These criteria from Table 2 for border gate site selection also reinforce Pranoto et al. (2021) statement on the importance of infrastructure in driving the development of cross-border tourism destinations, suggesting that the quality of infrastructure at the Malaysia border checkpoint is a key consideration. Border checkpoints and their spatial quality should closely relate to tourism, economy, and security aspects. Szabó et al. (2017) conducted spatial econometric analysis of the Hungarian Border Crossing using the spatial econometrics method based on Luc Anselin's and Varga Attila's (in Hungarian) works whereby 5 points of views were considered including whether the border gate is on a bridge, the type of the road, the effect of the European International E-network, the country where the border gate is opening, and the effect of the Schengen borders. It was identified that the type of main road influences the border-crossing effect (Szabó et al., 2017). The higher the road classification and quality, the better the effect for the border crossing. Furthermore, the relationship with neighboring countries also influences the border crossing capability with the highest being with the members of the European Union.

RESEARCH METHODOLOGY

A case study research design was conducted using a combination of techniques, including a questionnaire of border checkpoint end users and precedent and case study observation. The purpose of this project is to better understand the operation and spatial condition employed in the Malaysia-Thailand Rantau Panjang border facility and ways to improve it. Furthermore, this qualitative research approach also aligns with previous studies related to border checkpoint. Deutschmann's comparative study is focused on qualitative methodology ranging from data observation and analysis to case study and content analysis. Thus, the border permeability index (BPI) to analyse data obtained from OpenStreetMap (OSM) and World Food Programme (WFP) was constructed. The data is more focused on borders and their transport infrastructure. Based on Deutschmann et al. (2023), the approach provided data and proven that Malaysia's border permeability requires more focus. Traffic and transportation efficiency of said border checkpoints need further details and improvement and the order of full enforcement of security will significantly lower the permeability (Deutschmann et al., 2023).

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Research Approach and Design

First, a case study was conducted to gain primary data and through site visit, the research team had the opportunity to observe and interact with the border facility users and their surroundings. These approaches enabled the researcher to present the findings in a visually engaging manner, enhancing the overall understanding of the research outcomes. These approaches allow for the collection of detailed information through various means such as questionnaires, conversations, and the capture of visual data in the form of pictures. Secondly, a precedent and case study research design were employed in unison with questionnaires to delve deeply into the selected environment under investigation. This design is particularly suited for gaining a comprehensive understanding of the current situation of border facility, as it allows to focus on a small number of samples in great detail. Furthermore, by selecting one case study with 4 precedent studies, it can thoroughly examine the best space planning of border facilities, exploring its various components, interactions, and contextual factors and where to implement it in the border.

Case Study

One building was selected as the focus of the investigation: the Rantau Panjang ICQS Border Checkpoint Complex, Rantau Panjang, Malaysia (Fig. 1). This building serves as a formally dedicated space for cross-border checkpoints in Malaysia. The methodology adopted for this study involves conducting an in-depth examination of the building and the experiences of the users such as government staff, tourists, and goods drivers. By selecting this specific location, the researchers can closely observe the physical environments, amenities, and facilities provided for them.

Fig. 1. ICQS Border Checkpoint Complex, Rantau Panjang, Malaysia.

Source: Google Earth (2023)

In addition, four (4) local and international buildings were selected as precedent studies: the Immigration Department of Malaysia, Bangunan Sultan Iskandar, Johor Bahru, Malaysia, the Ninotsminda Border Checkpoint, the United States Land Port of Entry in Calais, and the Sarpi Border Checkpoint. These buildings are international border checkpoints buildings with data availability.

Data Collection Method

The data collection was structured with the list of variables of space planning in the literature review. This method is used to identify clear data collection, as reported in other studies (Shaari et al., 2020a; 2020b; 2020c; Shaari et al., 2021; Othman et al., 2023a; 2023b). It focuses on the variables of space planning in the building being applied. The case study was conducted at the Rantau Panjang ICQS Border

Checkpoint Complex, Rantau Panjang, Malaysia. To compare the analysis, four (4) precedent studies were also observed. This case study will give further insight and understanding of the current border facility in Malaysia whereas the precedent studies will give insights into the international border facility and what can be implemented in the Rantau Panjang Border facility. Refer to Fig. 2 for the flow of findings.

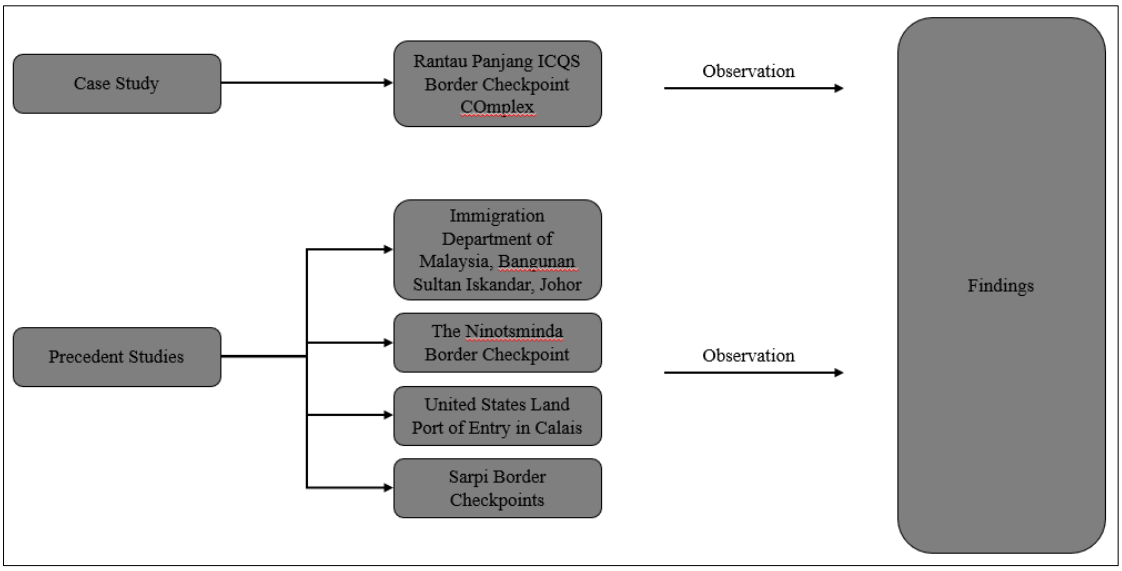

Fig. 2. The Flow of Findings

Source: Authors (2024)

Variables

The independent variable in this study is the space planning of the border facility, while the dependent variable is the space planning aspect experience quality by the users within the border facility. The independent variable of space planning encompasses multiple aspects such as Geographical location, border traffic volume, and security threat level. The dependent variable covers the quality experience and encompasses aspects such as space utilisation efficiency, processing time, infrastructure design, user experience, and technology integration. Refer to Table 3 for the variables.

Table 3. The Variables of Independent and Dependent Variables

Independent Variable: The Space Planning	Dependent Variable: Quality of Experience
Geographical Location	Space Utilisation Efficiency
Border Traffic Volume	Processing Time
Security Threat Level	Infrastructure Design
Site Plan & Utilisation	User Experience
	Technology Integration

Source: Authors (2024)

Procedure

Firstly, a site visit was conducted to the Rantau Panjang ICQS Border Checkpoint Complex. During the visit, the researcher sought permission from the person in charge and provided a clear explanation of the purpose of the visit. This step ensures transparency and establishes a cooperative relationship between

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staff and participants. Subsequently, the Space planning of the border facility was observed and pictures were taken for analysis.

FINDINGS AND DISCUSSION

Evaluating the existing operation and spatial condition employed in the Malaysia-Thailand Rantau Panjang border facility

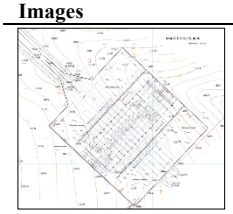
First, we identify the best practices of operation and space planning. This critical analysis aims to distil the most successful methods used in the operational and spatial aspects of border facilities by drawing on a wide range of experiences and insights obtained from previous studies.

Table 4. Precedent studies data analysis & synthesis

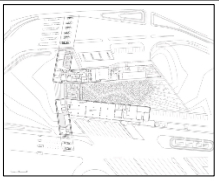
Precedent Study 1: Sultan Iskandar ICQ Complex, Johor Bahru, Malaysia

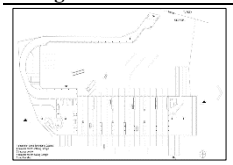
Images	Analysis & Synthesis
 Fig. 3. Sultan Iskandar Building Vehicles CIQ Counters Source: Harian Metro (2022)	Traffic volume typically varies during the day and is impacted by commuter patterns, cross-border activities, and special events. Rush hours in the morning and evening and weekend peak travel periods, can have a big impact on traffic. For the Sultan Iskandar building, the traffic volume is considered one of the highest and busiest border checkpoints in the world. According to an article by Today Online (2018), it is estimated over 450,000 people are estimated to enter and exit Singapore from Johor via both border crossings daily. To mitigate the high traffic volume, for immigration purposes, the building offered 38 immigration counters for vehicles to enter Malaysia, 39 immigration counters for vehicles to exit Malaysia and 50 immigration counters for motorcycles to exit and enter Malaysia. On the other hand, for customs purposes, 20 customs counters for vehicles to enter Malaysia, 16 customs counters for vehicles to exit Malaysia, 17 customs counters for motorcycles to enter Malaysia and 8 customs counters for motorcycles to exit Malaysia. The large amount of immigration and customs counters corresponds to the expected high traffic volume managed to accommodate the demand up to a certain degree. However, due to the increasing influx of people and goods, the checkpoint and causeway are still faced with daily traffic jams and demand for expansion.
 Fig. 4. Automated Passport Control Counters Technology Source: Harian Metro (2023)	Using cutting-edge technology has become essential in today's border control scenario, changing the way important checkpoints like the Sultan Iskandar building in Johor Bahru, Malaysia, operate. Exploring the various innovations intended to strengthen security, optimise operations, and improve the facility's overall effectiveness. ranging from sophisticated surveillance networks and biometric identity systems to automated kiosks and intelligent infrastructure The list of technology integrated to the building is stated below: Biometric Systems – RFID System – Surveillance Cameras – Automated Passport Control (APC) Kiosk – Electronic Visa System – Automated Gates and Turnstiles – Integrated Border Management System – Communication System – Automated Vehicle Plate Recognition – Queue Management System – Information Display System- Mobile Application.
 Fig. 5. Vehicular Circulation Entrance of Sultan Iskandar Building Source: Authors (2024)	Johor Bahru Eastern Dispersal Link Motorway is the primary route from Malaysia that leads to the structure. Vehicles (and pedestrians) proceed onto the Causeway following border check, finally arriving at the Singaporean Woodlands Checkpoint. The Johor Bahru Sentral railway station, which is connected to the skyscraper by a footbridge, offers pedestrian access to the structure. The flow of each circulation is as below: Vehicular Circulation Flow Entry Point – Queuing and Waiting Areas – Customs and Immigration Checks – Processing and Clearance – Exit Points – Integration with Surrounding Roads Pedestrian Circulation Flow Entry point – Document Verification – Security Check – Custom Declaration (If Applicable) – Clearance and Exit Points – Integration with Surrounding Area – Amenities and Services

Precedent Study 2: The Ninotsminda Border Checkpoint

Images	Analysis & Synthesis
 Fig. 6. Site Plan of Ninotsminda Border Checkpoint Source: Furuto (2012)	The border checkpoint site plan is focused on direct access and crossing to the border checkpoint. The vehicular circulation does not require any turning when crossing the border and the immigration and customs documentation counters are planned with the targeted traffic volume. The site boundary is also focused and demarcated with a wide boundary in comparison to the Rantau Panjang border checkpoint. Furthermore, like many modern border checkpoints, the Ninotsminda border checkpoint is equipped with various facilities to facilitate smooth border crossings. These include customs offices, immigration and passport control, cargo inspection areas, and other infrastructure to manage the flow of people and goods.
 Fig. 7. Passport Biometric Scanner Technology Source: Travel and Leisure Asia (2023)	Border checkpoints often incorporate technology for efficient processing. This can include biometric systems for identity verification, surveillance cameras for security, and possibly automated systems to streamline immigration and customs procedures. Furthermore, Given the geopolitical context of the region, border checkpoints implement rigorous security measures to ensure the integrity of the border. This may include security personnel, surveillance technology, and other measures to prevent illicit activities.

Precedent Study 3: United States Land Port of Entry in Calais Border Checkpoint

Images	Analysis & Synthesis
 Fig. 8. License Plate Reader Camera Technology Source: News 5 Cleveland (2024)	A 60-foot-long device for reading licence plates of passenger automobiles is installed inside the island before the main inspection area for those vehicles. The readers enable critical information to show up on an inspector's computer screen without her having to manually enter data because they are nearly always accurate. Additionally, the device has embedded radiation portal monitors. The building also includes an additional set of RFID readers that read the associated chips in passports issued recently and documents issued under the Western Hemisphere Travel Initiative. A main inspection used to take up to two minutes, but thanks to this technology, it now only takes an average of thirty seconds.
 Fig. 9. United States Land Port of Entry in Calais Border Checkpoint Site Plan Source: Frearson (2012)	The focus of the site planning in this building is the vehicular circulation. The architectural elements of the border station had to be arranged and placed in a way that maximises effectiveness while communicating security and welcome. The building's location at the summit of a relatively level plot ensures line-of-sight visibility between the Station and the entry and departure points of the property. As a result, entering and leaving traffic is clearly, safely, and effectively controlled. The building itself also segregates the heavy load cargo from daily commute vehicles to smoothen the traffic congestion.

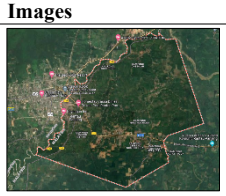
Precedent Study 4: Sarpi Border Checkpoint in Georgia	
Images	**Analysis & Synthesis**
 Fig. 10. Sarpi Border Checkpoint in Georgia Site Plan. Source: Frearson (2012)	First, the site boundary of the checkpoint is wide in comparison to an elongated site boundary. This type of site boundary provides a direct straight-line vehicular circulation with multiple immigration and customs counters. Furthermore, the site boundary also gives an easier planning for future expansion if needed. Apart from the standard customs amenities, the building also has a conference room, staff quarters and a restaurant. As a symbol of the nation's progressive movement, the edifice greets guests visiting Georgia.

Source: Authors (2024)

In general, the space planning of the other border checkpoints is catered for bigger scale with easier room for expansion. For example, this is shown by the size of the border checkpoint site and wide type of site. This is mainly for easier future expansion for circulation. Furthermore, the border checkpoints selected were integrated with high-tech technology and facility for better security and management control.

Second, understanding and evaluating the existing operation and spatial condition employed in the Malaysia-Thailand Rantau Panjang Border Facility is important. It aims to unravel the intricacies surrounding the operational and spatial aspects of the border facility, shedding light on its current state. Through several methods, it seeks to provide a nuanced understanding of the dynamics influencing the facility's functionality and physical layout. By examining the existing conditions, the first section serves as a crucial juncture in the research, paving the way for insightful conclusions and informed recommendations to enhance the efficacy of the Malaysia-Thailand Rantau Panjang border facility.

Table 5. Analysis of Rantau Panjang border facility

Case Study Observation: Rantau Panjang Border Facility		
Variable	**Images**	**Analysis & Synthesis**
Geographical	 Fig. 11. Map of Rantau Panjang Source: Google Maps (2023)	The landscape surrounding Rantau Panjang is characterised by diverse topography. Two of the state's major rivers, the Kelantan and Sungai Golok, flow close by and add to the ecology of the area as a whole. The rice crop is a major contributor to the local economy, and these lush fields support local agriculture. The region's tropical environment, which is characterised by high temperatures and rainfall adds to the landscape's lush foliage. Rantau Panjang is surrounded by elevated regions with hills or mild slopes in addition to lowland and riverine habitats close to the Sungai Golok River. Such topography may affect the region's layout and accessibility, which may have an impact on border security and control. Surveillance and monitoring may be complicated by dense vegetation on hillsides or uneven terrain. Because of the lush green vegetation and natural border landscape of the Golok River, the border area is considered porous and permeable. For example, the surrounding area has become a transit ground for illegal trading and smuggling with the presence of illegal jetties along the Golok River.

Traffic Volume

Fig. 12. Rantau Panjang Traffic During Weekend

Source: Authors (2024)

Fig. 13. Rantau Panjang Traffic During Weekday

Source: Authors (2024)

Rantau Panjang serves as a transit hub for people and products travelling between Malaysia and Thailand, there may be fluctuations in the volume of road traffic within the area. One important factor to take into account is the amount of traffic on the routes heading to and from the border crossing. This can include personal automobiles, large trucks, and public transportation, all of which affect the local traffic dynamics as a whole. the Rantau Panjang border checkpoint mainly acted as an interchange checkpoint for local and nearby communities at Kelantan to travel to Thailand as tourists for short vacations and vice versa. Thus, the Rantau Panjang border checkpoint has a fair but slightly lower goods transiting via the checkpoint in comparison to Padang Besar and Bukit Kayu Hitam border checkpoint. With this in mind, the Rantau Panjang border checkpoint traffic volume is mainly seasonal and fluctuates during holiday and weekend periods.

Table 6. Traffic volume by time

Seasonal Time	Weekday	Weekend	Holiday
Traffic Volume	Fair	High	High

Source: Authors, 2023

Security Threat Level

Fig. 14. Illegal Jetties & Goods Smuggling

Source: Authors (2024)

As a result of their location and weak borders, the possibility of transnational crime is one of the main security risks in Rantau Panjang. The town is vulnerable to illegal movements of products, human smuggling, and drug trafficking because of its closeness to Thailand. Rantau Panjang is engulfed with goods smuggling and the presence of illegal jetties along the riverside issue. Furthermore, these illegal activities are allowed by the local communities because it is part of their income and culture. This is strengthened by the statement in a previous study conducted by Hussin et al. in 2012, which found that Thailand accounted for 70% of the supply sources in the Rantau Panjang duty-free zone, whether they were brought in legally or illegally. Although not stated publicly, from an informal interview with the local municipal council staff, the majority of the local communities there have small ties with criminal organisations and most of the population carry personal small firearms. To counter the said issues, from observing the Rantau Panjang border facility and surrounding area, the facility is also equipped with few documentations and surveillance technology to mitigate security threats and increase control in the area while the surrounding area is guarded with well-equipped military personnel.

Site Planning and Utilisation

Fig. 15. Site boundary for Rantau Panjang Border Checkpoint

Source: Google Maps (2023)

Fig. 16. Vehicular Circulation at Rantau Panjang Border Checkpoint

Rantau Panjang border facility has a unique site plan, the site boundary demarcation itself is elongated compared to other border checkpoint site boundaries which are wide. Furthermore, due to the Rantau Panjang train track rail, the site is constricted for future expansion. The implication of this site boundary is quite significant for the building. This caused difficulty in future expansion, the site itself is constricted with a train track rail on the right and a public road to the commercial district on the left. Thus, the checkpoint can only expand vertically which gives fewer options and benefits. In response to the site boundary, the vehicular circulation of the facility also has to be elongated, future expansion is difficult. Thus, the traffic capacity of the facility cannot accommodate the increasing demand, especially during weekend and holiday seasons. Next, the vehicular circulation to enter the documentation counter has multiple turns to accommodate the side effect of an elongated site boundary, this causes additional time to process and not a seamless process of documentation for vehicular transportation.

Table 7. Number of counters for pedestrian at the facility

Lane for Exiting & Entering Malaysia	Number of Counter
Pedestrian	2
Lorry & Bus	2
Car	2
Motorcycle	1

Source: Authors, 2023

	Source: Authors (2024)	Referring to the table, for pedestrian documentation, the amount of documentation counters cannot accommodate existing demand, especially during peak season.

Source: Authors (2024)

Questionnaires Analysis & Synthesis

In this method, 50 respondents were received. For clarity and logical presentation, the analysis was organised by the question and the analysis and synthesis of each question.

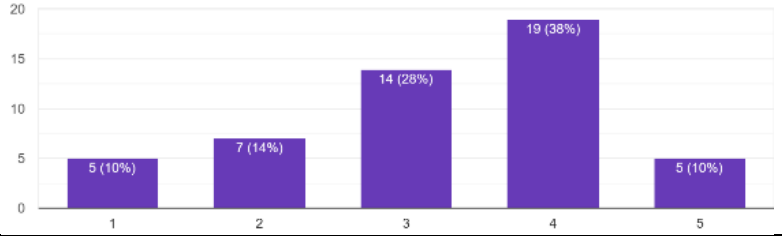
Table 8. Data analysis from questionnaires for Rantau Panjang users (Questions 1 to 3)

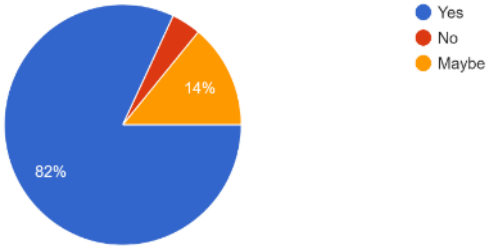
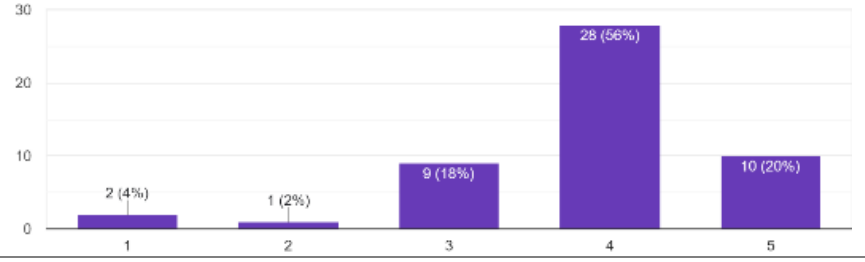
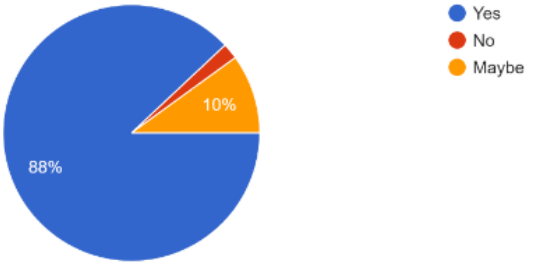
Demographic Section
Questions 1 to 3 was meant to determine the respondents' demographic. From the questions, the respondents' gender was almost equal for males and females. Concerning the age of the respondents, the majority of the respondents were older (35 years old and above). Next, the occupation or user type of the border facility ranges from tourist and local community, there's a small percentage (9%) of the respondents was the border facility personnel. The respondent chosen for the questionnaire is categorised by two types, 1) local population of border area and 2) border facility personnel. These two types of respondents are related to border checkpoints and always use the border facilities. Thus, understanding the respondent preferences and opinions is crucial in understanding current situation of the border.

Source: Authors (2024)

Table 9. Data analysis from questionnaires for Rantau Panjang users (Questions 4 to 18)

Evaluation of Border Facility		
No.	**Questions**	**Findings Analysis & Synthesis**
4	How would you rate the security level & control at the Rantau Panjang border checkpoint?	Participants were asked to provide their subjective evaluation of the overall effectiveness and robustness of security measures in place in correspond to the threat level. The respondents evaluated it as capable and fair in corresponding to the threat level of the area. After a thorough investigation of the answer, the majority of the border personnel, the local community and some tourist respondents select answers 3 and above. From the answers selected by each user, it can be concluded that the strategy enacted by the governments such as military posts provide better security for the surrounding area that satisfies them while there is still room for improvement based on the respondents' answers.



5	In your opinion, does the security level & control impact the space planning and layout of the border checkpoint and vice versa?	This inquiry seeks to discern the participants' perspectives on the influence of security considerations on the physical organisation and design of the checkpoint. From the pie chart, the majority of the respondents agreed that space planning and layout of the border facility impacted the security level and control. Space planning plays a major part in controlling the security level in an area, especially at border checkpoints. For example, the Rantau Panjang space planning of border facility can and manage to control the security of the place up to a certain degree of control. This stems from the utilisation of survey points and decks to the documentation counters which in turn provide security satisfaction to the users. 
6	How would you characterise the typical volume of people and goods crossing at the Rantau Panjang border checkpoint?	This explores the patterns and volume of cross-border movements, the frequency, volume, and fluctuations in the movement of people and goods. More than half of respondents agreed that the volume of people and goods crossing is high. Although not as high as the Bukit Kayu Hitam border checkpoint or Padang Besar Border Checkpoint, the volume of people and goods peaks during the weekend and holiday season. This reinforces the case study observation where the volume of people and goods crossing increased substantially during weekends, which led to traffic jams and longer processing time. 
7	In your opinion, do you believe the traffic volume affects the space planning and design of the border facility?	This inquiry attempts to clarify the pragmatic factors that might be taken into account in response to fluctuating traffic levels in addition to investigating the perceptual relationship between traffic patterns and spatial planning. It can be concluded that the majority of the respondents agreed that space planning and layout of the border facility impacted the traffic volume. Space planning plays a major role in mitigating and controlling the traffic flow and volume of a place. For example, from the case study observation, due to the space planning of the Rantau Panjang border checkpoint such as the small number of documentation counters, the waiting and documentation processing time increase significantly during peak season. The answers from respondents correspond with the case study observation. 

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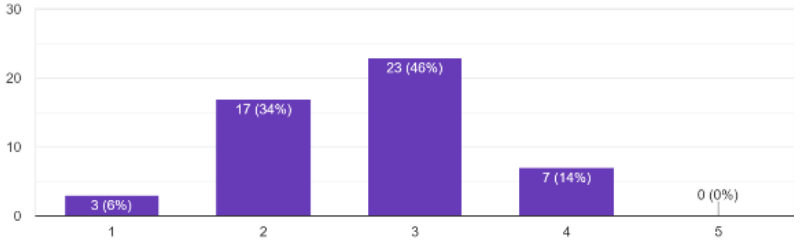
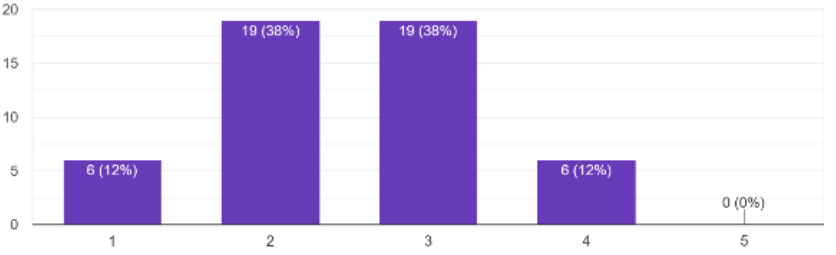
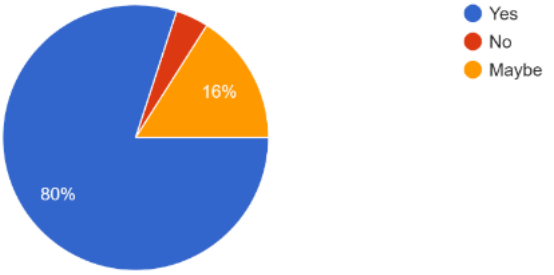
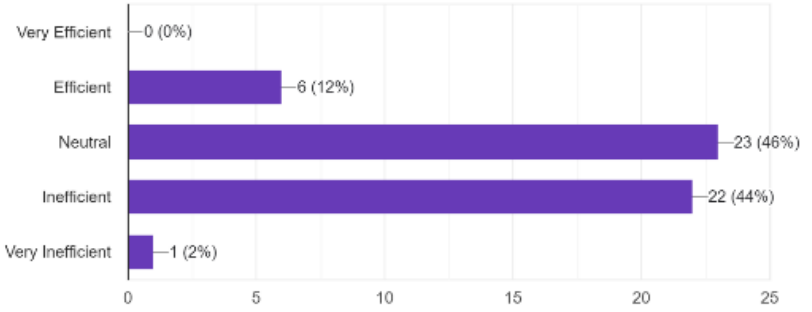
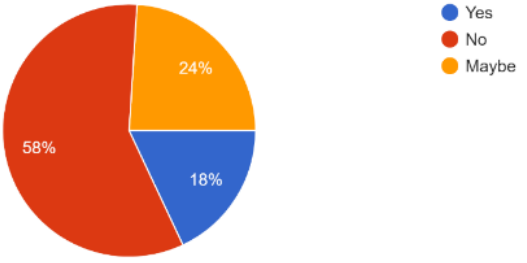
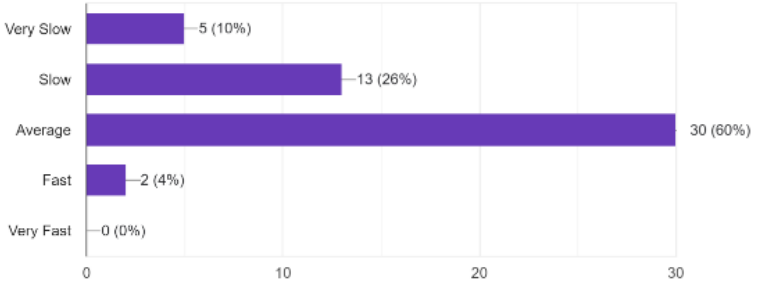
8	How would you evaluate the vehicular circulation at the Rantau Panjang border checkpoint?	The question encourages respondents to offer a detailed analysis of the movement and flow of cars through this important border crossing. From the answers provided, the majority of respondents feel that the vehicular circulation is fairly efficient and somewhat lacking. Further analysis shows that the majority of the border facility personnel and tourists selected answers 3 and 2. This shows the unsatisfactory level of vehicular circulation by the tourists and the personnel. 
9	How would you evaluate the pedestrian circulation at the Rantau Panjang border checkpoint?	This question aims to uncover valuable perspectives on the overall navigability and accessibility for individuals crossing the border on foot. From the answers provided, half of the respondents agree that the pedestrian circulation is fairly efficient while another half of the respondents feel that the pedestrian circulation is not efficient at all. From the observation, the pedestrian walkway from the Rantau Panjang checkpoint to the Sungai Golok checkpoint is not covered. However, the circulation in the Rantau Panjang checkpoint is direct and efficient but cannot accommodate the increasing demand during peak hours in documentation counters. 
10	Do you think the vehicular and pedestrian circulation at the Rantau Panjang Border checkpoint can be improved?	This question aims to uncover valuable suggestions and perspectives regarding possible improvements, contributing not only to the academic understanding of the border facility but also offering practical recommendations for enhancing its functionality. From the answers provided, the majority of the respondents expressed that pedestrian and vehicular circulation to be improved. 

11	How would you rate the efficiency of space utilisation within the Rantau Panjang border checkpoint?	The purpose of the question is to gather information on possible advantages and disadvantages in the layout and use of space, highlighting any areas that might require improvement. The majority of respondents agree that the space utilisation of the checkpoint is average on efficiency or consider the space utilisation inefficient. Correspondent with the case study observation, the Rantau Panjang border checkpoint space utilisation is constricted by the elongated site boundary. In addition, the zoning of the space in the checkpoint area is confusing in terms of private, semi-private and public areas. Due to these issues, many of the respondents answered the question with answers neutral or inefficient. 
12	Do you think the immigration and customs counter at the Rantau Panjang Border Checkpoint is sufficient?	The goal of the inquiry is to unearth important information about the efficacy and efficiency of the immigration and customs procedures, which are essential components of any border checkpoint's seamless operation. From the answers provided, the respondents expressed that the counters for the checkpoint are insufficient to accommodate the increasing demand. Concurrent with the respondents' express of inefficient pedestrian and vehicular circulations, the lack of immigration and customs counter caused significant setbacks and unsatisfactory. 
13	In your opinion, how well is the response and processing time of the immigration and customs at the Rantau Panjang Border Checkpoint?	Question 13 explored users' perspectives regarding the responsiveness and processing efficiency of the immigration and customs procedures at the Rantau Panjang Border Checkpoint. This question aims to capture nuanced insights into the practical aspects of border clearance, shedding light on potential strengths or areas that may require improvement. From the answers provided, the respondents expressed that the responses and processing time of the immigration and customs are average or below average. Concurrent with the respondents' expressed lack of counters, the longer processing time for each person caused a major bottleneck at the Rantau Panjang border checkpoint. 

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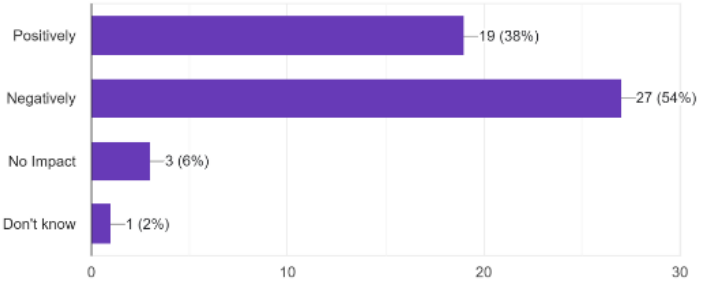
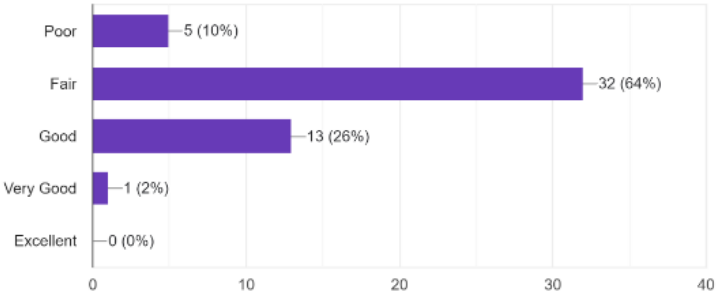
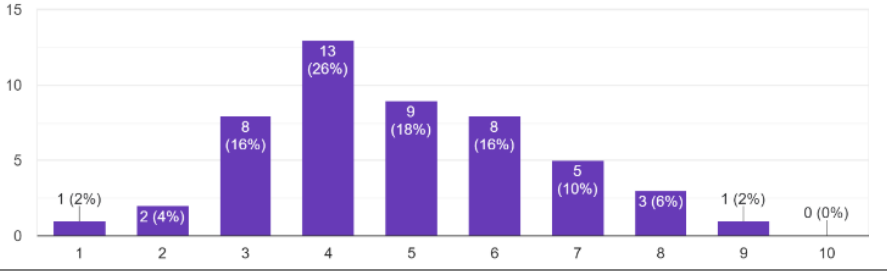
14	In your experience, how does the design of infrastructure elements (buildings, roads, etc.) impact the overall functionality of the Rantau Panjang border checkpoint?	Question 14 explored participants' experiential insights regarding the influence of infrastructure design on the overall functionality of the Rantau Panjang border checkpoint. This question provides an evaluation of how various design elements, such as buildings and roads, contribute to or impede the operational efficiency of the checkpoint from respondents' perspectives. For example, from the case study observation, due to the convoluted vehicular circulation, caused a significant bottleneck and longer processing time on the counter for vehicle users. 
15	How would you rate the communication and coordination between different agencies involved in border security at the Rantau Panjang Border Checkpoint?	Question 15 explored participant perspectives on the communication and coordination dynamics among various agencies responsible for border security. The purpose of this inquiry is to gather qualitative information about the cooperative efforts of various stakeholders and how they affect the border facility's overall security posture. . From the answers provided, the respondents believe that the communication between the various agencies at the border checkpoint is fair and good. Due to the space planning of each office for various agencies at the border checkpoint where offices are in 1 zone and beside each other. Communication and coordination of it significantly efficient. 
16	On a scale from 1 to 10, how satisfied are you with the overall user experience at the border facility, considering factors like navigation, information availability, and processing efficiency?	Question 16 explored the overall user experience at the Rantau Panjang border facility. the question seeks to capture a numerical representation of user sentiments. The scale provides a structured framework for participants to convey their satisfaction levels, allowing for a more standardised assessment. From the answers given, the majority of the respondents are on a scale of 3 to 6. Proving that the users are somewhat in between for the satisfaction level. 

17	What improvements, if any, would you suggest for the space planning of the border facility to enhance its efficiency and user experience?	The answers to this question will be varied and comprehensive, offering a wealth of information. Analysing the question's answers, the respondents repeatedly requested improvement in a few aspects. First, The improvement and addition of pedestrian and vehicular circulation like an expansion of more lanes. The idea of segregating vehicles for goods and vehicles for tourism also emerged in addition to the respondents' request for additional counters to mitigate the increasing demand and long queues.

New Facility	Proper Township Management
More public facilities and improved WIFI connection	They should facilitate the border with more parking space and a waiting area (covered) with seats for disabled people and senior citizens
More security and other agency personnel	Addition of immigration and customs counter
Expanding the road	Road expansion & more lines to avoid traffic jams
Fast Lane	Add more counters to speed up the process of checking in and out of the borders
Move the import-export to another passage and the existing path is only for personal (vacation, work, etc) entry exit only	Widen the border to accommodate more counter
Site planning and area	Circulation for all

18	In your view, what kind of advancements in technology can be added to further improve the space planning and functionality of the border facility?	This question shows potential enhancements to technology integration of the Rantau Panjang border facility. Analysing the question answers, the respondents suggested that the Rantau Panjang border checkpoint integrate fully computerisation and digital operation systems with the addition of a drone surveillance system. the respondents also suggested using satellite imaging and scanning to survey and control the area. Biometric documentation and scanners are also suggested to improve the documentation process at the border facility while also using automated gates to reduce queue time.

Fully computerised operation	Digital Improvement & Integration
Drone & CCTV	Satellite imaging and scanning
Using computerised or AI instead of manually	Face recognition and less workers. More traffic controller
Automated gate just like the one in KLIA to reduce the volume of people queuing	GPS
Biometric Scanner	Biometric documentation
Patrol post	Patrol Station
Navigation and telecommunications	Security technology

Source: Authors (2024)

The Rantau Panjang border checkpoint facility has its pros and cons. Users are on the middle ground between satisfied and unsatisfied with the overall experience of the facility. Dissatisfaction comes from traffic jams and long queues during the documentation process. Thus, expansion of the facility is a must to accommodate the traffic volume and demand. Furthermore, the integration of advanced technology to smoothen and fasten the documentation process of the border crossing. Identifying the best practices of operation and space planning in various precedent studies of international and local border facilities.

Retrofit or developing a new design for the Malaysia-Thailand Rantau Panjang border checkpoint facility

As the crossroads of international transit, this border checkpoint holds strategic importance, necessitating a meticulous evaluation of the structural, operational, and technological aspects that influence its functionality. Based on the previous studies and evaluation of the current practices employed locally and internationally. This section will focus on employing and suggesting new design strategies, planning, and technology that can be integrated into the Malaysia-Thailand Rantau Panjang border checkpoint facility.

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Table 10. Design strategies, planning & technology suggestion

Design Strategies, Planning & Technology	Justification & Explanation
Wide Site Boundary	Learning from the precedent studies, wide site boundaries will lead to easier future expansion and more direct straight-line for vehicular circulation
Large-Sized Site	Learning from the United States Land Port of Entry in Calais Border Checkpoint. The building uses a large site to utilise and design a meticulous better circulation for all transportation
Segregating Cargo & Communal Transport	From the precedent studies, the goods vehicle circulation is segregated from the daily commute vehicle. This is to mitigate and reduce traffic congestion
Covered and Comfortable Pedestrian Circulation	Pedestrian users of border checkpoints requested a covered walkway circulation to the next checkpoint. Connection between two checkpoints is needed and comfortable
Line-of-sight visibility to Entrance and Exit	Learning from the United States Land Port of Entry in Calais Border Checkpoint. Line of sight is required to ensure safety and security control for the building
Public Facilities	Learning from the precedent studies, border checkpoints can be integrated with public facilities such as duty-free commercial zones, waiting areas, cafeterias and staff relaxation spaces
New Security and Documentation technology	All precedent studies use and integrate new advanced technology to help mitigate and shorten the documentation process. In addition, satellite scanners and drone technology can also be added to help the security factor of the area
Additional immigration and customs counters	Traffic and influx of goods and people at a border checkpoint increase yearly. Thus, additional immigration and customs counters are required to accommodate the increasing traffic
Double or staggered counters	Double or staggered immigration and customs counters can be used to help accommodate the increasing traffic

Source: Authors (2024)

CONCLUSION AND RECOMMENDATIONS

The in-depth study of border security space design for the Malaysia-Thailand border in Rantau Panjang, which serves as the dissertation's capstone, produces illuminating findings and useful suggestions. The thorough examination of the operational, security, traffic, and geographical aspects clarifies the complex web of variables influencing the Rantau Panjang border post. The results are presented in a way that highlights the dynamic nature of border security and the necessity for a flexible and thoughtful approach. Combining these results highlights the need for a multifaceted, all-encompassing approach that balances security requirements, user-centered space planning, and technology developments. Furthermore, by adopting in-depth and suitable space planning to Malaysia's specific needs, this research can inform the development of comprehensive spatial frameworks, enhancing the country's ability to address emerging threats while adds to the body of knowledge on border security.

Table 11. Recommendations

No.	Recommendations
1	**Technology Integration and Upgradation** Embrace a forward-looking approach by investing in advanced technologies, such as biometric authentication systems, automated processing kiosks, and smart infrastructure. Continuous upgrades in surveillance systems, incorporating artificial intelligence for threat detection, will bolster security measures and streamline operations.
2	**Collaborative Inter-Agency Coordination** Foster greater collaboration and coordination among the various agencies involved in border security and management. Implementing integrated communication systems and sharing real-time data will enhance the overall responsiveness to security threats and operational challenges.
3	**User-Centric Space Planning** Prioritise user experience in the space planning and design of the checkpoint. Enhance amenities for travelers, such as waiting areas, information kiosks, and streamlined pedestrian and vehicular pathways. Implement user-friendly technologies to reduce wait times and improve overall satisfaction.
4	**Traffic Flow Optimisation**

	Undertake a comprehensive analysis of traffic patterns and volumes to optimise vehicular and pedestrian circulation. Implement intelligent traffic management systems, including dynamic lane control and efficient queue management, to mitigate congestion and enhance the efficiency of the checkpoint.
5	**Security Threat Mitigation** Develop and implement proactive measures to mitigate security threats. This includes regular risk assessments, training programs for security personnel, and the deployment of cutting-edge technologies for early threat detection and response.
6	**Spatial Design Flexibility** Design the border checkpoint with flexibility in mind, allowing for future expansion or adaptations based on evolving security needs and increased traffic volumes. Consider modularity in infrastructure to accommodate changing requirements.
7	**Public-Private Partnerships** Explore opportunities for public-private partnerships to leverage private sector expertise and resources in the development and maintenance of border infrastructure. This collaboration can lead to innovative solutions and efficient project execution.

Source: Authors (2024)

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this paper. The authors have no financial or personal relationships with other people or organisations that could inappropriately influence (bias) their work. All authors have reviewed and approved the final manuscript and affirm that the statements made in this section accurately reflect their disclosures.

AUTHORS' CONTRIBUTIONS

Sabri, A. H. S. conceptualised the central research idea, developed the theoretical framework, carried out the research, and wrote the article. Shaari, M. F. provided additional ideas and waypoints for the research, and closely supervised the entire research progress. She also anchored the review standard, revised, and approved the article submission.

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