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Synthesising the competency of the Thailand land bridge venture as the new overland intersections in the global trade

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ABSTRACT

This study provides a comprehensive assessment of the proposed Thailand Land Bridge Initiative, which aims to establish an overland trade route in the global trade network. The study meticulously examines the potential advantages and disadvantages of this endeavour, focusing on the implications for Thailand and Malaysia, using a methodological framework centred on document analysis. This analysis summarises critical findings to shed light on the intricate facets and impacts associated with its implementation. The research conducts a comprehensive evaluation that includes the financial, logistical, regulatory, and socio-economic aspects. The findings emphasise numerous obstacles and intricacies linked to the land bridge proposal. Financial forecasts and logistical evaluations indicate substantial uncertainties and risks, suggesting possible financial constraints and operational inefficiencies that could threaten the viability of the project for both Thailand and Malaysia. Furthermore, the regulatory landscape is a substantial barrier, as legal concerns and adherence to regulations provide considerable challenges to the seamless execution of the plan. The document analysis reveals the socio-economic consequences of the project, emphasizing the possible disturbance to nearby communities, changes in employment patterns, preservation of cultural heritage, and maintenance of environmental sustainability. These findings raise concerns about the project's socio-economic feasibility. This paper contends that the land bridge project for Thailand and Malaysia is inapt as an alternative for Malacca Strait. The text highlights the uncertainties linked to the suggested project and advocates for a careful strategy that gives importance to sustainable growth and lasting socio-economic stability.

1. Introduction.

The Thailand Land Bridge venture is a significant endeavour that seeks to leverage Thailand's advantageous geographical position to facilitate trade routes across land and reduce reliance on sea trade, which has been prevalent in the past. Thailand's motivation behind initiating this huge project is to strengthen its position as a regional commerce hub and elevate its economic status globally. Thailand has historically benefited from its strategic geographical location in Southeast Asia, which allows it to function as a natural land bridge connecting several neighbouring regions (Bunyavejchewin et al., 2022). The nation's advantageous geographical position at the crossroads of Southeast Asia, South Asia, and China has long been acknowledged for its capacity to enable land-based trade routes. Nevertheless, it is only in recent years that deliberate endeavors have been undertaken to exploit this natural advantage (Ghosh & Basu Ray Chaudhury, 2023). The foundation of the Thailand Land Bridge venture has multiple purposes including broaden the Thailand's commercial networks and decrease reliance on

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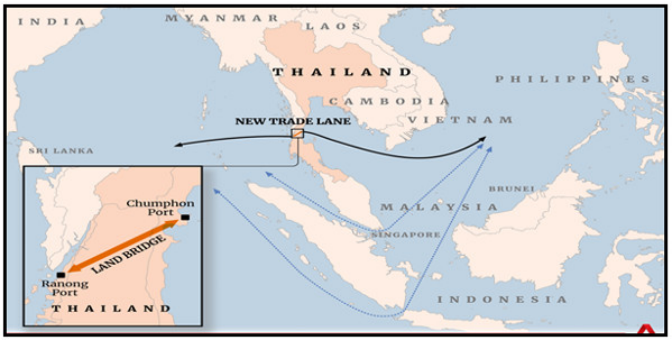
conventional maritime channels by establishing effective land connections, mitigate the potential disruptions to marine trade, such as geopolitical tensions or natural disasters, the aim was to minimize the related risks (Zahoor et al., 2023).

In addition, the project wanted to establish Thailand as a pivotal point in the developing global trade patterns. The nation sought to increase commerce, investment, and economic activity by building a strong transportation infrastructure and logistical networks (Abdul Rahman et al., 2016). In addition to benefiting Thailand, this also promised to improve connectivity with other regions, fostering regional integration and economic prosperity. It is impossible to overstate Thailand's geographic significance in this setting. Due to its advantageous location at the meeting point of rising markets and major economic powers, it is possible to establish a corridor that will facilitate trade between East and South Asia and allow for the smooth movement of people, capital, and goods (Duttagupta, 2023). Thailand is a great place for cross-border trade because of its vast road network and continuous investments in rail and other forms of transportation. Its geographical proximity to emerging economies such as Myanmar, Laos, and Cambodia reinforce Thailand's role as a key land trade route (Suruga et al., 2023). This project is in line with global trends that emphasise the importance of overland connections in global trade. Beyond their regional significance, such initiatives have far-reaching effects on international trade. They offer shorter transit times, cost efficiencies, and reduce the vulnerability associated with over-reliance on specific trade routes. Figure 1 illustrates the proposed land bridge in Thailand.

Figure 1: Thailand Proposed Land Bridge.



Source: Thailand's Ministry of Transport (2023).

However, the economic impact of such a project would severely affect existing sea routes, especially the Straits of Malacca, an important trade route. The diversion of maritime traffic from this route could disrupt established trade patterns and diminish the importance of ports dependent on this traffic, affecting revenue and growth prospects for both Thailand and Malaysia. In addition, the construction and maintenance of the land bridge pose a major challenge. The complex terrain, including mountainous regions and dense forests, poses obstacles to construction, which can lead to exorbitant costs and logistical difficulties. In addition, the seamless integration of transport networks between the two countries requires significant investment in infrastructure, which may not yield adequate benefits. Thailand's strategy would significantly impact the Malaysian logistics sector and major ports. particularly on the functionalities of Port Klang, Kuantan and Tanjung Pelepas, and predicted a reduction in maritime traffic through the Strait of Malacca upon completion of Thailand's proposed ports (Business times, 2023). The aim of this study is therefore to assess the feasibility and possible impact of the land bridge project proposed by Thailand, as well as the impact of the land bridge on the Malaysian maritime economy.

Conversely, overland connections serve as important diversification factors in global trade, as they offer alternative routes that reduce dependence on maritime trade. These connections significantly shorten transit times and increase the efficiency of goods transport between regions. By providing additional routes, they mitigate the risks associated with potential disruptions to sea routes, thus ensuring more resilient and reliable trade networks. These land connections play a central role in promoting economic development by creating channels for cross-border trade (Yang & Liu, 2022). They facilitate the movement of goods, capital, and services and promote economic exchange between nations. In addition, such hubs promote regional integration by connecting economies and cultures along these routes, fostering cooperation and mutual growth (Zalesski, 2023). By connecting nations through overland trade, these intersections provide not only logistical benefits but also opportunities for shared prosperity and cooperation, strengthening connections between regions in the global trading landscape. However, overland intersections in global trade also harbour potential geopolitical tensions. The establishment of new trade routes may intensify already-existing territorial disputes or spark new wars between countries fighting for influence or control over these corridors (Khan, 2023). Moreover, the development and operation of these routes may present infrastructural limitations, regulatory obstacles, and environmental effects that could impede the smooth operation of land trade and, consequently, reduce their efficacy in the global trading scene.

According to the Northern Corridor Implementation Authority (NCIA, 2022), the identified road risks include infrastructure failures, accidents, including collisions and rollovers of cargo vehicles, road robbery and delays due to breakdowns. In addition, there are concerns regarding the transport of dangerous goods that could lead to spills and affect the environment, as well as pipeline spills and the risk of adulteration affecting quality. The transport of flammable and explosive substances carries the risk of environmental pollution. A greater number of loading points also increases the risks. These include improper handling leading to damage, accidents with machinery and delays in loading and unloading due to equipment failure or power outages. The structure of the paper is as follows: The literature review, which covers the historical context and importance of land bridges for international trade routes, and an outline of regional trade routes and financial corridors are all covered in the second section. The following section looks at the methodology and describes the approach adopted for the study. The fourth section then presents the result and discussion including

case study, examining the anticipated issues of the land bridge project, the challenges and constraints involved, the economic impact on Singapore and Malaysia seaports. The final section includes the conclusion, management and societal implications and recommendations for policy makers and stakeholders.

2. Land Bridge and Global Trade Routes: A review of the literature.

The historical context and the significance of land bridges to global trade routes considerably increase the potential of the land bridge project in Thailand. Throughout history, land bridges have played a crucial role in shaping trade routes and economic progress. The Silk Road, an antiquated system of land connections linking the East and the West, is particularly noteworthy. Along the journey, this historic trade route greatly aided in the development of civilizations by facilitating the flow of products, ideas, and cultures. There are several advantages to land bridges, such as reduced transportation costs, increased trade efficiency, and improved interregional connectivity (Pomfret, 2019). Land bridges eliminate the difficulties of sea transportation, such as narrow straits and piracy risks, by offering a direct overland path. The success of overland trade routes throughout history shows how flexible and robust they are to the shifting demands of international trade. Initiatives like China's Belt and Road Initiative (BRI) and the New Silk Road (NSR) highlight a revived interest in land-based connectivity in the current setting (Ip & Lam, 2023). These large-scale initiatives acknowledge the potential for increased trade and economic cooperation while highlighting the strategic significance of overland transport routes. The BRI specifically seeks to establish an infrastructural network that connects Asia with Europe and Africa, comprising highways, railroads, and harbours. This historical background and current endeavours serve as inspiration for the Land Bridge Project in Thailand. It envisions a vast land-based transportation network that connects the Gulf of Thailand and the Andaman Sea by means of the current rail and road networks. The initiative aims to minimize environmental impact, optimize resource utilization, and avoid the geopolitical issues connected with marine routes by exploiting existing established transit corridors.

The choice to concentrate on a land-based solution is consistent with the knowledge gained from previous trade routes. Sea routes might not provide the same level of control and predictability as land bridges. The land bridge project intends to boost regional autonomy and resilience in the face of global economic uncertainties by establishing a land connection and reducing reliance on maritime chokepoints (Lubchenco & Haugan, 2023). Moreover, the project's pragmatic approach is demonstrated by its concentration on leveraging existing infrastructure. By enhancing what currently exists, the Land Bridge Project aims to increase connection as opposed to starting massive, disruptive construction projects. This strategy reduces environmental effect while simultaneously optimizing resource use a feature that is becoming more and more crucial in the current discourse on sustainable development (Borreggine, 2023). Recognizing and navigating the geopolitical complexities of maritime lanes is another aspect of the Land Bridge Project. Major waterway control has historically caused conflict between states. The project fosters stability in the area and lessens possible geopolitical risks related to canal management by offering a substitute land route. This strategic placement is consistent with the ideas of peaceful development and economic cooperation. In summary, the literature analysis has given rise to a foundation for comprehending the dynamics of regional trade, the difficulties encountered in the construction of the Kra Canal, and the historical significance of land bridges in forming international trade routes. The Silk Road is one example of a land-based trade route that was successful throughout history, demonstrating the value of these routes for fostering cultural and economic interchange. Inspired by these historical models, Thailand's land bridge project is a forward-thinking endeavour to manage geopolitical complexity, optimize resources, and minimize environmental effects.

3. Methodological approach.

Document analysis is the main technique used in the research approach for data collection and analysis. This method entails a methodical assessment and analysis of all available records, reports, and pertinent literature pertaining to the Land Bridge venture. Numerous sources are examined, such as government records, feasibility studies, project proposals, evaluations of the environmental impact, and scholarly publications (Shibasaki et al. 2016; Shibasaki et al. 2017; NESDC & UNISEARCH, 2022; NCIA, 2021, 2022). A thorough grasp of the historical background, project specifics, financial factors, and environmental effects related to the Land Bridge Project can be obtained by analysing the materials. It guarantees a comprehensive view of the projects by enabling a thorough analysis of the information that is already available from multiple sources. The objective of this analysis is to review the implication of land bridge on Malaysian maritime business and the impact of the Thailand Land Bridge Venture on regional and global trade dynamics. The comparison research evaluates the two projects' possible effects on regional and international trade from an economic standpoint. Economic development, cost effectiveness, and transport efficiency were among the factors considered. Projected trade volumes, expected transportation costs, and each project's economic impact are all examined in the analysis. The research evaluates the Land Bridge project's environmental impact from an environmental standpoint.

t Examining possible disruptions to biodiversity, water flow patterns, and ecosystems is part of this. The research evaluates each project's compliance with government documents' recommended mitigation techniques and environmental sustainability goals. The comparative research's core focus is geopolitical factors. It looks at potential effects on global commerce routes, diplomatic ties, and regional power dynamics. The geopolitical implications of each project, control over vital waterways, and possible points of conflict between countries were examined. The research evaluates the geopolitical risks and opportunities related to the Land Bridge project. The research methodology comprises case studies of successful land bridge projects

in various locations in addition to the comparative research. By looking at initiatives like the North American Canamex Corridor, the Trans-Siberian Railway in Russia, and the Eurotunnel that connects the UK and France, lessons can be learned from successful projects. The case studies illustrate useful insights, industry best practices, and possible difficulties that may arise during the planning, building, and maintenance stages of land bridge projects. The research looks at how these effective initiatives have tackled geopolitical and environmental issues, enhanced trade efficiency, and aided in economic development. It is instructive to draw comparisons between the achievements and difficulties of these projects and the upcoming land bridge project in Thailand. Taking into consideration the worldwide context of successful land bridge initiatives, the research aims to uncover practical recommendations and lessons learned for the planning and implementation of the land bridge project.

4. Result and Discussion.

In the following section the outcomes from the document analysis are discussed supported with case study which has been conducted to analysed the competency of the diversion or new route compared to Malacca Strait.

4.1. Geopolitical Complexity.

The Land Bridge Project's goal of creating overland trade routes encounters a complex geopolitical landscape as the route passes through several countries. Each nation along the route has its own political dynamics, interests, and priorities. Balancing these different geopolitical concerns is a major challenge when it comes to ensuring the seamless passage and effective cooperation necessary for the success of the project. At the centre of these challenges are the complicated relationships between the countries involved (Theiventhran, 2023). Geopolitical tensions, historical conflicts, different trade policies, and varying levels of economic development between these nations add to the complexity. Differing political ideologies, strategic alliances, and territorial disputes further complicate the establishment of harmonious trade corridors. Navigating through these geopolitical entanglements requires delicate diplomatic manoeuvres. Negotiating agreements and protocols that cater to the interests of all nations involved becomes a daunting task (Nomer & Aksoy, 2023). Conflicting national interests may hinder consensus building on issues that are crucial to the realisation of the project, such as trade regulations, customs procedures or infrastructure development plans.

In addition, geopolitical shifts and power dynamics within the region or at a global level can influence the course of the project. Changes in leadership, changes in foreign policy priorities or emerging regional conflicts can affect the co-operation required for the land bridge project. Concerns about national sovereignty, security and economic interests must be taken into account to ensure smooth progress and co-operation. Some countries may not want to give up control or influence over their territory or may value the protection of their industries and markets (Keshavadasu, 2023). These concerns may manifest as opposition to standardised trade arrangements or infrastructural developments that they perceive as favouring other nations. Effective diplomacy and negotiations are essential to overcome these challenges. Building trust, promoting dialogue and creating mutually beneficial frameworks are of paramount importance. Platforms for sustained communication between participating nations are essential to resolving disputes, reducing misunderstandings, and harmonizing objectives. In addition, it is important to create multilateral agreements and mechanisms that take into account the different needs and aspirations of individual countries while ensuring mutual benefits. Promoting joint ventures, joint investments and cooperative projects to address common challenges can foster a sense of collective ownership and shared prosperity, contributing to the success of the project, despite the complicated geopolitical landscape it traverses.

4.2. Infrastructure Development.

The creation and maintenance of the infrastructure required for efficient overland trade routes, a cornerstone of the land bridge project, requires significant investment in various areas such as roads, railways, and logistical facilities. However, the process of financing and executing these developments poses daunting challenges that often make it an arduous task. The sheer scale of infrastructure required to enable seamless trade links across multiple countries is immense. Building and maintaining modern highways, robust rail networks, border checkpoints, and advanced logistics centres requires significant financial resources. This includes not only the initial construction costs but also long-term investments for maintenance and upgrades to ensure lasting efficiency. Financing such large-scale infrastructure projects is a multi-faceted challenge (Hayakawa et al., 2022). Raising funds often requires a combination of public and private investment, international loans, grants, or partnerships. Obtaining these funds requires going through bureaucratic procedures, obtaining authorizations, and considering legal and regulatory frameworks both domestically and across international borders. Furthermore, the financial burden is not limited to the construction phase. Operating costs, regular maintenance, technological upgrades, and administrative costs add to the financial challenges.

To ensure the sustainability of these infrastructures, a constant and long-term financial commitment is required, which can overstretch the resources of the countries involved. In addition, the development of infrastructure for overland trade routes is associated with geographical difficulties. Terrain variations, environmental issues, and connecting remote regions pose additional challenges (Huong & Kieu, 2023). Building infrastructure that can withstand the various climatic and geographic challenges while complying with environmental regulations increases both the complexity and cost of these projects. Execution presents a further difficulty. Coordinating construction across multiple jurisdictions with different regulations, policies, and administrative procedures requires effective collaboration and streamlined processes. Delays due to bureaucratic hurdles, land acquisition issues or disputes over construction contracts can significantly impede progress. Overcoming these challenges

requires innovative financing models, efficient project management strategies and co-operation between the stakeholders involved. Promoting public-private partnerships, attracting foreign investment and utilising international cooperation mechanisms can reduce the financial burden. In addition, the introduction of advanced technologies and sustainable practises can optimise costs and improve efficiency in the long term.

4.3. Regulatory and Policy Hurdles.

Harmonizing trade regulations and customs procedures in the different countries along the proposed route of the land bridge project is a complex and complicated challenge. Each country has its own laws, regulations, and trade policies that create discrepancies that hinder the smooth movement of goods across borders. The variety of legal frameworks includes customs duties, trade standards, documentation requirements, and customs procedures. These differences, if not harmonised, pose significant barriers to trade (Promsaka et al., 2022). Inconsistent regulations lead to delays, increased transaction costs, and administrative complexity, which hinder the efficient movement of goods along the route. Tariff discrepancies, for example, can drastically impair trade dynamics. Differences in import duties or taxes in neighbouring countries can distort market competitiveness, hinder trade, and create incentives for informal or illegal trade practices. Such inconsistencies become a stumbling block to the desired smooth and efficient flow of goods. In addition, different standards and regulations regarding product quality, safety, and labelling create hurdles (Palmgren, 2022). Compliance with different standards across borders requires adjustments to production processes and documentation, which increases the cost of compliance for companies. This not only complicates trade, but also affects the quality and consistency of traded goods, which can affect consumer confidence and market access. Customs procedures represent another layer of complexity. Different clearance processes, documentation requirements, and control protocols contribute to delays and uncertainty at border crossings. Inefficient customs procedures lengthen transit times, increase transport costs, and create opportunities for corruption or irregularities, affecting the reliability and efficiency of land trade routes.

4.4. Environmental Impact.

The development of large-scale infrastructure, such as the Land Bridge Project's overland trade routes, often poses significant environmental challenges. These initiatives can lead to negative impacts such as deforestation, habitat destruction, and increased pollution and pose a major challenge when it comes to reconciling development and environmental sustainability. Deforestation is a problem when large areas of land have to be cleared for roads, railway lines, and logistical facilities in order to build infrastructure. This process has a direct impact on ecosystems and leads to the loss of biodiversity, the destruction of natural habitats, and the degradation of forest areas. It threatens endemic species, reduces carbon sinks, and weakens the overall resilience of ecosystems. Habitat destruction is another consequence, especially in ecologically sensitive regions. Infrastructure development can fragment habitats, impede wildlife migration, and alter ecological corridors (Kaewunruen et al., 2023). There is a risk to the survival of species that depend on these environments due to the isolation of populations and decrease in genetic diversity caused by these disruptions. Furthermore, one of the primary drivers of major infrastructure projects is rising pollution. Pollution of the air, water, and soil is caused by construction activities, automobile emissions from increased traffic, and industrial developments related to these projects. The quality of the water is impacted, nearby ecosystems are harmed, and human health is at danger due to this pollution. It is a significant challenge that calls for all-encompassing methods to mitigate these environmental effects of trade route growth.

It is crucial to implement eco-friendly procedures and technologies throughout the phases of design, building, and operation. This includes the use of sustainable building materials, minimising land consumption, and introducing environmentally friendly transport and energy solutions. Mitigation measures such as reforestation, habitat restoration, and the creation of wildlife corridors can offset environmental disruption. These measures aim to restore ecosystems and biodiversity and ensure the resilience of natural habitats affected by infrastructure development (Goodwin et al., 2022). In addition, conducting thorough environmental impact assessments (EIAs) prior to project commencement is crucial. EIAs help identify potential environmental risks and enable the formulation of mitigation and adaptation plans. Monitoring and compliance with environmental regulations and standards throughout the project lifecycle is critical to minimising and mitigating negative impacts. International cooperation and compliance with globally recognised environmental standards play an important role. Joint efforts by the nations involved to fulfil environmental commitments, share best practices, and support sustainable development initiatives will help to reduce the environmental footprint of the land bridge project. Ultimately, achieving a balance between developing land trade route infrastructure and protecting the environment requires a holistic approach that harmonises economic development goals with environmental sustainability goals. Prioritizing sustainable practices and mitigating negative impacts is essential to ensuring the long-term viability of these projects while preserving natural ecosystems.

4.5. Socioeconomic Disparities.

The implementation of the land bridge project and the subsequent unequal distribution of benefits and economic gains pose a significant risk of exacerbating socio-economic inequalities and potentially fueling regional imbalances and social discontent. The infrastructure developments associated with the project often concentrate benefits on specific regions or industries, leading to economic inequalities between regions along the trade route. Regions that are directly connected to the trade corridors may experience rapid economic growth, increased investment, more jobs, and better access to markets. However, areas away from these routes may experience relative stagnation or slower growth, leading to regional imbalances. Inequalities in access to opportunities and resources could also result from

it (Wongwatkit et al., 2023). While residents of isolated places might have restricted access to services, markets, and infrastructure, communities along trade routes might profit from better access to these resources, which would exacerbate already-existing economic disparities. The uneven allocation of financial gains has the potential to intensify societal strains and unhappiness. Marginalized communities or localities may believe that specific groups or locations are being favored by the development if they feel left out of the project's benefits. Social unrest and dissatisfaction within the impacted populations can be fueled by this view, which can lead to feelings of neglect, inequity, and alienation.

Furthermore, the uneven allocation of financial gains could worsen already-existing social injustices such differences in income, access to healthcare, education, and work opportunities. This has the potential to worsen socioeconomic inequality by expanding the divide between wealthy and underprivileged demographic groups and escalating social stratification. Proactive steps are required to guarantee a more equitable distribution of the project's benefits in order to remedy these disparities. It is imperative to put into practise inclusive development policies that give priority to disadvantaged areas, vulnerable populations, and sectors that could be adversely affected. According to Panyavaranant et al. (2023), this entails making deliberate expenditures in social services, infrastructure, and economic development initiatives in regions that are underperforming economically. Promoting stakeholder participation, engagement, and consultation during the project's planning and execution stages is also crucial. In addition, the establishment of revenue-sharing mechanisms, equitable resource allocation, and inclusive policies can help close socio-economic gaps and promote more balanced regional development. Lastly, allowing local communities to actively participate in decision-making processes and making sure their voices are heard can help mitigate feelings of marginalisation and strengthen social cohesion. To reduce the possibility of escalating inequality and to encourage a fairer distribution of benefits across impacted areas and people, social and economic inclusion must be given top priority in the project's policy and implementation.

4.6. Security Concerns.

Ensuring security along the trade routes of the land bridge project is a major challenge, especially in regions prone to conflict or instability. Protecting goods, infrastructure, and personnel in such areas requires comprehensive strategies to minimise risk and ensure uninterrupted trade operations. Regions prone to conflict or political instability often harbour an increased security risk. Factors such as political tensions, border disputes, insurgencies, or cross-border criminal activity can pose a threat to the safe transport of goods and personnel. Trade routes and infrastructure are much more vulnerable to theft, vandalism, piracy, and terrorist strikes in such an environment. Furthermore, there is a concern for the workers' safety along these routes. Employees in the construction, logistics, and transportation industries are susceptible to security risks that jeopardize their well-being and impede project progress. Maintaining their safety and well-being is essential to the project's success. To tackle these security issues, a multifaceted strategy is needed. To establish a safe and secure environment for trade routes, cooperation between governments, international organizations, security agencies, and local people is crucial (Thamsutiwat & Charoensri, 2022). Strong security measures, such as patrols, checkpoints, and surveillance systems, can be put in place to help identify potential hazards and repel threats along routes. Investing in cutting-edge technologies to track cargo and keep an eye on transportation can increase security and traceability while lowering the risk of theft or other illicit activity. It is essential to have strong institutional capacity and equip local security personnel with the knowledge and skills needed to handle security issues. A safer environment for business transactions will result from providing them with the resources, training, and tools they need to handle security concerns (Anuar & Omar, 2023).

Furthermore, fostering diplomatic communication and dispute settlement procedures amongst neighboring nations can aid in lowering hostilities and advancing stability along trade routes. Information sharing and coordinated actions to counter security threats are made easier by cooperative agreements and collaboration on security-related matters. Encouraging and supporting the community is essential to maintaining security. A support system that assists in identifying and mitigating security risks might arise when local communities assume accountability for security protocols and engage in vigilant monitoring. But even with these initiatives, attaining total security is still a difficult task, particularly in areas where there are protracted hostilities or instability. To maintain the unhindered movement of people and products along trade routes while navigating the changing security landscape, constant surveillance, tailored security protocols, and adaptable reaction tactics are crucial.

5. Case Study: Analysing the competency of Landbrige compared to Malacca Straits.

The Office of the National Economic and Social Development Council collaborated with ChulaUnisearch to analyse the market demand for land bridge services. This comprehensive study, conducted by a shipping company, carefully considered financial and time expenditures. An analytical framework and modelling were used to examine the decision-making process of shipping companies when selecting routes. The findings from the research conducted by Shibasaki et al. in 2016 and 2017 formed the basis for this study. Shibasaki et al. (2016) and Shibasaki et al. (2017) utilised the logit choice model, a theoretical framework for examining the decision-making process in the selection of shipping routes. This model, developed by Ben-Akiva & Watanatada (1981), focuses on the analysis of choice behaviour. The study emphasised the cost differences between container ships and bulk carriers. To illustrate these cost dynamics, the authors specifically detailed the costs associated with a container ship, as shown in Table 1.

The study also analysed the navigational preferences of ships that opt for non-stop voyages without docking in ports. Figure 2 shows the course of a ship travelling through the Strait of

Table 1: Measurement Model Results.

TEU	DWT	Fuel cost (US$/ship/day)	Capital cost (US$/ship/day)	Operation cost (US$/ship/day)	Total cost (US$/ship/day)
500	10360	13526	3416	4670	21612
1000	16310	18305	4711	5066	28082
2000	28210	26375	7302	5859	39536
3000	40110	33350	9893	6651	49894
4000	52010	39657	12484	7444	59585
5000	63910	45496	15075	8236	68807

Source: NESDC & UNISEARCH, (2022).

Malacca without stopping to connect with other ships via the land bridge.

Figure 2: Shipping Routes for Ships Passing through the Malacca Strait without Stopping at Ports Cases of using and not using Land Bridges.

Source: Authors.

However, ships using the land bridge routes will require increased operations in the harbours at both ends of the land bridge. The cargo containers will be unloaded from the ships, transported by rail and then loaded onto a ship at the harbour on the opposite bank. Carrying out work at both berths incurs double the cost. Table 2 shows a breakdown of these different costs.Table 2. The time and cost of cargo handling activities between ports and inland ports.

In this case, the calculation has been done by assuming that 500 TEU (twenty-foot equivalent units) are transported from the port of Ho Chi Minh City (PoHCM), Vietnam, to the port of Colombo (PoC), Sri Lanka. In another case, we have assumed that 500 TEU (twenty-foot equivalent units) are transported from the port of Leam Chabang (LCBP), Thailand, to the port of Colombo (PoC), Sri Lanka. In both cases, the ship speed is set at 10 and 15 knots. The handling charges at both ports remain constant.

Table 3 shows the summary of time and cost for different scenarios with a speed of 10 knots, and Table 4 shows the summary of time and cost for different scenarios with a speed of 15 knots. In the first scenario, the ship sails from PoHCM to PoC through the Strait of Malacca. In the second scenario, the ship sails from PoHCM to the port of Chumphon (PoCh) and then over a land bridge to the port of Ranong (PoR). From PoR, it then travels to PoC in Sri Lanka. The ship sails from LCBP to PoC through the Straits of Malacca. Finally, the ship travels from LCBP to PoCh and then over a land bridge to PoR. From PoR, it then travels to PoC in Sri Lanka.

In the second phase of the landbridge, the containers are unloaded from the ships, reloaded by rail and then loaded onto a ship at the port of destination. Therefore, the time delay and financial costs are twice as high compared to Table 2, with the exception of the rail transit fee, which is only incurred once. It is important to note that the payments depend on the size of the vessel. However, for comparison purposes, the terminal handling fee is estimated to be around $40 per TEU, according to the 2022 NESDC and UNISEARCH reports. The cost of port activities varies depending on the volume of containers and includes various charges, including time-related costs.

The cost and time analysis of shipping routes, especially with regard to the use of a land bridge, reveal critical insights into the comparative efficiency of different transit scenarios. The establishment of a land bridge has a significant impact on the time and financial aspects of cargo transportation. While it offers an alternative route, it requires increased operational activities at both ends of the land bridge, resulting in double the cost of cargo handling. This can be seen in Table 2, which shows the detailed expenditure for cargo handling between the ports and the inland ports. Tables 3 and 4 summaries the costs and duration for scenarios with ship speeds of 10 and 15 knots, respectively. These scenarios involve shipping 500 TEU from different origins (Ho Chi Minh City and Leam Chabang) to the port of Colombo, Sri Lanka, via different routes, some of which include the land bridge. The costs and times for the landbridge

Table 2: The time and cost of cargo handling activities between ports and inland ports.

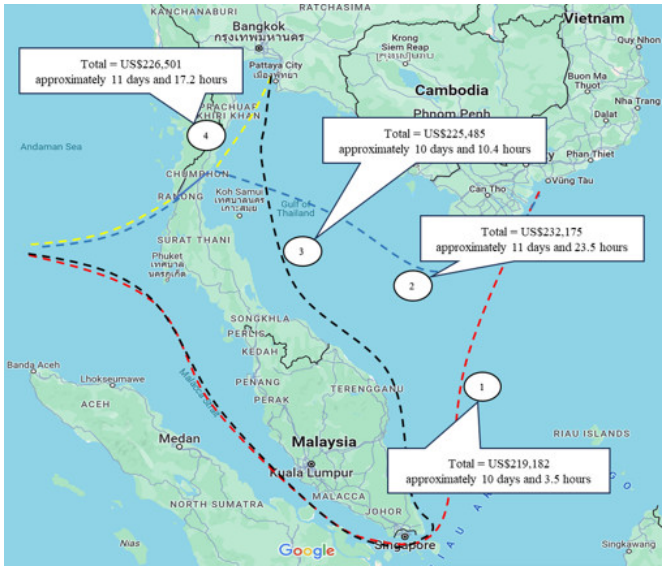
Ship waiting for berthing	Berthing	Unloading	Move to container stacking yard	Container stacking yard	Move container form stacking yard to rail station	Loading to rail	Transport by rail with distance approximately 100 km
Tugboat (2500 THB/hrs./ship) (US$71.4//hrs./ship)	Port dues 6 THB/GRT Berth Hires 7.5 THB/100 GRT., GT/hr.	Container Lifting Charge 800 THB/TEU/ time (US$23.4/TEU/ time) Container Wharfage 1,000 THB/TEU (US$28.6/TEU/ time) (Average in and out)			Lifting Charge 370 THB/TEU/time (US$10.6/TEU/ time)		Rail transportation charge 1500 (THB/TEU) (US$42.9/TEU)
Waiting time 6 hrs.	Berthing time 19 hrs. (refer Singapore Port)			1 Day			12 hrs.

Source: NESDC & UNISEARCH, (2022).(US$1=35 THB).

routes are significantly higher due to the additional processes for unloading the containers, rail transport and reloading onto ships at the port of destination. The costs for terminal fees and transport contribute significantly to the total costs.

The analysis of Figure 3 and Figure 4, which show a comparative summary of the four shipping routes at constant and increased speeds, respectively, provides a clear overview of the effects on costs and time. At a speed of 10 knots, Route 1 proves to be the most cost-efficient, generating costs of $219,182 over a period of approximately 10 days and 3.5 hours. Route 2 incurs higher costs of US$232,175 and extends the journey to around 11 days and 23.5 hours. Route 3, at a cost of US$225,485, has a shorter duration of around 10 days and 10.4 hours and offers a good balance between cost and time efficiency. Route 4, with a cost of USD 226,501 and a duration of around 11 days and 17.2 hours, proves to be slightly more costly and time-consuming than Route 3. For routes travelling at 15 knots, Route 1 remains the most cost-effective, costing US$146,121.1 for approximately 6 days and 18.3 hours. Route 2 is more expensive at US$178,905.2 and extends the journey to around 9 days and 12.3 hours. Route 3, with a cost of US$150,323.5 and a journey time of approximately 6 days and 22.9 hours, offers a good balance between cost and time efficiency. Route 4, with a cost of US$ 175,123.1 and a journey time of around 9 days and 8.1 hours, is more expensive and time-consuming than Route 3. The comparative analysis shows that although the land bridge offers an alternative route, it significantly increases both the financial and time aspects due to the duplication of cargo handling activities at both ends. Routes that avoid the land bridge are generally more cost- and time-efficient. This shows how important it is to consider established sea routes for optimal cost and time management in cargo transportation.

Figure 3: Shipping Route Comparisons at 10 Knots.



Source: Authors.

Figure 3 shows a comparative summary of four different shipping routes at a constant speed of 10 knots. Route 1 proves to be the most cost - effective option, costing a total of USD 219,182 for a journey of around 10 days and 3.5 hours. Route 2 costs more, at USD 232,175, but extends the journey to around 11 days and 23.5 hours. Although Route 3 costs USD 225,485,

Table 3: Summary cost and time from different scenario with speed 10 knots.

Scenario	Phase	From	To	Distance	Time	Cost
1	Sea phase	PoHCM	PoC	2,434 Nm	10 days and 3.5 hours	(US$21,612/ day*10 days) + (US$21,612/ day*3.5/24 days) = **US$219,182**
2	Sea phase	PoHCM	PoCh	450 Nm	1 day and 21 hours	(US$21,612/ day*1 days) + (US$21,612/ day*21/24 days) = **US$40,523**
	Landbridge	PoCh	PoR	Around100 km.	4 days and 14 hours.	- Tugboat at terminal 2 sides = $71.4/hrs./ship*2 ships*1 hr*2 = US$285.6 - Terminal Handling Charge at terminal 2 sides = US$40/TEU*2 = US$80/TEU - Rail transportation charge = US$42.9/TEU - Lifting Charge 2 sides = $10.6 /TEU*2 = $21.2/TEU Total cost for terminal charge and transportation for 500 TEU = (US$144.1 /TEU*500 TEU) + US$286 = **US$72,336.**
	Sea phase	PoR	PoC	1,325 Nm	5 days and 12.5 hours	(US$21,612/ day*5 days) + (US$21,612/ day*12.5/24 days) = **US$119,316**
3	Sea phase	LCBP	PoC	2,504 Nm	10 days and 10.4 hours	(US$21,612/ day*10 days) + (US$21,612/ day*10.4/24 days) = **US$225,485**
4	Sea phase	LCBP	PoCh	387 Nm	1 days and 14.7 hours	(US$21,612/ day*1 days) + (US$21,612/ day*14.7/24 days) = **US$34,849**
	Landbridge	PoCh	PoR	Around100 km.	4 days and 14 hours.	- Tugboat at terminal 2 sides = $71.4/hrs./ship*2 ships*1 hr*2 = US$285.6 - Terminal Handling Charge at terminal 2 sides = US$40/TEU*2 = US$80/TEU - Rail transportation charge = US$42.9/TEU - Lifting Charge 2 sides = $10.6 /TEU*2 = $21.2/TEU Total cost for terminal charge and transportation for 500 TEU = (US$144.1 /TEU*500 TEU) + US$286 = **US$72,336.**
	Sea phase	PoR	PoC	1,325 Nm	5 days and 12.5 hours	(US$21,612/ day*5 days) + (US$21,612/ day*12.5/24 days) = **US$119,316**

Source: Authors.

Table 4: Summary cost and time from different scenario with speed 15 knots.

Scenario	Phase	From	To	Distance	Time	Cost
1	Sea phase	PoHCM	PoC	2,434 Nm	6 days and 18.3 hours	(US$21,612/ day*6 days) + (US$21,612/ day*18.3/24 days) = **US$146,121.1**
2	Sea phase	PoHCM	PoCh	450 Nm	1 day and 6 hours	(US$21,612/ day*1 days) + (US$21,612/ day*6/24 days) = **US$27,015**
	Landbridge	PoCh	PoR	Around100 km.	4 days and 14 hours.	- Tugboat at terminal 2 sides = $71.4/hrs./ship*2 ships*1 hr*2 = US$285.6 - Terminal Handling Charge at terminal 2 sides = US$40/TEU*2 = US$80/TEU - Rail transportation charge = US$42.9/TEU - Lifting Charge 2 sides = $10.6 /TEU*2 = $21.2/TEU Total cost for terminal charge and transportation for 500 TEU = (US$144.1 /TEU*500 TEU) + US$286 = **US$72,336.**
	Sea phase	PoR	PoC	1,325 Nm	3 days and 16.3 hours	(US$21,612/ day*3 days) + (US$21,612/ day*16.3/24 days) = **US$79,554.2**
3	Sea phase	LCBP	PoC	2,504 Nm	6 days and 22.9 hours	(US$21,612/ day*6 days) (US$21,612/ day*22.9/24 days) = **US$150,323.5**
4	Sea phase	LCBP	PoCh	387 Nm	1 days and 1.8 hours	(US$21,612/ day*1 days) + (US$21,612/ day*1.8/24 days) = **US$23,232.9**
	Landbridge	PoCh	PoR	Around100 km.	4 days and 14 hours.	- Tugboat at terminal 2 sides = $71.4/hrs./ship*2 ships*1 hr*2 = US$285.6 - Terminal Handling Charge at terminal 2 sides = US$40/TEU*2 = US$80/TEU - Rail transportation charge = US$42.9/TEU - Lifting Charge 2 sides = $10.6 /TEU*2 = $21.2/TEU Total cost for terminal charge and transportation for 500 TEU = (US$144.1 /TEU*500 TEU) + US$286 = **US$72,336.**
	Sea phase	PoR	PoC	1,325 Nm	3 days and 16.3 hours	(US$21,612/ day*3 days) + (US$21,612/ day*16.3/24 days) = **US$79,554.2**

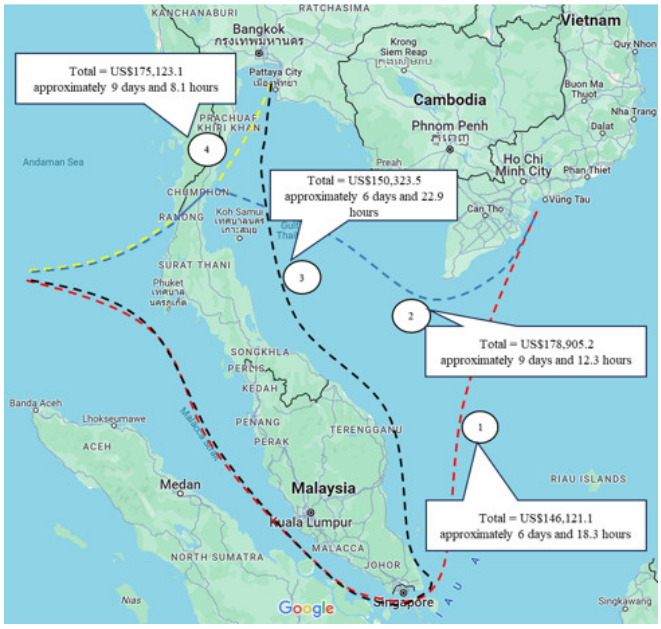
Source: Authors.

it has a shorter journey duration of around 10 days and 10.4 hours and therefore represents an attractive balance between cost and time efficiency. Finally, Route 4, with a duration of around 11 days and 17.2 hours, incurs total costs of USD 226,501 and is therefore a slightly more expensive but more time - consuming alternative compared to Route 3.

Figure 4 provides a comprehensive overview of four different shipping routes at an increased speed of 15 knots. Route 1 proves to be the most cost-effective option, costing a total of US$146,121.1 with a journey time of approximately 6 days and

18.3 hours. Route 2 incurs a higher cost of US$178,905.2 and extends the journey time to around 9 days and 12.3 hours. It is worth noting that Route 3 is relatively cheap at US$150,323.5 and has a slightly longer journey time of approximately 6 days and 22.9 hours, making it an efficient balance between cost and time. Finally, Route 4, with a total cost of US$175,123.1 and a duration of approximately 9 days and 8.1 hours.

Figure 4: Shipping Route Comparisons at 15 Knots.



Source: Authors.

6. Implications emerge from the case study.

The implementation of the land bridge project could potentially have several negative impacts on seaports in Singapore and Malaysia. The following section discuss the implication which potentially emerges from this Land-bridge venture

6.1. Loss of Transhipments Dominance.

Singapore's Port of Singapore Authority (PSA) and Port Klang in Malaysia serve as central hubs for global transhipment and enjoy a dominant position due to their strategic location. Their advantageous location on major shipping routes has facilitated their significant role in global maritime trade (Ducruet, & Notteboom, 2012). However, the planned land bridge project poses a significant threat to their current transhipment supremacy. A substantial proportion of shipping traffic may be redirected away from these ports by the proposed land bridge project, which will provide an alternate route. This route could be used by cargo heading to neighbouring regions, avoiding the need to pass through these significant ports. The amount of cargo handled at PSA and Port Klang could decline as a result of this change in shipping preferences (Yap, & Notteboom, 2011). PSA and Port Klang may lose their hegemony in the transhipment market if freight is redirected via the land bridge. Their revenue sources and significance in the world's maritime trade might be severely impacted by a drop-in cargo quantity. Ports face financial difficulties when there is a decrease in maritime traffic because handling fees, port services, and other activities decrease. Furthermore, their prestige and power worldwide may suffer if they lose their dominant position in transhipment. Since these ports have long served as key nodes linking different international trade routes, a reduction in their significance could change the nature of trade in the area. As shipping companies seek out more effective routes and adjust to the shifting terrain, this could also result in changes to supply chain strategies and operations (Blanchard, 2021). The existing transhipment dominance of Singapore's PSA and Port Klang in Malaysia is seriously threatened by the land bridge project's ability to siphon off sizable maritime traffic. The possibility of cargo diversion could alter trade routes and put these ports' current standing in international maritime trade at jeopardy.

6.2. Decreased in Shipping Traffic.

Ships can avoid docking in Singapore's and Malaysia's harbors to reload or unload goods by using the land bridge as an alternate route. The throughput and revenue of these ports are directly threatened by this bypass route (Yap, 2020). These ports have historically profited from substantial transhipment activities, especially the Port of Singapore Authority (PSA) in Singapore and Port Klang in Malaysia. These ports are regularly visited by ships that unload and tranship cargo in order to distribute it to different locations. But this established pattern is upset by the land bridge's introduction as a substitute route. There may be fewer ships calling at these ports as more choose the land bridge route. As a result, less cargo will be handled, which will have an immediate effect on PSA's and Port Klang's revenue streams. Reduced ship calls translate into lower freight handling costs, port fees, and associated costs. There is a major financial impact. The revenue generated by services like cargo handling, storage, logistics, and port-related operations is crucial for these ports. Reduced ship calls translate into lower revenues, which may put a strain on finances. The utilization of the infrastructure at these ports as well as operating efficiency may be impacted by the reduced flow (Alamoush, et al., 2020). Less ships to manage could mean that existing facilities aren't used to their full potential, which would raise operational expenses per handled unit. Ultimately, these ports' operational effectiveness and financial sustainability are directly threatened by the land bridge's capacity to offer a substitute route that avoids transhipment at these ports. The revenue and general operation of the ports in Singapore and Malaysia may be considerably impacted by the decreased ship calls and the ensuing drop in cargo throughput.

6.3. Downturn in Regional Trade and Economic Integration.

The land bridge project may result in a possible drop in cargo transshipment and shipping volume at important ports like Port Klang in Malaysia and the Port of Singapore Authority (PSA) in Singapore, which might have a significant economic

impact on both nations. In addition to being significant hubs for maritime transportation, these ports stimulate the economies of Singapore and Malaysia by generating employment and supplying allied sectors (Jeevan, et al., 2022). These ports employ a sizable percentage of the labour force directly or indirectly in the ship services, logistics, cargo handling, and associated businesses. A decrease in throughput resulting from the diversion of shipping traffic across the land bridge could lead to a significant loss of jobs in these sectors. Reduced activity in these ports may have a cascading effect on related businesses that depend on port operations. This downturn could affect the maritime services industry, transport and logistics companies, and other companies associated with port activities. Job losses and reduced business operations in these sectors could further exacerbate the economic burden. In addition, the reduced contribution of these ports to countries' economies could affect national GDP and economic growth. As ports are important contributors to the economies of Singapore and Malaysia, a decline in throughput and revenue from these ports could lead to an overall economic downturn (Mindur, 2020). Port-related activities generate substantial revenue through handling charges, services, and taxes and thus contribute significantly to national income. A decrease in this revenue stream could potentially lead to a decrease in government revenue and investment opportunities. Ultimately, the shift of shipping traffic away from these important ports as a result of the land bridge project could trigger a chain reaction of negative economic consequences. Job losses, a decline in business activity in the maritime sector and a general slowdown in the economy could be expected if the throughput of these ports decreases significantly due to the change in shipping routes.

The development of the land bridge project has the potential to unintentionally reshape the dynamics of regional trade, particularly impacting nations such as Malaysia. While the initiative aims to improve connectivity, its implementation could redirect established maritime trade patterns. Such shifts may lead to changes in trade routes and trade volumes within Malaysia, which play a central role in the regional economy. There are concerns about economic dependencies and potential disruptions to existing trade agreements resulting from these changes. Uncertainty over the extent of Malaysian trade's dependence on certain sea routes raises concerns over supply chain disruptions, shipping schedules and economic forecasts (Salleh, et al., 2021). This change may require a reassessment of current trade agreements, posing a risk to regional economic integration and stability efforts. The implementation of the land bridge project requires increased labour at the ports at both ends, as cargo containers need to be unloaded from ships, transported by rail and reloaded onto ships on the opposite shore. This duplication of labour creates additional costs, as shown in Table 2, which lists various expenses associated with cargo handling between the ports and the inland ports. These costs can have a significant impact on overall trade and logistics expenditures. Tables 3 and 4 outline different scenarios considering vessel speeds of 10 and 15 knots and show the aggregation of time and costs over different shipping routes. In particular, the routes that include a land bridge have a longer duration and higher costs, especially in the second phase when the containers are transhipped by rail at the port of destination. These adjustments to routes and handling procedures require careful consideration and proactive measures to mitigate potential disruptions to established trade patterns and agreements.

6.4. Infrastructure Underutilization.

The potential diversion of significant shipping traffic from the ports of Singapore and Malaysia due to the land bridge project poses a critical challenge: the underutilization of the significant infrastructure investments that have been made in these ports. Both the Port of Singapore Authority (PSA) and Port Klang in Malaysia have invested heavily in state-of-the-art infrastructure, including container terminals, cargo handling facilities, and associated logistics networks (Ignatius, et al., 2018). These investments were aimed at accommodating and efficiently managing the high throughput volumes that have flowed through these ports in the past. However, if the land bridge draws off a significant amount of shipping traffic, these infrastructure investments could not be utilised. The overcapacity in container terminals and transhipment facilities could lead to inefficient utilisation of resources. Operating at reduced capacity could lead to higher costs per unit of freight handled due to a higher proportion of fixed costs, which would impair the cost efficiency of these infrastructure facilities. Underutilization also affects the profitability of investments in the expansion and modernization of these port facilities. Revenue from port operations could fall short of the expectations necessary to justify the original investment costs. As a result, it could take longer than expected for the significant investments in these infrastructure developments to pay off (Hin, 2020). This underutilization could lead to further challenges in maintaining and modernising port facilities in line with technical progress and industry standards. If revenues decline due to lower traffic volumes, this could affect the ability of ports to continuously improve and renew their infrastructure in order to remain competitive in the global maritime industry. In essence, the potential diversion of traffic from these ports through the land bridge may lead to a mismatch between the investment made in efficient infrastructure and the actual volume of traffic, resulting in inefficiencies, financial burdens and barriers to maintaining competitive standards in port operations.

6.5. Compression in Competitiveness.

The emergence of the land bridge as a viable alternative shipping route is leading to increased competition between ports in the region, especially for the ports in Singapore and Malaysia (Jeevan, et al., 2021). These ports might need to modify their pricing policies or enhance their service offerings to be competitive in order to preserve their market share and relevance in the face of this new route. The issue of cost presents itself right now. The land bridge might provide shipping with more economical and timely options by rerouting traffic from the established ports in Malaysia and Singapore. In response, these ports could have to reconsider their pricing strategies and perhaps reduce tariffs or provide discounts in order to keep their

customers. A price cut, however, might directly affect their revenue streams and profit margins, making it more difficult for them to make additional investments and continue operations. Furthermore, it becomes imperative that services be improved (Nguyen, & Woo, 2022). These ports may be compelled to enhance the caliber of their offerings, operational effectiveness, and general clientele experience due to competition from the land bridge. To match or surpass the efficiency of the land bridge, this might necessitate a large investment in technology advancements, optimized logistics, better handling procedures, and upgraded infrastructure which align to the requirements of fourth industrial revolution (Jeevan et al. 2022b) However, making such improvements frequently takes a large amount of time and money. Furthermore, more competition might spur innovation in port operations and supply chain logistics. Ports in Singapore and Malaysia may have to increase their operational costs in order to stay competitive by investing in digitization, automation, and sustainability efforts. The advent of the land bridge presents a challenge for ports in Singapore and Malaysia, even if competition tends to spur improvement and innovation. In the face of changing global shipping route dynamics, they must simultaneously retain profitability and make enhancements to their services to keep them appealing and competitive.

6.6. Adverse Effects and Thailand's Global Supply Chain Position.

The emergence of the land bridge has detrimental effects on Thailand's position in the global supply chain. Primarily, it can disrupt well-established international supply chain networks. The shift in trade routes could lead to uncertainties and inefficiencies in the movement of goods, resulting in higher costs and longer transit times. These disruptions could affect Thailand's global position in certain industries or markets and reduce the country's competitiveness due to the change in trade routes (Jomthanachai, et al., 2022). In addition, large-scale infrastructural developments related to the land bridge could trigger environmental issues such as habitat destruction, deforestation and increased pollution from construction and operational activities. These environmental impacts could spark controversy and provoke protests or demands for more sustainable practises, potentially stalling or altering the implementation of the project. In addition, geopolitical tensions could escalate due to changes in trade flows and the strategic importance of the land bridge. Competing interests or disagreements over control or influence along the trade routes could strain diplomatic relations and thus affect regional stability (Jermsittiparsert, et al., 2019).

However, the utilisation of the land bridge routes will require increased operational activities at both harbours ends. This includes unloading cargo containers from ships, transporting them by rail, and transferring them to ships in the opposite harbour. Performing these tasks at both terminals will result in duplicated costs, as shown in Table 2, which lists various expenses related to cargo handling between ports and inland ports. These costs contribute significantly to the overall operating costs and logistics of the trade. Tables 3 and 4 show different scenarios for vessel speeds of 10 and 15 knots, summarising the time and costs for different shipping routes. In particular, the routes that include the land bridge have a longer duration and higher costs, especially in the second phase when the containers are transhipped by rail at the port of destination. These adjustments to routes and handling procedures need to be carefully considered to mitigate potential disruptions to established trade patterns and arrangements. Figure 3 and Figure 4 provide a comprehensive insight into four different shipping routes at different speeds. The analysis shows that while certain routes may appear more cost-effective, their complexity in terms of duration and operations requires careful consideration. This consideration is particularly important when it comes to the potential impact on existing trade dynamics within the region.

6.7. Geopolitical Considerations and Regional Cooperation.

This ambitious land bridge initiative connects regions with different geopolitical landscapes and spans key sea lanes and strategically important areas, particularly the Strait of Malacca. The unimpeded passage shown in Figure 2 serves as an example of the potential impact on existing sea lanes, particularly those that depend on this vital waterway. Nations with a vested interest in the geopolitical importance of the Strait of Malacca may express concern over the changing trade dynamics, which could lead to diplomatic discussions and strategic alignments. In addition, discussions on port sovereignty, jurisdiction and operational standards become inevitable due to expanded operations in the ports, which have significant geopolitical implications.

The analysis highlights the changing nature of traditional trade routes and economic linkages between the nations involved. The establishment of the land bridge has the potential to disrupt established sea routes and economic linkages by altering prevailing trade patterns and dependencies (Flint, & Zhu, 2019). Such changes could force governments to reassess their alliances and trade agreements, requiring diplomatic efforts and regional cooperation to align interests and maintain economic stability. However, the implementation of the land bridge routes requires increased operational activities at both ends of the bridge, resulting in double the cost of cargo handling, as shown in Table 2. The process involves unloading cargo containers from ships, transporting them by rail, and reloading them onto ships at the port of destination. This duplication significantly increases the time delays and financial costs compared to traditional routes, with the exception of the rail transit fee, which is only incurred once. Tables 3 and 4 contain a comprehensive summary of various scenarios, considering ship speeds of 10 and 15 knots, respectively. These scenarios include the shipment of 500 TEU from various countries of origin to the port of Colombo, Sri Lanka, via different routes, some of which include the land bridge. The costs and timeframe for the land bridge routes increase significantly due to additional cargo handling processes, rail transport and transshipment activities at the port of destination.

6.8. Environmental Issues.

The land bridge initiative, while designed to improve connectivity and trade efficiency, raises significant environmental

concerns due to increased operational activities and revised shipping routes. The use of this route requires increased activity at the ports at both termini, which includes unloading cargo, rail transport and transshipment to vessels on the opposite shores (Yoder, 2023). This dual port activity increases the associated emissions, contributes to increased carbon dioxide emissions, and raises concerns about local noise and air pollution. The integration of rail transport into the logistics system via the land bridge simplifies container transport between ports. However, this method raises questions about its carbon footprint, notwithstanding its potential to reduce some maritime emissions. Diesel-powered locomotives, in the absence of energy-efficient technologies, can significantly increase greenhouse gas emissions and negatively impact the environment while operating on railway lines (Kokkinos, & Emmanouilidou, 2023). The construction of the land bridge will alter existing shipping routes, potentially impacting sensitive marine habitats and ecosystems.

Changes in the volume and composition of shipping traffic could increase risks such as collisions or oil spills and jeopardize local fisheries, coral reefs and marine biodiversity (Wan, et al., 2022). The longer transit times and distances associated with the land bridge project will increase fuel consumption and emissions from ships, exacerbating air pollution and contributing to climate change. However, the increased operations required by the use of the land bridge routes by ships at both ends of the harbor result in double costs. These scenarios show shipping routes that include the land bridge project and traditional sea routes and illustrate the differences in cost and duration (Pruyn, et al., 2022). Although land bridge routes are a promising transport alternative, they cause higher costs and time delays due to additional cargo handling processes and rail transport, which underlines the importance of established sea routes for optimal cargo transport management.

Conclusion and Implication.

The comprehensive analysis conducted on the Thailand Land Bridge and the comparison with established sea routes such as the Strait of Malacca show that the bridge is a good alternative for global trade by land. The comprehensive assessment included economic, environmental, geopolitical and operational factors and highlighted the complexity and challenges associated with the realisation of such an ambitious infrastructure project. Despite initial ambitions and expectations, the study comes to the clear conclusion that the Thailand Land Bridge is not a feasible alternative in today's global trade landscape. The cost and time analyses conducted for different scenarios and speeds consistently show that building a land bridge significantly increases both the financial and time aspects of transporting goods. This increase in operational activities, in particular the doubling of cargo handling at both ends of the land bridge, causes double the costs compared to traditional sea routes. These results highlight the inefficiency and impracticality of the land bridge project compared to the existing sea corridors. In addition, the study thoroughly analysed various aspects such as environmental impacts, regulatory hurdles, geopolitical complexity and socio-economic inequalities. The conclusions drawn from the comprehensive analysis point to adverse effects on the efficiency of seaports, a potential decline in shipping traffic, a decrease in regional trade and economic integration, and significant losses in the competitiveness of the countries involved. The analysis emphasises the importance of considering established sea routes for optimal cost and time management in freight transport. It is evident that the complexity and additional costs associated with the operation of land bridges outweigh the perceived benefits. In addition, the potential negative impacts on regional co-operation, geopolitical relations and environmental sustainability have been examined, highlighting the multiple challenges of the land bridge project.

The managerial and social implications arising from the synthesis of the Thailand Land Bridge project as a new overland hub in global trade emphasise the multiple challenges and concerns in various areas. First and foremost, the feasibility analysis highlights critical business and social implications that raise significant concerns about the project's viability. From a management perspective, the unfeasibility of the Land Bridge project poses an immense strategic and logistical challenge. The extensive document analysis and case studies highlight the significant complexity associated with infrastructure development, regulatory hurdles, and geopolitical dynamics. The projected increase in operational activities at both ends of the land bridge will lead to a significant increase in costs, a doubling of freight handling costs, and an increase in transit times. This financial burden, combined with time inefficiencies, poses significant management challenges for shipping companies in terms of cost optimisation, operational efficiency, and supply chain management. In addition, the expected impact on seaports in Singapore and Malaysia poses a looming threat of reduced shipping traffic, underutilisation of infrastructure and a decline in competitiveness. The loss of transhipment dominance could undermine the strategic positioning of these ports and potentially lead to a downturn in regional trade and economic integration. Such scenarios would require major strategic realignments and investments in alternative port infrastructure to mitigate these potential losses. From a social perspective, the environmental impact of the land bridge project is of great concern. The disruption to biodiversity, water flow patterns, and ecosystems could lead to environmental degradation. The proposed project's failure to adhere to recommended mitigation techniques and environmental sustainability goals raises ethical and social concerns. This requires strict adherence to environmental regulations and comprehensive sustainability practises to minimise the negative impacts on the ecosystem and local communities. In addition, geopolitical considerations and potential conflicts over vital waterways emphasise the challenges for regional cooperation more broadly. The geopolitical risks of the land bridge and its impact on global trade routes and diplomatic relations reinforce the need for cooperative approaches and conflict resolution mechanisms.

Despite the study shows that the land bridge is not a viable alternative for either Thailand or Malaysia in current global trade, several recommendations emerge from the analysis. Policymakers should refocus on established sea lanes such as the

Straits of Malacca and recognise their efficiency and cost-effectiveness. Emphasise the optimisation of existing sea lanes rather than investing in the land bridge project. Ensure strict adherence to environmental sustainability targets and techniques when developing infrastructure. Policymakers must enforce strict environmental regulations to minimise negative impacts on biodiversity, water flow patterns, and ecosystems. Stakeholders must prioritise the economic viability and cost-effectiveness of transport systems. Channel investment into improving infrastructure on existing routes, optimising trade efficiency, and reducing logistical complexity. Promote regional cooperation and diplomatic relations on trade initiatives. Recognise and address potential geopolitical conflicts over trade routes while promoting joint ventures that benefit multiple stakeholders. Channel investments into improving port infrastructure and efficiency along established sea routes such as the Straits of Malacca. This would mitigate the risks of underutilization and loss of transhipment dominance in the Singapore and Malaysian seaports. Conduct thorough risk assessments before embarking on major projects. Ensure that all stakeholders are involved in the risk assessment to minimise potential negative impacts on regional trade, economic integration, and competitiveness. Gather lessons learned from successful land bridge projects such as the North American Canamex Corridor, the Trans-Siberian Railway, and the Eurotunnel. Gather best practises and lessons learned to support future infrastructure initiatives. Develop a comprehensive, long-term trade strategy that recognises changing global dynamics. Rely on established trade routes while fostering innovation in supply chain management and logistics.

The analysis and results of the Thailand Land Bridge project case study show that it is not a viable alternative route in the current global trade landscape. Looking ahead, future prospects and research directions should focus on optimising existing sea routes, promoting sustainable trade practises, and mitigating the potential negative impacts of the land bridge project. Future research should focus on increasing efficiency, reducing costs, and streamlining operations along established sea lanes such as the Straits of Malacca. Explore technological advancements and operational strategies to maximise the potential of existing sea corridors. Prioritise sustainability in trade. Research and advocate for green logistics to reduce the carbon footprint and environmental impact of freight transport. Investigate strategies to offset the potential negative consequences of failed or unrealisable infrastructure projects such as the land bridge. Develop contingency plans to mitigate adverse impacts on regional trade, economic integration, and port infrastructure. Explore integrated transport systems that combine multiple modes of transport and utilise synergies between sea, rail, and road networks. This could optimise trade routes without the complexity of the land bridge concept. Advocate with policymakers to formulate sound policies that prioritise investment in sustainable and proven trade routes. These policies should promote infrastructure development and efficient trade practises along established maritime corridors. Promote international cooperation between trade actors, policymakers, and researchers. This cooperation should aim to share knowledge, best practises, and lessons learned from successful trade projects to facilitate informed decision-making for future trade initiatives. Explore innovative technologies that can increase efficiency and reduce costs in maritime trade. This includes advances in container handling, navigation systems, and energy-efficient transport. Develop comprehensive, long-term trade strategies that take into account geopolitical shifts, environmental concerns, and the changing dynamics of global trade. These strategies should be adaptable and responsive to new trade trends. Conduct thorough risk assessments for planned infrastructure projects and ensure that stakeholders are prepared for potential challenges and have contingency plans in place. Invest in educational programmes and knowledge-sharing platforms that raise awareness of the complexity of trade routes and highlight the importance of evidence-based decision-making in infrastructure development.

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