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Mr Somxay Sengdala
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Opportunities and Challenges of Lao-China railway on transportations

Internal supervisor: Dr. Enikő LENCSÉS

Associate Professor

Author: Mr. Somxay Sengdala

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1. Introduction

The Lao-China Railway also known as the Boten-Vientiane Railway is part of six international economic under China's Belt and Road Initiative (BRI). It runs from Lao People's Democratic (Lao PDR) capital of Vientiane to the town of Boten on the border with China. The railway is a segment of the China-Indochina Peninsula Economic Corridor which would expand the trade network from Kunming in China to Singapore via Lao PDR, Thailand and Malaysia (World bank, 2020). As part of the BRI, the Vientiane-Boten Railway do not connect Lao PDR only also the entire BRI network. The BRI aims to develop a global transport network connecting to Europe, Africa, Central Asia, and the rest of Asia to China (oecd, 2018). Therefore, the corridor will benefit Lao PDR through overflow effects from investment in all other connected BRI corridor. The ability of the railway can reduce trade costs within the larger BRI network has the potential to increase Lao PDR's competitive advantage with the right reforms in place. The railway might increase the country's appeal as a location for investment and connect it to important manufacturing and consumption centres in China and the Association of Southeast Asian Nations, allowing firms to access global value chains. The Lao-China railway and the broader BRI network have the potential alter the comparative advantage of Lao PDR and increase the country's attractiveness as an investment destination. A significant reduction in trade costs and travel time will effectively improve Lao PDR's location relative to major production and consumption areas in China, ASEAN, and the world. An efficient railway connection with China will position Lao PDR halfway between China and ASEAN, offering opportunities for existing and new firms to leverage changes in transport prices and time, access global value chains and participate in distribution network. This could help link the railway to productive areas in neighbouring countries, increase regional economic activity, lower transport cost and make Lao PDR more attractive to investor (ESCAP75, 2023)

Lao-China railway which will connect Lao people's Democratic Republic (Lao PDR) to the entire network of the belt and road initiative (BRI) has the potential to transform Lao PDR from a landlocked to a land-linked country. The railway is expected to significant increase economic activities in agriculture sector, traveling sector, logistics sector and manufacturing sector.

To study these opportunities and challenges on Lao-China railway, aim to study the differences before and after opening Lao-China railway in three sectors (i) Agriculture sectors, (ii) traveling sectors, (iii) logistics sectors. Due to Lao PDR opened high speed railway

to connect to China in December, 2021 which will increase the potential to export more agricultural product to China through Lao-China railway. To study this will show how the differences of import and export before and after opening the Lao-China railway by using data to analysis. Traveling sector is one of an important part to attract tourism from everywhere around world to visit Laos. Due to the railway corridor connects the main important of traveling area in Lao PDR such as Vientiane capital, VangVieng, Luangpabang, Luang Namtha, and Oudomxay province. These provinces absolutely will get benefit from the railway. To study this will show how the differences of tourisms before and after opening Lao-China by using data analysis. Logistic sector is one of the important parts as well to drive the economic in Lao PDR, according to new railway will benefit to Laos. This aims to study the import and export goods into five countries such as Thailand, China, Vietnam, Singapore and Cambodia. This will show how the differences of import and export on logistics sector by using data analysis.

This study identifies key investment and policy reforms to maximize the Vientiane-Boten Railway for Lao PDR. It describes physical and non-physical barriers and gaps along the railway corridors and study provides capacity of improving agriculture sector, traveling sector, and logistic sector in Laos. The study does not assess the detail of proposed railway operation, the financial viability of the railway project, spatial and income distribution effects within Lao PDR, or debt sustainability.

2. Literature review

The Lao-China railway aims to improve trade links between the Lao PDR and China as well as between all of the BRI economies, which is anticipated to minimize trade costs, speed boost economic growth, and reduce poverty in the area. Lao PDR is expected to benefit from the Vientiane-Boten Railway due to its strategic location along the corridor and in the region (World bank, 2020). The trade along the corridor will be able to compete with current maritime route due to the railway's ability to cut land-based transportation costs. It would allow Lao PDR to benefit from freight transit moving between China and ASEAN. Laos would also benefit from cheaper and faster movement of goods between Lao PDR and China, as China represents a large market for Lao export and import. Lao's exports to China amounted US\$ 2.22 billion in 2021 (International trade administration, 2022). Major export commodities include base metal ore, metal salts, ore, semi-processed wood products, and agricultural product (e.g., rubber, rice, maize, fruits and nuts, and cereal). Except for rice, most agricultural products are produced in the mountainous part of Lao PDR that borders China and along the Lao-China railway line. Import from China have also increased significantly since transport connectivity improved between Lao PDR and the southern/southwestern parts of China. Lao PDR's import from China including consumer goods as well as construction materials and machinery for building the Lao PDR railway amounted US\$ 1.25 billion in 2021 (International trade administration, 2022).

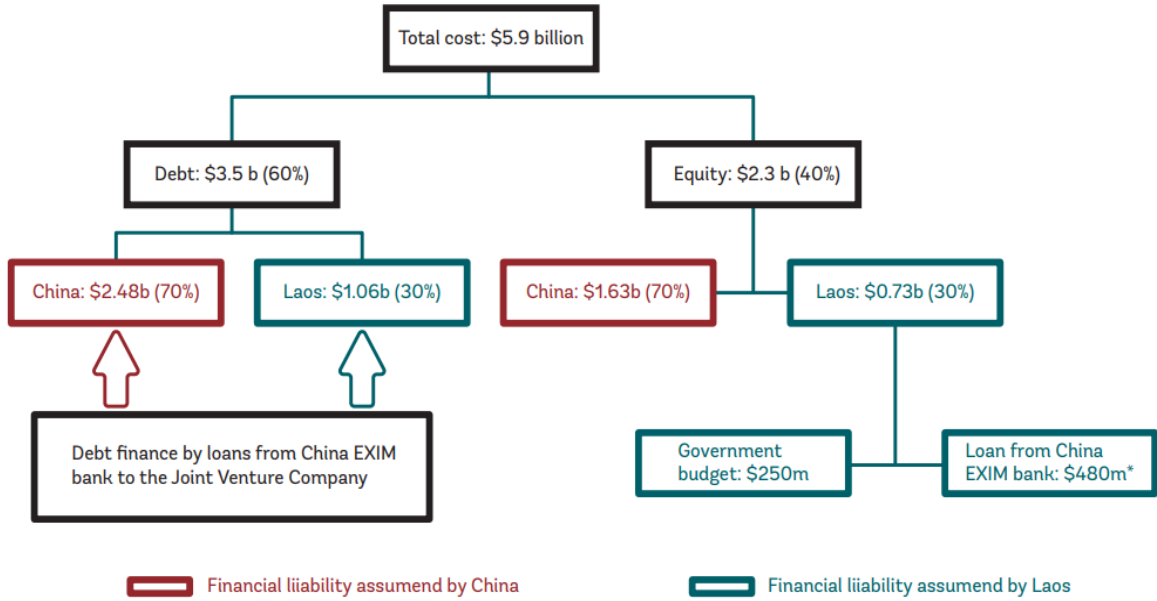
The Vientiane-Boten railway runs through a variety of economic zones with differing potential for manufacturing and tourism. It travels through the four provinces of Luang-Namtha, Oudomxay, Luang Prabang, and Vientiane, as well as the nation's capital of Vientiane. The road network that connects the railway to five northern provinces is in fair condition and covers about one-third of the country's population. In the northern region produces the agricultural commodities, including in provinces along the railway corridor, are paddy, banana, maize, starchy roots and tea. The provinces connect by the railway also have considerable tourism potential (World bank, 2020).

The 414 km railway connects the country's capital of Vientiane with the city of Boten at the northern border with China. At Boten, the railway will connect with the BRI network at Kunming, China through another 595 km railway link. The railway journey between Vientiane and Boten takes approximately four hours significantly less than fifteen hours by car. For Boten to Kunming, it will take approximately four hours which is interesting point for Chinese tourism come to visit Lao PDR comfortably (ASEAN BRIEFING, 2021). The railway

from Vientiane to Vang Vieng will take 1 hour, less than current four hours by car. The Vientiane-Boten railway would offer Lao PDR a land link to the regional and global supply chain, which could increase the country's appeal to investors, create new jobs, and drive economic growth. This is providing an effective border process for people and freight (Xinhua, 2021).

Laos's investment in the Vientiane-Boten Railway also pose considerable risk. The estimated cost for the railway section within Lao PDR is US\$ 5.9billion (World bank, 2020). While the railway corridor is expected to support trade between China and ASEAN as a part of China's BRI, Lao PDR will only fully benefit if it undertakes significant complementary policy reforms and improves the quality of connecting road infrastructure. Lao PDR also needs to adopt efficiency-enhancing reforms to attract some of the trade flows between China and ASEAN that are currently using maritime routes, which could increase trade volumes reduce average cost (World bank, 2020).

Figure 1: Lao-China railway project's financing structure



Note: Terms of the loan from the Export-Import Bank of China: interest at 2.3 percent per year, twenty-five-year maturity, and five-year grace period.
 Source: World Bank staff discussions with authorities.

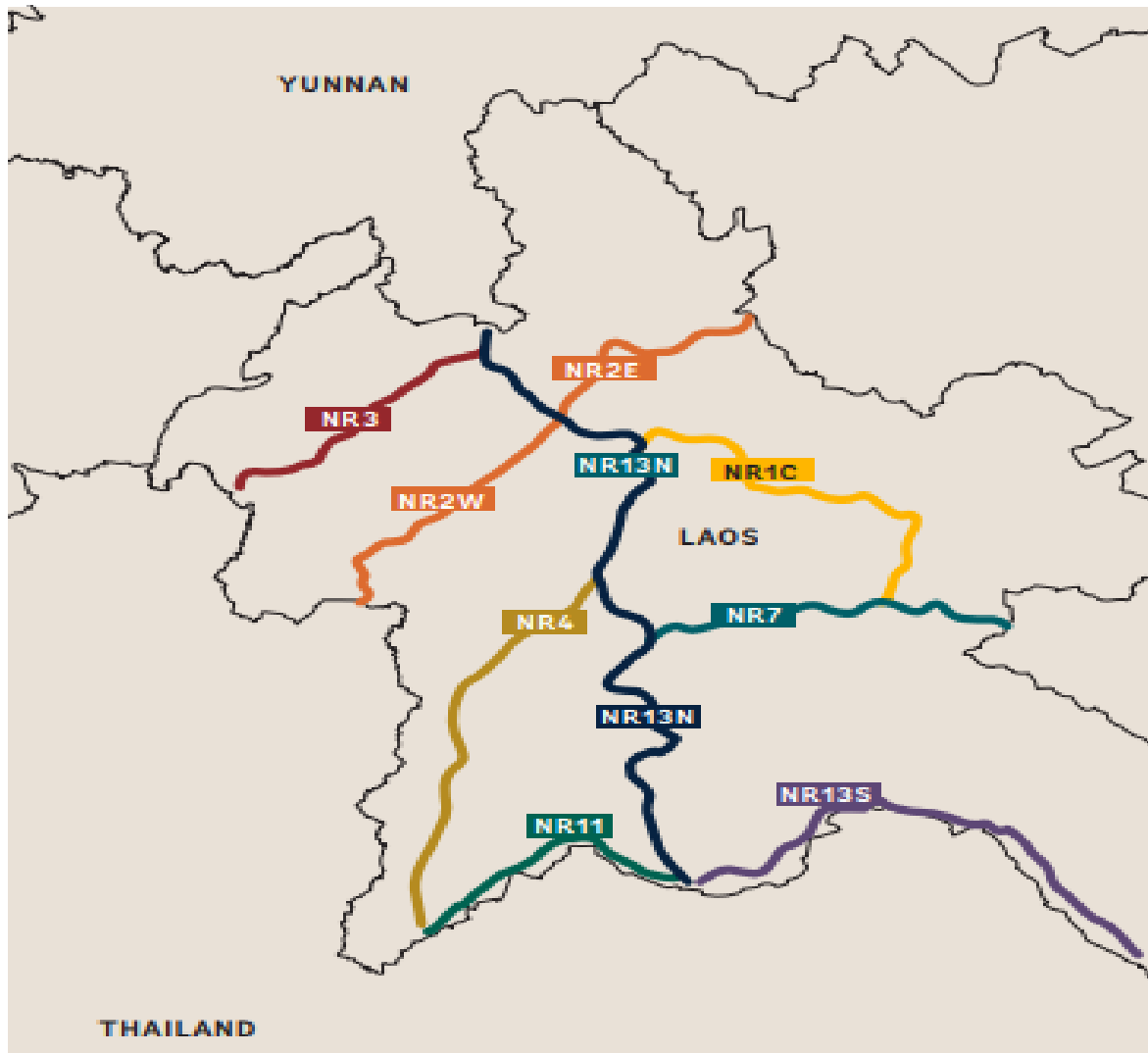
We can see the table of financing structure (Figure 1.) above shows the total investment of the railway project is US\$ 5.9 billion and the equity/debt ratio is 40:60 percent. One-third of the 40 percent equity will be provided by Lao government, of which US\$ 480 million will be financed with loan form import and export bank of China (World bank, 2020).

2.1 Key corridors crossing by road

In Lao PDR, driving is the most common form of transportation. National Road 13 constitutes the backbone of the road network that connects Lao PDR with China in the north and Cambodia in the south. The road comprises NR13 road takes 671Km from the capital of Vientiane to Boten on the Chinese border and NR13 south from the capital to the Cambodian border 829 km (Ministry of public work and transport , 2017).

- **China-Thailand Corridor:** National Road3 serves as the main corridor connecting Thailand with China through Lao PDR's provinces of Boten and Luangnamtha. The Road is in need of improvement due to rapid increase in heavy transit traffic, couple with increasing number and frequency of flash floods (World bank, 2020).
- **Thailand-Lao-Vientiane Corridor:** National Road 2 takes 187 km connects Thailand with Vientiane through the Lao PDR province of Oudomxay, and the main train station is located in Muang Xai. (World bank, 2020).
- **Luang Prabang area:** National Road 4A serves the main route to the provinces of Xayabouly and Nan in Thailand. National road 1C connects Luang Prabang and tourism sites at Nongkoe as well as Houaphan. National Road 7 connects Luang Prabang with Xiengkhuang and Vang Vieng via National Road 13, and there are train stations in Luang Prabang (World bank, 2020).
- **Vientiane Province:** National road 11 connects four southern districts and Xayabouly province to Vientiane. The first 56 km of Road was upgraded to asphalt concrete in 2021, and the remaining road is under construction with support from the government of Thailand, which is expected to be completed by 2023 (World bank, 2020).
- **Capital of Vientiane:** The main passenger station of the Lao-China Railway is located 9 km from Vientiane's city centre and is called Vientiane South. The freight station is at Thanaleng, close to the Thai-Lao Friendship Bridge south of Vientiane, which will likely become the point of cargo transshipments from standard-gauge train in Lao PDR to the meter-gauge freight network in Thailand (World bank, 2020).

Figure 2: Lao PDR's Key road corridor



Source: OpenStreetMap.

We can see the map (Figure 2.) above shows the key road corridor in Lao PDR through NR3 connects Lao PDR with China, NR2W and NR2E connect Thailand with China through Lao PDR, NR13 connects Lao PDR with China in the north and Cambodia in the south, NR1C connects Luang Prabang and Tourism site, NR7 connects Luang Prabang with Xiengkhuang and Vangvieng via national road NR13, and NR11 connects four southern district of Xayyabouly province to Vientiane, and NR4 connects the main route to the provinces of Xayyabouly and Nan in Thailand (World bank, 2020).

2.2 Key corridors crossing the railway

There are existing transport corridors that cross the Vientiane-Boten Railway. The corridors that connect with the railway at different points are (i) NR3 in the north that connect Lao PDR with Thailand and China, (ii) NR2 that connects the provinces of Xayabouly, Oudomxay, and phongsaly as well as the country with the north eastern part of Thailand and the northern part of Vietnam, and (iii) NR13 south that connects areas south of Vientiane (World bank, 2020).

- **China-Thailand Corridor**

The trade route between China and Thailand through NR3 crosses the railway at Boten and Nateuy stations of Lao PDR. Boten station is located at the border between Lao PDR and China in the province of Luang Namtha, this border can also be crossed on the road, and there are already numerous trucking operations nearby. Passenger traffic is anticipated to cross the border at Boten station. However, the distance from Boten and Nateuy only takes 20 km, which means that logistics activities are expected to be concentrated between these two stations. Due to the possibility for increased expansion of logistics services for commodities traveling between Thailand and China via Lao PDR, local employment could be created (World bank, 2020).

Figure 3: China - Thailand transport corridor



Source: OpenStreetMap.

We can see the map above show that NR3 crosses the railway at Boten and Natuey station of Lao PDR directly to Thailand.

- **Thailand-Lao PDR-Vietnam Corridor**

Figure 4: Thailand-Lao PDR-Vietnam corridor



Source: [OpenStreetMap](#).

The Lao-China Railway’s Muang Xai station crosses the NR2, which connects with Thailand to west and Vietnam to east. Muang Xay station is situated in the most populated area in the northern of Lao PDR. There is great potential for tourism development in the area could benefit from the Muang Xai station. Chinese passenger vehicles have been observed in this area, and NR2W between Muang Xai and Nan province in the Thailand is a popular route for tourist (World bank, 2020).

- **Vientiane-Nong Khai (Lao PDR-Thailand) Corridor**

The Capital of Vientiane is a gateway to both Thailand and the southern part of Lao PDR. Vientiane station will constitute a major strategic, multi-purpose, and multi-modal connectivity hub. It will be the final station before trains enter Thailand, and cargo will have to be transloaded to the meter gauge at this station (World bank, 2020). There are also tentative plans to enable transloading at the station in Thanaleng or Nong Khai. Meanwhile, the station in Vientiane is also likely to function as transloading hub for goods originating in, or being

destined to southern parts of Lao PDR and arrive in Vientiane by truck. An effective link between the Lao-China railway and the Thai meter-gauge network will also be crucial to enable cargo to reach the port in Laem Chabang, Thailand, and potentially attract additional manufacturing or logistics investment. There are also plans to develop the capital of Vientiane as a regional logistics hub. By expanding the railway or road connection between the Thai port of Laem Chabang and the capital city of Vientiane, Lao PDR could benefit from expanded regional transit trade. Trade between the Lao PDR and its neighbours could be significantly improved by linking the railway to maritime routes in Thailand. This would require not only the railway link but also better transport and supporting infrastructure. The Lao China railway could potentially compete with not only road transport but air transport as well. The expected reduction in transportation costs because of the railway could eventually make it competitive to ship high-value manufacturing products. For example, intermediate inputs by rail. The railway could create new opportunities to attract investment in the Vientiane capital area and beyond, but the level and impact of new investment spending will depend on the development of Lao PDR's road network and the success of investment facilitation measure. For the traveling part, the Vientiane-Boten Railway has the potential to attract more tourists to Lao PDR, more efforts are needed to improve local connectivity and the infrastructure in and around tourist destination. According to some estimates, the railway is expected to carry more than 1 million cross border passengers by 2023 (ESCAP, 2022). However, the railway link alone is likely not enough to attract more tourists. A railway network that suffers from long border delays, lack of interconnectivity and insufficient transport options to and from tourist site can deter tourists from traveling to Lao PDR by rail. This section provides an overview to two key destination in Lao PDR that are situated along the railway: Luang Prabang and Vang Vieng. (World bank, 2020)

- **Luang Prabang Area**

Luang Prabang station, which will be serving tourist who visit Luang Prabang city, is located 8 Km from the city centre. With the railway in place, intermodal transport options in Luang Prabang would be the key main point to the integrated development to the tourism industry. To ensure the station and the city can benefit from an increase in tourist arrivals (JICA, 2016).

Figure 5: Luang Prabang area



Source: OpenStreetMap.

Figure 6: The train of Lao-China railway



We can see the train above is an electric multiple unit train that stretches 1,305 kilometres (643 miles) (Figure 6.) and is designed to link Vientiane with Kunming, the capital and largest city in China's Yunnan province.

- **Vang Vieng Area**

Vang Vieng is the main key point to attract the tourists within domestic and international. But Vang Vieng needs to improve public transport services and create transport linkage with the Vang Vieng station to leverage the benefit of an expected increase in tourists. While the area has experienced a rapid increase in tourism in the current years. Connecting infrastructure needs to improved. In addition, the city needs to develop its public transport network such as creating a bus service that connects the railway station with important tourist areas (World bank, 2020).

Figure 7: Vang Vieng area corridor



Source: website China-Lao railway

3.1 Logistics and transport in Lao PDR

Lao-China railway successfully integrate the country’s economy into regional and global markets with an efficient and well-functioning logistics industry. The competition between service providers and open access to infrastructure are necessary for the supply of high-quality and reasonably cost logistics services. Effective logistics services are crucial for Lao PDR's competitiveness in general because they enable the effective import of inputs and consumer goods, domestic product distribution, and export of finished goods. However, Lao PDR’s logistics and transport infrastructure continue to suffer from poor quality (World bank, 2020). The necessary infrastructure to handle containers is limited and multimodal transport services are currently non-existent. To take advantage of the new railway the government needs to create an infrastructure capable of handling containers. In addition, the country needs to remove existing institutional constraints to the development of the logistics sector if it is to benefit from multimodal transport options and other value-added logistics service (World bank, 2020).

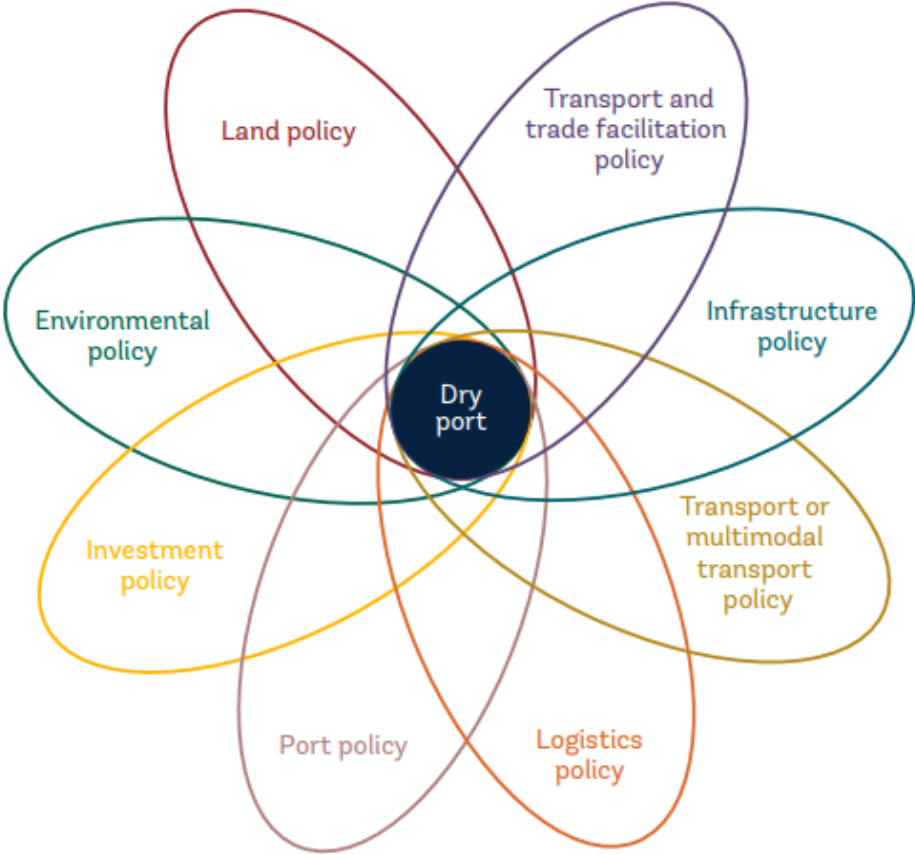
Table 1: Minimum infrastructure needed to handle containers in Lao PDR

INLAND TRANSPORT	
ROADS	*Axle Loading
	*Bridges & Tunnels
RAIL	*Rolling Stock
	*Motive Power
	*Bridges & Tunnels
	*Cranes & Stacking Areas
INLAND DESTINATION³⁵	
INLAND CLEARANCE DEPOT	*Container Handling Equipment
	*Stacking Areas
	*Road, Rail & Inland Waterway access

Source: UNCTAD 1990.

Being a landlocked country, Lao PDR depends heavily on inland clearance depots (ICD), also known as dry or inland ports, for the growth of its logistics sector. In order to provide an inland destination, an ICD serves this purpose (LIFFA, 2019). (1) customs clearance of export and import goods, (2) warehouse facilities including cold and reefer storage, (3) container and cargo handling, (4) cargo stuffing and un-stuffing service, (5) efficient communication facilities, (6) road haulage brokerage, (7) consignment consolidation services and (8) cargo tracking service (World bank, 2020). The management of containerization and value-added logistics services is important for the integration of transport chain. In Lao PDR, the Vientiane-Boten railway needs to have the necessary capacity to handle containers and dedicated location at key train stations for freight access with adequate freight handling equipment. As export and import customs procedures can be executed on site, ICD, which has grown to be critical nodes in the provision of door-to-door service, will provide an intermodal transfer capability between road and rail freight. These services will benefit Lao PDR's cargo owner as they will be able to handle the import and export clearance process without having to be located at any physical land border. In accordance with good international practice, the Lao-China Railway will include two ICDs at Boten or Nateuy and Vientiane. Trade facilitation measures are crucial to reducing the need for additional border-related infrastructure. ICDs at other stations could be built, but their effectiveness will depend on the volume of freight traffic, which is necessary to realize economies of scale, as well as the needs of cargo owners in these particular areas. ICDs should be connected to the railway line to allow intermodal capability between road and rail transport. This would enable the provision of multimodal transport and value-added logistics services, enabling door to door multimodal transport and connectivity between the road network and the transport and connectivity between the road network and the railway. The loading and unloading of freight should have its own dedicated service to benefit from additional supplementary services. Additionally, the railhead, which will be the location where cargo is loaded, unloaded, or transferred from the railway to other forms of transportation, needs to be accessible to the general public. The railhead can be found next to major stations or at significant railroad and highway crossings close to commercial, industrial, and agricultural centres (World bank, 2020).

Figure 8: Policies and regulations related to dry ports



Source: Hanaoka & Regmi 2011

The national logistics development plan for Lao PDR requires the construction of at least nine ICDs, although three to four dry ports would be enough to service the entire nation, especially in conjunction with reforms that speed up inspection and clearance processes. Nine places for international logistics parks have been designated by Lao PDR: the province of Bokeo, Nateuy in Luang Namtha, Xay in Oudomxay, Luang Prabang province, Thanaleng in Vientiane, Lak Xao in Borikhamxay, Thakheak in Khammuan, Xeno in Savannaket and Vangtao in Champasak. The cities of Nateuy, Xay, Luang Prabang, and Thanaleng are located along the railway, while Huoayxai lies along NR3 that connects Nateuy and the railway to Thailand. It may be excessive for Lao PDR to have up to nine ICDs, considering its domestic international, and transit market in the near term. Limiting the overall number ICDs will increase the volume at remaining ICDs, increasing their economic profitability (World bank, 2020).

3.1.1 The Changing requirement of a rail-linked economy

Lao PDR will require access to new infrastructure that links the road network and the railway into developing multimodal transport. This will require the establishment of other logistics-related services such as warehousing, domestic distribution and dry ports. It could be necessary to create a logistics park and other facilities of a similar nature. Each train station, however, as well as other associated logistics nodes, must be capable of intermodal transfer. Additionally, a clear charge schedule for service must be ensured to allow for public access to railheads. In addition, efficient multimodal transport will require a number of integrated value-added logistics services, many of which are currently not provided by private operator in Lao PDR. For example, the country's logistics providers are unable to provide intermodal transfer, container leasing, inbound management and distribution, or inventory management. It is important to ensure that all types of freight and value-added logistics services are available in Lao PDR so the country can receive the full benefit from the Vientiane-Boten Railway. This would require increase competition in the logistics sector to support and incentivize the growth of high-quality private logistics firms. Lao PDR's rail traffic will be part of a multimodal transport system and rely heavily on logistics services. Multimodal transport options and logistics will remain important for the railway in the foreseeable future, as only one main rail line is being constructed, and the construction of Thai section has yet to begin. Rail traffic will have to rely on logistics companies that can provide cross-docking services to move freight from truck onto train (soysouvanh, 2018).

Table 2: Multimodal transport and value-added logistics services

Capability	Service	Current Status in Lao PDR
Global integrated supply chains	Integrated door-to-door multimodal transport	Not available
Freight	End-to-end transport solutions	Partial service ^a
	Consolidator	Available
	Intermodal transfer (road/rail/IWT/air)	Not available
	Customs brokerage	Available
	Transit customs	Available
	Freight agency	Available
	Container leasing	Not available
Value-added logistics	Cold chain	Partial service
	Vendor managed inventory	Not available
	Inbound management & distribution	Not available
	Merge in-transit & cross-dock operations	Not available
	Consolidations & finished-goods management	Available
	Configuration & built-to-order management	Not available
	Kitting-to-line operations	Not available
	Order fulfilment & management of purchase orders	Not available
	Material handling	Available
	Packaging	Available
	Inventory management	Not available
	Warehouse management	Available
	Sourcing & supplier management	Not available
Reverse logistics	Partial service	
Cargo insurance	Available	

Note: a: Only for pick up or last-mile delivery.

Source: World Bank.

In addition, efficient multimodal transport will require a number of integrated value-added logistics services, many of which are currently not provided by private operator in Lao PDR. For example, the country’s logistics providers are unable to provide intermodal transfer, container, leasing, inbound management, and distribution, or inventory management (World bank, 2020).

3.1.2 Logistics performance and operational challenges

Lao PDR's logistics services suffer from high costs and prices and relatively low quality, which negatively affects the country's ability to fully benefit from railway. The survey results show that logistics costs are twice as high in Lao PDR relative to other ASEAN countries (World bank, 2020). High costs have an adverse effect on the competitiveness of all Lao enterprises, which is a barrier to both the growth of the country's logistics sector and efforts to draw in international investment. High logistic costs are not only the result of infrastructure constraint but also challenges related to trade facilitation, and high logistics prices are due to limited competition in the logistic sector. Domestic logistics service providers are not able to provide the necessary services required for multimodal transport and value-added logistics. There are many types of logistics services available in Lao PDR, but none are dedicated to supporting rail freight logistics. Traditional logistics services like freight forwarding, customs brokerage, trucking, and warehousing are primarily provided by local businesses. Local service providers have an edge over international service providers due to transit transshipments and country-specific import/export procedures. Other modern value-added logistics services such as labelling, packaging, tracking and tracing, and even managing vendor inventory are limited, as they require specific expertise and technology not available in the domestic market. Local logistics providers lack skills related to optimization models, quantitative tools for logistics decision-making, and logistics simulation, and they do not have access to enterprise resource planning software, warehouse management systems, or transport management systems (World bank, 2020).

3.1.3 Benefit of trade facilitation reforms for the railway corridor and the BRI Network

The adoption of trade facilitation reforms will be essential to increase the attractiveness of the railway compared to other modes of transport and potentially attract some of the cargo that is currently being transported by sea between ASEAN and China (ASEAN, 2019). The Lao PDR is expecting an improvement in traffic throughput as a result of the implementation of effective trade facilitation and transit processes for all forms of transportation. Additionally, it would make transport operators more affordable. Higher trade volumes would consequently put greater pressure on border authorities and cross-border checks, requiring the further implementation of trade facilitation policies. Without complementary reforms, delays are expected to increase, limiting the increase in traffic compared to expectations and esti-

mates. This would make it less profitable to use the railway network and affect the ability of Lao PDR to leverage its access to the global transport network through the BRI (World bank, 2020).

Trade facilitation reforms are especially important for countries along economic corridors, as weak performance in one country can undermine the impact of infrastructure and regulatory reforms in other countries. The performance of trade facilitation measures varies widely in countries along the future Kunming-Singapore corridor as it does in other BRI land corridor. For trade corridors that incorporate a lot of counties, there is a higher risk of delays and costs due to regulatory compliance. Moreover, trade facilitation reforms need to focus on not only the railway but also on other modes of transport such road and sea transport. Efficient logistics services are important for the success of the railway and its link to the BRI network, and trade facilitation reform will directly contribute to improving logistics performance. Trade facilitation reforms improve the capacity of firms to participate in regional and global value chains. While the speed and efficiency or border clearance is important, trader also need predictable and reliable border processes. In Lao PDR, as in many developing countries, poor risk management practices lead to time consuming and often unnecessary physical inspections and laboratory testing requirements, affecting clearance times (World bank, 2020). For example, multiple inspections by different border agencies are relatively common in Lao PDR. An unpredictable trade environment prompt trader to adopt costly hedging strategies, such as maintaining large inventories to prepare for worst-case supply scenarios, or switching to more reliable, and frequently more expensive, transportation modes. To ensure the efficient use of the trade corridor, Lao PDR also needs to adopt an efficient transit regime. This will be important for the efficient movement of goods along upgrade transport infrastructure that connects to the rest of the corridor. There is currently no efficient transit regime for domestic transit (i.e., for the transit of goods from border crossings to inland locations where they can be cleared or international transit for the transit of goods between two neighbouring countries. Moreover, there is no efficient system to manage or guarantee international transit as the current manual system is very resource intensive, results in high costs, and does not allow for effective compliance and risk management (World bank, 2020).

3.1.4 Challenges of a rail corridor

It will be important for Lao PDR and China to exchange and manage data on cargo shipments for the efficient processing of declarations. Data on rail freight transport are more similar to that of airfreight than road transport in term of data availability and management. Manifest and transaction-level data will be available the railway operator and could be shared with Lao PDR's border control agencies prior to train arrival. This would allow authorities to analyse shipments and make decision before freight arrives at the border, reducing the likelihood of delays. Moreover, a regional whole of corridor portal with end-to-end information on not only regulatory processes and procedures but also rail operational procedures and freight rates would increase trade facilitation and increase transparency of trader. Many officials in Lao PDR are unaware of operational and infrastructure plans related to the Lao-China railway. Beyond the operational requirements of the railway and the control of passenger traffic, planning for freight operations appears to be an afterthought in Lao PDR. At the Boten-Mohan border, Chinese officials could identify plans for goods clearance facilities, including the potential for joint clearance operations and location for x-rays, while officials from Lao PDR are not informed about where and how clearance would take place. Moreover, there is a lack of plans to establish appropriate facilities at intermediate location within Lao PDR to close to where agricultural products are produced or sourced to support agricultural exporters. It will be important that exporters do not have to transport produce long distances to access a railhead for freight loading with suitable inter-modal or appropriate storage facilities. The government need to clarify if the facilities at intermediate locations will be able to clear the export and import of goods. If stations will have this capacity which is recommended by international best practices, they need to be equipped with the necessary equipment and infrastructure. The private sector should also be involved in the planning of railway-related infrastructure, as it would allow private firms provide feedback on the relevance of plans and incorporate set plans into their investment decision. Being able to clear exports at intermediate locations rather than at the border would offer opportunities to reduce regulatory bottlenecks and avoid delays at the border, and this will require all relevant regulatory agencies involved in the clearance of export to be present at these locations (World bank, 2020).

Figure 9: Tunnels and Bridges of Lao-China railway



Tunnel and bridge of Lao-China railway is the world highest plateau (Figure 9.) with eastern plain which the province is filled with mountain and valleys, which naturally are not ideal for rails.

4.1 Agriculture sectors in Lao PDR

Agriculture sector plays a significant part of Lao P.D.R for supporting in domestic and international country. It can be seen that Laos government pay attention and support the agriculture industry with a number of policies which try to make stable the output and seeking ways to ensure the sector is growing healthily and sustainably. Due to supportive policies from the government, agriculture sector has been improved steadily since more than 10 years ago. Now Laos can keep the first rank in the world in terms of farming output such as producing large quantities of rice, wheat, meat, poultry, eggs and fishery products. Laos government plans to make an integration for old agriculture platform to new agriculture platform by using new technologies in order to improve the sector's efficiency (UNDP, 2010). At present, China becomes a biggest supplier, purchasing agriculture products from Laos and also support new technologies which can be said that China is a part of Lao economic growth (World bank, 2020). Since Laos has high speed railway to connect China, it can be seen that China needs more purchasing agriculture product from Laos. Therefore, Laos will not meet the requirement, it means that China need more agriculture product from Laos.

The export of any agricultural products must comply with Chinese requirements and regulation such as standard on quality, disease control and food safety. In practice, majority of Lao agricultural products exported has not met with Chinese standard. Moreover, the export must follow mutual agreement between the two countries and use services of Chinese trading companies to facilitate the trade. Theses condition are considered as challenges and areas that need attention to promote Lao agriculture export (Sayavong, 2019).

China is a key purchaser of agricultural product from Laos, having account for more than 80 percent of Laos's export, with the main crop sold to China being cassava, bananas, watermelons, sugarcane and rubber. In 2021, Laos exported agricultural product to China more than USD 900 million which divided bananas earned USD 225 million, rubber earned USD 214 million, cassava earned USD 196 million, sugarcane earned USD 25 million, and watermelon earned 26 million (ECCIL, 2022). It is apparently that in 2022 Laos has high speed railway to connect to China, so this year the revenue of exporting agricultural product has increased rapidly which half of this year can earn USD 870 million. Laos is the biggest supply chain of agricultural product to support to China, which exports almost 80% of agricultural product (Xinhua, 2021). Laos has a huge wide land for supporting agricultural product to China. Mostly, the location is used to grow agricultural product is on the north of Lao

P.D.R. It can be seen that the north of Laos is a good place to do the agricultural product because land is quite suitable to grow any type of agricultural product (ECCIL, 2022). As we can see the picture below:

Figure 10: Map of Laos



Source: Google map

Figure 11: The north areas for growing agriculture product



We can see the picture above the location is used to grow agriculture product is on the north of Lao PDR

4.1.1 Purchase of types

The government of China purchases agricultural product from Laos, there are mainly banana, rubber, cassava, sugarcane, and watermelon. Laos earns money from China more than USD 900 million per year from exporting agricultural product which divided USD 225 million from bananas, USD 214 million from cassava, 196 million for sugarcane, and 26 million from watermelon (ECCIL, 2022).

Figure 10: Top five agriculture products in Laos



Source: Lao agriculture product's website

Lao-China railway will benefit for any businesses which would be a reduction in cost and time used for transportation and shipment of goods. Not only external but domestic markets would expand due to the time and cost reduction. According to key informant interviews, agri-business companies would definitely use the railway if the transport cost is lower. They expect the sale will be increased because it will provide more access to Cambodian and Chinese market. For the service charged the freight by the railway and trucks. It obviously shows that the charge by the railway is much lower than the truck by 36.9%. For instance, the transport cost from Oudomxay province to Boten at the Lao-Chinese border is 8.5% USD/ton by the railway whereas the cost of truck is round 23.1 USD/ton. More importantly, the time used could be saved for about 3 hours, from 4 hours to 1hour. This shorter shipment time would benefit the export of agricultural products that have a short life circle. (Tabel 3.)

Table 3: Transportation cost of railway

No	Route	Distance	Railway		Truck	
			Time	Cost/ton	Time	Cost/ton
1	Vientiane-VangVieng	125	1 hours	8.7 USD	≥4 hour	23.4 USD
2	Vientiane-Luangprabang	300	2.5 hours	20.8 USD	11 hours	56.3 USD
3	Vientiane-Boten	427	4 hours	29.5 USD	20 hours	80.1 USD
4	Oudomxay-Boten	123	1 hour	8.5 USD	4 hours	23.1 USD

(Source: World bank's calculation)

3. Own research and (Material and Method)

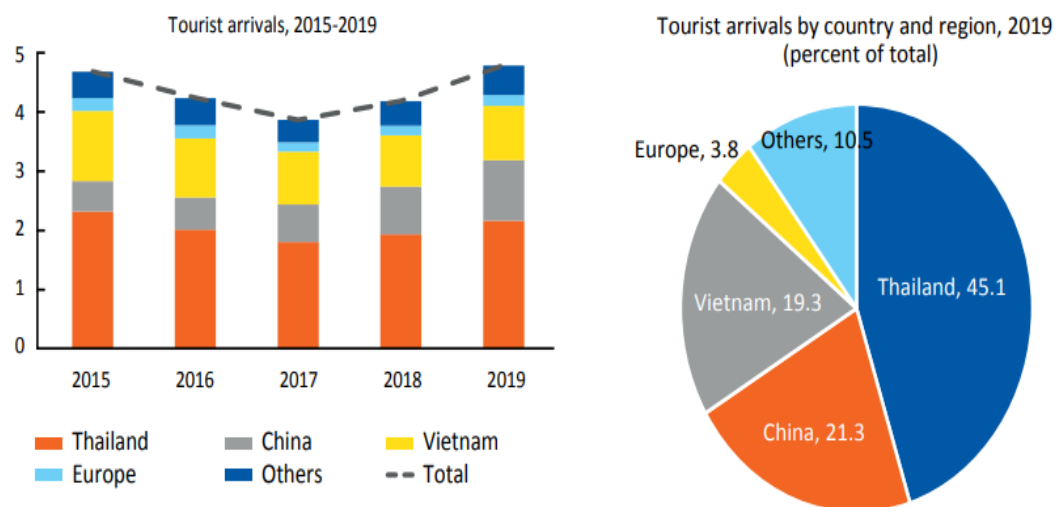
This research aims to study three purposes (i), traveling sectors, (ii), agriculture sectors, and (iii), logistics sectors in order to study the revenues before & after opening Lao-China railway by using data analysis.

This aim needs to know:

- 1.) What are the differences of tourisms before and after opening Lao-China railway?
- 2.) What are the differences of import & export of Lao agriculture products?
- 3.) What are the differences of import & export on logistic sector?

3.1 Traveling sectors

Lao PDR's tourist arrivals before the Pandemic



Source: Ministry of Information, Culture and Tourism.

Table 4: Travel and tourism contribution to GDP in Laos

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Gross Domestic Product (GDP) USD BN	8.3	9.4	11.2	11.7	12.6	15.9	17	17.9	18.2	19.1
Percentage of GDP- Travel & Tourism Total Contribution to GDP	14.6	15.0	14.2	14.1	14	14	13.7	12	10	4.8

(Source: Lao Ministry of Information, Culture and Tourism)

The tourism industry in Laos is dramatically dropped since 2016 to 2019. Due to tourism’s relative share of GDP substantially fluctuated in recent years. As we can see the GDP of travel and tourism was dramatically decreased 5.2% during 2019-2020 due to the impact of Covid-19 global pandemic. Since the end of 2019, the tourism industry was sorely impacted by Covid-19 pandemic which led to a substantial drop for traveling sector. The opening of Lao-China railway is expected to increase the number of tourists arrivals from around the world, especially Thai and Chinese people.

This research has proposed to study six provinces which connects to the railway corridor in Lao PDR. For study this aim to use data analysis to compare the revenues of six provinces. To study before and after opening Lao-China railway: Vientiane Capital, Luang Prabang, Ouxomxay, Bokeo, Luang Namtha and Vang Vieng from 2020 to 2022.

Table 5: Table of Provinces’ revenues

Province	2020	2021	2022
	(millions of Dollars)	(millions of Dollars)	(million of Dollars)
Vientiane Capital	8	10	50
Luang Prabang	2	2.5	138
Oudomxay	0.7	1	20
Bokeo	0.5	0.9	15
Luang Namtha	0.4	0.6	10
Vang Vieng	3	5	110

(Source: own calculation based on data analysis)

The table shows the revenue of six provinces in 2020 and 2022. Vientiane Capital, the amount of revenues USD 8 million, and increased significantly USD 10 million in 2021, and the revenue suddenly jumped USD 50 million due to end of 2021 Laos opened the railway and unlock Covid-19 as the same time. Luang Namtha, the amount of revenues USD 0.4 million in 2020 and increased significantly USD 0.6 million in 2021, and increased USD 10 million in 2022 respectively. Luang Prabang, the amount of revenues 2 USD million in 2020 and increased significantly USD 2.6 million in 2021, and suddenly jumped USD 138 million in 2022. Vang Vieng, the amount of revenues USD 3 million in 2020 and increased significantly USD 5 million in 2021, and suddenly jumped USD 110 million in 2022. Finally, it is personally believed that Lao-China railway will a game changer for Lao people in the future and will attract domestic and international tourisms come to visit Lao PDR.

3.1.1 Logistics and transport sector

Lao PDR is one of the fastest growth economies in the ASEAN region with the economic growth of more than 7% in recent year. With a population of just more than 6.5 million, the logistic sector is quite less develop compared to other countries. Due to the construction of railroad is low and lack of management. However, Lao PDR has opened Lao-China railway in December of 2021, and there is a possible to benefit for Lao PDR import and export. This research aims to use data analyses to compare the revenues of import and export for Lao PDR in five countries such as Thailand, Vietnam, Singapore, China and Cambodia. To study before and after opening Lao-China railway in 2020 to 2022.

Table 6: Table of export's revenues

Export	2020	2021	2022
	(millions of Dollars)	(millions of Dollars)	(million of Dollars)
Thailand	2950	2310	5300
Vietnam	440	1250	1700
Singapore	93	91	125
China	1689	2250	2800
Cambodia	103	129	210

Source: own calculation based on data analysis

The table above shows that first year of 2020, Lao PDR total exported to Thailand USD 2950 million, and amount of exported significant decrease USD 2310 million in 2021, but the amount of exported rapidly increased USD 5300 million in 2022 which highest amount exported. Lao PDR exported to China in 2020 amounted USD 1680 million, and the amount of exported increase significantly USD 2250 in 2021, and continue significantly increase USD 2800 million in 2022 respectively. Lao PDR exported to Vietnam first year of 2020 amounted USD 440 million and next year sudden increased USD 1250 million, and 2022 increased USD 1700 million respectively. For Singapore, Lao PDR exported amount USD 93 million in 2020 and dramatically decreased USD 91 million in 2021, and continue significantly increased USD 125 million in 2022. For Cambodia, Lao PDR exported amount USD 103 million in 2020 and significantly increased USD 129 million in 2021, and continue increased 210 in 2022 respectively.

Table 7: Table of Import’s revenues

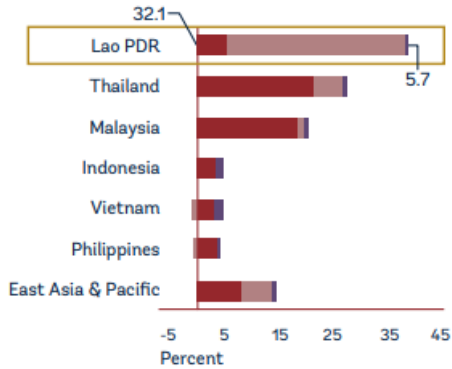
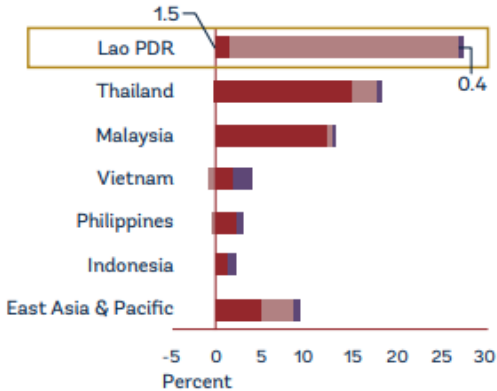
Import	2020	2021	2022
	(millions of Dollars)	(millions of Dollars)	(million of Dollars)
Thailand	3360	2740	4500
Vietnam	300	470	650
Singapore	26	64	125
China	1420	1330	2134
Cambodia	1.3	6	17

Source: own calculation based on data analysis

The table above shows that Lao PDR imported from Thailand in the first year of 2020, amounted USD 3360 million, which the next year dramatically decreased amounted USD 2740 million, but the mounted of 2022 rapidly increase USD 4500 million. Lao PDR imported from China amounted USD 1420 million in 2020, and significant decrease in 2021, amounted USD 1330 million, but the amount of imported 2022, sudden increase USD 2134 million. And Lao PDR imported from Vietnam amounted USD 300 million in 2020 and significant increase in 2021, amounted USD 470 million and significant increase in 2022, USD 650 million respectively.

1.) Increases in exports of goods and service

2.) Increases in import of goods and service



4.1 Agriculture sector

The opening of Lao-China railway and the development of trade corridors with neighbouring countries. This provides Lao PDR with an opportunity to transform the country from an isolated, landlock nation to one that is linked to other countries in the East Asia region through infrastructure that foster trade and integration. These trade linkages also represent an opportunity for Laos to develop high value agricultural production and processing value chain by partnering with agri-processing firms along the economic corridor.

This research aims to use data analysis to study the potential of increasing agriculture products, after and before opening Lao-China railway in 2020 to 2022. To study top five products in Lao PDR such as banana, rubber, cassava, sugarcane, watermelon export in three countries China, Thailand and Vietnam.

Table 8: Table of Export to China

Product	2020	2021	2022
	(millions of Dollars)	(millions of Dollars)	(million of Dollars)
Banana	190	225	422
Rubber	108	214	261
Cassava	150	196	250
Sugarcane	20	25	45
Watermelon	20	26	40

(Source: own calculation based on data analysis)

The table above shows that first year of 2020, Lao exported banana product to China amounted USD 190 million, and next year 2021 significantly increase amount USD 255 million, and 2022 exported rapidly increase amount USD 422 million respectively. Rubber, Lao exported in the first year of 2020 amounted USD 108 million, and 2021 significant increased USD 214 million, and 2022 the amount of export increased USD 261 million respectively. Cassava, Lao exported in the first year of 2020 amounted USD 150 million, and next year 2021, significant increased amount USD 196 million, and 2022 the amount of exported USD 250 million respectively. For sugarcane and watermelon significantly increased year by year respectively.

Table 9: Table of Export to Thailand

Product	2020	2021	2022
	(millions of Dollars)	(millions of Dollars)	(million of Dollars)
Banana	6.9	9	13
Rubber	0.2	0.5	0.8
Cassava	71.3	103	150
Sugarcane	1.5	3.4	7
Watermelon	1.5	2.1	4

Source: own calculation based on data analysis

The table above shows that Lao PDR exported bananas product to Thailand in 2020 amounted USD 6.9 million, and the amount increased significantly USD 9 million in 2021, and in 2022 the amount of exported significantly increased USD 13 million respectively. For rubber, the amount of exported USD 0.2 million in 2020, and increased significantly USD 0.5 million in 2021, and increased continuously USD 0.8 million in 2022 respectively. For cassava, the amount of exported in 2020 USD 71.3 million and increased significantly USD 103 million in 2021, and rapidly increased USD 150 million in 2022. For sugarcane and watermelon significantly increased year by year respectively.

Table 10: Table of Export to Vietnam

Product	2020	2021	2022
	(millions of Dollars)	(millions of Dollars)	(million of Dollars)
Banana	6.24	9.5	15
Rubber	97.7	180	242
Cassava	19.7	25.7	85
Sugarcane	40	61.3	102
Watermelon	9	20	8

Source: own calculation based on data analysis

The table above shows that Lao PDR exported bananas product to Vietnam in 2020 amount USD 6.2 million, and significantly increased USD 9.5 million in 2021, and the exported suddenly jumped USD 15 million in 2022. For Rubber, exported to Vietnam in 2020 amount USD 97.7 million and suddenly increased amount USD 180 million in 2021, and the amount of exported jumped suddenly USD 242 million in 2022. For cassava, Lao PDR exported in 2020 amount USD 19.7 million, and significantly increase USD 25.7 million in 2021, and the amount of exported suddenly jumped USD 85 million in 2022.

4. Results

Lao PDR, from land-lock to land-linked by construction of Lao-China railway. It seems that Lao PDR will get benefit from this railway (BRI), according to the result analysed from method part above. It is obvious that the change of infrastructure of railway affected good in economic in Lao PDR which one of them, traveling sector, logistics sector and agriculture sector. During Covid-19, Lao PDR encountered the biggest challenge, lacked of working capital at least 50% of tourism businesses and up to 65% of formal businesses. However, it seems that Lao-China railway will come a game changer for Lao PDR to attract tourists, and export goods through the railway to Europe, Africa and central of Asia. The opening of Lao-China railway and include unlocked Covid-19 at the same time in 2021 indicated that there is a sudden increase of traveling sector in 2022 especially three provinces such as Luang Prabang, Vang Vieng, and Vientiane Capital. Three of them revenues suddenly jumped compared revenues from 2021 to 2022. For example, all revenues of Luang Prabang from traveling sector amounted USD 2.6 million in 2021 and suddenly jumped USD 138 million in 2022 which mostly tourists are Thai and Chinese people approximately 80%, European people around 4%, and 16% others. One of the reason tourists decide to come to visit Laos unless the opening the railway, because of cost of living quite cheap compared with other countries. Currently in 2022, Lao PDR has been given the top 10 the lowest cost of living in the world and the 1st lowest cost of living in Asia.

For logistics sector, as the result above indicated that Lao PDR exported all products into five countries: China, Vietnam, Thailand, Singapore and Cambodia. It can be seen that Lao PDR exported to Thailand with highest value amount USD 5300 million in 2022, and imported with highest value from Thailand amount USD 4500 million in 2022. And Lao PDR exported to China at the second highest value amount USD 2800 million, and imported from China USD 2134 million. As the result from 2021-2022 of export and import in Lao PDR shows that there is a rapidly increase of amount of revenues. There are two mainly reasons to make Lao PDR exported more than imported, first Lao PDR unlocked Covid-19 and second opened Lao-China railway in December of 2021 affected economic growth by 2.5% in 2022 and expected grow by 4% in 2023. It is personally believed that Lao-China railway will result of Lao PDR economic growth approximately 7-8% in 5 years forward.

For agriculture sector, will be play a significant role for Lao PDR due to Laos has a huge land to grow agriculture product and the main country, Laos will export agriculture product is

China, Thailand, Vietnam, Africa and European country. The opening of Lao-China railway will be a game changer for Lao agriculture. As result above shows that Lao PDR exported agriculture product to China in 2022. For example, exported bananas sudden jumped amount USD 422 million in 2022, compared amount USD 225 million in 2021. And Lao PDR exported Cassava to Thailand in 2022, sudden jumped amount USD 150 million compared in 2021 amount USD 103 million. And Laos exported rubber to Vietnam in 2022, sudden jumped amount USD 242 million compared in 2021 amount USD 180 million. It is personally believed that there will be a potential of Lao agriculture product to export out of Asia countries like Africa and European countries by using the Lao-China railway.

Research Questions and answers

- 1.) What are the differences of tourisms before and after opening Lao-China railway?

The opening of Lao-China railway and include unlocked Covid-19 at the same time in 2021 indicated that there is a sudden increase of traveling sector in 2022 especially three provinces such as Luang Prabang, Vang Vieng, and Vientiane Capital. Three of them revenues suddenly jumped compared revenues from 2021 to 2022. For example, all revenues of Luang Prabang from traveling sector amounted USD 2.6 million in 2021 and suddenly jumped USD 138 million in 2022 which mostly tourists are Thai and Chinese people approximately 80%, European people around 4%, and 16% others. One of the reason tourists decide to come to visit Laos unless the opening the railway, because of cost of living quite cheap compared with other countries. So, it is indicated that there is a significant difference on traveling sector after opening Lao-China railway.

- 2.) What are the differences of import & export of Lao agriculture products?

The opening of Lao-China railway absolutely makes the differences on import & export of Lao agriculture product. For example, Lao PDR exported Bananas to China sudden jumped amount USD 422 million in 2022, compared amount of exported in 2021 USD 225 million, and exported Cassavas to Thailand in 2022, sudden jumped amount USD 150 million compared in 2021 amount USD 103 million, and exported rubbers to Vietnam in 2022 sudden jumped amount USD 242 million compared in 2021 amount 180 million. Therefore, it is indicated that there is a significant difference on agriculture sector after opening Lao-China railway.

3.) What are the differences of import & export on logistic sector?

The opening of Lao-China railway of import & export on logistic sector sudden jumped from 2021 to 2022. The amount of exported to Thailand USD 4500 million in 2022, compared the amount USD 2740 million in 2021, and the amount of exported to China USD 2134 million in 2022, compared the amount USD 1330 million in 2021, and the amount of exported to Singapore USD 125 million in 2022, compared the amount USD 64 million in 2021, and the amount of exported to Vietnam USD 650 million in 2022, compared amount USD 470 million in 2021. So it is indicated that there is a significant difference of import & export on logistic sector after the opening of Lao-China railway.

5. Conclusions and recommendations

The Lao-China railway, which connects Lao people's Democratic (Lao PDR), to the entire network of the belt and road initiative (BRI), has the potential to transform Lao PDR from a landlocked to a land-linked economic. The railway connects the country's capital of Vientiane with the city of Boten at the northern border with China. At Boten, the railway connects with the BRI network at Kunming, China through by 595-km railway link. The railway journey between Vientiane capital of Lao PDR and Boten will take 4 hours by train and significantly less than fifteen hours by car. The Vientiane-Boten Railway could provide Lao PDR with a land link to global and regional supply chain which could make the country more attractive to investors, create new jobs, and accelerate economic growth. However, this would require policymakers to implement reforms to improve the country's business and trade environment and facilitate well-targeted complementary infrastructure investment. Lao-China railway along with associated reduction in trade cost within the border BRI network, has the potential to improve the comparative advantage of Lao PDR and the railway could make the country more attractive as an investment destination and link it to major production and consumption areas in china and the association of southeast Asian Nations (ASEAN). With a number of planed export processing zones around the station. There is a potential to serve as attractive investment location as long as they are properly equipped and effectively managed with efficient logistics services. Lao PDR could develop into a logistics hub, while targeted investments in agriculture and tourism could result in new export opportunities.

To support the rail facilities. In the near term, Lao PDR need to improve the road that connect the railway with various trade corridors. It also needs to ensure open access to rail-head and that stations are equipped with facilities that can handle containers and facilities multimodal transport. Logistics facilities such as inland container depots should be managed by private operators, and the regulatory framework needs to ensure that private operators can operate competitively and at scale. Lao PDR doesn't have operator that can offer integrated multimodal transport service, as the logistic market is dominated by local providers that mainly offer traditional logistics services. There is limited the availability of value-added services such as integrated door to door multimodal transport, container, leasing, inventory management, order fulfilment, purchase order management, or cold chain services. The Lao-China railway will be the east and west economic corridor and the key road networks. Lao PDR can fully benefit from improved regional connectivity, not only as a transit country but also through increased economic activities and export volumes, value-added services, and the crea-

tion of new and better jobs. These connections are expected to reduce transport cost and boost bilateral and transit trade by attracting some traffic currently using maritime and air transport routes. The improvement of regional connectivity could support economic recovery, especially in agriculture and tourism sector, promote private investment, create jobs for the poor and reduce rural poverty, especially in the northern and central regions of the country. Finally, it is personally believed that Lao PDR will gain the opportunities and challenges on Lao-China railway such as attract private investor to invest in Lao PDR, be able to create new jobs, motivate tourism sector, and the ability of export agriculture product into European country.

6. Summary

The Lao-China railway is 414-kilometer standard gauge track that connects Laos's northern border town of Boten to its capital city, Vientiane. The railway runs through some of the country's most populated, biodiverse, and resource rich region. The Lao national railway state enterprise holds a 30% share in the project, while Chinese capital holds the remaining 70%. The railway is built on a single track with passing loops and is electrified to China's class I truck railway standards, suitable for 160 km/h (99 mph) passenger and 120 km/h (75 mph) freight train. The railway is a part of the Kunming-Singapore regional railway, covering a total distance of approximately 3,000 km, and China, and China's One belt, One road initiative. It will turn Laos from a landlocked country into one that is land-linked, facilitating more trade between provinces, ASEAN neighbours, as well as with China. The railway is expected to make domestic travel in Laos much quicker and open up opportunities for foreign investment and tourism and also attract greater foreign investment and tourist, and logistic costs from Vientiane are expected to decrease. The railway is expected to connect with other railway lines planed for Laos and has provisions in the south to link with the Bangkok-Nong Khai high speed railway in Thailand, and railway is expected to benefit Lao people of all ethnic groups, facilitate and reduce costs of transportation, stimulate the development of agricultural and industrial sectors, tourism, investment and trade, as well as generate income for Lao people and the country. The project was financed according to a 60:40 debt to equity ratio, with \$ 3.54 billion of debt and \$ 2.36 billion of equity. The railway was completed in December 2021, and it is expected to initially reach 3.98 million domestic rail passenger per year, according to a study by Lao authorities, and could reach up to 8.62 million passengers per year in the future.

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