

Planning the Urban Public Transport System in Vientiane, Lao PDR (CTCN Technical Assistance)

Background and VTMP Review Report



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CTCN Ref: Technical Capacity Enhancement for Planning Urban Public Transport System in Vientiane, Lao PDR



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Executive Summary

Project Objective and Scope

This Project is a Technical Assistance (TA) pro bono modality project facilitated by the UN Climate Technology Centre & network (CTCN) and funded by the Korean National Research Foundation (NRF) and is entitled: **Technical Capacity Enhancement for Planning Urban Public Transport System in Vientiane, Lao PDR.**

The main objective of the TA is to provide the Lao PDR assistance in planning their future urban public transport network including the use of advanced technologies (ITS) and enable knowledge transfer from Korea.

1. **Urban Public Transport Network for Vientiane:** Review of the ongoing plan for the urban public transport network in Vientiane. Based on previous studies, network planning concepts, and experience in Korea, review the network concepts and proposed policies and provide additional commentary and recommendations. Special focus will be paid the BRT expansion plans.
2. **Smart Public Transport:** Develop conceptual scenarios for Smart Public Transport, with a focus on ITS solutions including:
 - Electronic payment cards (T-money)
 - Bus management systems (real-time tracking of buses)
 - Bus information systems to provide real-time information and predicted arrival times of buses including physical terminals, web-based, app-based, and third-party data
 - Data management centre (TOPIS), big data tracking of public transport data
 - Real-time road condition monitoring (used by data management centre)
 - Third-party data sharing (Kakao, Naver, Google etc.)
 - Smart bus stops
 - Demand-Responsive Transit (DRT)
 - Autonomous vehicle shuttles (AV)
 - Mobility as a Service (MaaS) Applications
 - Taxi-hailing
 - Wi-Fi on buses
 - CCTV
 - i. Pre-Feasibility Study for One Intervention (e.g. DRT): Choose and implement a pilot project based on one of the short or medium-term interventions developed in the above studies
3. **Capacity Enhancement for Lao PDR urban Public Transport:** Strengthening the capacity of the Lao PDR to undertake public transport projects including planning and operations (focus on BRT)

Purpose of this Report

This report details a review of the proposed future public transport network for Vientiane. It can be considered a peer review of the works undertaken. This report is divided into the following Chapters:

1. Introduction
2. Summary of Other Works
3. Baseline/Existing Conditions

4. Review of the Vientiane Transport Master Plan (JICA)
5. Recommendations for Changes to the VTMP
6. Smart Transport Scenarios
7. Pre-Feasibility Study

1 Introduction

Project Details and Objective

- 1.1 This Project is a Technical Assistance (TA) under the pro bono modality project facilitated by the UN Climate Technology Centre & Network (CTCN) and funded by the Korean National Research Foundation (NRF) and it is entitled: Technical Capacity Enhancement for Planning Urban Public Transport System in Vientiane, Lao PDR.

Overview

- 1.2 This project is being undertaken in the capital city of the Lao People's Democratic Republic (Lao PDR), Vientiane. While Vientiane has slower population growth than other Asian metropolitan cities such as Bangkok, Jakarta, and Manila and does not yet suffer from the chronic large-scale traffic congestion that affect huge cities, for a city of its size it is developing more traffic issues and there is an increasing trend of more fossil-fuel-based private car ownership. The Lao PDR has ambitious targets related to Greenhouse Gas (GHG) emissions and will need to see large-scale reductions in GHG emissions across all sectors, including transport.
- 1.3 Much has been done in the way of planning the transport network in Vientiane over the last few years, especially on the development of a Bus Rapid Transit (BRT) system first proposed by the Japan International Cooperation Agency (JICA) and developed by the Asian Development Bank (ADB). This BRT project will benefit the people of Vientiane and will importantly help the Lao PDR on its quest to achieve its goals of reducing GHG emissions from transport by targeting a switch from privately operated, fossil-fuel based, transport modes to more environmentally friendly and efficient high-capacity electric buses.
- 1.4 The Lao PDR currently lacks the capacity to complete transport-related studies including their detailed planning, feasibility studies, financial arrangements, and institutional arrangements for planning and operation of a modern public transport system. As such, the Lao PDR requested Technical Assistance (TA) for planning their future public transport system through the United Nations (UN) Climate Technology Centre and Network (CTCN) program which "provides technology solutions, capacity building and advice on policy, legal and regulatory frameworks tailored to the needs of individual countries by harnessing the expertise of a global network of technology companies and institutions."¹

Objective

- 1.5 The urban public transport system best suitable to Vientiane Capital with the projected population growth and increased visitors (tourists) will be planned, surveyed, assessed, and implemented, based on the enhanced capacity for the urban public transport system

¹ <https://www.ctc-n.org/>

development in Lao PDR. Based on this, GHG emission reduction in the transport sector will be achieved by promoting a modal shift from private vehicle-based land transportation using fossil fuels (gasoline and/or diesel) to urban public transport system (potentially mass passenger transport mode). In addition, traffic accidents due to heavy dependency upon private vehicle-based road transportation could be decreased, and air quality could be improved, to contribute to the security of human health and lives, and the conservation of tourism resources in Vientiane of the historic city.

1.6 The details of the steps of The Project are as follows:

1. **Urban Public Transport Network for Vientiane:** Review of the ongoing plan for the urban public transport network in Vientiane. Based on previous studies, network planning concepts, and experience in Korea, review the network concepts and proposed policies and provide additional commentary and recommendations. Special focus will be paid the BRT expansion plans.
2. **Smart Public Transport:** Develop conceptual scenarios for Smart Public Transport, with a focus on ITS solutions including:
 - Electronic payment cards
 - Bus management systems (real-time tracking of buses)
 - Bus information systems to provide real-time information and predicted arrival times of buses including physical terminals, web-based, app-based, and third-party data
 - Data management centre (TOPIS), big data tracking of public transport data
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 - Smart bus stops
 - Demand-Responsive Transit (DRT)
 - Autonomous vehicle shuttles (AV)
 - Mobility as a Service (MaaS) Applications
 - Taxi-hailing
 - Wi-Fi on buses
 - CCTV
- i. Pre-Feasibility Study for One Intervention (e.g. DRT): Choose and implement a pilot project based on one of the short or medium-term interventions developed in the above studies
3. **Capacity Enhancement for Urban Public Transport:** Strengthening the capacity of the Lao PDR to undertake public transport projects including planning and operations (focus on BRT, DRT, and bus reform.)

Outcomes

- 1.7 Upon completion of this TA, the Lao PDR can focus on implementing public transportation service improvement projects that apply information and communication technology (ICT), modern transport planning standards, and modern administration based on knowledge transfer from Korea. This will allow them to cope with their increasing traffic congestion and air pollution problems, set-up expanded BRT, BIMS (Bus Information and Management System), or DRT and, as a result, improve the public transportation mode share.
- 1.8 As part of this TA, we will also identify funding opportunities and develop a pre-feasibility study for one intervention, to be determined during this study. This TA will also identify the

GHG emission reduction potential of several identified public transport network types, and the GHG emissions reduction potential of the chosen pre-feasibility study intervention. As such, this TA will aid the Lao PDR in understanding how its investment will aid in their NDCs and other goals, such as their goal of becoming a net zero country by 2050.

This Report

- 1.9 JICA in coordination with Katahira & Engineer International, International Development Center of Japan Inc., and Oriental Consultants Global, has been undertaking the Vientiane Transport Master Plan Project (VTMP). This project kicked off in June 2019 and is ongoing. The scheduled end date is December 2022. The VTMP covers all transport modes (road, public transport, taxi, private vehicles, urban rail etc.
- 1.10 This report details a review of the above-described proposed future public transport network for Vientiane. It can be considered a peer review of the works undertaken.
- 1.11 This report is divided into the following Chapters:
 - 1. Introduction
 - 2. Summary of Other Works
 - 3. Baseline/Existing Conditions
 - 4. Review of the VTMP
 - 5. Recommendations

Vientiane, Capital of the Lao People's Democratic Republic (PDR)

General Overview

1.12 The sovereign state of the Lao People's Democratic Republic (Lao PDR) has a long history dating back to at least 1353 with the establishment of the Lan Xang Hom Khao (Lan Xang kingdom). Laos most recently achieved its independence from France in 1953, with the Kingdom of Laos transitioning into the modern Socialist Republic upon abolishment of the Royal Lao Government in 1975. A landlocked country located in Southeast Asia; the population of the Lao PDR is currently estimated to be around 7.3m people¹. The country is contained within an area of 286,000 km² making it larger than neighbouring SEA counties of Cambodia, Brunei, East Timor, and Singapore, but smaller than other southeast Asian countries. In terms of population, Laos is only more populous than Singapore, East Timor, and Brunei.

Figure 1: Lan Xang Avenue, the Main Boulevard in Vientiane



1.13 Vientiane is the capital city of the Lao PDR and has been the capital of Laos since independence from France in 1953. Vientiane Capital is a growing city of approximately 0.97 million residents (as of 2021) which is projected to grow to over 1.4 million by 2045. Between 2000 – 2020, the average population growth rate of Vientiane Capital was approximately 2.9% annually. However, this is projected to reduce to an annual rate of approximately 1.85% from 2020 to 2045¹. The metropolitan area of the Vientiane Capital also includes parts of neighbouring Vientiane province, in total the metropolitan area of Vientiane is estimated to be around 1 million – 1.2 million people as of 2021.

1.14 The Lao PDR is bordered by Thailand to the west and south, Vietnam to the east, China to the north, Cambodia to the south, and Myanmar to the northwest (see Figure 2).

Figure 2: Map of Lao PDR in Indochina



Economy Overview

- Pre-pandemic, the Lao economy experienced significant growth. Year over year, the economy grew by around 6-8% every year since 2000, making it one of the fastest growing economies on earth during this period. This economic growth was driven in part by tourism, but Laos also exports some goods, including wood products, coffee, tin, copper, gold, and electricity to its neighbours, mainly Thailand, China, and Vietnam.
- The Lao economy has suffered greatly from the effects of the COVID-19 pandemic. The year over year GDP growth rate dropped by approximately 90% from 2019 to 2020, at the height of the economic crisis caused by the pandemic. However, the economy did not contract, but only grew by approximately 2.7% in 2021, according to the World Bank.
- At the same time, the Lao government had undertaken, partnered with China, the Lao-China railway which cost approximately \$6 billion USD, a significant portion of which was paid for through Lao debt to China. Due to the shock of the pandemic, there was a risk of default of this debt in 2020 and a subsequent economic crisis.
- However, the Lao economy managed to stave off default and is indeed forecasted to increase in 2022 once more, by around 3.5% over 2021. This is driven in part by a revival of tourism² and cross border trade, mostly through China. Overall, the Lao economy is the smallest in Southeast Asia (ASEAN), being worth approximately \$19 billion USD in 2019, which is around \$2,670 per capita according to IMF estimates

Transport Overview

- A growing economy means growing demand for services, vehicles, and transport. Transport demand, and especially car ownership, has significantly increased in recent years.
- Mobility in the Vientiane largely depends personally owned transportation: motorcycles and cars. This is supplemented by on semi-public transportation options such as bicycles, jumbo, songthaew, and taxis. Vientiane citizens prefer motorized means of transportation such as motorcycles and tuk-tuks, and the use of formalized public transport such as buses is relatively low at under 1%.
- Transport demand, and especially car ownership, has significantly increased in recent years. As of 2018, Vientiane's vehicles accounted for 43% of the 900,000 registered vehicles (of which 610,000 are motorcycles) in the country. The number of motor vehicle registrations in Vientiane is growing at a high annual average of 13%, especially the number of motorcycles, which accounts for a large proportion of the supply.
- Vientiane's public transport system has secured more than \$105 million USD in funding for the construction of 11.5km of busways with the goal of operating a BRT system with three routes, from 2024 or 2025 onwards.

Environmental Goals Overview

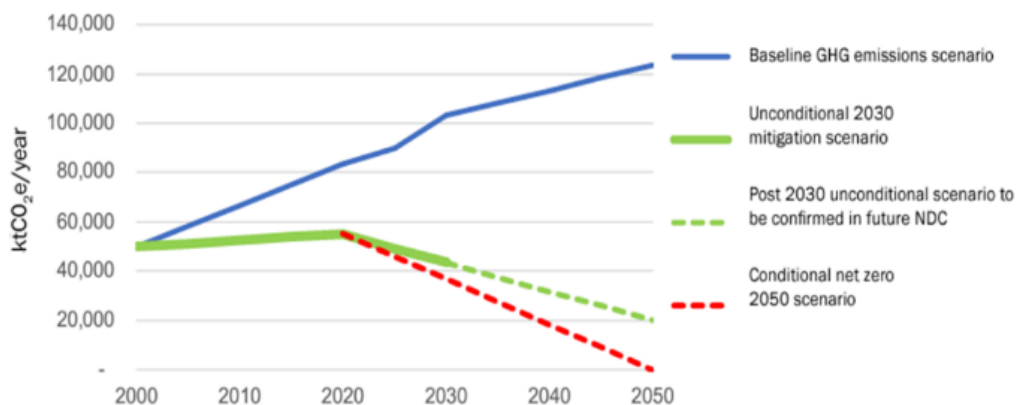
- The rapid increase in personal transportation has led to various urban problems such as various air pollution, traffic accidents, and vehicle congestion, and, it has

² Economist Intelligence Unit <https://country.eiu.com/laos>

caused social issues such as various environmental problems such as increased Greenhouse Gas (GHG) emissions and air pollution caused by exhaust gases.

- The Lao PDR was the first ASEAN member to join the Paris Agreement in 2016 and is striving to reduce GHG emissions in the transportation sector by increasing the penetration rate of two-wheeled and passenger electric vehicles by 30% by 2050 and reorganizing the public transportation system. The Lao PDR government has taken steps to achieve its targets, including asking for assistance to develop plans and pre-feasibility studies to improve the urban public transport network is Vientiane from other international organizations.
- Past plans for transport in Vientiane have focused on the public transportation network to cope with extreme traffic congestion, traffic accidents, and air pollution problems. Additionally, a BRT system that can transport large amounts of passengers at relatively low construction costs has been identified as a key project to improve the public transport system.
- **Lao PDR’s vision is for net zero GHG emissions by 2050.**
- Following the GHG reduction scenario, financial investment in climate change will be expanded by 2030 and applied to future Laos Green Urban Transport projects from the Vientiane Sustainable Urban Transport Project (VSUTP) and ADB.
 - Bus lanes and station construction and BRT Corridor, 2022.04 ~ May 2022
 - BRT depots and warehouses and control center, 2022. Q1

Figure 3: Greenhouse Gas Reduction Scenarios for All Sectors



Source: Lao PDR Government (Ministry of Natural Resources and Environment), 2021

- To reduce GHG emissions in the transportation sector, the Lao PDR made several proposals, including the introduction of a new high-speed rail system, BRT system, and other improvements to non-motorized transport, with a target of an average reduction of 25-300 ktCO2e/y between 2020 and 2030.
- Additionally, the Lao PDR intends to achieve a 30% penetration rate of electric vehicles including two-wheelers and passenger cars, and secondly, a switch to biofuels for 10% of transportation fuels. Together, these policies are targeted to reduce GHG emissions by 30 ktCO2e/y - 29 ktCO2e/y.
- Together, these policies are not enough for the Lao PDR to achieve its targets; additional policies are needed.

2 Summary of Other Reports

Overview

2.1 In this Section of the report, we will summarize the main findings of the following Reports for Ongoing and Completed planning works in Vientiane:

Figure 4: Reports to be Reviewed

		
<p>Asian development Bank (ADB)</p>	<p>Japan International Cooperation Agency (JICA) Katahira Engineers International</p>	<p>Ministry of Land, Infrastructure and Transport (Japan) Nippon Koei, Pacific Consultants</p>
<p>Vientiane Sustainable Transportation Project (2011 – present)</p>	<p>Transportation Master Pan, Others (2008)</p>	<p>Study Project for Smart City Development in Vientiane Capital (2022)</p>

Vientiane Sustainable Urban Transportation Project (VSUTP)

2.2 The Vientiane Sustainable Urban Public Transportation (VSUPT) includes multiple components with the aim to transform the public transport system in the capital and largest city of Lao PDR, Vientiane. The mainstay of this project is a 11.5 BRT busway system through the central area of Vientiane. Other components include:

- Support for non-Motorized Transport (NMT)
- Traffic Management (traffic signal priority)
- Parking Management
- E-Pedicabs

BRT Project

2.3 JICA developed a Transportation Master Plan (TMP) for Vientiane in 2008, which first recommended a BRT system for the city. Based on this and further development by ADB planner, an initial 12.9 km busway segment was studied, planned, and financed by the Asia Development Bank (ADB), European Investment Bank, Global Environment Facility, and OPEC.

2.4 Since 2011, ADB has undertaken the planning of this project while JICA have provided support to improve the operational and management capabilities of Lao PDR agencies who would be managing the operation of these transit systems.

2.5 The BRT project is currently in pre-construction phase, and will include 12.9 km of dedicated lanes, 24 closed stations, a system operation center, electronic payment system, real-time bus operation information provision system (BIS), and of BRT vehicles that meet EURO emission standards. The BRT is estimated to be complete by 2024.

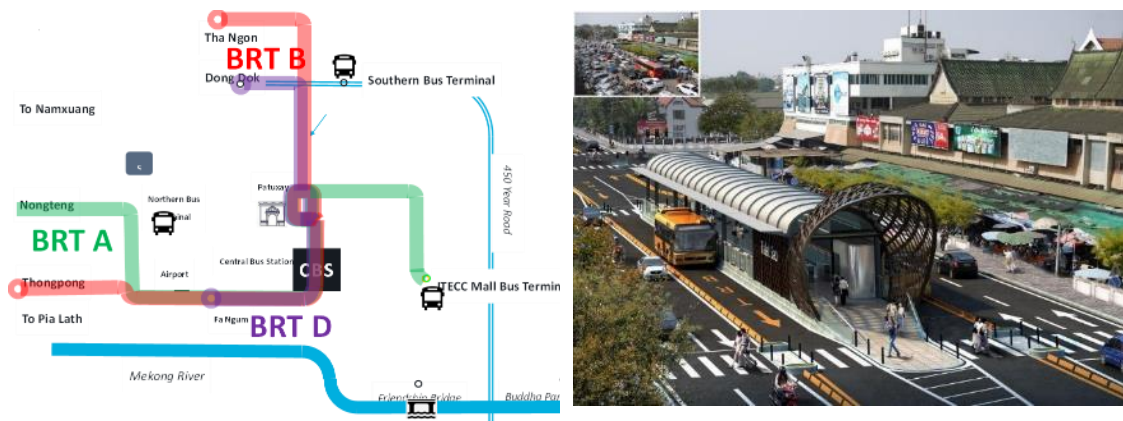
2.6 The Phase 1 portion of this project is an 12.9 km busway connecting Dong Dok (National University of Laos) through the Central Bus Terminal west to Fa Ngum Park (BRT D). The project will be an open BRT concept, meaning routes are not restricted to the bus lanes only. By 2024/2025 there should be three routes operating through a portion of the buaway (BRT A, B, and D):

- BRT A: ITECC Mall–Non Teng
- BRT B: Tha Ngon–Thongpong
- BRT D: National University of Laos–Fa Ngum Statue

2.7 The approved BRT network and a sample rendering of a station is shown below in Figure 5. The combined network is expected to be completed in 2024 with a total bi-directional route length of more than 300 km, carrying 48,000 passengers daily and reducing CO₂e emissions by 25,000 tonnes per year.

2.8 BRT will provide a combined service frequency of less than 5 minutes in the busway section, and the three BRT routes will run for 18 hours a day (6:00 AM – 10:00 PM).

Figure 5: Planned BRT Configuration and Station Rendering



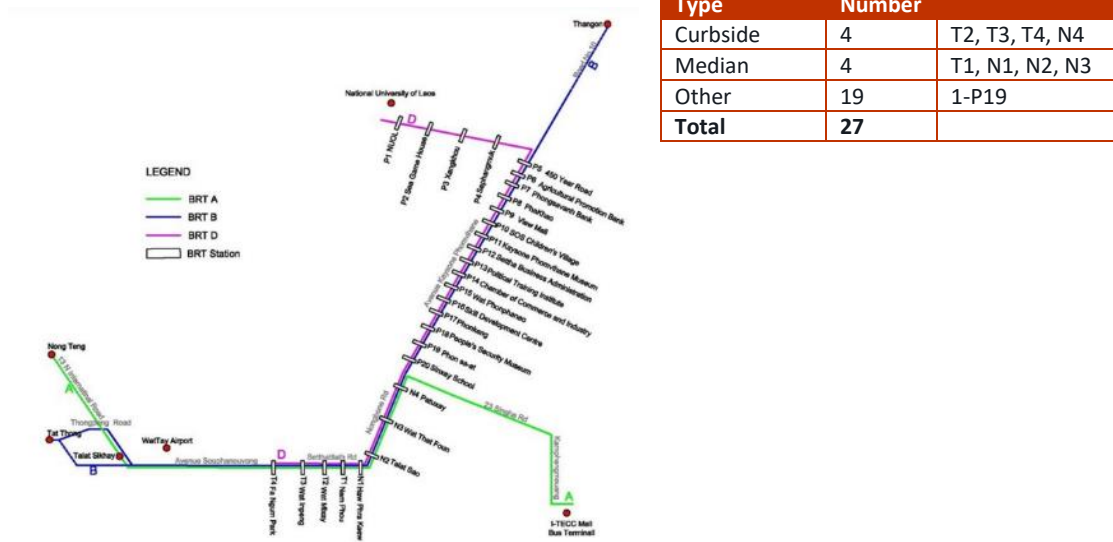
Source: Vientiane Department of Transport, ADB VSUPT Website, 2022

2.9 These initial routes were planned according to the BRT Planning Guide using the latest in international best practices. In general, the BRT lines and stations were chosen to

- serve high transit passenger volumes;
- be located near planned and existing high density development;
- be located where existing road has enough right-of-way; and
- have stations located roughly 450 meters apart.

Additional information is included below in Figure 6.

Figure 6: BRT Stations



Source: ADB VSUPT

2.10 All buses should be equipped with validators, including QR Code validators for smart payment.

- Customers can pay into an “e-wallet” from their phone bill or bank account.
- The system should interact with different banking apps (not only BCEL)

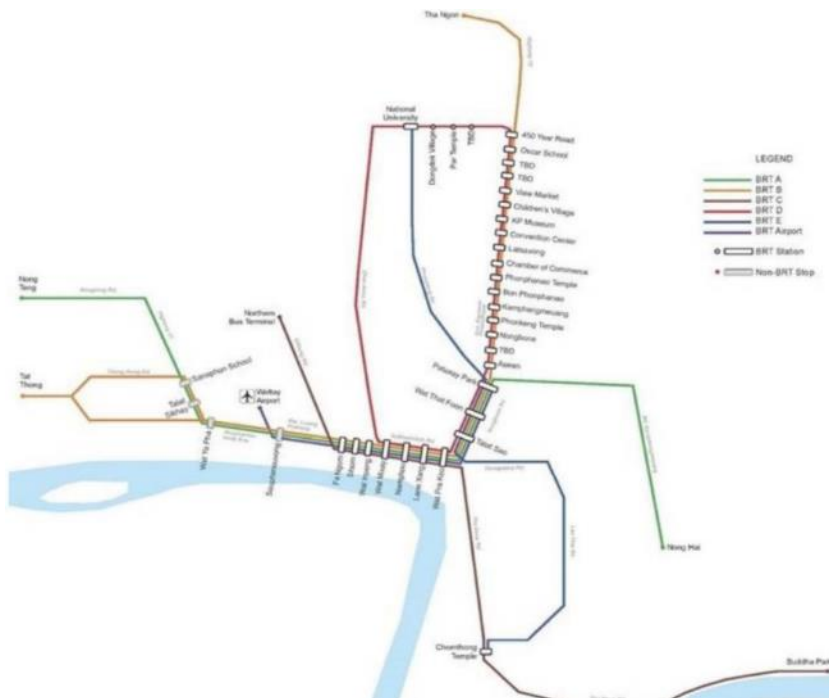
- Paper tickets are available from retail stores for passengers without a smart phone or e-wallet.

2.11 The BRT project will include advanced traffic signal priority (TSP). In VSUTP, bus priority will be required in the mixed traffic sections and where bus course is shifting lanes to avert general traffic hindering the BRT.

Future Expansion

2.12 After Phase 1, the network is planned to be extended throughout the entire Vientiane region. ADB developed a conceptual network for the eventual expansion of the BRT network, which is shown below in Figure 7.

Figure 7: Planned BRT in Vientiane (ADB Proposal)



Source: ADB VSUPT Website, 2022

2.13 Further, as part of this project ADB funded a loan for the Lao PDR to develop a smart public transport fare collection system (QR code-based payment system) for the public bus system, which is has been completed.

Parking Management

2.14 On-street parking is allowed on all streets, except for the Transit Mall, streets with traffic priority and streets with pedestrian priority. These non-parking zones are shown below in Figure 8.

Figure 8: Parking Management (VSUTP)



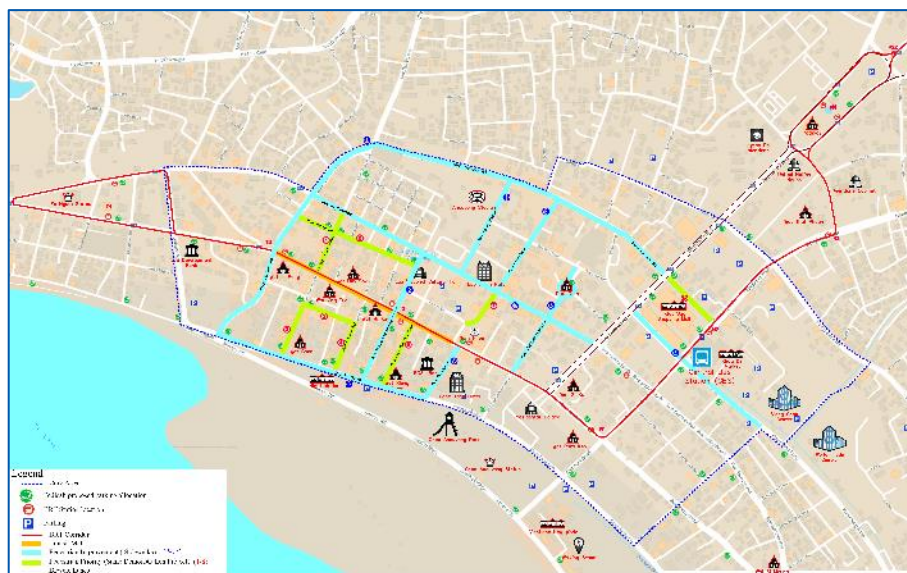
Source: ADB VSUTP

- 2.15 As part of this plan, parking management will be increased with increased manual enforcement of illegal parking, potentially by a private operator.

Non-Motorized Transport

- 2.16 Another major component of this Project includes non-motorized transport support. The VSUTP includes a plan to increase patronage of NMT in the central Vientiane area, refer to Figure 17.

Figure 9: NMT in the VSUTP



Source: ADB VSUTP

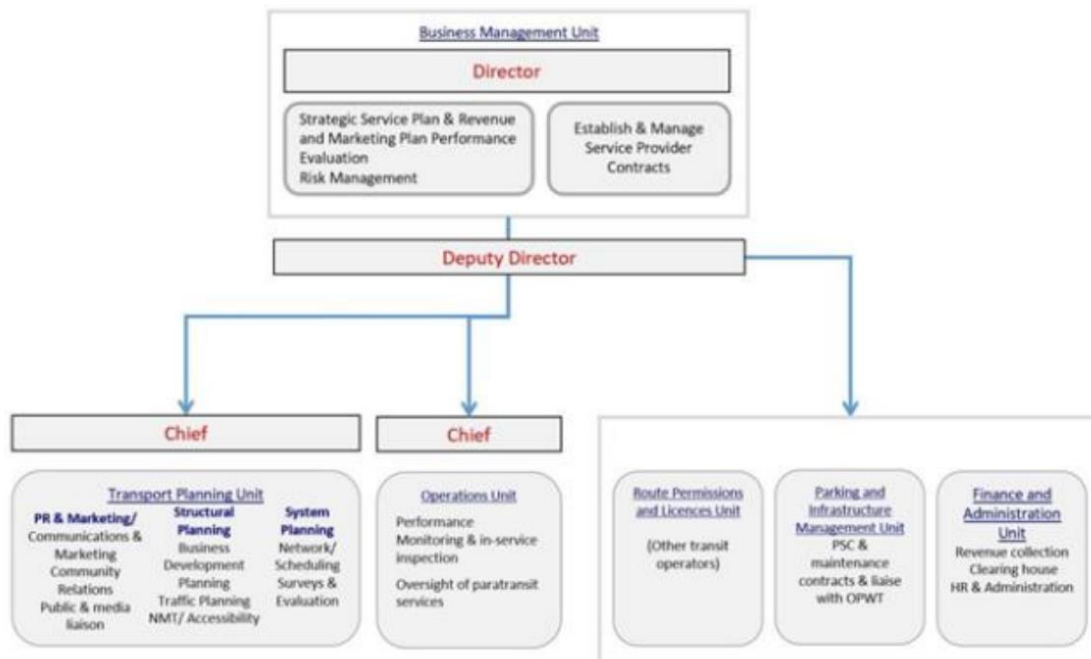
- 2.17 Bicycle lanes continue to be considered. Additionally, an E-Pedicab pilot project will be implemented in Vientiane. Preliminary locations for Pedicab parking have been identified and

plotted on the NMT map (Figure 9). These will be provided at all BRT stations from the City Centre to Patuxay Park to attract more users and make the BRT system more attractive.

Management Agency

- 2.18 The project will also set up a transport management agency, the Urban Transport Management Section (UTMS) that will oversee BRT operations and facilities and other sustainable transport operations in the future.

Figure 10: Management Agency Org Chart



Outcomes

According to ADB reporting, the BRT will increase the use of public transport to 6% by 2025. When the BRT is fully operational, it will serve 48,000 riders a day and cut down the city's GHG emissions by 25,000 metric tonnes of CO_{2e} per year from 2020 onwards.

Transportation Master Plan (2008)

Overview

- 2.19 JICA have been involved in providing aid and expertise to the Lao PDR for many years. One of their major studies was the 2008 Transportation Master Plan (TMP). This document set a bold vision for the future of Vientiane. JICA is currently engaged in updating/creating a new TMP for Vientiane and have recently completed other transport-related projects including the *Vientiane Bus Construction Capability Improvement Project (2016.8 - 2020.3)* and others. In this overview of this document, we focus on the public transport network recommendations and targets.

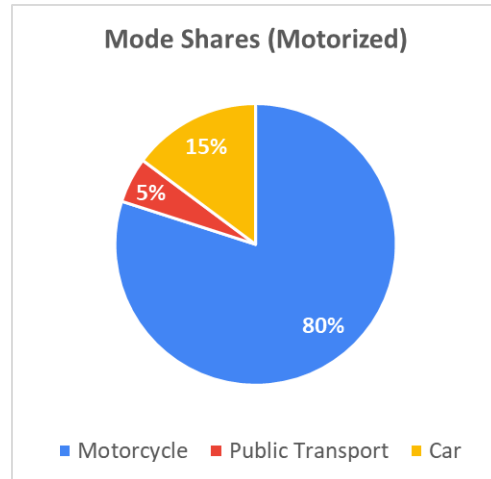
Existing Conditions (2005)

- 2.20 This report details the state of the Vientiane public transport network as it was in 2007. This is accomplished through field surveys, observation, modelling, and data collection. Namely, JICA conducted an OD Survey in 2007 which provides the basis for most of the future recommendations.

2.21 Firstly, this report notes that the public transport system in Vientiane in 2007 is “insufficient to meet the demands and requirements of the present and potential users.” This is primarily based on observation, and communication with Lao PDR officials. In 2007, the following mode shares were noted:

Figure 11: Mode Shares (Motorized Transport) 2007

Mode	Number	Share
Motorcycle	572,739	80.0%
Public Transport	37,427	5.2%
Car	106,189	14.8%



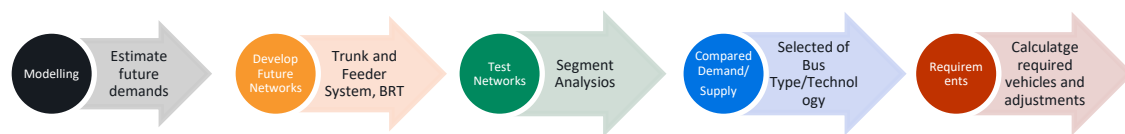
2.22 Further, it had been noted that ridership on the Vientiane Capital Station Bus Enterprise (VCSBE), the on (state-owned) provider of public transport in the city had seen declining ridership over the last few years. In 2007, the public transport network consisted of the following:

- 15 minutes or less: 4 routes
- 30 minutes or greater: Other routes
- Hours of service: 6:00 AM – 17:30 PM (11.5 hours per day)
- Coverage: 124 km total (13% of population)
- Buses generally well utilized

Planning Process and Outcomes

2.23 The general process for planning the future networks was as follows:

Figure 12: JICA TMP (2008) Design Flow for Scenario Evaluation



2.24 The TMP set the following Level-of-Service targets to for any new route design:

- Express route: 16 – 18 hours a day
- Other route: 13 – 16 hours a day
- 315 km total length (33% of population)
- Reliability targets (only one late bus per week)
- Comfortable load factors

2.25 These design targets represent a significant change from the existing conditions. Further, JICA set the following mode share targets:

Table 1: Mode Share Targets in the 2008 TMP

Mode	2013	2018	2025
Reductions			
Motorcycle	-15% (Work purpose) -40% (School purpose)	-35% (Work purpose) -70% (School purpose)	-75% (Work purpose) -90 (School purpose)
Car	-5% (Work purpose)	-10% (Work purpose)	-30% (Work purpose)
Overall			
Walk		25%	20%
Motorcycle		60%	39%
Car		11%	15%
Public Transport		15%	25%
			18%
			24%
			18%
			40%

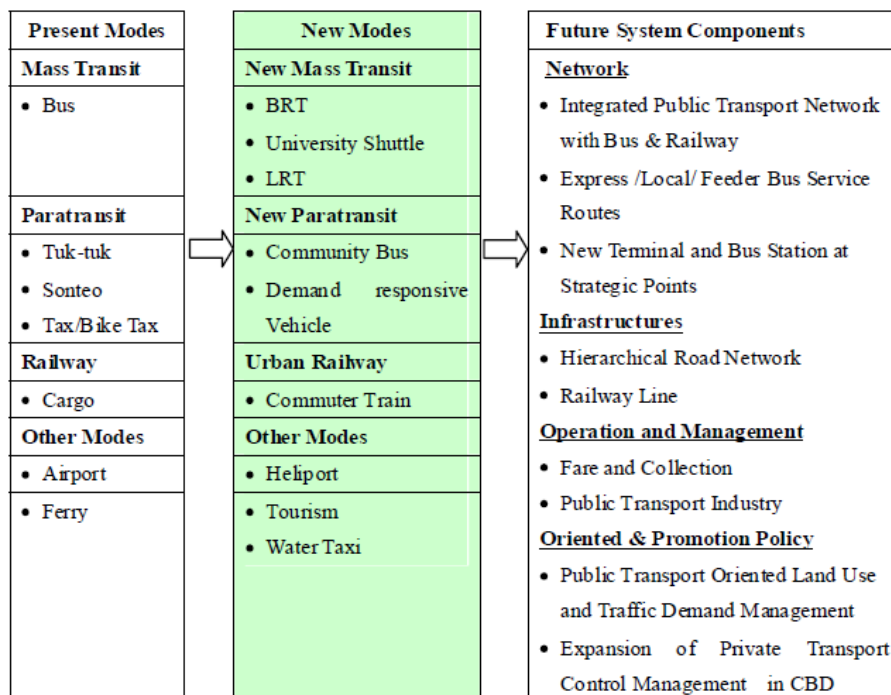
2.26 Notably, the targets include a massive increase in public transport rising rapidly from around 4% in 2007 to 40% in 2025 (corresponding to a 2pp increase per year).

Network Improvements

2.27 To accomplish these targets, the TMP makes several recommendations and plans for the future public transport network, including implementing new modes:

- Bus Rapid Transit (BRT)
- Shuttle buses
- Light Rail Transit (LRT)

Table 2: Mode Development in the 2008 TMP



2.28 These new routes are shown below in Figure 13. The 2008 TMP estimates that by 2025, the following vehicles would be required, refer to Table 3.

Table 3: Bus Network and Required Vehicles

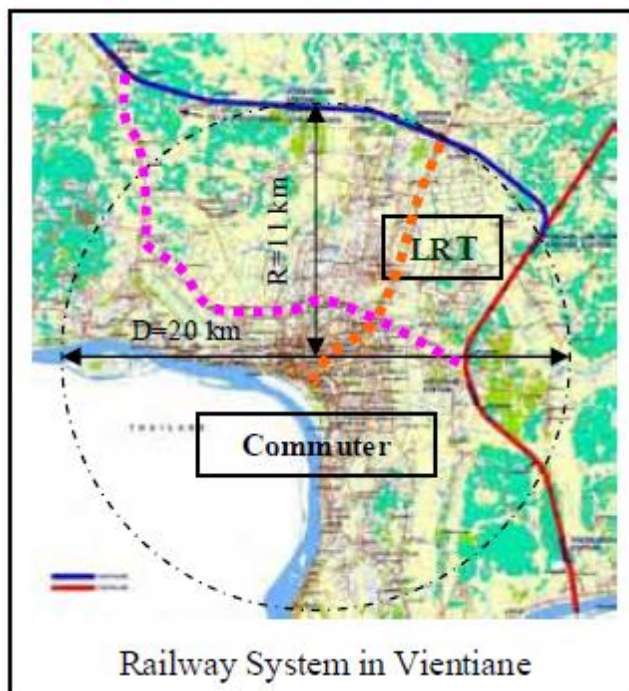
Year	2013	2018	2025
Number of routes	35	35	43
Minibuses	126	109	152
Regular buses	138	189	132
BRT buses	0	12	68
LRT trains	0	0	0
Total	264	310	352

Figure 13: Proposed Bus Routes

Light Rail or Metro

2.29 As a long-term (beyond 2025) projects, some rail lines were planned for the Vientiane urban area. A light rail (LRT) route for city center and commuter line (MRT) line for the missing link of circular route, along the Mekong River, see Figure 14 below.

Figure 14: LRT Design, 2008 TMP



- Two different central stations in Vientiane for passengers and freight.
- Formation of urban circular railway
- LRT route for city center and MRT commuter for missing link of circular route, along the Mekong River.
- Establishment of new Urban Commuter and LRT Operator.

Paratransit Operations

2.30 Paratransit operations (tuk-tuks, jumbos, songthaews, and official taxis) are described by the 2008 TMP as “small and shabby vehicle modified from light trucks and motorcycle”. Improvements to the systems are recommended, including the following:

- Coordination with mass transit modes
- Upgrade of services level by new vehicle
- Promotion of usage for feeder transport

- 2.31 The TMP recommends reforming and restructuring the paratransit system, including phasing out the tuk-tuk services in CBD or urban area. Overall, an incremental approach is recommended proposing that paratransit be reviewed in accordance with the bus mass transit development and finally supplemental operation on feeder bus routes where the transport demand is sparse and low.

Reform of the Vientiane State Bus Company

- 2.32 It was noted that the VSBC suffered many issues, including that its profits have been decreasing and has no financial affordability to increase its capacity by renovating or purchasing new buses. The quality of bus services was getting worse below the Level of Service was unattractive to choice-riders. The following recommendations was provided:

It is recommended to introduce a well-managed competition or regulated competition at the first stage taking great benefits to the poor into consideration. In this context, subsidies to the poor or the disadvantages will be reviewed. The equity share of the VSBC will be preferable way of public and private partnership at the beginning stage.

Implementation Plans

- 2.33 The TMP dictates an implementation program to realize the above-described routes and vehicles, in short-term and long-term scenarios.
- 2.34 **Short-term plan:** To improve service quality of the present public transport system with urgent and immediate means and to mitigate transport related-negative impacts to urban environment. To meet these objectives, the present Bus Capacity Improvement and the urgent University Shuttle Bus Service are proposed in the short-term phase.
- 2.35 **Long-term plans:** To provide preventive and environmentally sustainable public transport system to meet future public transport demand; and to achieve the target modal share. To meet these objectives Bus Priority Treatments/Bus Rapid Transit and Light Rail Transit and Railway Commuter are proposed in the long-term phase.

Financing

- 2.36 The TMP estimates the total costs of the programs (in short, medium, and long-term scenarios). The costs estimates are shown below in Table 4.

Table 4: Cost Estimates, 2008 TMP

	Short	Medium	Long
Buses	\$8.4	\$17.4	\$25.7
Bus Priority	\$4.0	\$6.0	\$13.0
BRT	-	-	\$17.0
LRT	-	-	\$42.1
Other	\$2.0	\$10.0	\$20.0
Est. Total (million \$USD 2007)	\$14.4	\$33.4	\$75.7
Est. Total (million \$USD 2022)	\$20.8	\$48.0	\$108.8

- 2.37 Potential funding scenarios (i.e. funding sources) are recommended in the 2008 TMP. The following possibilities for funding are proposed:

- Commercial loan

- Loan from the aid agencies such as the World Bank, ADB and JBIC
- Loan from the fund operated by the Government such as National Pension Fund
- Grant/subsidy from the Government
- Participation of private investor(s)

Evaluation and Conclusions

2.38 The TMP was evaluated economically, to determine if the recommendations represented good value for money. The TMP provided the following alternatives and economic results for four alternatives, described below in Table 5.

Table 5: Economic Evaluation (2008 TMP)

Alternative	Description	Cost (\$millions USD)	NPV (\$ millions USD)	BCR
Do-Nothing			87.2	
Alternative 1	Pursuing the present tendency (BAU)	2.0	87.2	1.54
Alternative 2	Paratransit oriented	48.2	398.3	3.24
Alternative 3	Bus Rapid Transit (BRT) oriented	47.2	551.5	4.17
Alternative 4	Light Rail Transit (LRT) introduced	79.2	565.5	4.05

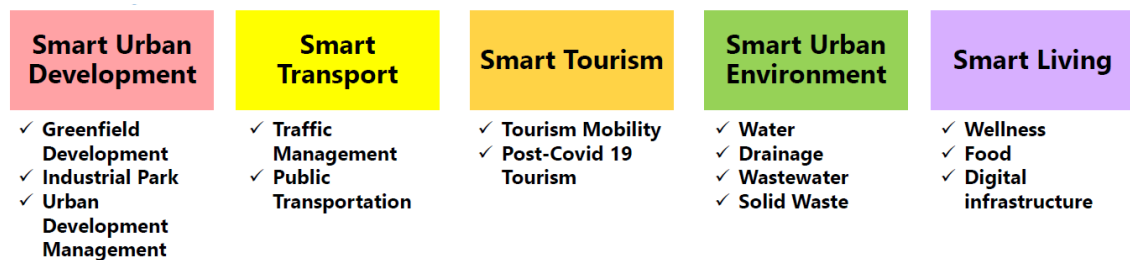
2.39 The benefit-cost ratios (BCR) were all well-above 1.0 indicating exceptional value for money.

Study Project for Smart City Development in Vientiane Capital (2022)

Overview

- 2.40 This project, funded by the Japanese Ministry of Land Infrastructure and Transport (MLIT) is a study of Smart City development in Vientiane. The study team for this project includes consulting teams Nippon Koei and Pacific Consultants. This project is ongoing as of 2022.
- 2.41 The goal of the project is to produce a basis for a Smart City Master Plan. Specifically, the following elements are included:
- Current (Existing) Conditions
 - Visions and Policy
 - Action Program
- 2.42 The Smart City concept, includes the following sub-categories:

Figure 15: Smart City Concepts



- 2.43 In this summary of the programme so far, we focus on the Visions and Policy and Action Programme.

Vision and Policy

- 2.44 The following study area is noted for this project, which corresponds to the Vientiane Capital areas, refer to Figure 16 below.

Figure 16: Study Area (Smart City Development)



Benefits of Smart City

2.45 The visioning and policy of this plan is that Vientiane is to be considered a **capital city, regional hub, and eco-city**. Further, **Vientiane is to be a Smart Capital**, meaning it will benefit from:

- Efficient urban governance
- Promote industries and promote private investments
- Increase tourism
- Improvements to quality of life of Vientiane citizens

2.46 The vision of a Smart Capital means that Vientiane will be

- effectively administered using ICT,
- develop green infrastructure,
- develop a smart lifestyle by using smart applications for health, academic and agriculture,
- transition to a paperless government,
- transition to digital payments,
- transition to real-time environmental management through the use of technology
- transition to a safe environment by using smart security protection systems and services,
- attract tourists,
- build sustainable and convenient public transport, and
- develop digital industrial infrastructure.

Action Program

2.47 The plan specifies an action program, with specific policies – these are summarized in Table 6.

Table 6: Smart City Action Program

	Objective	Contents	Location
Smart Urban Development			
Greenfield development	To improve admin. efficiency, and to increase QoL with developed infrastructure	Smart streetlight, CCTV, 5G network technology, smart meters, MaaS application, Parking lot management system, urban management system, renewable energy	Dongmakkhai
Smart Industry Park	To improve administrative efficiency, and To attract foreign investment	Renewable energy, wastewater smart meter, visualization of consuming Electricity and water, local 5G, employees health check system	VITA Park
E-Government	To improve administrative efficiency To attract domestic/foreign investment	GIS platform, urban 3D modeling, online application system of construction permission	Entire Vientiane Capital
Smart Transport			
Smart Traffic Control	To increase QoL with comfortable urban environment	Smart Traffic light control, CCTV, central monitoring & commander center, smart	Inner City, Central Vientiane

	Objective	Contents	Location
		parking control system, vehicle location system	
Smart Public Transport		Bus location system, MaaS applications, Smart Traffic light control, big data analysis of passengers etc.	Inner City (BRT system and VCSBE buses)
Smart Tourism			
Smart Mobility for Tourism	To attract foreign tourists	Rental mobility service, Tourism MaaS, mobility big data utilization, digital coupon among transport and restaurants/shops	Historic City Center
Post-Covid Tourism		5G network, electronic certification system for Vaccine or PCR test, online virtual tourism (AR,VR)	Entire Vientiane Capital
Smart Urban Environment			
Smart Water Supply	To improve administrative efficiency, To collect fees and reduce non-revenue water	Smart meter, and Pipeline management system, capacity development	Densified district or Water supply area.
Inner Flood Mapping System	To increase QoL with safe infrastructure	Real-time monitoring system, inner flood alert system, online mapping system for frequent inundation	Inundated areas (flood prone areas)
Smart Waste Collection	To improve administrative efficiency, and to collect fees	Automatic measurement of quantity and weight, Routing analyzer and location system, sensor of environment (road, temperature, humidity etc.), reporting application by residents	Entire Vientiane Capital
Waste Utilization	To improve administrative efficiency by reducing waste volume To increase QoL by reducing Carbon dioxide emission.	Waste separation, waste Incineration, biomass for electric generation, biomass for fertilizer, recycle of waste	KM32 disposal center
Smart Living			
Smart Health	To increase QoL	Health monitoring platform, developing wearable device, Ambulance location system, employee's health check system	Entire Vientiane Capital
Smart Farming	To increase QoL with safe foods To attract foreign tourists by organic farming and logistics	Logistic tracking system, tracing system, registration system of certified farmers	Entire Vientiane Capital

	Objective	Contents	Location
Digital Payments	<ul style="list-style-type: none"> To improve administrative efficiency by reducing invoicing work To collect taxes and fees definitely To increase QoL by convenient public services 	Management and transaction system of digital payment, QR and IC chipped payment system, Transaction devices in public sectors (tax payment, utilities, transportation)	Entire Vientiane Capital

2.48 Two projects will be ongoing as of 2022, including Smart Traffic Control and Smart CCTV, as part of Smart Transport.

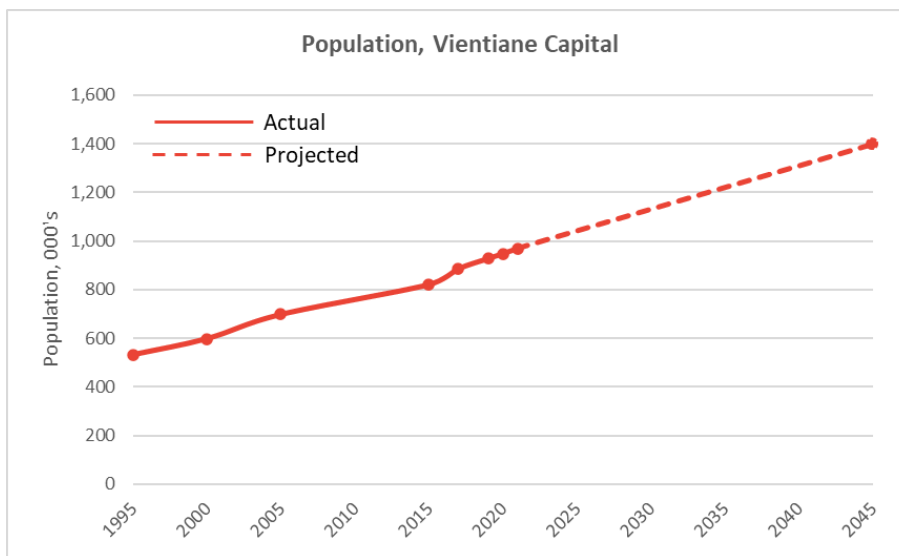
3 Baseline/Existing Conditions

Socioeconomic

Population and Demographics

- 3.1 Vientiane Capital is a growing city of approximately 0.97 million residents (as of 2021) which is projected to grow to over 1.4 million by 2045. Between 2000 – 2020, the average population growth rate of Vientiane Capital was approximately 2.9% annually. However, this is projected to reduce to an annual rate of approximately 1.85% from 2020 to 2045¹. Refer to Figure 17 below.
- 3.2 The metropolitan area of the Vientiane Capital also includes parts of neighbouring Vientiane province, in total the metropolitan area of Vientiane is estimated to be around 1 million – 1.2 million people as of 2021.

Figure 17: Population, Vientiane Capital (Province of Lao PDR)



Data Source: Lao PDR (LaoSIS)

Economy

- 3.3 Pre-pandemic, the Lao economy experienced significant growth. Since 2000, the Lao economy (measured in GDP) has grown by around 6-8% every year, making it one of the fastest growing economies on earth during this period, refer to Figure 18 below. This economic growth was driven in part by tourism but also through exports of wood products, coffee, tin, copper, gold, and electricity to its neighbours, mainly Thailand, China, and Vietnam.

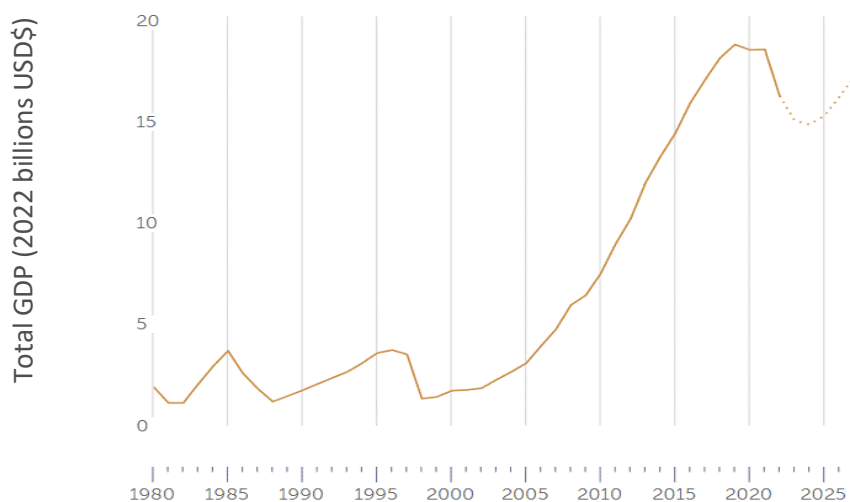
Figure 18: Annual Growth in GDP, Lao PDR



Data Source: WorldBank, 2021

- 3.4 The Lao economy has suffered greatly from the effects of the COVID-19 pandemic. Year over year growth in GDP dropped by approximately 90% from 2019 to 2020 at the height of the economic crisis caused by the pandemic. However, the economy did not contract, and grew by approximately 2.7% in 2021, according to the World Bank.
- 3.5 At the same time, the Lao government had undertaken, partnered with China, the Lao-China railway which cost approximately \$6 billion USD, a significant portion of which was paid for through Lao debt to China. Due to the shock of the pandemic, there was a risk of default of this debt in 2020 and a subsequent economic crisis. However, the Lao economy managed to stave off default and is indeed forecasted to increase in 2022 once more, by around 3.5% over 2021. This is driven in part by a revival of tourism and cross border trade, mostly through China. Overall, the Lao economy is the smallest in ASEAN, being worth approximately \$19 billion USD in 2019, which is around \$2,670 per capita according to IMF estimates.

Figure 19: Total GDP, Historical Lao PDR



Source: International Monetary Fund Country Statistics, 2022

Tourism

- 3.6 A popular tourism destination in recent years, tourism to the Lao PDR was on the rise. According to data from the Lao Statistics Bureau, since 2010, tourist arrivals to the Lao PDR have risen from around 2.5 million per year to 7.3 million in 2019. During this period, arrivals to the Vientiane Capital account for approximately 25% of this total value or around 2 million per year (in 2019). However, since the COVID-19 pandemic, tourist arrivals have been reduced by 88% (in 2021) compared to 2019, refer to Figure 20. However, with restrictions on entering the country fully lifted since May 2022, a rise in tourism is expected in 2022 and beyond. Further, the recently completed train line linking Vientiane to Kunming, China will likely bring in significantly more tourists from China to the Lao PDR including Vientiane if China allows its citizens to freely travel again, post-pandemic.
- 3.7 Tourism represents a sizeable portion of the economy, representing approximately 10% of GDP in 2019, down from 15% in 2012, according to the International Trade Administration of the U.S. Department of Commerce⁴.

Figure 20: Tourist Arrivals in the Lao PDR



Data Source: Statistical Report on Tourism in Laos 2015, MICT 2010-2014; LAOSIS Lao Statistics Bureau 2015-2021

Land Use and Urban Development

Urban Form

- 3.8 As a relatively small city, the urban area of Vientiane is relatively small at approximately 210 km² of (as of approx. 2011). Vientiane is a roughly triangularly shaped city with the southern end being confined the Mekong River, and border with Thailand. Urban development is generally equally spread out from the central node of the intersection of Lan Xang Avenue (major North-West thoroughfare) and Rue Setthathilath one-way couplets (major east-west routes).
- 3.9 In the CBD, the streets are narrow and dense. This area, which is the main tourist area, is heavily populated with guest houses, hotels, government offices, services, and other businesses. In the peri-urban areas, several new highways and wide boulevards (like Lan Xang Avenue) act as the main arterials funneling most of the traffic in and out of the city.
- 3.10 Outside the CBD, in suburban areas, many streets are unpaved and basic. Amenities such as sidewalks or adequate width, are lacking, refer to Figure 21.

Figure 21: Typical Street in Vientiane



Typical CBD: Narrow and Busy



Rue Sissatheth: Main East-West Road through CBD



Unpaved Road, Suburban Area



Lan Xang Ave: Main North-South Corridor

Image sources: © Google Maps Streetview, 2022

Built-up Urban Area

- 3.11 The built-up area of Vientiane has changed significantly and rapidly over the last two decades. In 1995, approximately 532,000 people live in the Vientiane area, of which 337,000 lived in urban areas (63%), in 2005, 81% were living in urban areas, and by 2011 that had risen to 96%. In 2015, there were just over 800,000 people living in the Vientiane Capital area. Please refer to Figure 23 on the following page for a look at the changes of the built-up area over time, which have been significant as urbanization and population have grown.
- 3.12 The built-up area has also increased significantly, in line with the population increase. However, Vientiane has also been densifying, with the average density increasing from about 3,400 person/km² within the built-up area to around 3,900 in 2015, which is an increase of around 15%. The built-up (urban) area has increased by 34% between 1995 – 2011, or around 2.1% per year. Urbanization has occurred as a densification of the core area, as well as the development of peri-urban areas. Notably, new built-up areas have occurred in four areas:
1. In Northwest Vientiane, along Route 13 and nearby the newly built Vientiane-Boten Expressway (2020)
 2. Sikhottabong District (West Vientiane, especially the area west of Wattay International Airport)
 3. Xaythany District (North Vientiane)
 4. Saysettha District (East Vientiane)
- 3.13 Notable recent major urban developments in Vientiane include the Lao-ITECC Mall and Lac-ITECC Exhibition Center as well as the Vientiane Lao Center, located in the Vientiane CBD.

Figure 22: Examples of Recent Large Development Projects in Vientiane



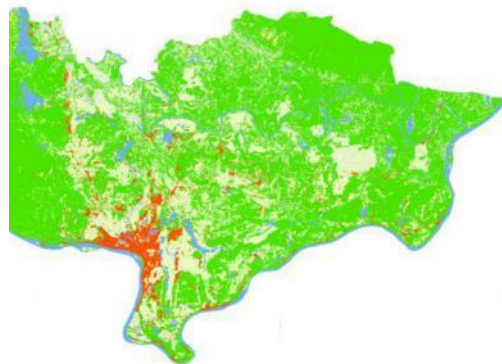
ITECC Mall



Vientiane Lao Center

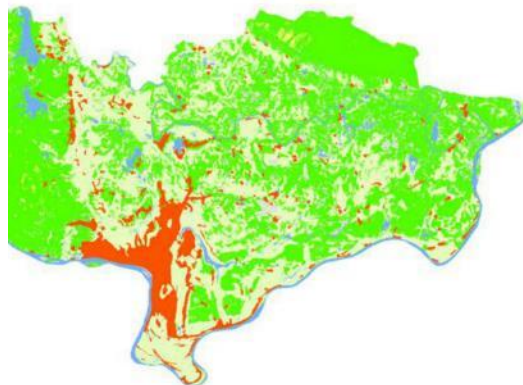
Images sources: Various (creative commons licenses)

Figure 23: Vientiane Region Land Use (1995 - 2005)



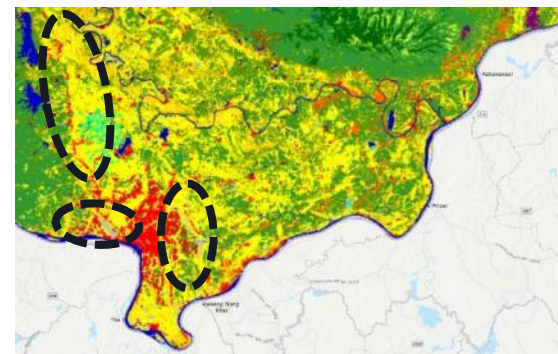
1995

- Population: 532,000
- Urbanized: 62%
- Built up area: 154.16 km²
- Density (in built-up area): 3,454 persons/km²



2005

- Population: 698,000
- Urbanized: 81%
- Built-up area: 188.722 km²
- Density (in built-up area): 3,698 persons/km²



2015

- Population: 821,000
- Urbanized: 96%*
- Built-up area: 206.68km²*
- Density (in built-up area): 3,972 persons/km²

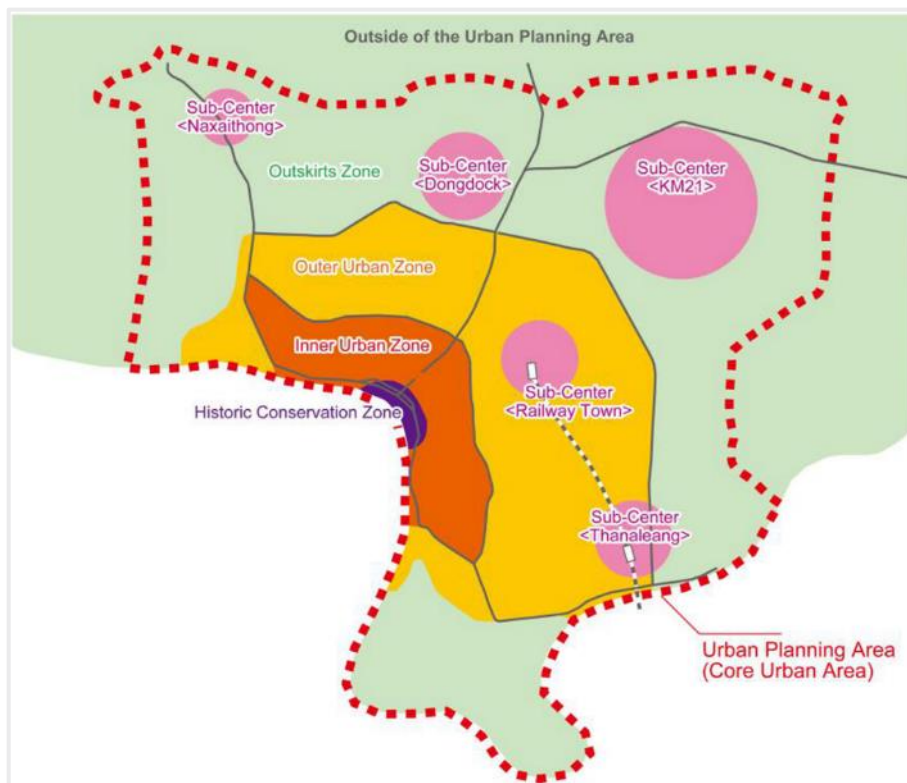
*Data from 2011, rather than 2015

Data Source; Sahrifi et al, 2012 ⁵ 1995-2011; LaoSIS (Lao Data and Statistics Bureau) 2015

Future Land Use

- 3.14 Future land use is governed by the 2030 Urban Master Plan for Vientiane. This plan was developed by JICA and released in 2011. The purpose of this plan is to guide future urban development in Vientiane, to avoid a situation where urban growth is arbitrary or fragmented in the outskirts area. In short, it is a pragmatic plan that aims to avoid urban sprawl and instead concentrate new development in specific designations zones/areas.
- 3.15 The general planning areas of Vientiane, defined by this plan, are shown below in Figure 24. This plan designates *sub-centres* which are to be the concentrated development areas in the future, and which are outside of the central *Historic Conservation Zone*, which is the central, touristic area of Vientiane.
- 3.16 The five identified sub-centres in the Outskirts and Outer Urban Zones area:
- KM21 (northeast outskirts zone)
 - Dongdock (National University of Laos in the central outskirts zone)
 - Naxaithong (northwest outskirts area)
 - Railway Town (west side of the outer urban zone, in the vicinity of the planned Khamsavat railway station connecting to Thailand)
 - Thanaleng (in the southeast outer urban zone, in the vicinity of the existing Thanaleng border crossing area)
- 3.17 These planning principles are partially based on principles of Transit-Orientated-Design (TOD), these *sub-centre* areas, if developed accordingly, will be easier to serve with higher-order transit services, like BRT.

Figure 24: Land Use Plan (2030)



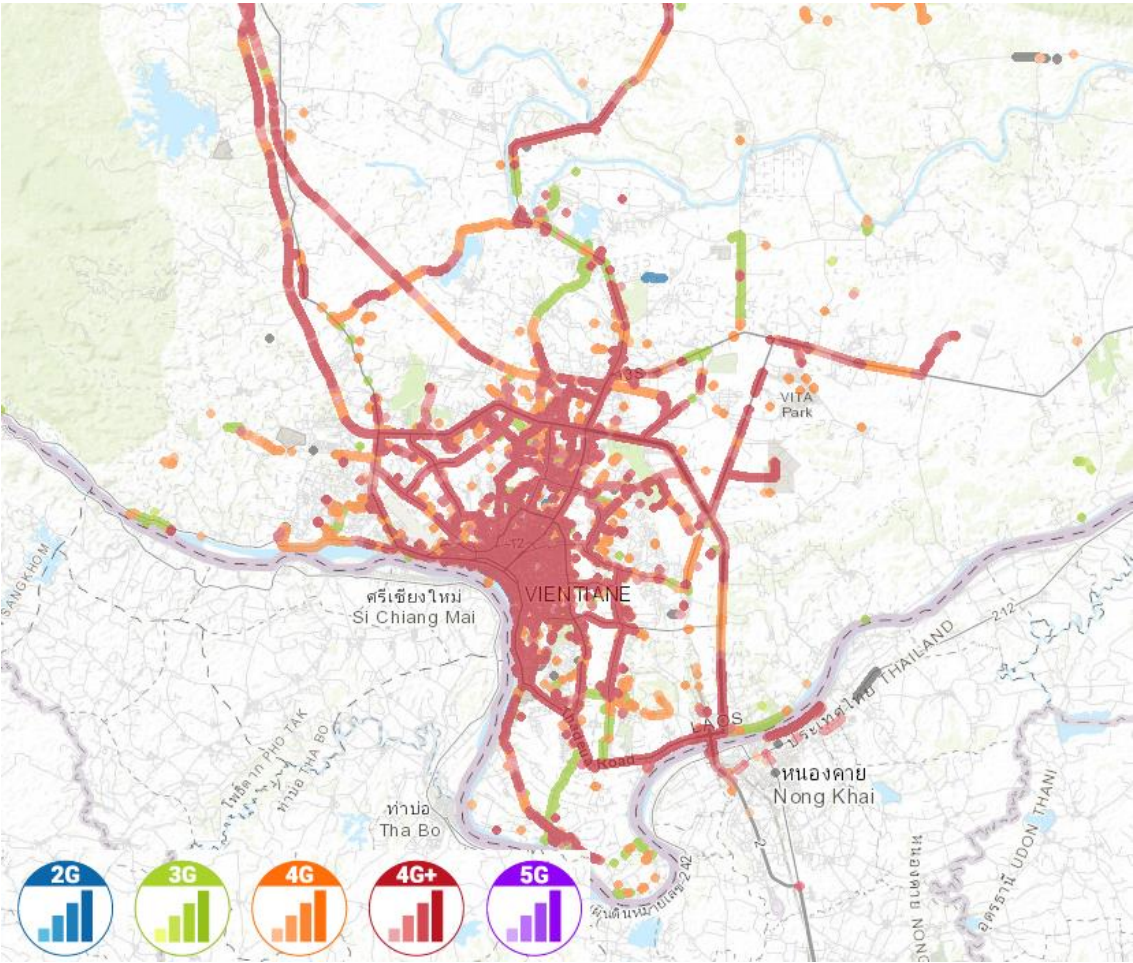
Source: 2030 Urban Master Plan (JICA, 2011)

Telecommunications

Infrastructure (Mobile)

- 3.18 Lao Telecom (LaoTel) is the largest telecommunications operator in Laos, providing a range of services including mobile, fixed-line, and internet services. Unitel was launched in 2008 and has since grown to become the leading mobile operator in Laos, with a market share of over 50%. Unitel's network covers more than 95% of the population and offers 2G, 3G, and 4G LTE services. In addition to voice and SMS, Unitel offers a range of mobile data plans and value-added services such as mobile banking, entertainment, and information services.
- 3.19 As of 2021, both Unitel and Lao Telecom offer 4G LTE services in Laos. Unitel was the first mobile operator to launch 4G LTE services in the country in 2014, and since then, it has expanded its 4G network to cover most major cities and towns in Laos. Lao Telecom also offers 4G LTE services, and its network covers more than 95% of the population. Other operators include TPlus and ETL.
- 3.20 The availability and quality of 4G LTE services in Laos is improving, driven by increasing demand for high-speed mobile data services and the growing adoption of smartphones. Both Unitel and others are investing heavily in their network infrastructure to provide faster and more reliable 4G services to their customers. Lao telecom companies do not produce maps of their coverage areas, however, some crowdsourced data is available from nPerf, see below. In this figure most of the Vientiane region is covered, however, a full picture is not available since this data is only crowdsourced at points, not areas. However, we can deduce that the areas within continuous.

Figure 25: Map of Cell Network (Crowdsourced)



Source; nPerf, 2023

Table 7: Lao PDR Frequency Bands (Used by all Carriers)

2G (GSM)	3G UMTS	4G LTE
900 MHz (E-GSM)	B1 (2100 MHz)	B1 (1800+ MHz)
1800 MHz (DCS)		

3.21 Average home internet speeds are an estimated 44 Mbps, significantly lower than Korea’s 240+ Mbps average data connection (according to Ookla). Further, average mobile internet speeds are estimated to be just 23 Mbps in Laos, compared to around 118 Mbps in Korea (also according to Ookla).

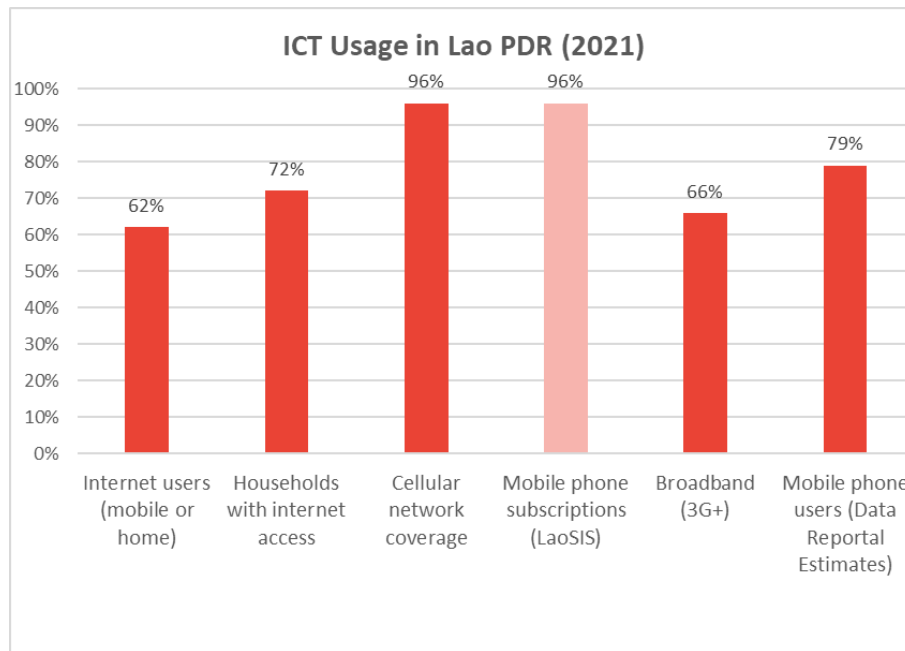
Table 8: Carriers and Speeds in Lao PDR

Carrier	Minimum (Mbps)	Maximum (Mbps)
ETL	21	91
Lao Telecom	17	53
Unitel	22	54

ICT Usage

- 3.22 Estimates of mobile phone users are conflicting. LaoSIS estimates more than 90% of the population has a mobile phone, while others estimate 79%³. The latter is more likely. Of those mobile phone users, around 66% are broadband (3G+ users). SmartPhone penetration is estimated to be around 60% of the population in Vientiane.
- 3.23 While over 90% of the urban areas and population are covered by cellular networks, as of 2021, internet (including mobile internet) is used by only about 60% of the population, in line with other developing countries like the Philippines, Algeria, or Pakistan.

Figure 26: ICT Usage in Lao PDR (2021)



Data source: LaoSIS database; Data Reportal, 2022

Transport

Overview

- 3.24 Mobility in the Vientiane largely depends personally owned transportation: motorcycles and cars. This is supplemented by on semi-public transportation options such as bicycles, jumbo, songthaew, and taxis. The bus-based public transportation system in Vientiane is currently of low quality and investment into it has been lacking, and as a result, ridership is low. Further, as the number of registered private cars continues to rise, they are causing serious traffic congestion and air pollution problems.
- 3.25 Vientiane has been experiencing difficulties in the operation of public transport in recent years due to the rapid increase in the use of passenger cars and the lack of road capacity, traffic congestion, low pavement rates, and narrow road widths. The rapid increase in personal transportation has led to various urban problems such as various air pollution, traffic accidents, and vehicle congestion, and, it has caused social issues such as various

³ <https://datareportal.com/reports/digital-2022-laos>

environmental problems such as increased Greenhouse Gas (GHG) emissions and air pollution caused by exhaust gases.

3.26 A summary of the transport infrastructure in the country as of 2022, is described below in Table 9.

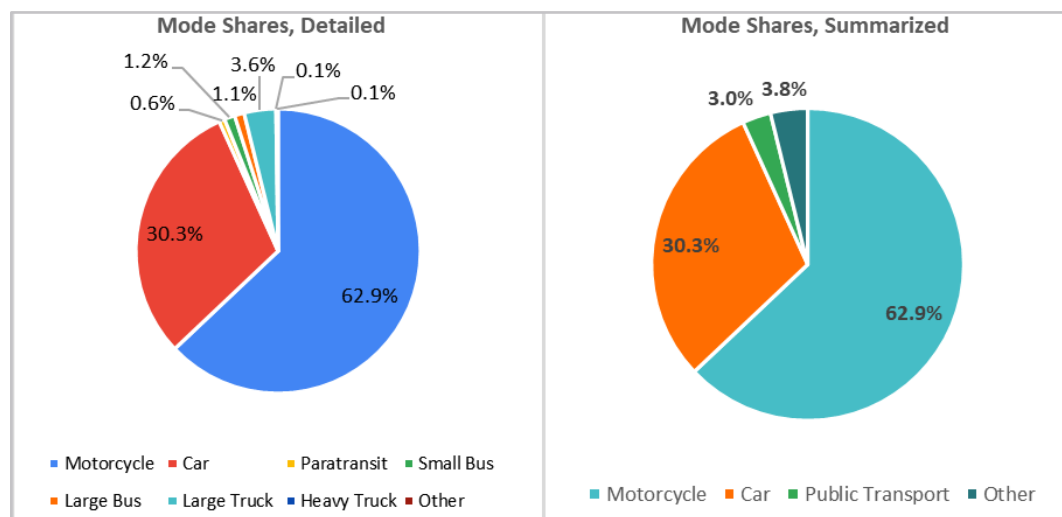
Table 9: Overview of the Transport Network (Lao PDR)

Type	Length/Details
Road	Total = 59,101 km (Lao PDR, 2020) Paved = 13,757 km ²
Railway	414 km (standard gauge, Chinese compatible) 3 km (metre gauge, Thai compatible)
Public Transport	Routes = 13 Length = <200 km

Mode Shares and Origin-Destination Trips

3.27 An OD survey was conducted in 2021, which indicates origins and destinations, and modes of trips throughout the Vientiane area. The following figures indicate the overall mode shares in Vientiane (motorized modes only, that is no walking or cycling etc. included).

Figure 27: Mode Shares Vientiane (O-D Survey)



Data source: OD Survey, conducted by JICA in 2021, used with permission

3.28 Motorcycle transport dominates the transport market accounting for approximately 63% of all trips. Trips by car account for approximately 30% of trips throughout the Vientiane area. Since 2007, the car mode share has doubled, rising from approximately 15% 2007⁴.

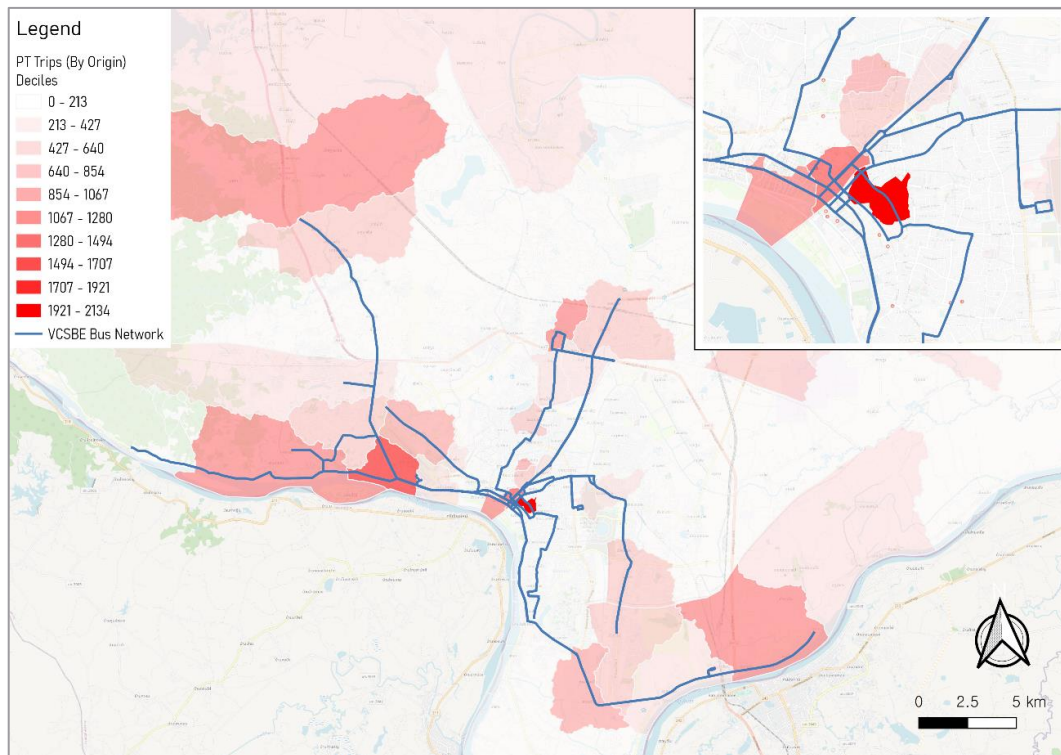
3.29 We also examined the public transport, and informal public transport (songthaew, paratransit) demand by origins, see Figure 28 and Figure 29 below. There is a total of approximately 30,000 public transport trips and 8,600 paratransit trips (per day) in Vientiane. Most of this demand comes from a select few areas, all of which are served by VCSBE routes. In general, public transport is popular near the ends of lines, which commuters may use to travel into the city

⁴ Based on 2007 OD Survey (JICA) as part of the 2008 TMP. OD Survey data collection parameters was not exactly the same between the 2007 survey and 2021 survey.

centre. Dong Dok, and surrounding area (at the National University of Laos) accounts for a fair portion of trips as does the western area of Vientiane, in the vicinity of the Xang Jieng market. However, the biggest concentration of trips appears to originate in central Vientiane, in the vicinity of the Central Bus Station (CBS), which is the busiest transit exchange in Vientiane. This area alone accounts for 10% of all trips.

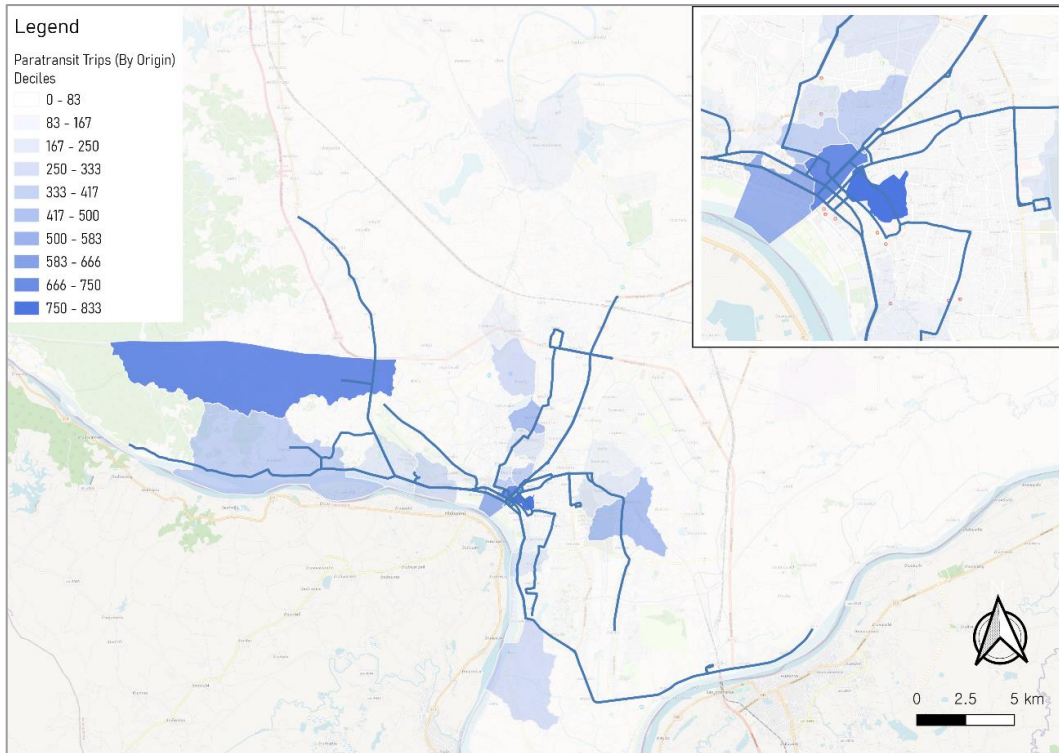
3.30 Paratransit trips take on a slightly different pattern when compared to public transport trips. These trips tend to originate in the west areas of Vientiane, with more trips originating outside of the coverage area of the VCSBE routes. However, in many places, demand origins for paratransit overlap with those of VCSBE routes, indicating there may be inefficiencies and competition on heavily used routes between Songthaew and VCSBE bus routes.

Figure 28: Public Transit Trips (By Origin) OD Survey



Data Source: OD Survey, conducted by JICA in 2021, used with permission

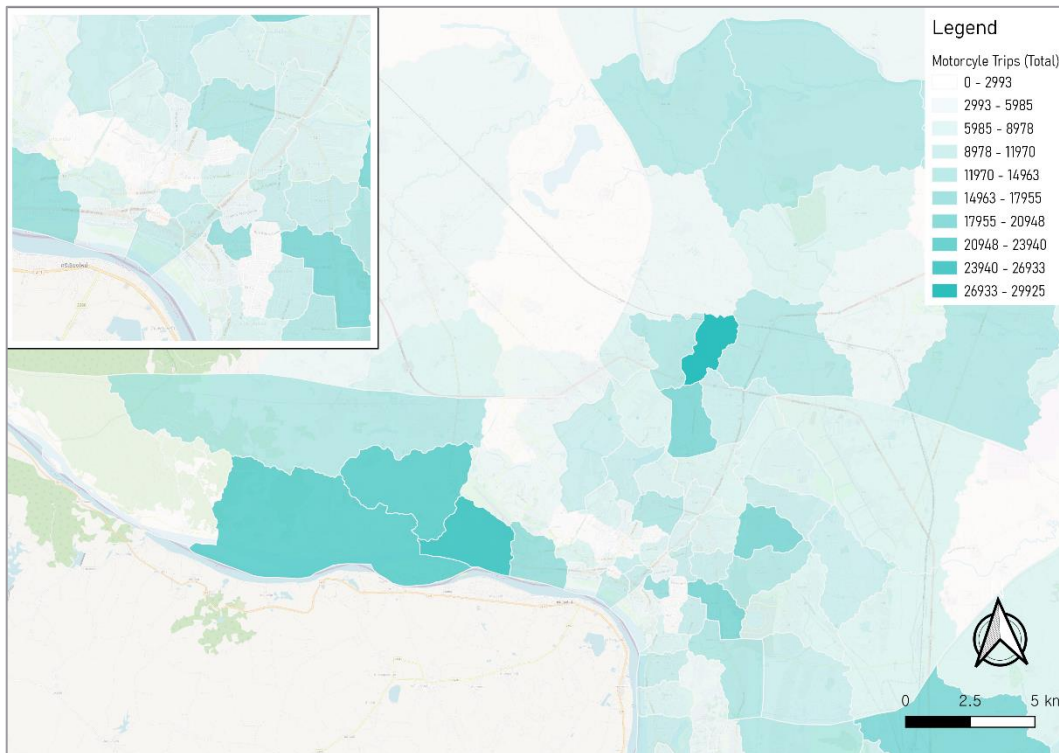
Figure 29: Paratransit Trips (By Origin) OD Survey



Data Source: OD Survey, conducted by JICA in 2021, used with permission

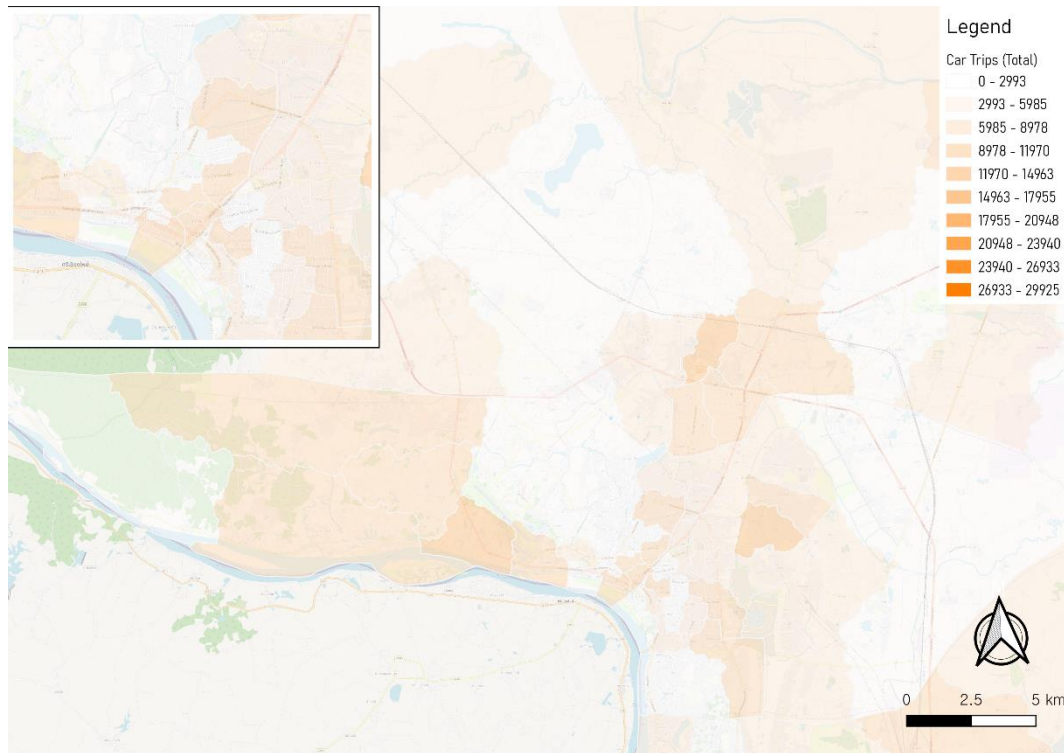
3.31 In Figure 30 and Figure 31 below the total trips by private car are presented, at the same scale. We see that motorcycle is the dominant mode, with many motorcycle trips originating throughout the Vientiane metropolitan area, especially so at the NUOL, which is a major trip generator/attractor.

Figure 30: Motorcycle Trips (By Origin) OD Survey



Data Source: OD Survey, conducted by JICA in 2021, used with permission

Figure 31: Car Trips (By Origin) OD Survey



Data Source: OD Survey, conducted by JICA in 2021, used with permission

Vehicle Types

3.32 In Vientiane, as throughout Southeast Asia, specific vehicle types are popular. In addition to cars and motorcycle, there are several public and semi-public transport options. These are depicted below in Figure 32.

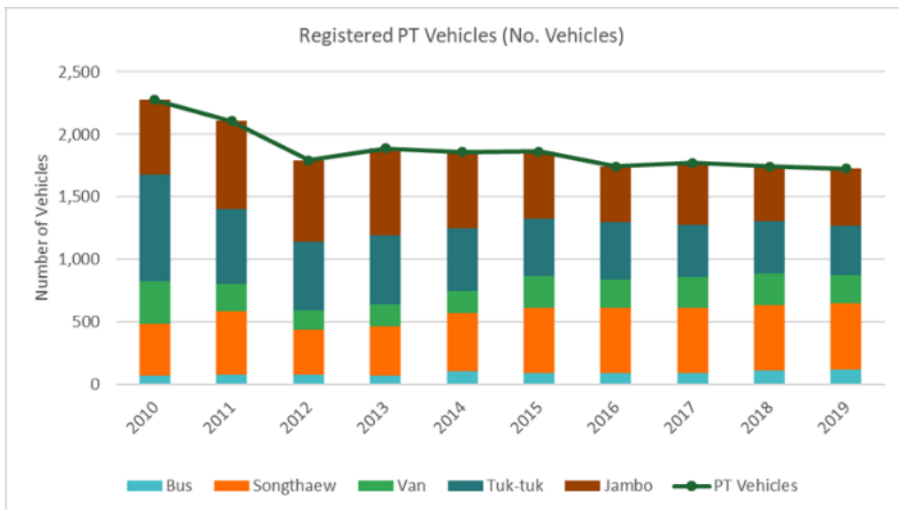
Figure 32: Public Transport Modes in Vientiane

Motorbike Taxi	Tuk-Tuk	Jumbo
		
Songthaew		Official Taxi
		



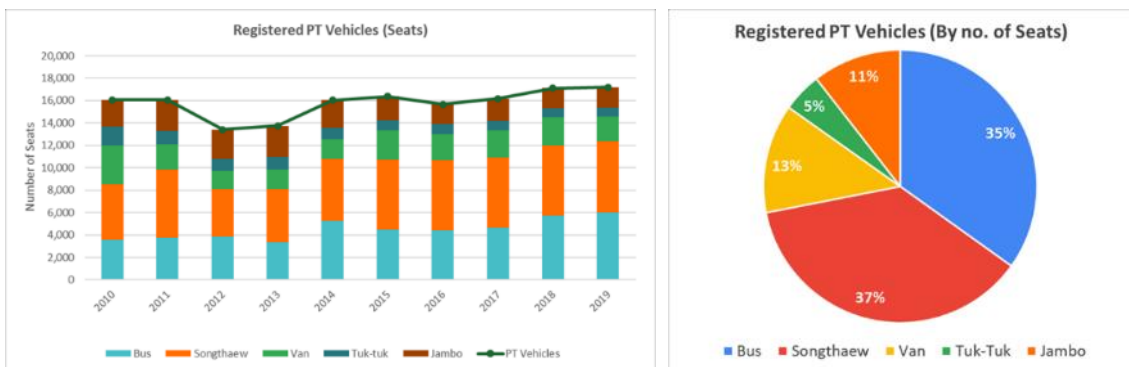
3.33 The total number of registered public transport-like vehicles (which includes buses, songthaew, tuk-tuk, and jumbo) has seen a minor decreasing trend over the last few years, refer to Figure 33 below, however, when considering total seat capacity (that is, the total number of transit seats available) there has been a slight increase of the past few years, see Figure 34. Note that these values are applicable for the entire Lao PDR (not just Vientiane). Outside of Vientiane, there are few official public transport operations using large buses. In most of these communities, paratransit operation like songthaew, are the main public transport systems. Therefore, songthaew provides the most seat capacity of any public transport mode in Lao PDR (37% of total seat capacity), just edging out buses at 35%.

Figure 33: Registered PT Vehicles in Lao PDR (No. Vehicles)



Data Source: Lao PDR, MPWT

Figure 34: Registered PT Vehicles in Lao PDR (By total Seats)



Data Source: Lao PDR, MPWT

3.34 In Vientiane as of 2022, the following number of public transport vehicles were accounted for (officially registered):

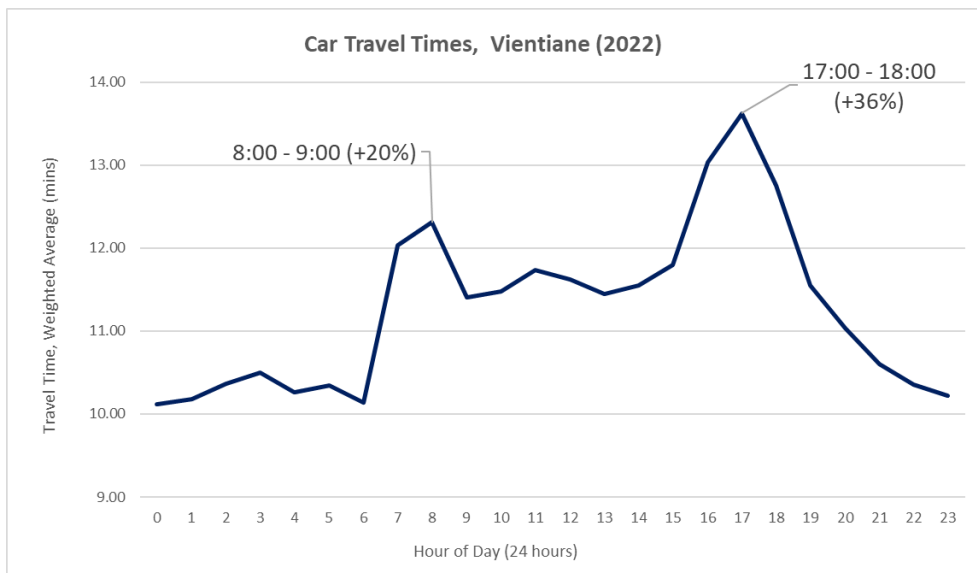
- Official taxis = 86 legal units
- Bus = 43 (VCSBE) (52 on order from Japan, to arrive in 2023) (2,150 seats)
- TukTuk/Jumbo = 512 (2,048 seats)
- Songthaew = 136 (1,088 seats)
- RHS (LOCA) = unknown

3.35 Despite the relatively small fleet size, buses still account for a slight majority of the total seats available. Currently, songthaew and buses each supply approximately 1/2 each of the total public transport capacity (hypothetical). However, after the arrival of more buses from Japan next year, the total seat-capacity of buses will increase to over 4,750 which will be more than twice that of the songthaew fleet.

Traffic and Speeds

3.36 Traffic congestion in the Vientiane area has reportedly been increasing in recent years, as motorization (and therefore traffic demand) has increased significantly. Road capacity to the outskirts of Vientiane has also increased, although the major urban roads have remained the same. According to Google Maps API traffic speed data (which uses data from cell phones), Vientiane experiences moderate traffic congestion in peak times (8:00 AM or 5:00 PM). In the following Figure 35, the travel times (by car or motorcycle) for the *top 100 origin-to-destination (O-D) pairs by car and motorcycle demand* (from the O-D survey) for a 24-hour period is shown. Figure 35 shows the weighted average for those 100 O-Ds by total daily demand per O-D pair. Data were collected in December 2022, for a typical weekday.

Figure 35: Car Travel Times, Vientiane (2022)



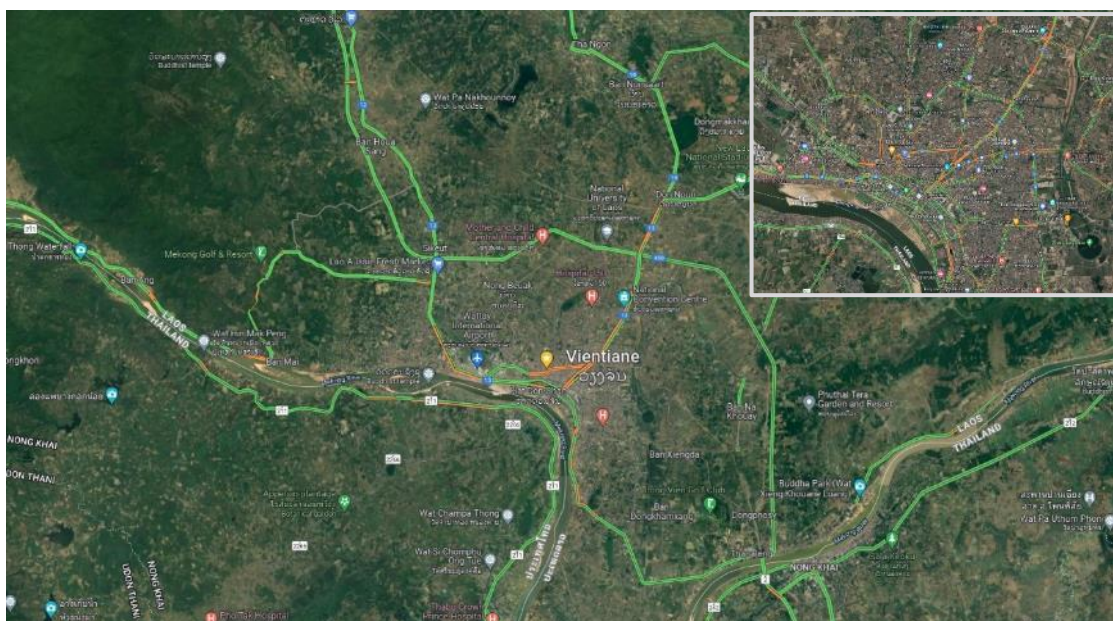
Data source: Google Maps Algorithm, 2022 December

3.37 This data shows that although O-D travel times in Vientiane are relatively short at an average of just over 10 minutes (free-flow time). Morning and afternoon slow-downs do occur, with the afternoon slow-down being significantly more severe than the morning. Morning rush hour increases travel times over the free-flow time by approximately 20%, while afternoon rush hours increase travel times by approximately 36%.

3.38 Overall, we can determine an average congestion index similar to that of the methodology employed by US-based transportation company, TomTom⁵. Vientiane would score a rating of 13% (that is, travel times are an average of 13% above the free-flow speed for all road-user trips), which would put it on par with Calgary, Canada, Cincinnati, USA, or Brasilia, Brazil. Compare this with approximately 53% in Bangkok, 29% in Singapore, and 34% in Jakarta (in 2021).

3.39 Further, Figure 36 and Figure 37 depict the “typical” traffic maps, also using the Google Maps’ algorithm. These maps confirm that traffic congestion in Vientiane is not yet considered severe (which would be a red colour), however, slow-downs do occur especially in the AM peak in the central Vientiane area and along Lan Xang Avenue. More severe slow-downs also occur in the PM peak mostly throughout the historic downtown area, and along Lan Xang Avenue (Route 13) and the Rue Sissateth east-west one-way couplet.

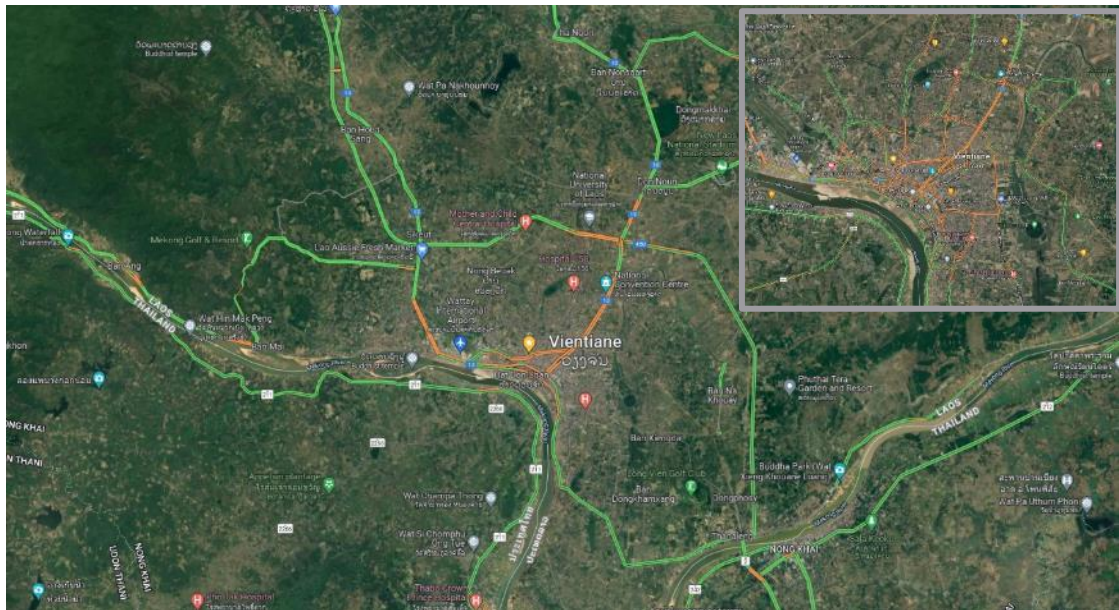
Figure 36: Traffic Speeds, AM Peak Period



Data Source: © Google Maps, 2022 (Typical Wednesday, 7:40 AM)

⁵ <https://www.tomtom.com/traffic-index/about/>

Figure 37: Traffic Speeds, PM Peak Period



Data Source: © Google Maps, 2022 (Typical Wednesday, 4:40 PM)

3.40 Buses are affected by these slow-downs as well, according to the JICA-implemented bus tracking data which is available online, refer to Figure 38 below. These data confirm slow-downs due to traffic congestion are especially prevalent on Av. Kaysone Phomvihane in the vicinity of Ministry of National Defence building.

Figure 38: Bus Traffic Speeds, JICA System

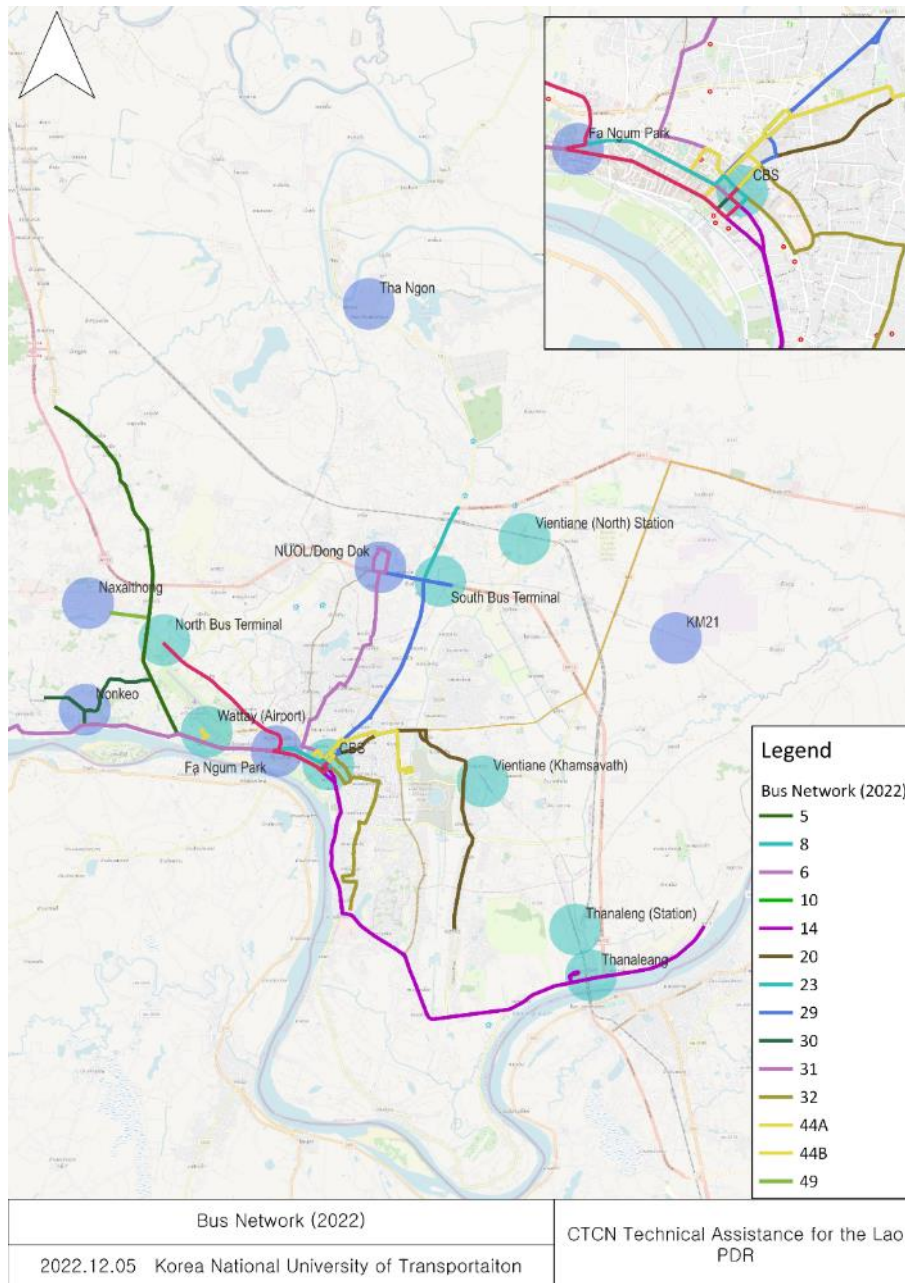


Data source: JICA-produced Lao BusNavi website (<https://lao.busnavi.asia/>)

Public Transport

3.41 The public transport network, that is the bus network as offered by the Vientiane State Capital Bus Enterprise (VSCBE), which is the sole (state-owned) operator of public transport services in Vientiane. An approximate map of the current (2022) service patterns is shown below. About 13 routes offering frequencies as high as 15 minutes operate throughout the city serving most major destinations. In recent years service has been cut on some routes, and updated information is not available.

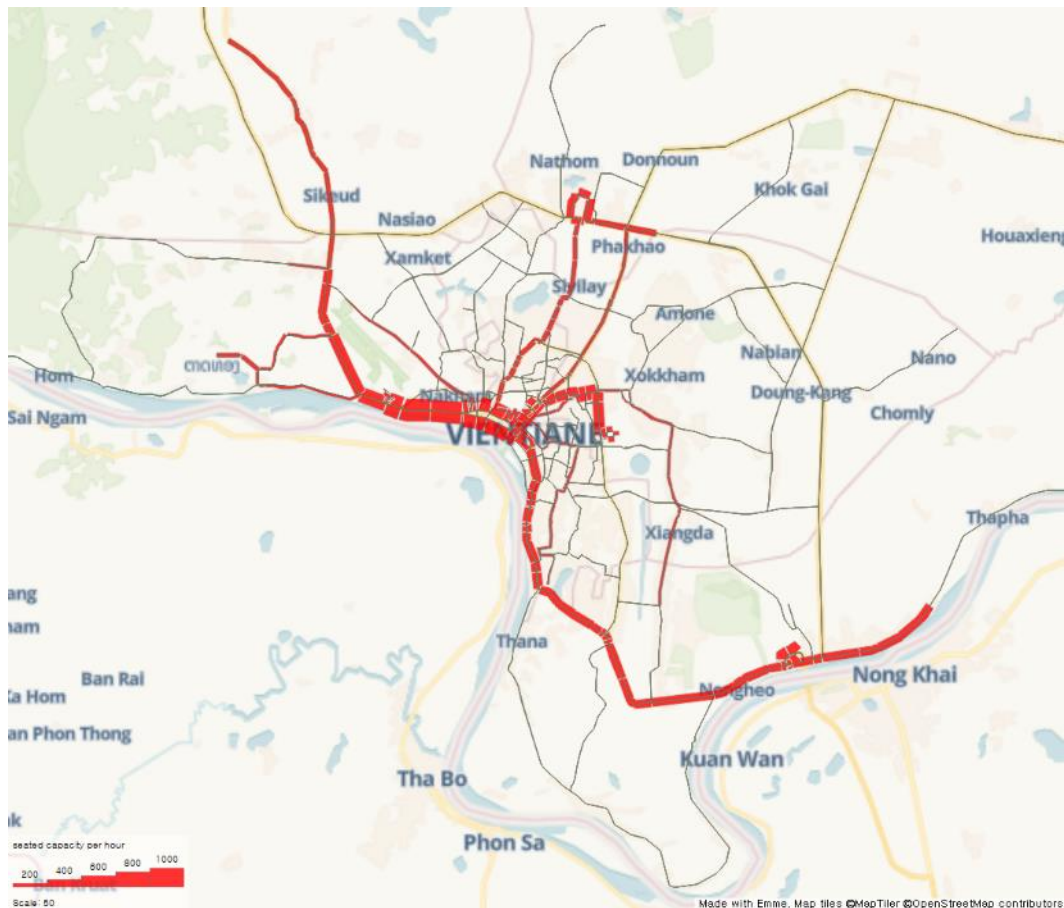
Figure 39: Vientiane Bus Network (2022)



Data Source: VCSBE schedules, maps; JICA-produced Lao BusNavi (lao.busnavi.asia)

- 3.42 The bus network (seated) capacity is shown below in Figure 40. Most of the capacity is along the major east-west couplet arteries in central Vientiane. In this corridor, the maximum capacity of around 1,000 pphpd (during peak periods) is achieved.
- 3.43 The existing bus network is not sufficient to effectively cover the Vientiane urban area. Approximately 31%⁶ of the Vientiane population has access to any public transport stop (including songthaew or other paratransit), which may not be of high quality. The portion of the population with good access to high quality, frequent, transit is very low indeed.

Figure 40: Current Bus Network (Seated Capacity)



Data Source: KNUT-produced Emme Modelling Network (Vientiane)

Ridership (Bus, Songthaew, and TukTuk)

- 3.44 Up to date ridership data were not available for this report, however, based on the O-D survey results undertaken as part of the VTMP, formalized public transport (VCSBE buses) commands an approximately 1.1% mode share (of motorized modes), while unformalized paratransit (like songthaew) commands a 1.8% share of motorized modes. Overall, public transport accounts for around 3% of the motorized trips.

⁶ According to the 2022 Vientiane Transportation Master Plan (JICA)

Intercity Transport

Bus/Road

- 3.45 Intercity transport within the Lao PDR is generally accomplished with buses. Buses connect the capital to various other destinations including Vang Vieng, Luang Prabang, Pakse, and other smaller destinations throughout the country. International buses connect Vientiane to its neighbours Vietnam, Thailand, and China.
- 3.46 The Vientiane-Vang Vieng expressway, the Lao PDR's first major expressway, was completed in December 2020. Paralleling the old Route 13, this dual carriageway is 113km in length connecting the capital, Vientiane, to the town of Viang Vieng, north of Vientiane. This expressway was developed by and is mainly owned by Chinese developers. Thanks to this infrastructure, the travel time between Vientiane to Viang Vieng was reduced to just 90 minutes from over 6 hours. The total travel time from Luang Prabang to Vientiane was reduced to under 6 hours, which previously could take up to 11 hours. Eventually, the expressway will be extended north towards the Chinese border, at Boten.

Table 10: Vientiane - Vang Vieng Expressway



Expressway



Tunneled Portion

Image source: Wikimedia Commons (Creative Commons License)

Railway

- 3.47 In the modern era, the Lao PDR was first connected to Thailand through a rail connection in 2009 with the construction of the Thai-Lao Friendship bridge at Thanaleng, southeast of Vientiane. A short 3 km section of track connecting Thanaleng to the Thai city of Nong Khai and the wider Thai rail network was inaugurated in 2009. Shuttle trains connect Thanaleng to Nong Khai, with no through services to Bangkok or other major destinations in Thailand available as of 2022. This rail line utilizes the metre-gauge system of the Thai railways. The Thanaleng railway station is located approximately 20 km southeast of the central part of Vientiane. However, there is an ongoing project to extend this metre-gauge rail link further northwest, into the urban area of Vientiane at Khamsavat, refer to Figure 41.

Figure 41: Railway Connections in Vientiane



Image source: © Railway Gazette, 2022

- 3.48 In December 2021, the long-anticipated Lao-China Railway (LCR) line connecting the Lao PDRs' northern border (at Boten) to the capital Vientiane, was inaugurated. This Chinese-network-compatible standard gauge rail system is 422 km long and was built and financed through the Chinese state-owned railway companies. It is operated by China Railway Kunming Group.
- 3.49 The railway connects the Lao PDR to the Chinese highspeed railway network in Yunnan Province. Eventually, once pandemic restrictions are relaxed, international services connecting Kunming, China to Vientiane will be possible. Currently up to eight trains per day, per direction, run on the LCR domestically with a runtime of approximately 5hrs15mins between Boten and Vientiane. The railway has a maximum design speed of 160 km/hr, falling somewhat short of a high-speed designation. However, travel time between Vientiane and Luang Prabang has been reduced to just over 2 hours, which is a reduction of almost 4 hours per direction compared to a connection by car or bus on the new expressway and a reduction of over 8.75 hours when compared to the old Route 13.
- 3.50 Several trainsets are currently being used, including the Chinese-built CR200J Electric Multiple Units (EMUs) shown below in Figure 42.

Figure 42: China-Lao Railway Trainset (CR200J EMU)



Image source: Wikimedia Commons (Creative Commons License)

- 3.51 Demand for the service since introduction has been very high, with tickets often selling out, especially on weekends. The rail line is expected to be extended south, to Thailand, to connect to the under-construction Bangkok-Nong Khai standard-gauge high-speed line, part of the greater imagined Kunming – Singapore high(er) speed rail backbone.

Ride Sharing Services (RHS) and Taxi

- 3.52 Ride Sharing Service (RHS) exist in the Lao PDR. Since starting service in 2017, a local Lao start-up called LOCA has dominated the ride-hailing market in Vientiane.

Figure 43: Loca (Ride Hailing Service)



Image source: © LOCA, 2022

- 3.53 LOCA can be used by locals or tourists alike. Similar to other ride-hailing services like Uber, Grab, or Lyft, LOCA provides a high-quality taxi-like service in Vientiane. LOCA allows user to

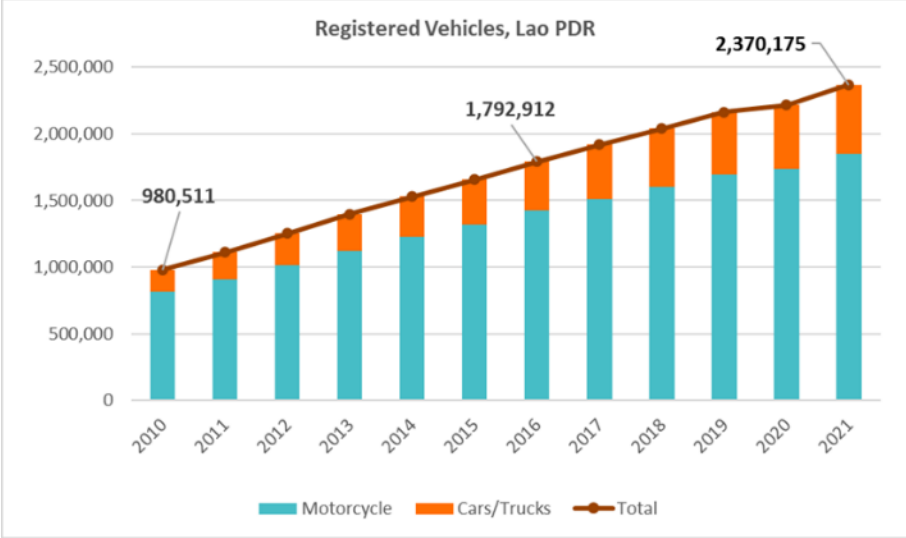
pay with either cash or credit and it is even possible to pay a driver in cash and then have them credit any change you may receive to pay for future rides.

3.54 In terms of its legality, LOCA claims on its website to be licensed, but it operates in a legal gray area. Like Uber and Lyft in the US, vehicles or drivers operating LOCA services are not officially licensed taxis, and therefore operate as technically illegal taxi services. There are efforts underway to legalize RHS in Lao PDR.

Motorization

3.55 There is a significant trend, as data confirms, of motorization in Vientiane. The number of registered personal vehicles (i.e. cars, pickup trucks, SUVs, and vans) has increased dramatically over the last 10 years, from just under one million in 2010 to more than 2.3 million in 2021. The number of registered personal vehicles has increased at an astounding 12.8% increase per year, on average between 2010 and 2021. This far outpaces the population growth (by 7.5-fold) during this period, which is around 1.7% per year on average. Therefore, the number of registered personal vehicles per capita has almost doubled from 2010 (0.16 per capita) to 2021 (0.30 per capita), refer to Figure 44 and Figure 45.

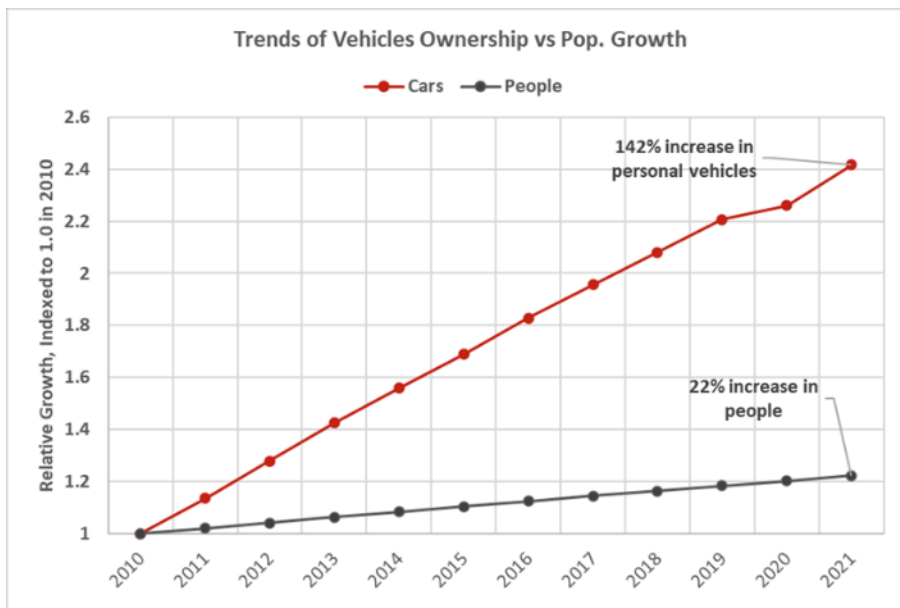
Figure 44 Registered Personal Vehicles in Lao PDR



Data Source: Lao PDR, MPWT

3.56 Motorcycles account for approximately 70% of the total registered vehicles, but this value is dropping as more cars are bought over motorcycles. In addition, many vehicles are imported illegally, and may not be accounted for in the above statistics.

Figure 45 Trends of personal Vehicle Ownership and Population Growth

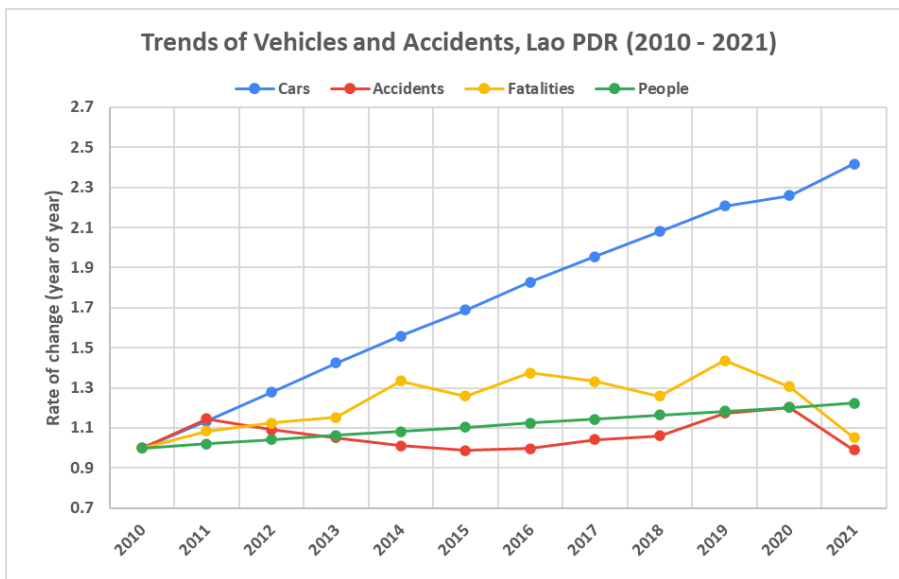


Data Source: Lao PDR, MPWT

Road Safety

- 3.57 As the number of personal vehicles per household has increased significantly, so indeed has the number of fatalities on the road. Between 2010 and 2021, the number of traffic accidents has remained relatively constant, but unfortunately traffic fatalities overall did increase by almost 50% in 2019 over 2010 levels. The rate of increase to traffic accidents has been less than the rate of increase of both population and registered vehicles. However, the rate of traffic fatalities has increased more than that of population, but still falling well short of the phenomenal increase in registered personal vehicles.
- 3.58 This is a concerning statistic, and both traffic accidents and traffic fatalities reached a relative peak point in 2019. In 2020 and 2019, the rate of traffic accidents and traffic fatalities has fallen sharply, likely due to reduced driving because of the pandemic. Before then pandemic, there were hints of an increasing trend for more accidents and fatalities which is concerning. Refer to Figure 46 below.

Figure 46: Trends of Vehicles and Accidents, Lao PDR (2010 - 2021)

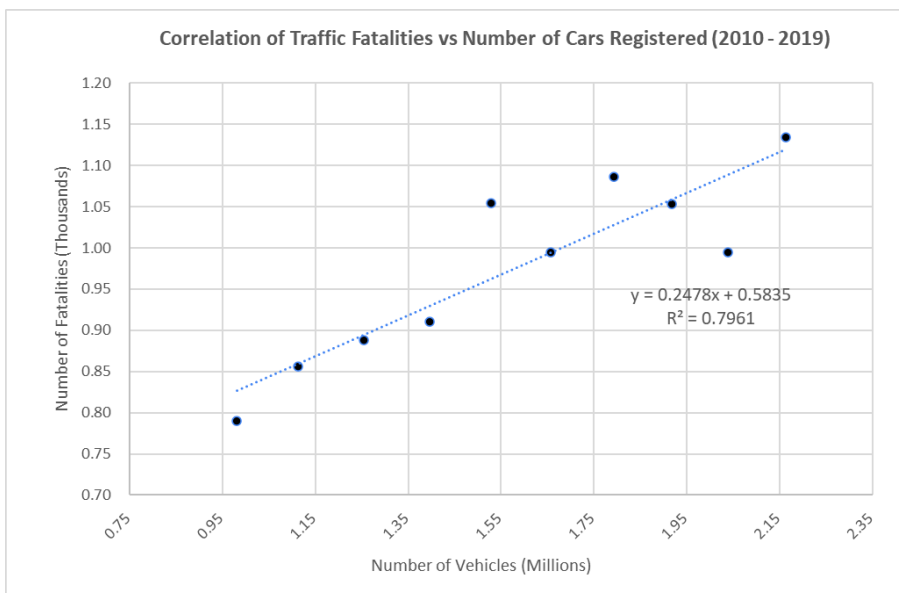


Data Source: Lao PDR, MPWT

3.59 The number of traffic fatalities in Lao PDR (years 2020 and 2021 are excluded to accommodate for the effects of the pandemic years) correlates to the increase of registered vehicles, according to the following approximate formula. Also refer to Figure 47.

$$\text{Annual Fatalities} = (0.25 * [\text{Millions of Vehicles}] + 0.53) * 1000$$

Figure 47: Correlation of Traffic Fatalities vs Registered Vehicles



Data Source: Lao PDR, MPWT

4 Review of the VTMP

Background and Overview

- 4.1 The Japan International Cooperation Agency (JICA) in coordination with Katahira & Engineers International, International Development Center of Japan Inc., and Oriental Consultants Global, has been undertaking the Vientiane Transport Master Plan Project (VTMP). This project kicked off in June 2019 and is ongoing. The scheduled end date is December 2022. The VTMP covers all transport modes (road, public transport, taxi, private vehicles, urban rail etc.)
- 4.2 In this Section, we review and present the results of our review of the Katahira & Engineers International and JICA-produced Transportation Master Plan (TMP), public transport planning section.
- 4.3 The JICA-produced networks will be reviewed as follows:
1. **Issues**
 - What challenges may be faced by the Lao PDR when implementing the plan?
 2. **Opportunities**
 - What additional opportunities may be available for the Lao PDR to undertake implementing the plan?

VTMP Planning Approach

- 4.4 The following figure illustrates the approach taken by JICA to develop the future public transport networks and vision, as part of the VTMP. This approach represents standard approach to transport planning and includes
- understanding existing conditions,
 - setting future visions,
 - developing plans and networks scenarios,
 - evaluation those networks,
 - and providing recommendations.

Table 11: Issues Uncovered (VTMP)

No	Issues	Description	Theme
1	Motorization, COVID-19 and decreasing public transport usage	<ul style="list-style-type: none"> Decline in public transport ridership due to motorization Change in transport behavior and avoidance of public transportation due to the pandemic of the COVID-19 Further decrease in the share from 5.4% (2007) to 1.4% (2019) 	Attitudes towards transport Great shift from pandemic
2	Inconvenient and unpredictable public transport services	<ul style="list-style-type: none"> Aging bus fleets and inadequate maintenance Decrease in punctuality and slow speed due to traffic congestion Low frequency of service, short service hours and early termination of buses Need for further improvement of bus stop environment and information provision 	Fleet and service characteristics
3	Uneven delivery of public transport services leading to social disparities	<ul style="list-style-type: none"> Worsening of public transport service provision due to withdrawal of bus routes and private operators (songthaew, tuk-tuk, etc.) Population coverage within 500m catchments of public transport is limited to about 31%. Need to ensure fundamental mobility for low-income groups, elderly, students, and people with disabilities 	Service coverage
4	Vulnerabilities of transport network and dependence on informal transport	<ul style="list-style-type: none"> Inadequate coordination of public transport network and operation Need for coordination of fares and schedules for seamless transfer Inadequate bus routes typically in circular and semi-trunk routes 	Transportation governance
5	Fragile governance system to operate public transport and coordinate operators	<ul style="list-style-type: none"> Unsustainable self-financed system of the VCSBE Insufficient corporation between bus and songteo in terms of operation schedule, routes, fares, stops, etc. 	Transportation governance/financing
6	Lack of integrated strategies with urban development	<ul style="list-style-type: none"> Urban sprawl of land use and residential areas into suburban and peripheral areas Lack of a legal system that allows for integrated urban development with public transport investment 	Land-use planning

Goals and Targets

4.9 The stated goals of the VTMP are as follows:

- **Goal 1.** Accessible, include and reliable transport service provision and network development
- **Goal 2.** Sustainable public transport operation and governance with coordination mechanism
- **Goal 3.** Mitigation of environmental impacts of transport to contribute to global sustainability
- **Goal 4.** Compact urban form harmonized with public transport development

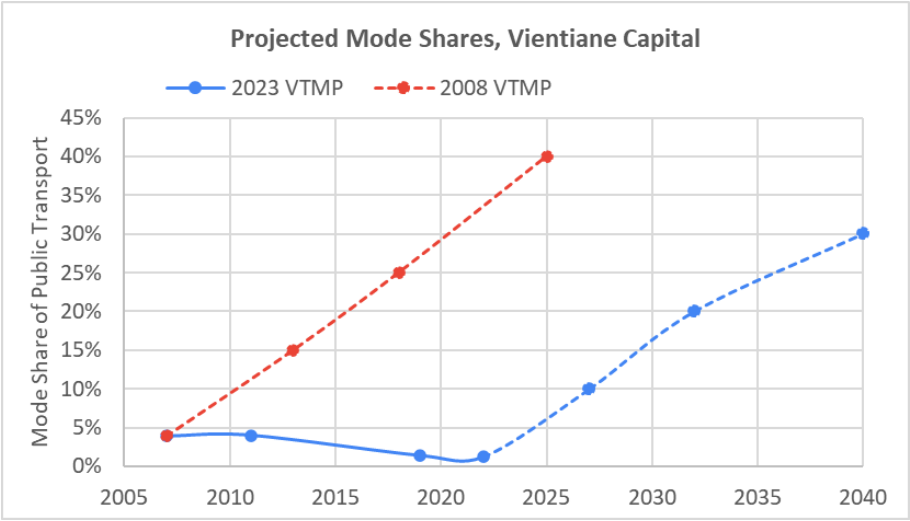
4.10 The stated targets of the VTMP, relating to public transport, are as follows:

Table 12: Major Targets set by the Plan

Goal	Today * (2021)	Horizon	Value
Public transport mode share	1.4%	2027	7.5%
		2032	20%
		2040	30%
Population covered within a 500m catchment of public transport stops	17% (VCSBE Bus), 31% (VCSBE, Songthaew, other)	2027	40%
		2032	50%
		2040	60%

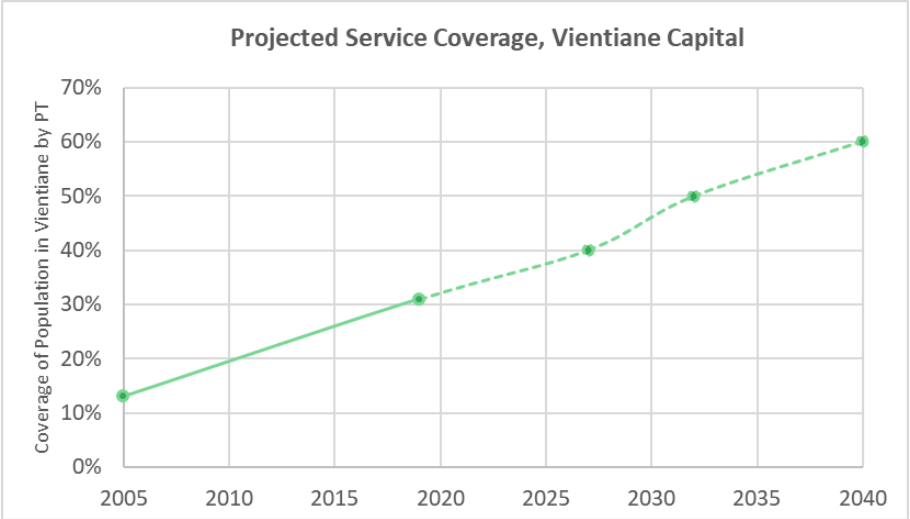
- These targets represent a significant departure from the norm. Visualized, these targets appear as follows in Figure 49 and Figure 50.
- The future mode shares are strategic targets, not projections or forecasts.
 - Mode shares have not significantly changed since 2007
 - Mode shares have decreased in recent years

Figure 49: Mode Shares and Targets



Data source: 2005: 2008 TMP (JICA); 2022: OD Survey (JICA); 2019, 2027 – 2040 (VTMP, JICA)

Figure 50: Public Transport Coverage and Targets



Data source: 2005: 2008 TMP (JICA); 2019 – 2040 (VTMP, JICA)

Proposed Policies & Projects (Strategies)

4.11 The VTMP proposes several interventions and policies that will achieve the goals and targets as they have set out, those policies and goals are as follows:

Table 13: Summary of Proposed Policies and Projects

Policy or Project	Sub-policy and Description	Target/Monitoring Indicator		
		2027	2032	2040
1 & 3: Increased public transit supply (Level of Service)	BRT routes (busways)	*See Table 3 3 routes	*See Table 3 8 routes	*See Table 3 10 routes
	Increased service (improvements to timetables and schedules, new buses, Increased feeder network and routes)	+537,000 annual service hours, 40% pop. covered	+717,000 annual service hours 50% pop. covered	+975,000 annual service hours 60% pop. covered
	Upgrades to the Central Bus Station (CBS)	Yes	Yes	Yes
	Upgrades to bus stops for waiting passengers	Yes	Yes	Yes
1.1: ITS (Smart Public Transport)	Smart payment card	Yes	Yes	Yes
	Traffic signal priority	Yes	Yes	Yes
2.: Travel Demand Management (TDM)	Mobility management & modal shift programs	6 programs a year	8 programs a year	10 programs a year
	Education programs			
4 & 5: Sustainable Governance and Integration	Cooperation, formalization, and integration with paratransit providers' (i.e. Songthaew) networks and operators	Operational cooperator program	Service integration program	Fleet renewal program
	Institutional reform of the VCSEBE and establishment of a public transport management entity	Establishment of a management entity	Service integration led by management entity	Mobility as a Service (MaaS)
	Reform of the fare system	-	Yes	Yes
	Financial (funding) reform	Yes	Yes	Yes
	Switch to public/private operation	-	Yes	Yes
6.: Transit Oriented Development (TOD)	Strategic urban planning/connect transport and land-use planning	3 corridors + 4 sub-centres	4 corridors + 5 sub-centres	8 corridors + 6 sub-centres

1 & 3. Increased Transit Supply

- The VTMP recommends step-by-step improvements to create a more comfortable, convenience, and sustainable public transport system
 - New Routes
 - Increased service (hours)
 - New buses and equipment etc.
- The VTMP recommends a hierarchical public transport network based on BRT as trunk lines (especially in the long term) with bus and songthaew as feeders or as circular and semi-trunk routes
- The eventual goal is to expand the BRT and bus networks and establish a trunk and feeder system

Table 14: Approach to Network Integration and Supply (Urban)

Service coverage	Function	Current	Short-term	Mid./Long-term
Inter-city	Long-distance transport services between Vientiane and other cities	Inter-city Bus/Songteo	Inter-city Bus/Songteo	Inter-city Bus / HSR
Trunk route	Arterial transport corridors along radial trunk roads from the city center to the sub-centers	Bus	BRT	BRT
Circular Semi-trunk/	Minor transport corridors not covered by the trunk routes	Songteo +Van	Bus	Bus
Feeder route	Circular transport corridors along the ring roads between the sub-centers	Tuk-tuk +Jambo +MC	Songteo + Minibus/Van	Minibus/Van
Last-mile	Feeder services to trunk and circular routes, especially to BRT lines	Tuk-tuk +Jambo +MC	Tuk-tuk +Jambo +MC	RHS+ E-paratransit

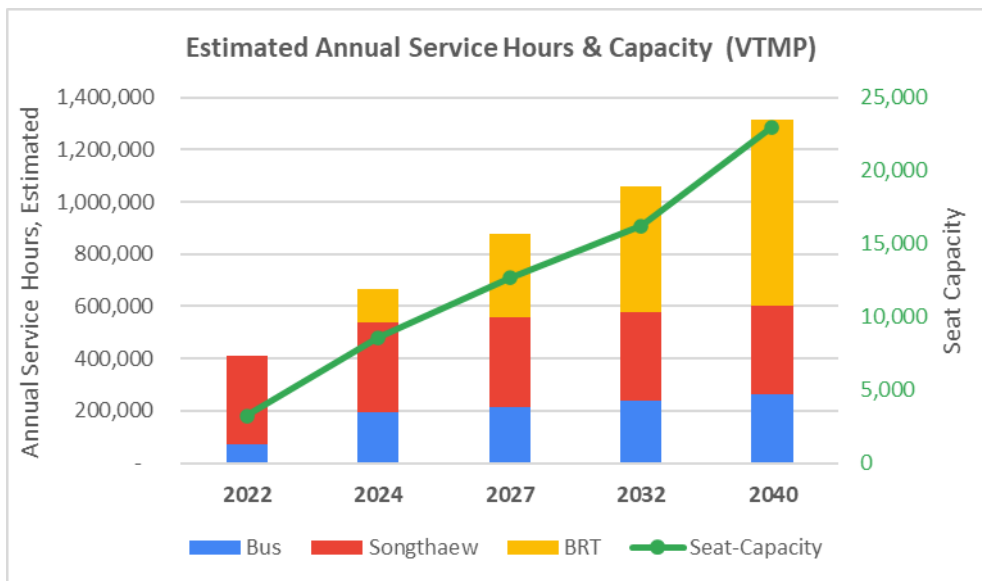
Service Hours and Characteristics

- 4.12 At the time of writing this report service characteristics of BRT, regular buses, and Songthaew routes were not available. However, the following estimates of service hours and seat-capacity were made for the purposes of this analysis. Increases to the feeder buses, which may make use of the existing service hours or increase, could increase these values by another 30 – 40%.
- 4.13 The VCSBE does not currently utilize its full fleet of 43 buses but supplies approximately 65,000 – 70,000 annual revenue service hours, according to published and available schedules. Songthaew routes provided significantly more service, albeit with a lower overall hypothetical capacity due to the smaller size (and service quality) of the songthaew vehicles, which are essentially pick-up trucks. There is currently 136 songthaew vehicles operating in the Vientiane area.
- 4.14 Figure 51 below indicates the increases to service hours which will be required because of planned projects in Vientiane, including the ADB VSUTP (2024) and the proposed VTMP (2027 – 2040). By 2024, total service hours could be increased by over 60% if the newly arrived 52 buses from Japan are utilized and the BRT system is fully up and running.

4.15 From that point, a major increase in service hours will be needed, rising from approximately 400,000 total hours in 2022 to well over 1.3 million in 2040, which is a 220% increase in total service hours. Most of this additional service is planned to come from the BRT services, which may account for an estimated 710,000 hours in 2040. If not including the estimated songthaew service-hours, by 2040 there could be an approximately 1,300% increase in formalized public transit service hours (i.e. buses).

4.16 Further, the total seat capacity is estimated to increase by well over 600% between current conditions (2022) and the 2040 plan, rising from around 3,200 in 2022 to nearly 23,000 in 2040.

Figure 51: Annual Service Hours, Estimated (VTMP)



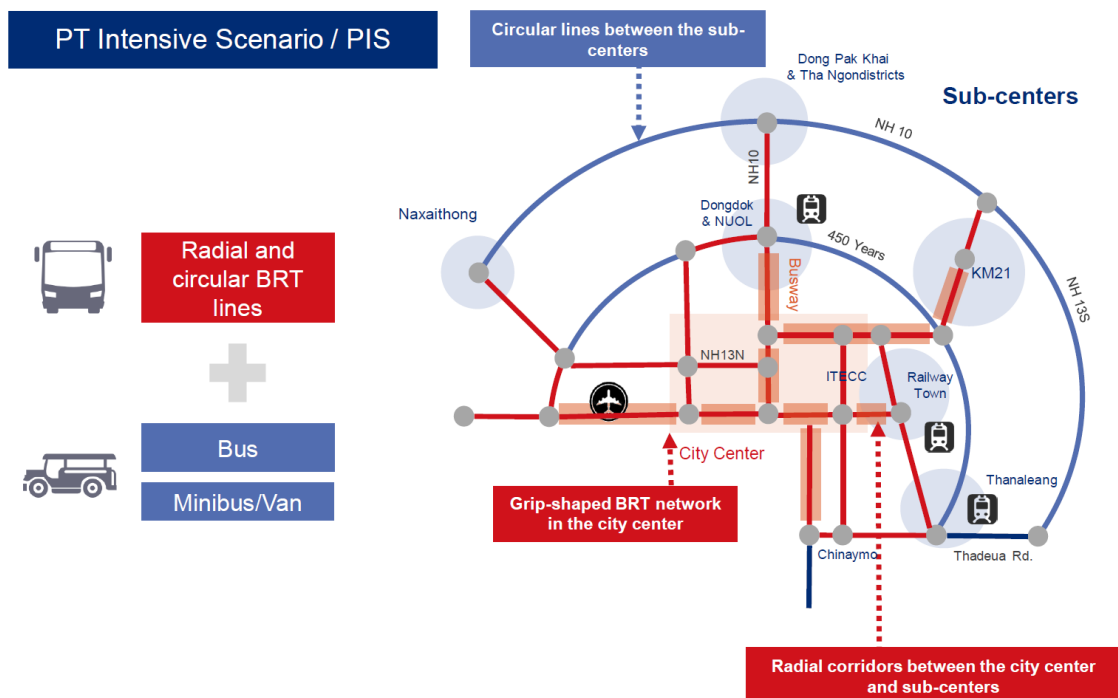
Bus Rapid Transit (BRT) and Busways, Feeder, Semi-Trunk, and First-Mile/Last-Mile

- 4.17 The BRT networks and their feeder networks, as simplified graphics, are shown below in Figure 52 and on the following page, Figure 53. These simplified graphics indicate the general concept of the BRT (trunk) lines. The BRT and feeder lines form radial corridors which connect the city centre to other sub-centres (National University of Laos, Naxaithong, Thanaleang, Dong Pak Khai, KM21, and Railway Town. Eventually, a grid shape is formed with trunk lines and circular feeder lines connecting sub-centres to each other. These locations correspond to the areas identified for concentrated developed areas from the 2011 Urban Development Plan, also developed by JICA.
- 4.18 On the following page, the full 2040 network is shown as Figure 53. The full BRT networks for 2027, 2032, and 2040 are depicted in Appendix A.

Figure 52: BRT Concepts



Figure 53: Feeder Bus Concept



Intercity Rail and Other

4.19 The VTMP does not recommend or provide designs for additional urban rail-based transport projects. However, ongoing rail and cable car projects are noted:

Table 15: Proposed Fare System (kip)

Type	Project	Year
Standard Gauge Rail (Chinese)	Boten – Vientiane Station	2021
Standard Gauge Rail (Chinese)	Vientiane Station - Vientiane South Station	2022
Metre-gauge (Thai)	Thanaleng – Khamsavath Station	2023
Standard Gauge Rail (Chinese)	Vientiane South Station – Logistics Park Station	2024
Standard Gauge Rail	Vung Ang (Vietnam) – Vientiane Station	2030
Cable Car	Thanaleng – Thailand Cable Car	2030
Standard Gauge Rail (Chinese)	Vientiane – Bangkok	Future

Central Bus Station (CBS)

4.20 Details of this upgrade program as not available at the time of writing this report. However, the report refers to “Smart” features and other general upgrades to the quality of the station.

1.1. Smart Public Transport Features

- Smart public transport/ITS features do not represent a major portion of the VTMP
- Suggested inclusions are:
 - Card-based smart payment system (note that a QR-code banking-based system is already in use on the VCSBE buses, which is also widely used through Laos)

- Traffic signal priority (TSP) for transit vehicles. TSP is a common feature of BRT systems around the world.

2. Travel Demand Management (TDM)

4.21 Details of these programs were not available at the time of writing this report.

4 & 5 Sustainable Governance and Integration

4.22 Sustainable governance and integration

- Formalization programs with Songthaew operators
- Institutional reform of the VCSBE and establishment of a Public Transport management entity
- Reform of the fare system
- Financial (funding) reform
- Switch to public/private operation

Formalization of the Songthaew Networks

2.1 The VTMP notes the following issues regarding the Songthaew networks:

- Existing Songthaew routes needlessly compete with VCSBE routes
- Songthaew fares and timetables are not integrated with other forms of public transport (i.e. VCSBE buses)

4.23 Therefore, to solve some of these issues, proactive cooperation with songthaew operators is required, which would expand public transport services through its incremental formalization. The VTMP recommends the following three steps for implementation:

1. Operational cooperation with Songthaew operator including design of fare systems, timetables, bus stops, maps etc.
2. Service integration with Songthaew operators using existing Songthaew vehicles
3. Fleet renewal program for Songthaew operator vehicles

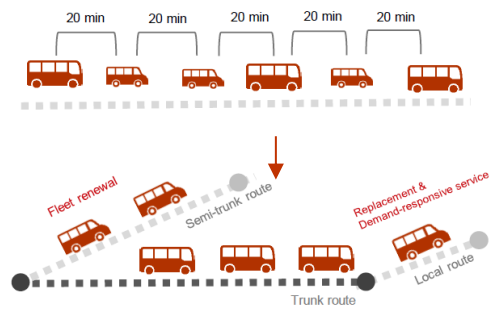
Figure 54: Process for Formalizing the Songthaew Operators

As-is



- Bus and songthaew are operated independently, and most routes needlessly compete

To Be



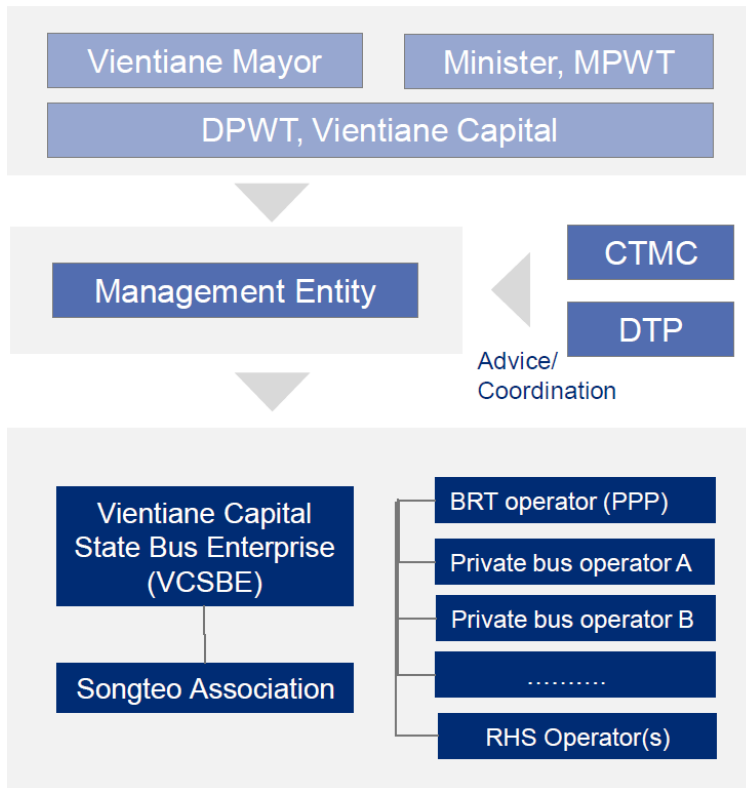
- Bus and songthaew launch operation cooperation on, and songthaew services are officially integrated based on concession (contract) agreements.
- Some songthaew routes are converted to demand-responsive services
- Old/deteriorated vehicles are replaced with new songthaew vehicles (e.g. e-songthaew or vans) through lease or concession programs.

Institutional Reform of the VCSBE

- 4.24 A major part of the VTMP involves an institutional reform of the VCSBE, to promote sustainable governance of public transport, at the regional level.
- 4.25 The VTMP recommends the following structure shown in Figure 55, which is based on the example of Hanoi, Vietnam and Bogota, Colombia. In this structure, the VTMP stresses the three hierarchies of the Vientiane model:
- Regulators
 - Governance
 - Infrastructure and property investors
 - Lao PDR government
 - Vientiane city government
 - Management organizations
 - Route and schedule planning
 - Operations management
 - Operators
 - State-owned operations, like VCSBE
 - BRT operators under PPP agreements
 - Songthaew associations and members (through concession agreements)
 - Ride-hailing service (RHS) operators, like LOCA

4.26 The VTMP notes that a transition to sustainable governance would likely lead to benefits of service integration, as in Mobility as a Service (MaaS) where discrete transport services can be merged into one.

Figure 55: Proposed Reorganization of Regional Governance of Public Transport in Vientiane



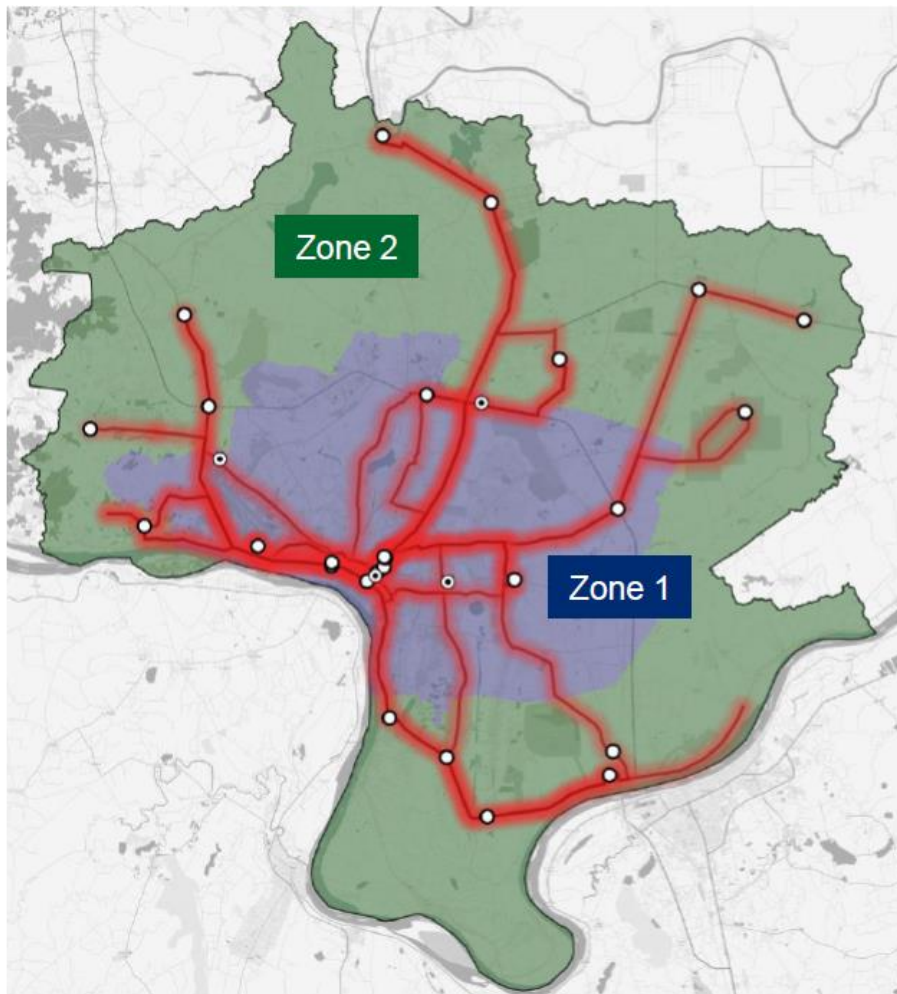
Fare System

4.27 The VTMP recommends a move to a distance-based zone system with a fixed time limit, see below in Table 16.

Table 16: Proposed Fare System (kip)

Zone	Existing	Proposed
Minibus	5,000 – 12,000	
Green Bus	4,000 – 7,000 (20,000, Route 6)	
Kyoto Bus	4,000	
Airport	15,000	
Zone 1	-	3,500
Zone 2	-	8,000

Figure 56: Proposed Fare System



5. Transit Oriented Development (Integrating Land-Use Planning)

4.28 **Details of the TOD planning was not available at the time of writing this report.** However, preliminary VTMP documents note that strategic urban planning and land use control is necessary to maximize the impact of public transport investment on sustainable urban development. Further that developing compact, mixed-use neighborhoods around existing or new public transport stops offering frequent and high-quality service.

4.29 Preliminary documents note the need for additional studies (or neighbourhood plan) surround each of the proposed TOD areas. The following recommendations are given:

- Transit oriented development (TOD) harmonized with BRT investment (BRT TOD)
- Reform of urban planning and land use laws to enable TOD
- Social housing development for low-income settlements to ensure their accessibility

Benchmarking

- 4.30 In this Section, we will compare the current and proposed public transport situation and compare it with two other similarly sized cities from developing countries, known for having reasonably good public transport networks:

Table 17: Benchmarking

Item	Vientiane Proposed 2040	Sejong, Korea	Ottawa, Canada	León, Mexico	Guatemala City
Metro area population	1.4m	0.4m	1.4m	2.1m	3.0m
Country GDP per capita	\$2,400	\$35,000	\$45,000	\$9,250	\$4,480
Number of BRT buses	~300	44	936	620	300
Peak Headways	? /5 mins	10-20	< 5 mins	< 5 mins	5 mins
Kilometres of busways	36 km	110 km	59 km	32 km	24 km
Public transport mode share	30%	9%	14%	35%	23%
Ridership, BRT	TBC	20,000	220,000	220,500	210,000
Centralized public transport authority	Proposed	Yes	Yes	Yes	Yes
Integrated fares	Proposed	Yes	Yes	Yes	Yes

Data sources: Vientiane: VTMP; Sejong Special Province Traffic Big Data Analysis System

- 4.31 In this high-level benchmarking analysis, we compared the vision for Vientiane in 2040 to that of other comparable cities, in both developing and non-developing countries, with BRT systems. Levels of service vary, in comparable countries, but in higher mode share cities the service frequency is correspondingly high. In the two Latin American cities (León and Guatemala), mode shares of 30% and high ridership are achievable with large systems of 30+ km of busways.
- 4.32 In Ottawa, relatively high ridership is achieved although massive investment in 60 km of busways and almost 1,000 buses are required to achieve the same ridership of the Latin American cities, with still a relatively low mode share.
- 4.33 Systems like that in Sejong do not achieve high ridership density as they are mainly focused on long-distance trips, for example to the airport. In Sejong, the central area is relatively compact without long travel times. Walking and driving are popular modes of travel within Sejong, and as such the public transport mode share is low at just 9%.
- 4.34 All the above-described systems have a centralized authority and integrated fare systems.

5 Recommendations for Changes to the VTMP

- 5.1 In this Section, we provide recommendations to be considered by Vientiane and the Lao PDR based on the results of our evaluation of the ongoing VTMP being undertaken by JICA/Katahira Engineering International. To highlight our recommendations, we will be highlighting issues, and opportunities that we see going forward.
- 5.2 Overall, our main recommendations focus on the following areas:
- minor changes to the proposed networks,
 - paratransit operations; and
 - ITS (Smart Public Transport) solutions.

Network Issues & Opportunities

National University of Laos (NUOL)

- 5.3 Access at NUOL, which is a major public transport destination, will be relatively poor with the new BRT lines, with an average walking time to all NUOL buildings of 8 minutes from the proposed BRT stop (from ADB and JICA plans). We identified two general solutions to this issue:
- Move the stop about 500m closer to the centre of the NUOL
 - First-mile/last-mile solutions within the campus (circulators)

Stop Extension

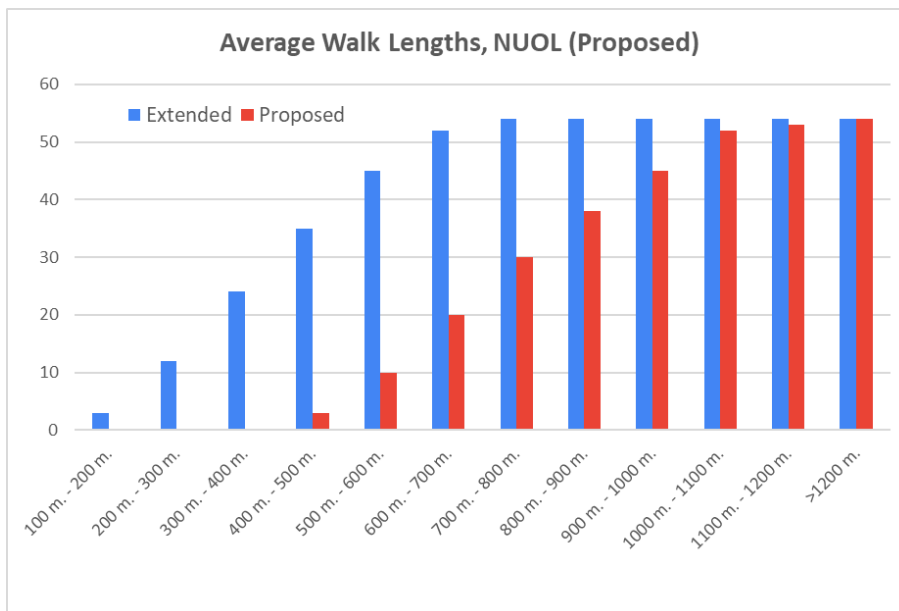
- 5.4 By extending the route, northwards by approximately 500m, the centre of the university will become more accessible, refer to Figure 57 below. By doing so, individuals would save considerable time for individuals accessing the approximately 54 buildings that are located on the NUOL campus. A relatively large space, the NUOL occupies an estimated 460,000 m², generally segmented by two east-west roads creating 6 areas. Notably, the majority (78%) of the buildings are in the Central and North areas. Near the front of the main road, where the proposed BRT stop would be located, is mostly forested area. Our analysis shows that the average walking distance to all buildings on the NUOL campus to the would be 683 m (around 8 minutes) with a minimum of 350 – 400 m, and a maximum of around 1.2 km.

Figure 57: National University of Laos (NUOL) Detail



- 5.5 The main central road in the campus is wide enough to accommodate buses but not a bus lane, at 10m in length. Busways would likely not be required, as this road is low traffic. An off-street transit exchange could be built on an existing parking lot, see above. BRT lines D and G would be affected by this change.
- 5.6 If the BRT stop is extended around 500 m into the centre of campus, walk distances are reduced considerably. In this scenario, the average walk distance is reduced to 328 m (4 minutes), and 65% of buildings would be located within 500m of the stop, compared to just 6% in the proposed location, refer to Figure 58. Considering the NUOL stop is likely to be amongst the busiest in the network, this small change has the potential to have a great impact on network travel time savings, mode shift, and GHG emission reductions.

Figure 58: Average Walk Lengths at NUOL



First-Mile Last-Mile Solutions within the Campus

- 5.7 On-campus transportation is a common issue in other locations round the world, including Korea. Several solutions are available for university campuses, including:
- Shared Personal Mobility (PM) on campus
 - Short shuttle buses (circulators) on campus

5.8 Shared PM could consist of a shared bicycle, e-bicycle, or e-scooter (kickboard). Such systems generally consist of small vehicles which can be rented for a cheap price for a period of less than 30 minutes, then returned to either a designated place, or a virtual area. The following figure depicts actual usage data from a PM system, including typical ODs, at a university campus in Korea.

Figure 59: Example of Shared PM and OD Data for an On-Campus PM System



Data source: KNUT

5.9 A short (2.2 km) circulator (shuttle) bus could be permitted to run within the NUOL area to connect many of the campus buildings with the BRT stop. At just over 2.2 km in length, with a single bus running in a loop, the loop could be completed very approximately 7 minutes. This could be halved if two buses are used. An example of a possible routing is shown in Figure 60.

Figure 60: NUOL Circulator (Shuttle Bus)



Extend the BRT terminus at the NUOL to around 500m into the campus area, which would walk travel times by almost 1/2 and increase the convenience of the system overall.

Modifications to BRT Lines

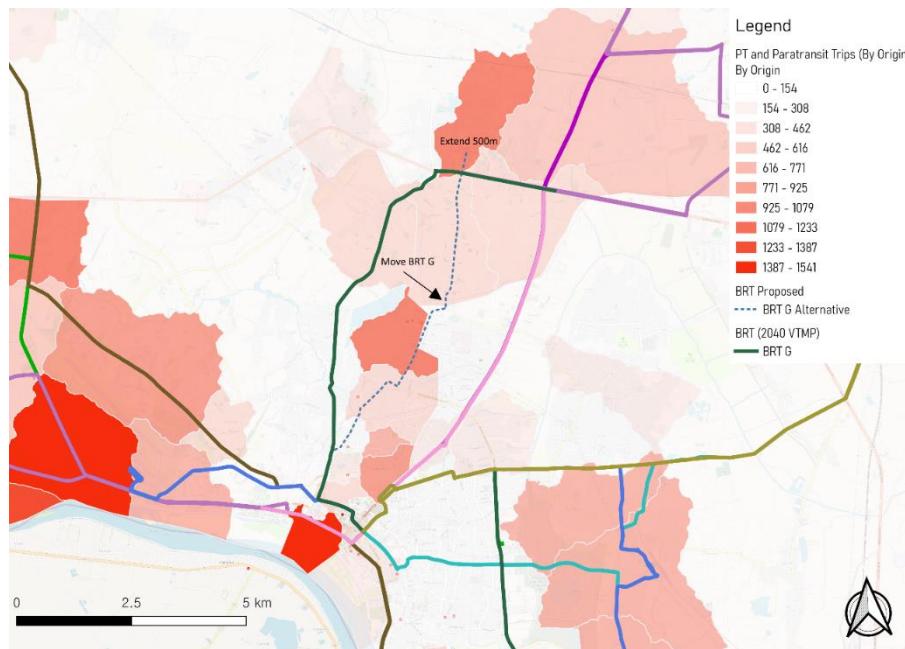
BRT G

- 5.10 On analysis of the existing demand (from the O-D survey) we note that a major corridor, which corresponds generally to today's route (#31) connecting the NUOL with the Central Bus Station does not fully capture the existing public transport demand. Instead, as proposed by the VTMP, a parallel corridor is recommended for BRT Route G. This route would rely on "new" demand, that is, users would need to change their patterns in some way to use the service, or the corridor would target a modal shift (from cars). The corridor located approximately 1 – 2 km east of the proposed BRT G could be more appropriate.
- 5.11 This corridor is utilized by the existing Route #31 and could better service the existing demand⁷ on this corridor, refer to Figure 61. Additionally, the eastern corridor would reduce

⁷ Includes paratransit and public transit (bus) demand, summarized by origin.

the over length of the route by around 200 – 300 metres (per direction). Rights-of-ways on both these corridors are similar. What’s more, since this corridor is already used by large buses today, less engineering or modifications to the corridor would be required.

Figure 61: BRT Route G Alternative Corridor

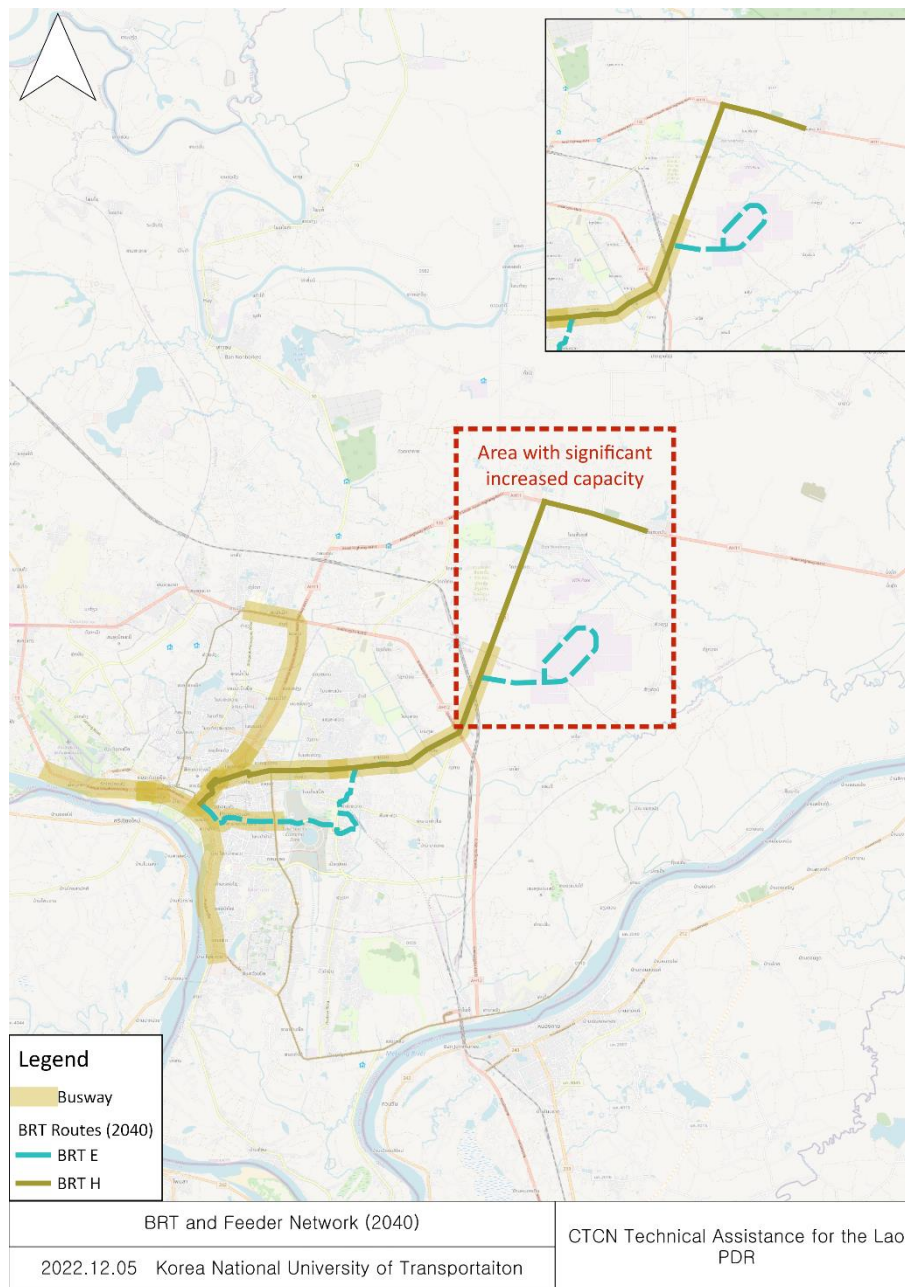


Consider modifying the corridor of BRT Line G to match that of existing Route #31 between Central Vientiane and Dong Dok (NUOL).

BRT H

- 5.12 The BRT H corridor is shown to serve the KM27 area in northeast of Vientiane. In previous years (2027 & 2032) it will be served by a songthaew route. It is unclear why a large jump in capacity (from songthaew to BRT) would be required by 2040. Note that here is no TOD planned for the KM27 area. Modelling results will confirm this need. If there is a need for BRT capacity by 2040 (e.g. more than 3,000 pphpd+) then a regular city bus feeder route should replace the songthaew route recommended in 2032.

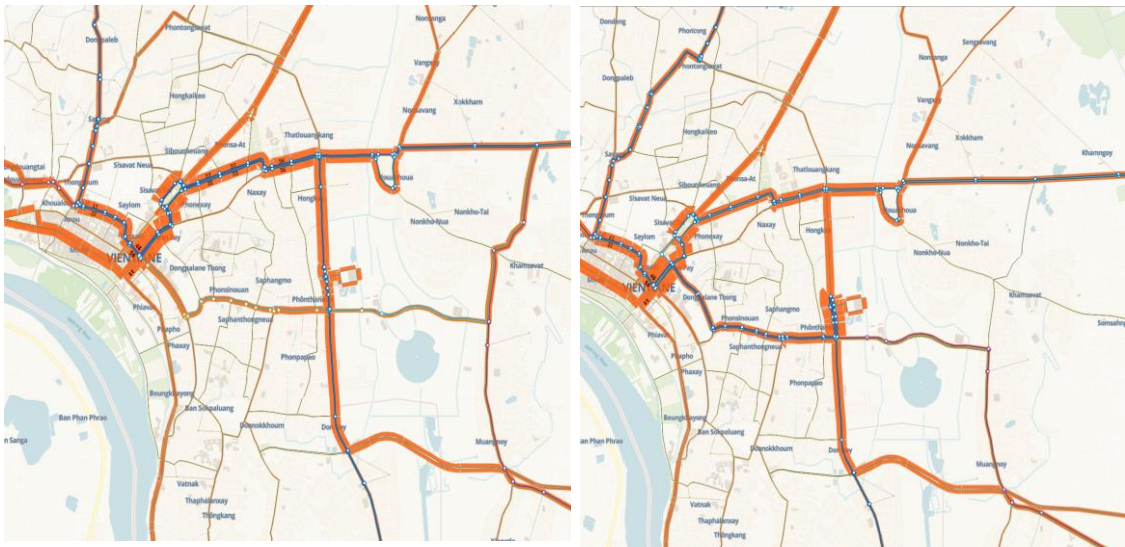
Figure 62: BRT H Capacity



Southeast Sections

- 5.13 In the eastern section, by 2040 there are two options for east west travel in and out of the Vientiane CBD: the slightly more southern busway on Rue Nongpaya, and the slightly more northern busway on Nongbone Road.
- 5.14 In the JICA proposals BRT E uses the Nongpaya Busway and BRT F, G, and H use the more northern Nongbone Road busway. With some modifications to routes, (see Figure 63 where total capacity is shown in orange), overall reductions can be made to both service hours and passenger hours by choosing to use shorter routes to get to the CBS , and the main transfer point of the network while still serving both corridors.

Figure 63: JICA vs KNUT Proposed Changes in Southeast



JICA Proposed

KNUT Proposed

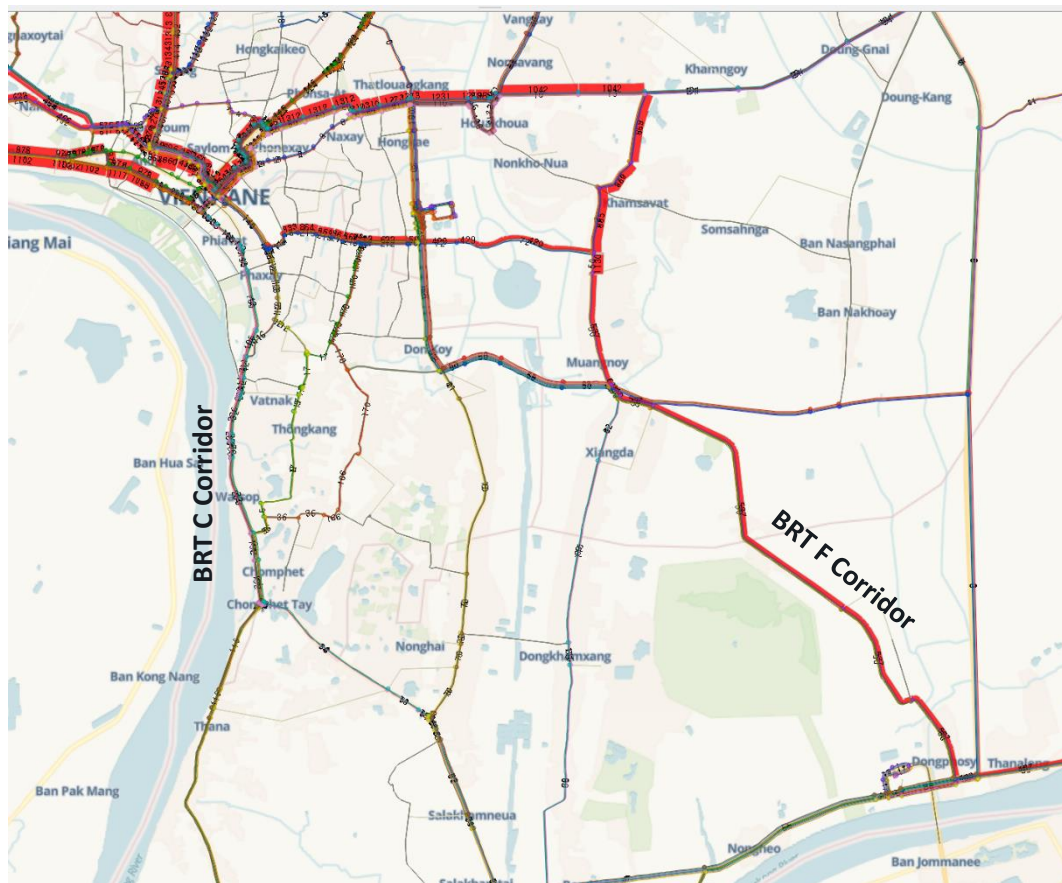
Some efficiencies can be gained by modifying the routing of BRT E, F, G, and G along the eastern busways.

BRT C

- 5.15 Our modelling results indicate that most sections of BRT, south of the Vientiane CBD will not be well utilized, with passengers' volumes as low as 150 pphpd (please note this value does not include future demand due to development, mode shift, or induced demand). However, our model shows that the southeast corridor of BRT F would be more popular and faster than the more circuitous BRT C routing, even with the existing 2022 public transport demand profile.

Priority may be preferred to the BRT F or G corridors rather than the BRT C corridor.

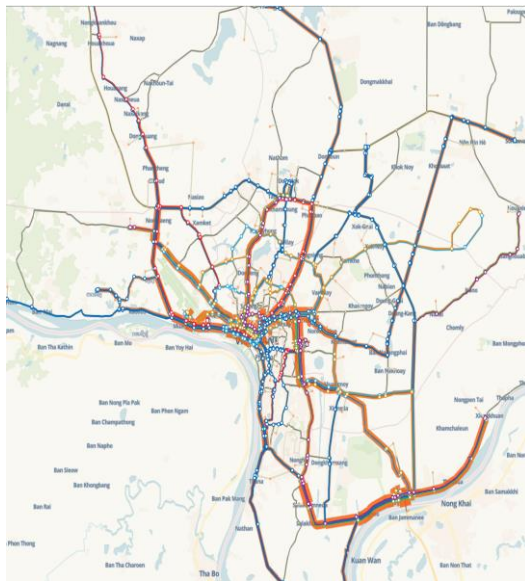
Figure 64: Southeast BRT Corridors



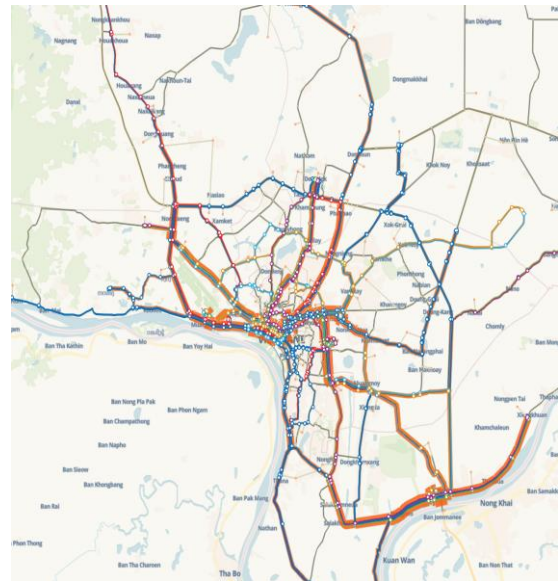
Modelling and Forecasting

- 5.16 As part of this project, a modelling tool was developed using the Emme software package and based on OD data collected by JICA. A fulsome report of the modelling tool that was developed for this project is available in another report (Modelling and Forecasting Report).
- 5.17 Two networks were developed based on the proposed 2040 BRT and background bus networks developed by JICA, refer to Appendix A. The two networks are very similar, other than the proposed changes listed above in this section. The two networks are shown below in Figure 65. The routes are shown in various colours, and total capacity is shown in orange.

Figure 65 KNUT and JICA Networks



JICA Network



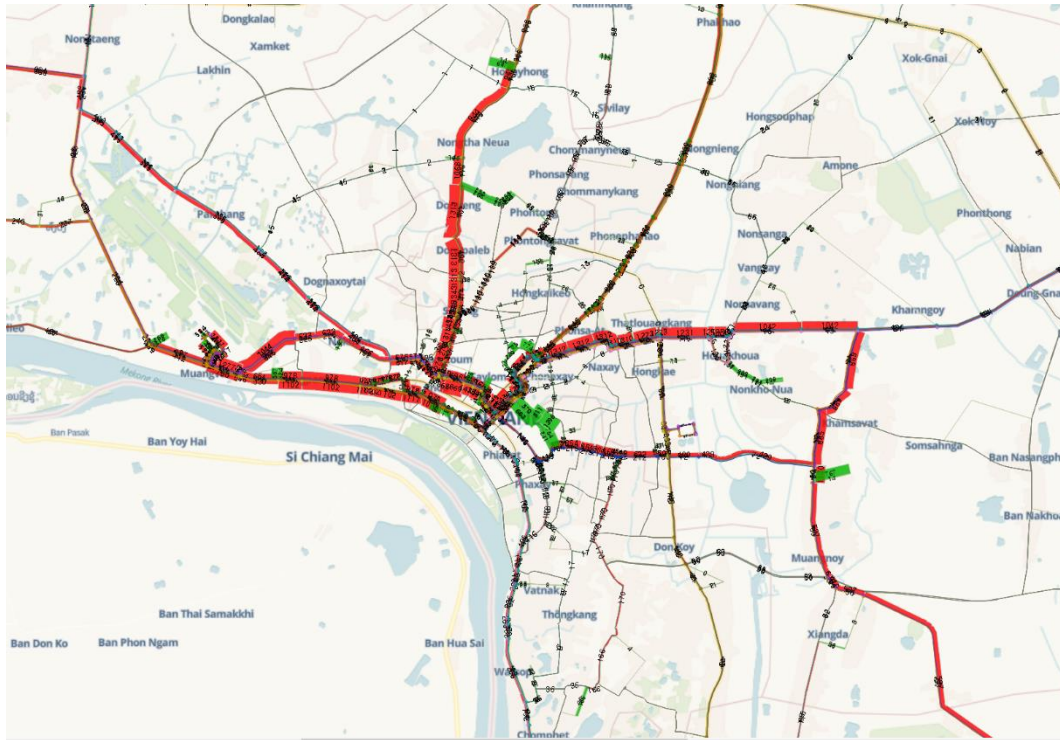
KNUT Network

These networks were both run using the existing (2022) demand profiles (refer to Modelling and Forecasting Summary report) The resulting differences on the assignments are shown below in Figure 67 and

Table 18.

- 5.19 These results indicate that the network modifications presented in this document may be worth considering. This experiment utilized a fixed OD demand matrix based on the 2022 base demand; therefore, **as run, the model cannot predict any differences in additional or lower total public transit ridership. Additionally, the model does not account for the likely potential for induced demand which could accompany such a huge increase in transit service hours and routes.** Total transit volume on the KNUT network is shown below in Figure 66.

Figure 66: Transit Volumes (KNUT Scenario)



- 5.20 However, results show that the network modifications could result in an approximately -3.27% reduction in passenger hours on transit vehicles with a similar reduction in total impedance, meaning a (small) increase in transit ridership is likely in this scenario. Simultaneously total service hours and service kilometres could be reduced by 4.6% – 6.2% versus the proposed JICA scenario while still providing the same capacity.
- 5.21 However, average total boardings would increase by around 6.6% indicating that generally more transfers would be required to effectively use the network. Most of the changes occur from the changes on the eastern side of Vientiane, by shifting the routes of BRT F and G to more southern BRT busway on Rue Dongpayna.

These results indicate that the network modifications presented in this document may be worth considering.

Figure 67: Transit Volume Differences

Table 18: Summary of Networks Items

Item	JICA Network	KNUT Network	Difference
Service-hours	349.216	333.2364	-4.58%
Service-kilometres	6,569.453	6,164.546	-6.16%
Passenger-hours	11,184.78	10,819.31	-3.27%
Avg. boardings per trip	1.42	1.5	5.63%
Total average impedance	67.71	65.49	-3.28%
Total average impedance to Zone 772 (NUOL)	81.95	63.31	-22.75%

Feasibility and Financing

- The proposed networks are a major shift in networks, service, and potentially lifestyle of Lao people. For example:
- By 2040, we estimate that the VTMP (including the planned service increases from the ADB VSUTP) would increase by the following amounts:
 - Total service-hours for public transport by 220%
 - Total service-hours for formalized public transport (i.e. buses) by 1,300%
 - Total seat-capacity by 600%
 - Total number of buses by up to 920% (to over 400 buses)
 - A corresponding increase in annual operating expenses will also be required.
 - The existing mode share of public transport is only 1 – 3% (depending on method uses to calculate it) and there is a massive upwards trend towards increased personal vehicle ownership, which is increasing at a rate of 12.8% per year, on average.
- A projected 30% public transport mode share may be achievable if the plan is implemented as above, however, it still requires a major change (up to 2,900% increase) at the same time, reversing a downward trend in ridership and combatting an upward trend in auto ownership.
- *Funding and financial details are **not yet available** from JICA reporting.*

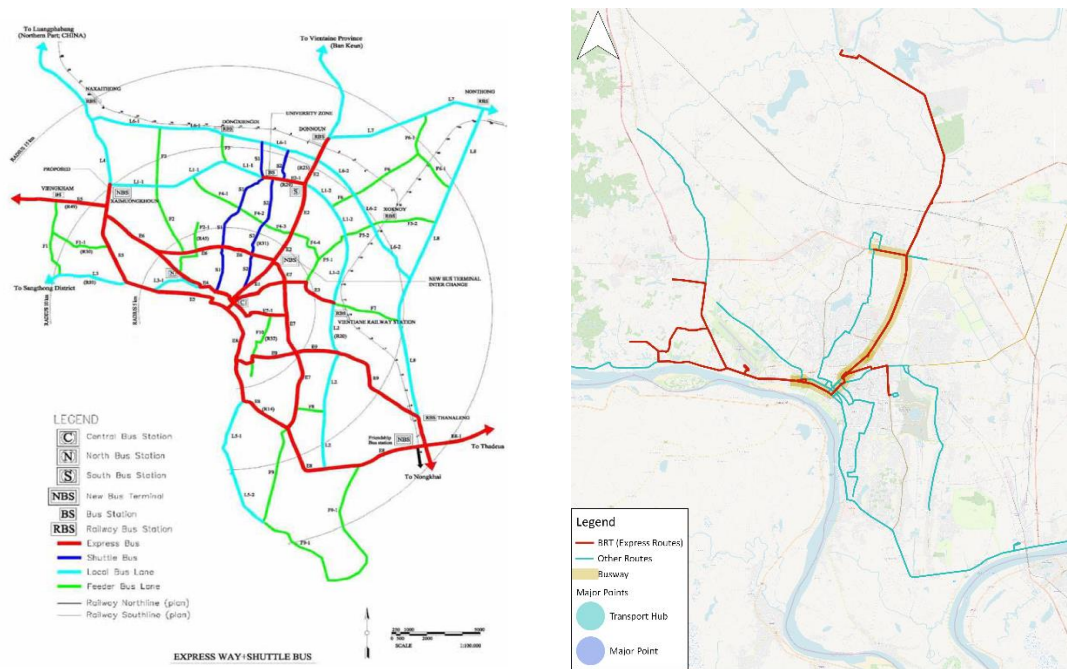
Learning from the Past

- 5.22 The 2008 Transportation Mater Plan (TMP) set the following selected targets, to be achieved by 2025. To achieve these targets, they designed a network as shown in Figure 68.

Table 19: Targets and Results, 2008 TMP

Target for 2025	Result 2022	Result 2025
40% mode share of public transport	1-3 % in 2022	Unknown in 2025
200 vehicles (352 if including minibuses)	43 in 2022 (179 if including songthaews)	Up to 95 in 2025 (231 if including songthaews)
43 routes total	13 in 2022	Potentially up to ~30 in 2025 (16 confirmed)
5 BRT (express routes)	0 in 2022	3* in 2024
Reform of the VCSBE	No	-
Re-organization of the paratransit service (songthaew etc.)	No	-

Figure 68: 2008 TMP Planned 2025 Network versus Predicted (2025)



5.23 Although there is still three years left in the plan, most of these targets and outputs (projects and policies) will not be met. In the VTMP, many of these same targets are repeated, and some have been slightly decreased versus the original 2008 targets.

Despite excellent socioeconomic forecasts, the 2008 TMP was not entirely successful. Targets will not be met, and specific items were not implemented. The newly developed plan has similar items to be implemented with a slightly more realistic target.

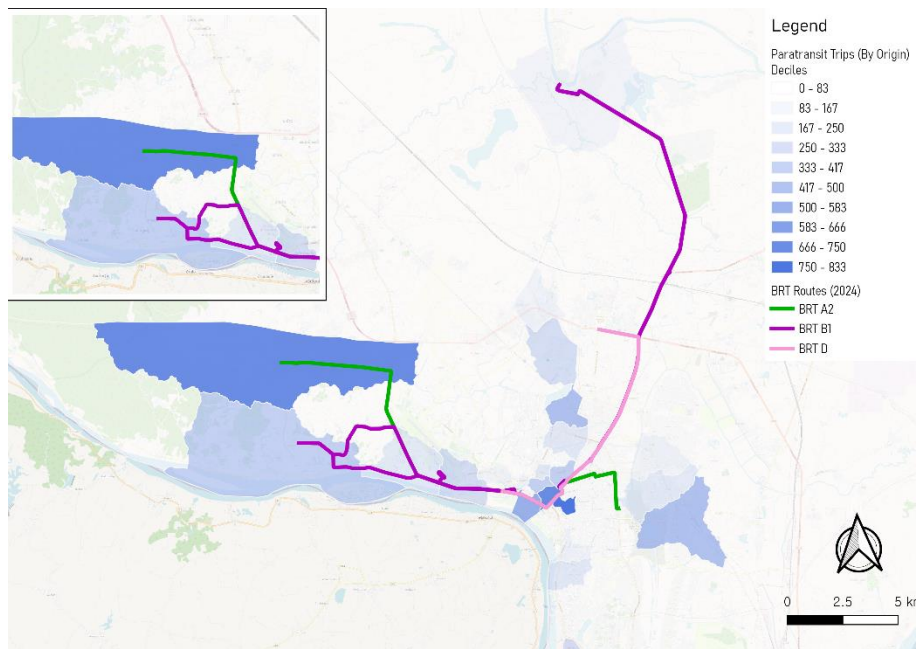
A further understanding, of why the 2008 TMP was not fully successful should be undertaken. Were the issues mainly political, financial, or operational etc.? Doing this may allow the new plan to become successful.

Opportunities

Songthaew Integration as DRT

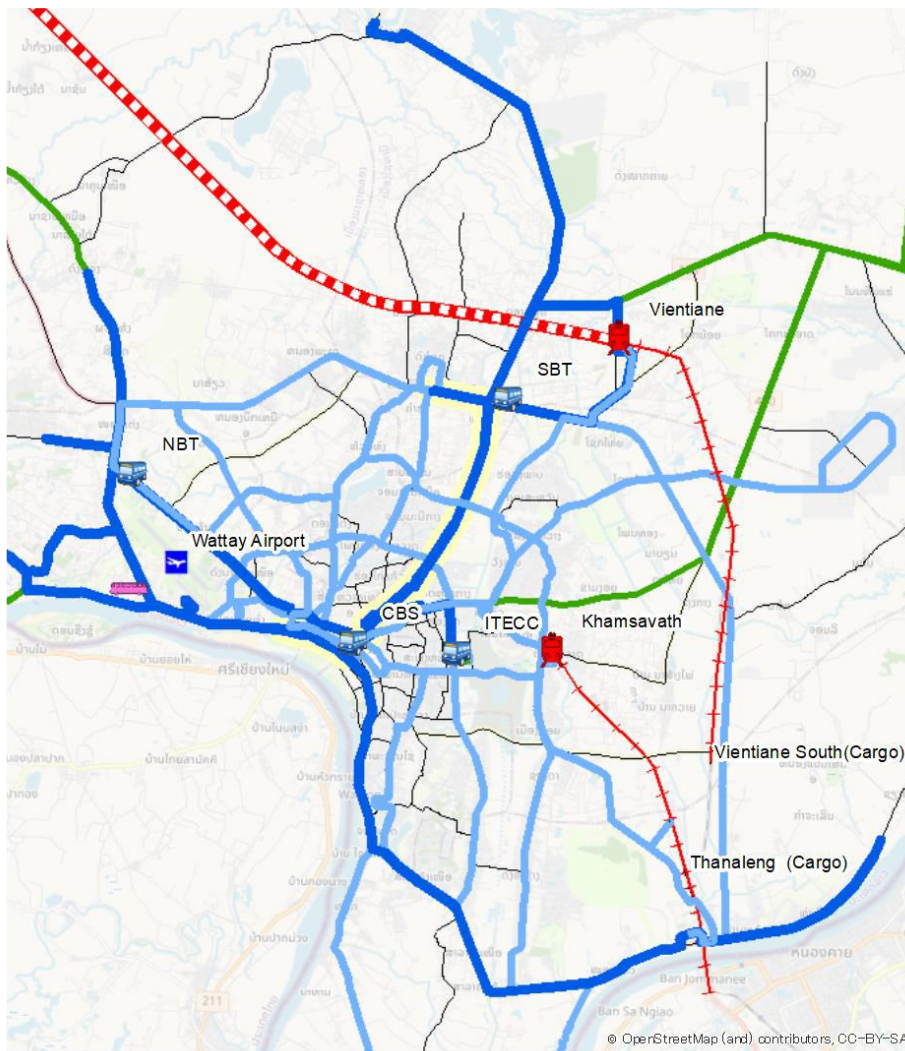
5.24 Today, demand for paratransit trips is limited to a few key areas, a western, central, eastern, and southeastern corridors. In total, paratransit commands a low mode share (<2%). However, when the first BRT systems open in 2024, they will compete with the existing songthaew demand, refer to Figure 69.

Figure 69: Paratransit Trips (OD Survey)



- 5.25 Most of these trips occur on the west side of Vientiane, where BRT route A2/A1, or B would compete directly with those songthaew routes. At this stage, the songthaew routes should be moved to serve other areas. Ideally, this would be done by integrating the songthaew into the public transport network, under a management entity as described by the VTMP. The VTMP recommends moving the songthaew to the outskirts areas of Vientiane which would feed BRT stations as fixed-route services, see Figure 70.
- 5.26 These routes are long and are serving under-development or low-density areas. Utilization of these routes may not be high and therefore may require significant subsidies.

Figure 70: Map of Public Transport Network from the VTMP (2027)



5.27 Instead, songthaew could be operated as Demand-Responsive Transport (DRT) in other areas in Vientiane. Specifically in areas which do not compete with the new BRT lines, or the existing bus lines. By doing so, the songthaew operators could:

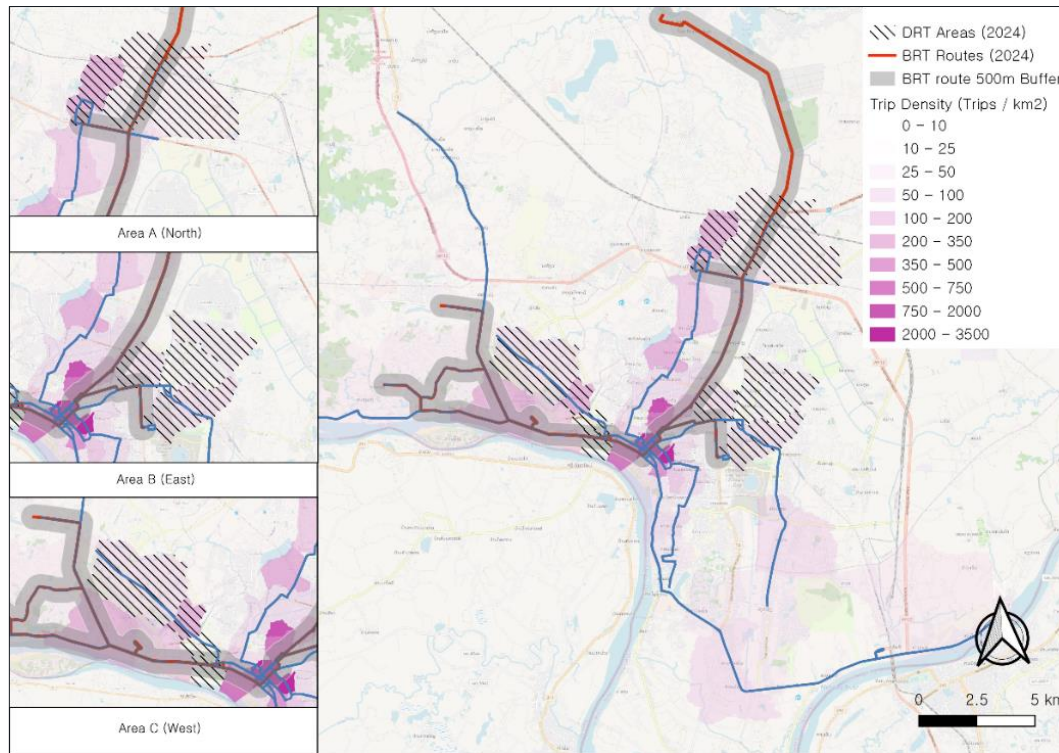
- save songthaew operators' revenue;
- save songthaew operators' jobs;
- utilize the existing fleet; and
- improve the public transport network.

5.28 DRT could be run in several areas that do not compete with BRT or the existing bus service (VCSBE). In Figure 71 below, three DRT areas are proposed. These areas are chosen to not compete with BRT lines or existing public transport and are in areas with relatively high trip densities (where total trips per km² are relatively high). According to Kaufman (2021), DRT systems may work well in cases where the demand density (of DRT trips) is around 20 trips per km².

5.29 According to some studies, DRT are appropriate where they can reduce the required subsidy of an existing fixed-route or indeed have a positive economic result from a cost-benefit-

analysis (CBA⁸). Previous research has shown that DRT can increase average utilization of transit vehicles and potentially make them economically viable in lower density area (peri-urban areas), but main depends on the demand density Previous research has shown that DRT can increase average utilization of transit vehicles and potentially make them economically viable in lower density area (peri-urban areas). Such a system is further discussed in Chapter 7 of this report.

Figure 71: Proposed DRT Areas (2024)



There is an opportunity to transfer songthaew services into DRT sustainable services in a short-term timeframe. Further studies are needed.


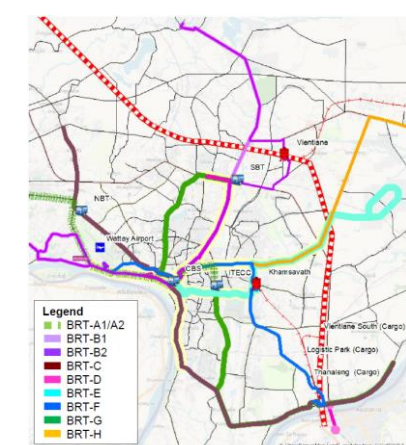
⁸ Papanikolaou, A; Basbas, S; Mintsis, G; Taxiltaris, C. A methodological framework for assessing the success of Demand Responsive Transport (DRT) services. *Transportation Research Procedia*, 2017, 24, 393-400, <https://doi.org/10.1016/j.trpro.2017.05.095>.



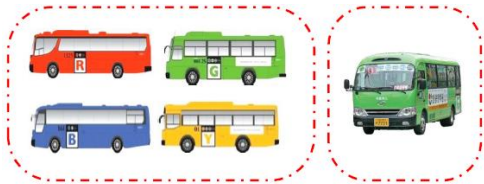
Full Bus System Reform (Based on Seoul Bus Reform, 2004)

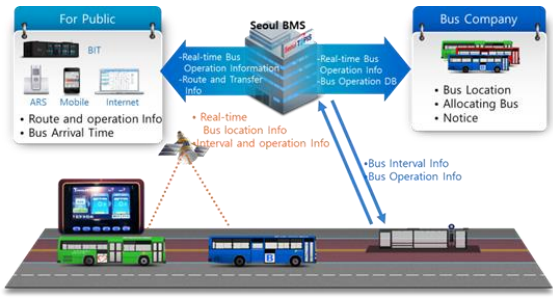

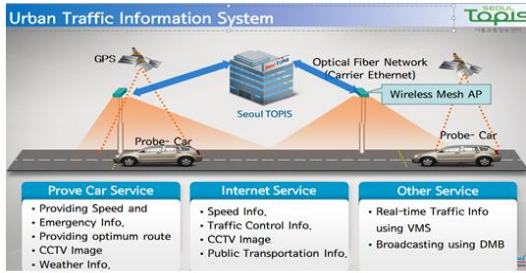

- 5.30 There is an opportunity for VCSBE reform as a so-called *big bang* when the BRT opens in 2024/2025. Indeed, the Vientiane case is like the story of the Seoul Bus Reform of the early 2000s. In 2004, the following elements of bus reform were undertaken simultaneously in Seoul, with a comparison to the elements of the more piece-meal plans for proposed for public transport reform in Vientiane, Lao PDR by both ADB and JICA.
- 5.31 Many of these elements are planned to be constructed or are proposed for the Vientiane area. The Seoul case shows that most, if not all, of these elements are required for successful reform of a public transport system.

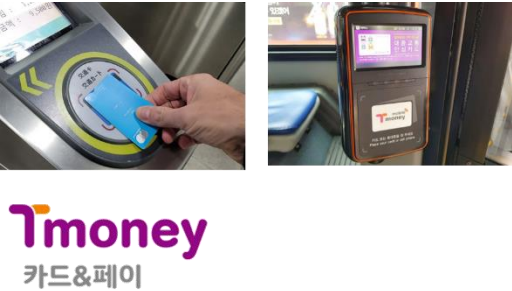


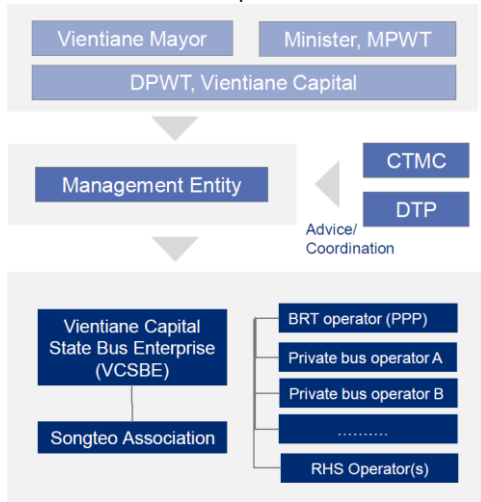
Legend


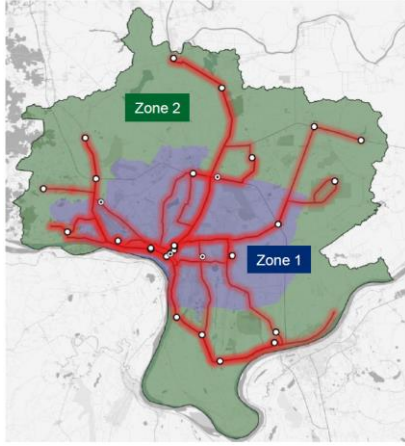
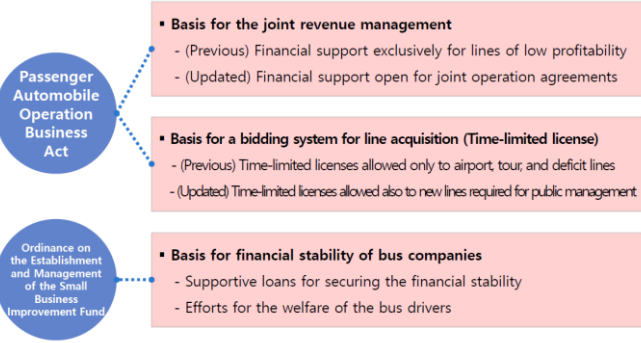
In Place	Proposed/To be Built	Not Proposed
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Item	Seoul	Status	Vientiane
Trunk and feeder lines including busways (BRT)		To be implemented through the ADB VSUTP and expansions proposed by JICA.	

Item	Seoul	Status	Vientiane
Exclusive bus lanes		<p>To be started by ADB VSUTP and expansions proposed by JICA.</p>	
Colour coordination system, based on the function of the buses	 <p style="text-align: center;"> City buses (semi-public) Community buses (private) </p>	<p>None</p>	<p>No proposal</p>

Item	Seoul	Status	Vientiane
<p>Bus management system (BMS), bus information system (BIS), and management centre, including third party data transfer</p>	 <p>The diagram illustrates the Seoul BMS system. It shows a central 'Seoul BMS' hub. On the left, 'For Public' users access information via ARS, Mobile, and Internet, receiving 'Route and operation Info' and 'Bus Arrival Time'. On the right, 'Bus Company' users receive 'Real-time Bus Operation Info' and 'Bus Operation DS', which includes 'Bus Location', 'Allocating Bus', and 'Notice'. At the bottom, buses on a road are connected to the system via 'Real-time Bus location Info' and 'Interval and operation Info'. The system also provides 'Bus Interval Info' and 'Bus Operation Info' back to the buses.</p> <p>Source: TOPIS</p>	<p>A BMS-like system with real-time tracking has been operated since 2017 by JICA, however it is a relatively basic system.</p>	 <p>A map of Vientiane, Laos, showing various bus routes in different colors (red, blue, green, yellow, purple) across the city. The map includes street names and landmarks.</p>
<p>CCTV monitoring of bus lanes for illegal parking</p>	 <p>The diagram shows the 'Urban Traffic Information System' (Seoul TOPIS). It features 'Probe-Car' units equipped with GPS and connected to an 'Optical Fiber Network (Carrier Ethernet)' and 'Wireless Mesh AP'. The system provides three main services: <ul style="list-style-type: none"> Probe Car Service: Providing Speed and Emergency info, Providing optimum route, CCTV Image, and Weather info. Internet Service: Speed Info, Traffic Control Info, CCTV Image, and Public Transportation Info. Other Service: Real-time Traffic Info using VMS and Broadcasting using DMB. </p> <p>Source: TOPIS</p>	<p>ADB recommended monitoring in the central area (proposed to be manual enforcement).</p>	<p>On-street parking on all streets, except the Transit Mall, streets with traffic priority (TBD) and streets with pedestrian priority (TBD)</p>  <p>The aerial map shows a central area of Vientiane with streets marked in red and blue. Key locations labeled include 'Fu Ngum Station', 'Chao Anokoen Station', 'Parou Y', 'Phu That Luang', 'VCOM S', and 'WTL'. The map also shows 'Rue Sam Sen Phit', 'Rue Khoun Phit', 'Rue Nam Phit', 'Rue Nam Phit', 'Rue Nam Phit', and 'Rue Nam Phit'.</p> <p>Orderly parking and improved streetscapes through:</p> <ul style="list-style-type: none"> Clearly defined on-street parking spaces Physical separation (curbs, bollards, street furniture) between parking spaces and sidewalk Manual enforcement of illegal parking by operator No more color coding of curbs, street signs only

Item	Seoul	Status	Vientiane																					
<p>Smart payment system (Tmoney)</p>		<p>Bank of Lao PDR-bank developed QR payment system</p>	<p>As of 2022, VCSBE accepts QR-code payment systems that are in widespread use in the Lao PDR. However, this system does not necessarily allow for integrated payments or data collection.</p> 																					
<p>Reorganization and establishment of the metropolitan transport organization at Seoul Metropolitan Government (SMG)</p>	 <p><Figure 3> Organizational Structure and Roles for the Bus Reforms²⁾</p> <table border="1" data-bbox="629 959 943 1273"> <thead> <tr> <th>Stakeholder</th> <th>Before</th> <th>After</th> </tr> </thead> <tbody> <tr> <td>The Seoul Metropolitan Government</td> <td>Function: License bus routes, Evaluation Organization: 329 persons(2002)</td> <td>Calculate standard operation cost and Settle Revenue Adjust routes and Create new lines License bus operations, Evaluation TDRS Manage bus operations Devise measure to increase profit for bus operators and reduce operating cost Organization: 106 persons (2004) / 310 persons (2005)</td> </tr> <tr> <td>The Seoul Bus Association</td> <td>Function: Coordinate opinions of bus operators Organization: 76 persons (2003)</td> <td>Coordinate opinions of bus operators Active management of revenue Organization: 60 persons (2006)</td> </tr> <tr> <td>Private bus operators</td> <td>Function: Bus operations Management of employee Devise bus routes Cost control Organization: -</td> <td>Bus operations Management of employee Organization: -</td> </tr> <tr> <td>Smart Card (K-1000)</td> <td>Function: - Organization: -</td> <td>Revenue pool management Dividing and manage transportation cost Organization: - / 2003 / 21 (2004) / 75 persons (2005)</td> </tr> <tr> <td>Bus Reform Citizens Committee (03.08.20)</td> <td>Function: - Organization: -</td> <td>Select the agenda items after consultation Organization: 20 persons (2004)</td> </tr> <tr> <td>Metropolitan Transportation Association (05.02.04)</td> <td>Function: - Organization: -</td> <td>Manage Metropolitan transportation BRT and Transfer facility Organization: 48 persons (2005)</td> </tr> </tbody> </table> <p>Image source: Seoul Solution</p>	Stakeholder	Before	After	The Seoul Metropolitan Government	Function: License bus routes, Evaluation Organization: 329 persons(2002)	Calculate standard operation cost and Settle Revenue Adjust routes and Create new lines License bus operations, Evaluation TDRS Manage bus operations Devise measure to increase profit for bus operators and reduce operating cost Organization: 106 persons (2004) / 310 persons (2005)	The Seoul Bus Association	Function: Coordinate opinions of bus operators Organization: 76 persons (2003)	Coordinate opinions of bus operators Active management of revenue Organization: 60 persons (2006)	Private bus operators	Function: Bus operations Management of employee Devise bus routes Cost control Organization: -	Bus operations Management of employee Organization: -	Smart Card (K-1000)	Function: - Organization: -	Revenue pool management Dividing and manage transportation cost Organization: - / 2003 / 21 (2004) / 75 persons (2005)	Bus Reform Citizens Committee (03.08.20)	Function: - Organization: -	Select the agenda items after consultation Organization: 20 persons (2004)	Metropolitan Transportation Association (05.02.04)	Function: - Organization: -	Manage Metropolitan transportation BRT and Transfer facility Organization: 48 persons (2005)	<p>Proposed by JICA VTMP</p>	<p>Proposal</p> 
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Item	Seoul	Status	Vientiane
Integrated fare system	<p>Fares between different modes (e.g. bus, songthaew, BRT) use the same system, which may be zone-based.</p>  <p>The diagram illustrates the data flow for an integrated fare system. It is divided into two main sections: Metro and Bus. The Metro section shows a sequence: '철도 단말기' (Metro terminal) connected via 'RS485' to '집계PC' (Aggregation PC) via 'TCP/IP Socket', which then connects to '철도 센터' (Metro center) via '통신망' (Communication network). The Bus section shows '버스 단말기' (Bus terminal) connected via 'TCP/IP Socket' to '버스 집계' (Bus aggregation) via '통신망', which then connects to '버스 센터' (Bus center) via '통신망'. Both sections lead to '파일 통합' (File integration) and '요금 D8' (Fare settlement center). The fare settlement center is shown as a server rack with a person at a terminal.</p>	Proposed by ADB and JICA	<p>Proposed zonal system, unclear if it applies to Songthaew too.</p>  <p>The map shows the city of Vientiane with a network of red lines representing transit routes. Two distinct zones are highlighted: Zone 1, a central blue-shaded area, and Zone 2, a larger green-shaded area surrounding Zone 1. The red lines are dense in the central area and more sparse in the surrounding areas.</p>
Reforms to the legal system	 <p>The infographic details three key legal reforms:</p> <ul style="list-style-type: none"> Passenger Automobile Operation Business Act <ul style="list-style-type: none"> Basis for the joint revenue management <ul style="list-style-type: none"> (Previous) Financial support exclusively for lines of low profitability (Updated) Financial support open for joint operation agreements Basis for a bidding system for line acquisition (Time-limited license) <ul style="list-style-type: none"> (Previous) Time-limited licenses allowed only to airport, tour, and deficit lines (Updated) Time-limited licenses allowed also to new lines required for public management Ordinance on the Establishment and Management of the Small Business Improvement Fund <ul style="list-style-type: none"> Basis for financial stability of bus companies <ul style="list-style-type: none"> Supportive loans for securing the financial stability Efforts for the welfare of the bus drivers <p>Data source: Seoul Solution</p>	None	No Proposal

Item	Seoul	Status	Vientiane				
Agreement on concession (semi-public) services for the Bus Operation Cooperative and Seoul	<table border="1"> <tr> <td>Bus companies</td> <td> <ul style="list-style-type: none"> Overnight workshop with public agencies in charge → stakeholder input and persuasion agreement concluded b/w Bus Operation Cooperative and Seoul </td> </tr> <tr> <td>Bus drivers</td> <td> <ul style="list-style-type: none"> Letter to 16,000 bus drivers to publicize the legitimacy of the bus reform 27-time special training sessions for bus operation workers (persuasion made by the mayor, deputy mayor, high-rank officials) </td> </tr> </table>	Bus companies	<ul style="list-style-type: none"> Overnight workshop with public agencies in charge → stakeholder input and persuasion agreement concluded b/w Bus Operation Cooperative and Seoul 	Bus drivers	<ul style="list-style-type: none"> Letter to 16,000 bus drivers to publicize the legitimacy of the bus reform 27-time special training sessions for bus operation workers (persuasion made by the mayor, deputy mayor, high-rank officials) 	Proposed by JICA VTMP for songthaew operators.	<p>Current Fragmented services</p> <p>Bus and Songteo are operated independently whilst most of their routes are overlapped.</p> <p>Step 1 Operational cooperation</p> <p>Bus and Songteo launch operational cooperation in terms of routes and timetable, etc. based on a <u>commission agreement (operating contract)</u> between operators and public side.</p> <p>Step 2 Service integration</p> <p>Sub-trunk services with songteo vehicles are officially integrated based on <u>concession agreement</u> with public sector. Some songteo routes might remain with the conventional system using its demand-responsiveness.</p> <p>Step 3 Fleet renewal</p> <p>Deteriorated vehicles are replaced by new Songteo vehicles (e.g. e-Songteo) through the <u>lease program or concession agreement</u>.</p>
Bus companies	<ul style="list-style-type: none"> Overnight workshop with public agencies in charge → stakeholder input and persuasion agreement concluded b/w Bus Operation Cooperative and Seoul 						
Bus drivers	<ul style="list-style-type: none"> Letter to 16,000 bus drivers to publicize the legitimacy of the bus reform 27-time special training sessions for bus operation workers (persuasion made by the mayor, deputy mayor, high-rank officials) 						

5.32 This comparison shows that several elements are currently not proposed for Vientiane, and others may need further development.

Full reform of the bus system will require multiple elements working in conjunction. Potentially some aspects are missing. Beyond the JICA VTMP and ADB VSUTP projects, additional studies for bus reform, based in part on the Seoul case, should be undertaken (especially to leverage the BIMS system).

Electrification of Light-Duty Vehicles

- 5.33 There are several ways in which the Lao PDR and Vientiane can achieve its goals, especially with regards to its GHG reduction goals. One way is to target motorcycles which are used by a majority of the population in Vientiane for everyday trips. Motorcycles are popular in Laos and indeed throughout southeast Asia due to their cheap cost, convenience, and familiarity. As a result, there is an unique opportunity to target these types of vehicles to fuel switching since they are many times cheaper than cars.
- 5.34 In Vientiane, it is estimated that around 63% of trips are by motorcycle or tricycle, the vast majority of which are fueled by gasoline. Motorcycles account for most of the registered vehicles in the country, at 78% of personal vehicles. There is just under 2.0 million motorcycles registered in the Lao PDR and this number is rising fast as Lao people continue to purchase motorcycles (and cars). As a result, transport fuels (i.e. gasoline) imports are rising and so are GHG emissions. Other light vehicles, like songthaews and tuk-tuks are also commonly used. Electrification of these light vehicle fleets could be highly effective to reduce GHG emissions, fuel consumption and imports, and air pollution.
- 5.35 This opportunity is recognized already in the Lao PDR and is currently being studied (as a pre-feasibility study) through Korea-based Global Green Growth Institute (GGGI), who are studying a public battery swapping system (BSS), also known as a hot-swap system, for Vientiane. In a BSS, the e-bike battery can be removed and replaced with a fully charged one, eliminating the need to wait for charging.

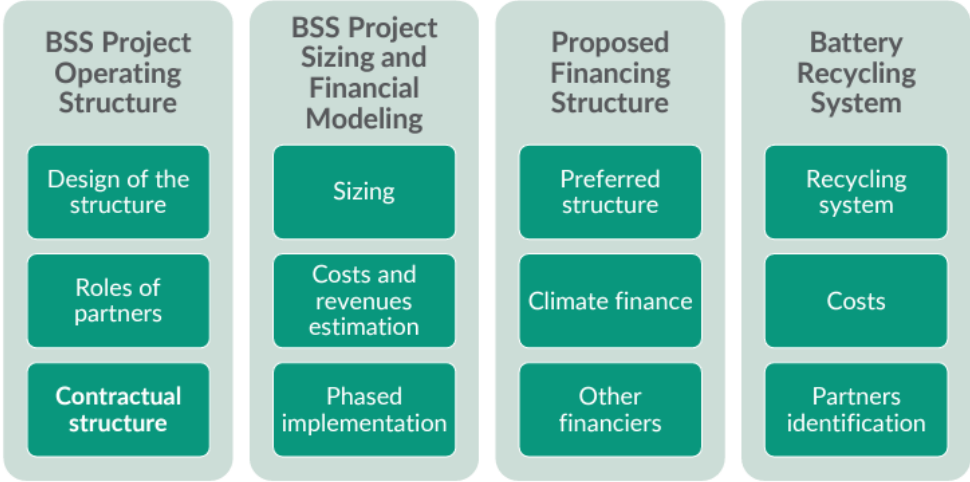
Figure 58: E-Bikes and Hot-Swap Stations



- 5.36 Indeed, an electrification plan could be a very cost-effective method to reduce GHGs. The GGGI study will study and report on numerous aspects of the system including its design, structures, financial models, and structures and how to deal with recycling, refer to Table 20. Additionally, E-motorcycles can be purchased for as little as \$1,500 USD.
- 5.37 In addition to this study, other models and modes can be studied, including
- non hot-swap charging infrastructure;
 - subsidies for individuals for privately-owned E-Motorbikes; and
 - subsidies for E-Songthaew and E-TukTuk operators.
- 5.38 One example of a subsidy program for private vehicle shifting to electric vehicles include the (now discontinued) British Columbia SCRAP-IT program, which compensated owners

“scrapping” their old gasoline-powered vehicles for either \$750 CAD towards and electric bicycle or up to \$7,000 CAD for a new electric vehicle (EV) car. This programme was eventually changed to disallow EV subsidies since they were very expensive. However, E-bike subsidies remain possible.

Table 20: GGGI BSS Study Functions



5.39 Expanding public transport will provide many benefits to Vientiane citizens and is sorely needed. Additionally, it will *encourage* a modal shift and therefore reduce fuel consumption and GHG emissions, but as with any public transport project, there is a risk that the services will not be fully utilized. The current trend in Vientiane is very low patronage of public transport, including songthaews, with incredible year-over-year increases private car ownership and use and therefore this risk could be classified as high. With the very high costs involved in expanding public transport compared to the current poor state of the public transport network is needed to achieve the goals set forth in the VTMP making expanding public transport an expensive, albeit beneficial, way to reduce GHG emissions.

5.40 As such, additional ways to reduce GHGs from transport such as subsidized e-motorcycles should be seriously considered. Table 21 below lists the pros and cons of electrification compared to expanding public transport and Table 22 lists a hypothetical subsidy of E-Bikes scenario compared to the GHG reduction potential of the ADB VSUTP BRT programme as a reference. In both cases, these tables do not imply that public transport expansion should not be undertaken, but instead imply that these programmes could be undertaken in addition to public transport expansion.

Table 21: Pros and Cons of Various Plans

Public Transport Expansion -with BRT	Electrification of Light-Duty Vehicles
Scalable, with high upfront cost	More easily scalable
Possibly effective	Guaranteed to be effective
Change in travel characteristics	Minor changes in travel characteristics
Private operation possible, but more challenging	Very flexible, can be public or private
Improves transport network	Does not substantially change the transport network

Table 22 : Hypothetical Comparison of Subsidies for E-Bikes to BRT

	ADB VSUPT (BRT)	E-Bike Subsidy (Estiamated)	
Subsidy per bike	-	\$750	\$1,500
Individuals served	48,000	88,000	44,000
Total cost (based on BRT portion of the VSUTP)	\$66m USD	\$66m USD	\$66m USD
Total GHG reductions	25,000 tonnes	To be estimated	To be estimated
Cost to remove 1 tonne of GHGs	\$2,600	To be estimated	To be estimated

In addition to public transport expansion to reduce GHG emissions, subsidy programmes for light-duty e-vehicles should be studied and if proven viable, implemented.

Bus Management and Information Sharing

- 5.41 One of the most effective ITS systems in the BIMS, which are two different and related technologies, the Bus Management Systems (BMS) and Bus Information Systems (BIS). BMS are systems and technologies that are generally used by the bus operator. They include tracking devices, management systems, and software. BMS can be used by bus operators or government agencies to significantly improve efficiency in operation and manage headways, drivers, monitor for accidents and incidents and have many other benefits. BIS refers to the systems, technologies, and devices which communicate the location of buses to customers.

Figure 72: BIMS Ecosystem

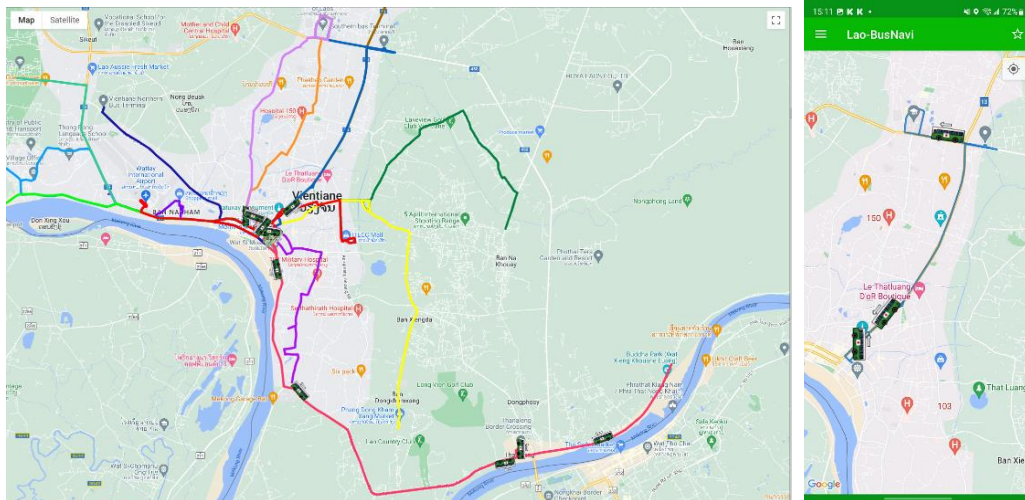


- 5.42 Examples of BIS include digital roadside signage which may state the expected arrival time of various buses which use the stop. Additionally, BIS may refer to systems, software and technologies that communicate with customers virtually include through mobile phone applications or websites. Together, BIS and BMS make up the real-time tracking system for public transport buses. BIMS will

- improve public transport service, convenience, and information dissemination;
- improve operation efficiency and therefore service quality; and
- establish a basis for system expansion and project tender etc.

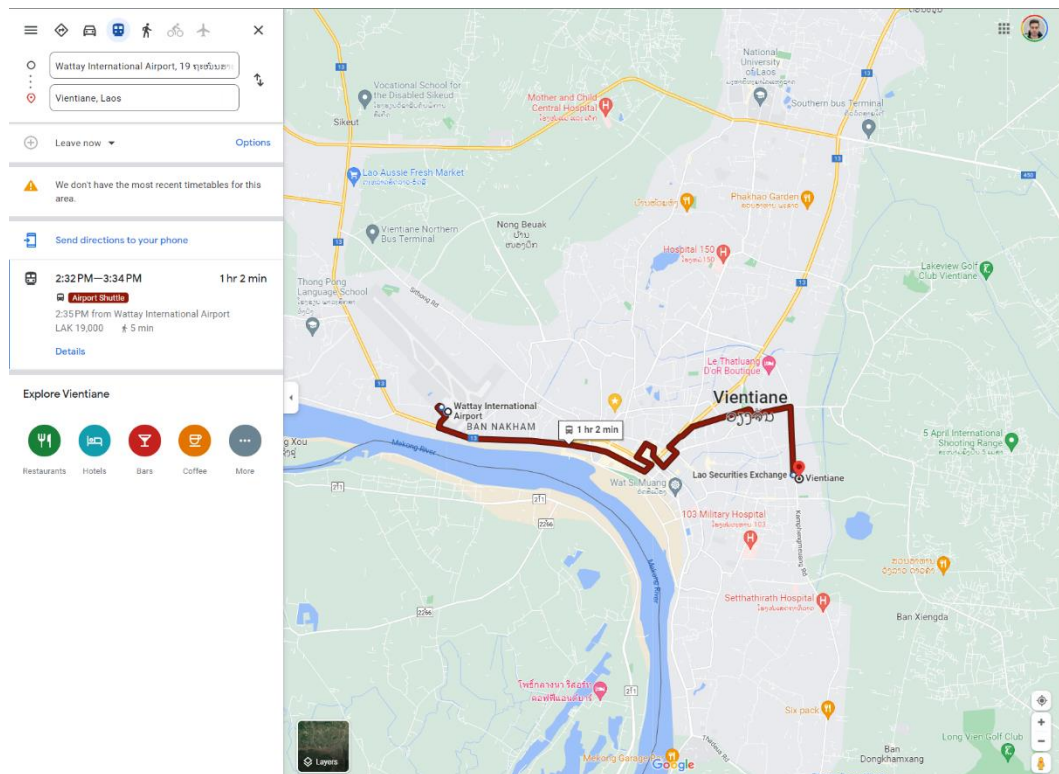
- 5.43 The existing BIMS-like system in Vientiane, which was implemented with the help of JICA in 2015, does not fully make use of all the features of a BIMS system. While real-time tracking is available via a website and application (lao.navibus.asia), the website and app are clunky to use with an outdated user interface. Additionally, for several months in 2022, the service was not working correctly or displaying bus locations.

Figure 73: Lao NaviBus Interface



- 5.44 Finally, the real-time data from this service is not currently being shared with any third-party applications, for example Google Maps. The data from the Lao NaviBus service could potentially be used to produce the Google-developed General Transit Feed Specification (GTFS) Real-Time database files which could then be utilized by Google Maps to display real-time location in a form of data sharing.
- 5.45 Google’s interface is standardized and superior to many applications or website developed by transit agencies. For this reason, many agencies choose to let Google or other third-party application developers utilize their open data.
- 5.46 Currently in Vientiane, only three out of 10-13 buses used the static version of GTFS, without real-time information. With some effort, the Lao NaviBus, or other BIMS system data, could be converted to a static or real-time open format and then used by third parties including Google to allow digital map users to access scheduled and real-time information about Vientiane’s buses.

Figure 74: Google Maps Static Information in 2022 in Vientiane



Studies should be undertaken to understand which Smart Transport scenarios (and especially BIMS) could be applicable for the Vientiane case, based on ITS technologies from Korea and systematically evaluate them for their appropriateness to Vientiane.

GHG Reductions

5.47 The above-mentioned recommendations may result in a reduction in Greenhouse Gases (GHGs), due to a modal shift, that is, people who previously used fossil fuel powered vehicles will instead switch to public transport, thus reducing the overall vehicle-kilometres travelled (VKT) in the region and consequently the amount of fuel burned, which in turn produces GHGs. The assumptions and methodology for how GHG reductions were estimated are presented below.

Table 23: Assumptions and Inputs for GHG Calculations – VTMP Changes

Description	Value	Unit	Source	
Travel time, JICA (VTMP) scenario by OD	TT_JICA	Varies	minutes, varies by OD	Emme-based model
Travel time, KNUT (VTMP) scenario by OD	TT_KNUT	Varies	minutes, varies by OD	Emme-based model
Travel distance, by car or motorcycle (avg. of possible routes) by OD	Dist	Varies	km, varies by OD	Emme-based model
Change in demand	ΔD	Varies	trips, varies by OD	Emme-based model

Description		Value	Unit	Source
Change in vehicle-kilometres travelled	ΔVKT	Varies	<i>km, varies by OD</i>	Emme-based model
Occupancy, motorcycle	OCC_{MC}	1.5	<i>people</i>	Assumption based on similar cities
Occupancy, car	OCC_{Car}	2.2	<i>people</i>	Assumption based on similar cities
Fuel economy motorcycle	FE_{MC}	1.76	<i>L gas/100 km</i>	Global Fuel Economy Initiative (2022), for Vietnam
Fuel economy light vehicle (car)	FE_{Car}	12.1	<i>L gas/100 km</i>	South Korean government target for average fuel economy, light vehicle
Carbon equivalent of gasoline	CE	2.32	<i>Kg CO2 / L gas</i>	U.S. Energy Information Administration
Elasticity of demand (time WRT demand)	E	-0.6	<i>% chg in travel time/% chg in demand</i>	Reported elasticity for Jakarta, Indonesia and other ASEAN bus systems
AM Peak – Daily factor	F_{AM}	~2.80	<i>unitless, varies by OD</i>	Calculated from 2021 OD survey
Daily – annual factor	F_{Daily}	300	<i>unitless</i>	Assumption
Mode choice car	MC_{Car}	74.4%		2021 OD survey (JICA)
Mode choice motorcycle	MC_{MC}	26.6%		2021 OD survey (JICA)

5.48 The following formulas were used to finally calculate the GHGs, in Tonnes of CO₂e, that would theoretically be removed (annually).

$$\Delta D = E * \frac{(TT_{JICA} - TT_{KNUT})}{TT_{JICA}} * D_{bus}$$

$$\Delta VKT = \Delta D * Dist$$

$$CO_2e(\text{kg}) = \sum \frac{\Delta VKT * MC_{car}}{OCC_{Car}} * \left(\frac{1}{100}\right) * F_{am} * F_{daily} * FE_{car} * CE + \sum \frac{\Delta VKT * MC_{mc}}{OCC_{mc}} * \left(\frac{1}{100}\right) * F_{am} * F_{daily} * FE_{mc} * CE$$

5.49 Results show that the modifications to the network result in an overall net decrease in impedance (which is a desirable result), and therefore an overall net increase of patronage equivalent to 415 trips per day or around 124,500 less motor vehicle trips annually.

5.50 This results in a change in Vehicle Kilometres Travelled (VKT) of around 650k km annually for cars and motorcycle⁹ which results in overall reduction in GHGs of **57 Tonnes of CO₂e**

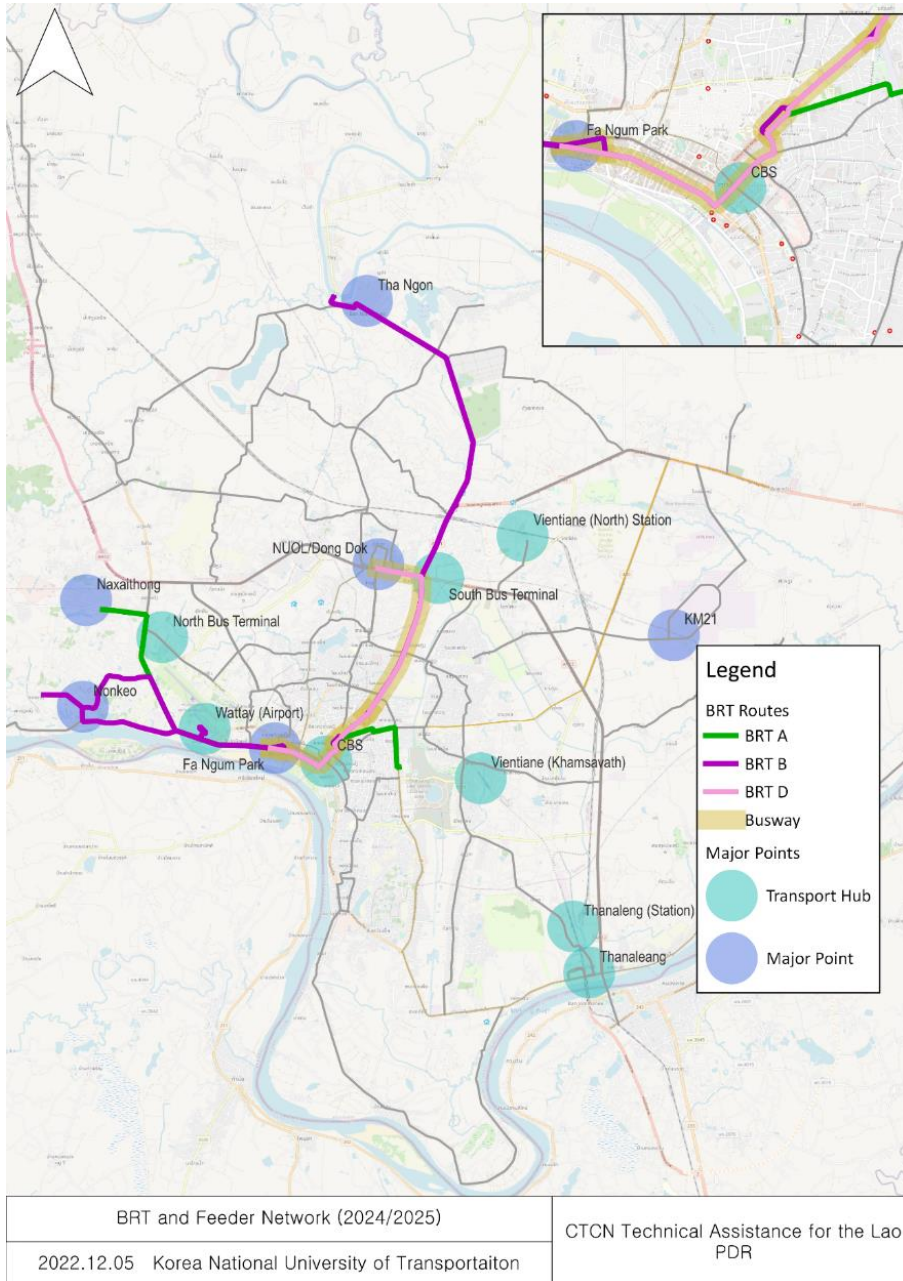
⁹ Roughly 74% motorcycles, 26% cars

annually, or 855 Tonnes over 15 years. This amount can be considered a relatively small amount since it is approximately the same as just around 2.5 households in the USA (annually), according to some studies.

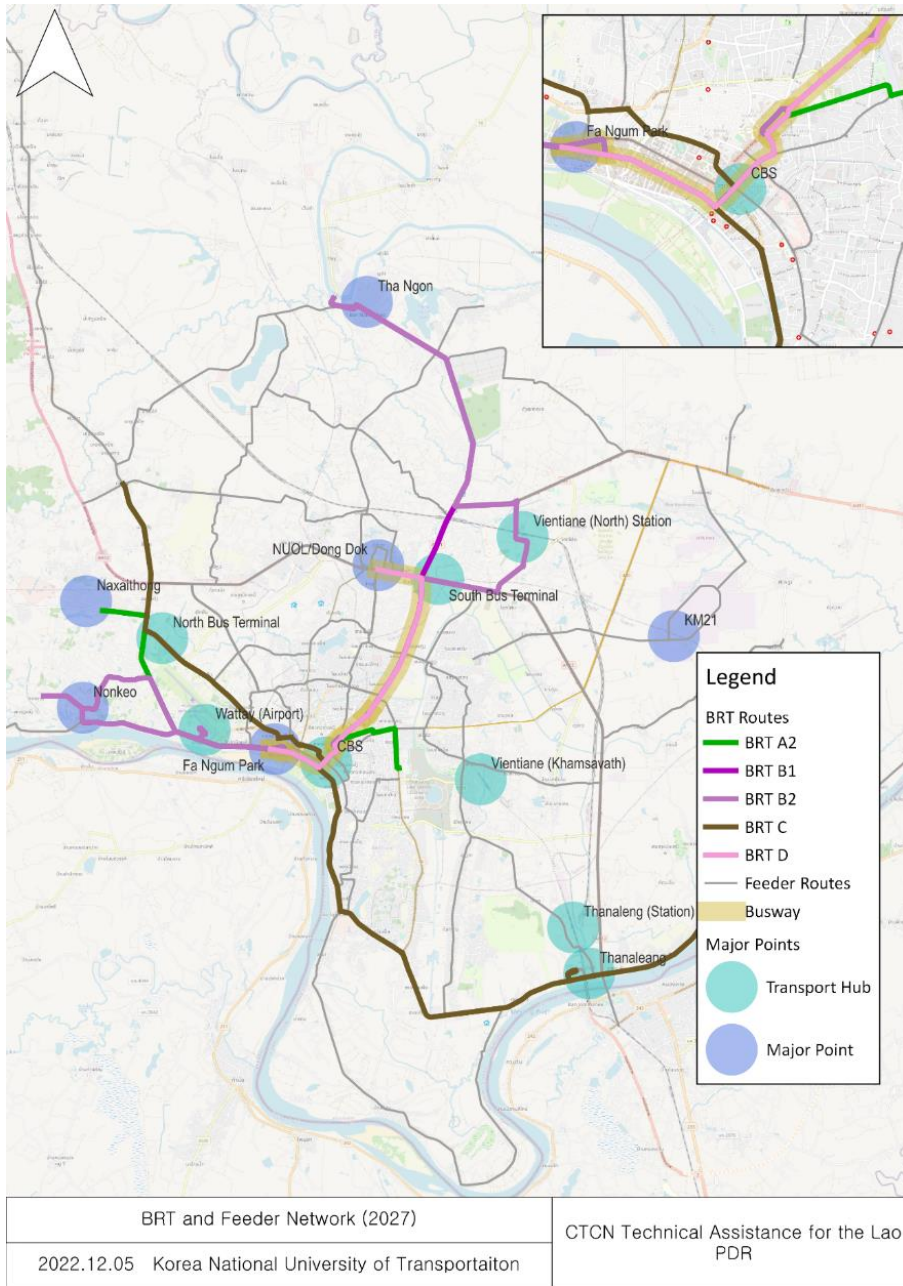
- 5.51 However, note that these assumptions are conservative, given that they are based on 2021 demand profiles assuming only changes based on the JICA plan (therefore only accounting for difference from the JICA plan to the KNUT plan).

A Proposed Transit Networks

A.1 2024 – BRT Plan by ADB

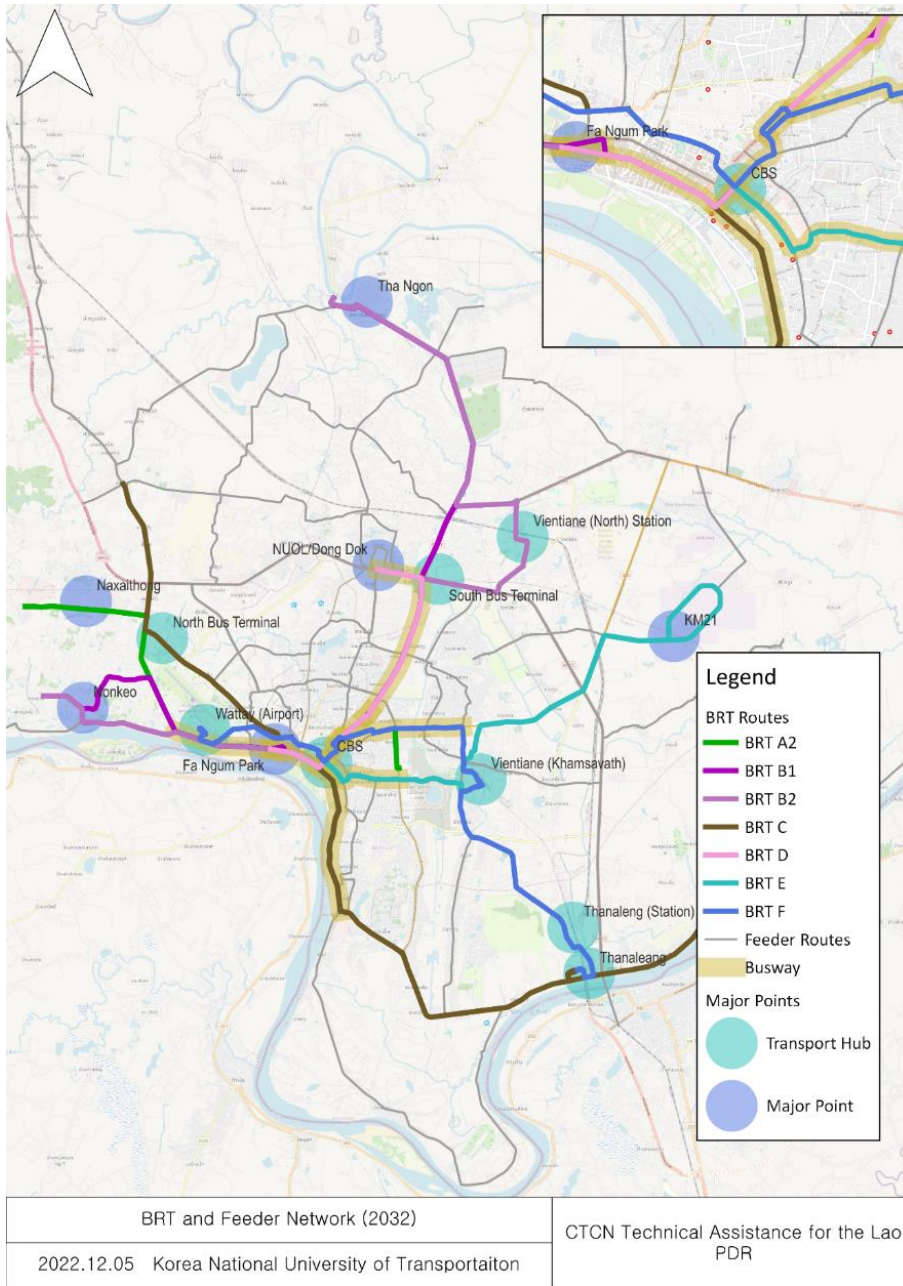


A.2 2027 – BRT plan by JICA



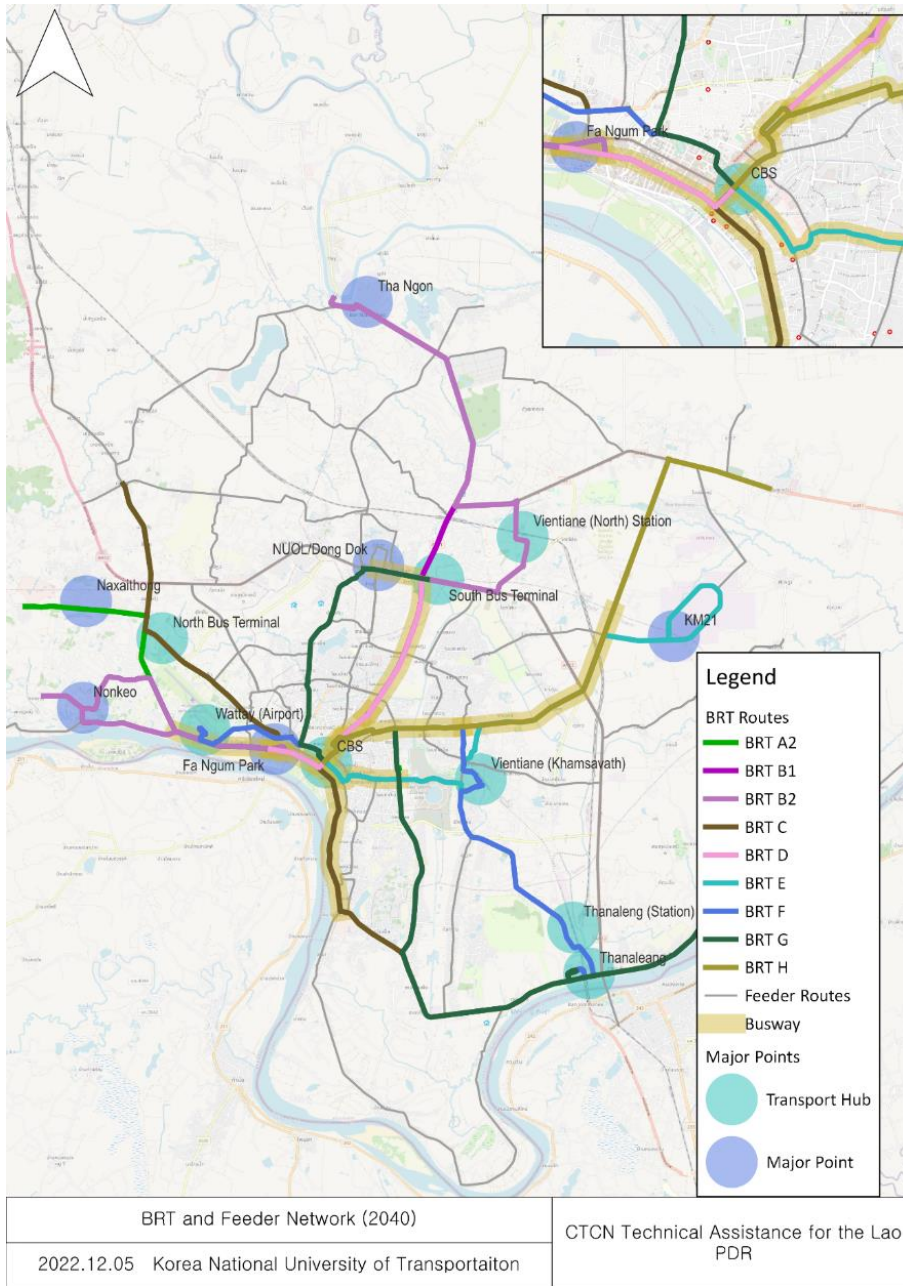
A.3

A.4 2032 – BRT Plan by JICA



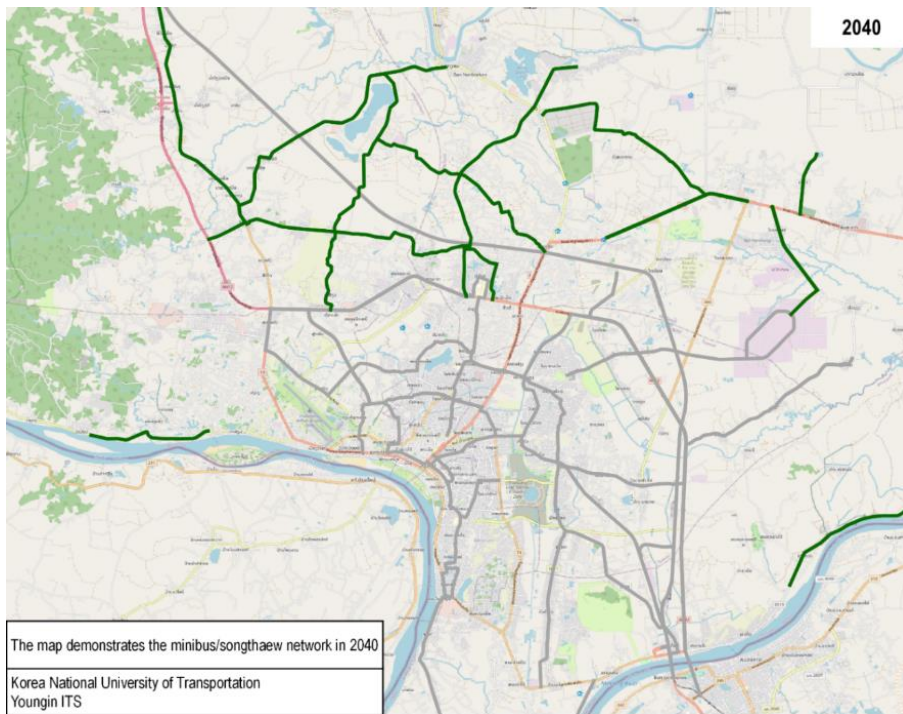
A.5

A.6 2040 – BRT plan JICa



A.7

A.8 Songthaew (Van or Other) - 2040



A.9

B Additional Information – Chapter 6

Short Term ITS Priorities (by 2025)

Item	Recommendation	Resp. Org.
Electronic fare collection (EFC) by QR-code	Maintain the existing QR code-based EFC.	VCSBE
Bus Management System (BMS)	Maintain, upgrade, and utilize existing BMS. Replace missing OBUs and maintain software and equipment.	VCSBE
Bus Information Terminal (BIT) at CBS	Upgrade monitors to include real-time departures information (in minutes) rather than a geographic display. This information can be displayed in conjunction with the GTFS-real time development.	VCSBE
Bus Information System (BIS) online & for third parties (GTFS real-time)	Abandon application and software, and instead focus on third party data provision based on the GTFS and GTFS-real time.	VCSBE, or Vientiane City DOT
Demand-Responsive Transit (DRT)	Invest in a DRT pilot program on outskirts of the city, refer to Chapter 8 of this report.	Vientiane City DOT or Lao PDR DOT
Ridesharing/taxi-hailing	Government should work quickly to legally support the develop of these services, and encourage to be used by other modes like TukTuk and Jumbos.	Lao PDR DOT
Provision of Wi-Fi at the central bus terminal (CBS)	Invest in free public Wi-Fi at the Central Bus Terminal (CBS).	Vientiane City
Provision of CCTV at the central bus terminal (CBS)	Invest in visible CCTV cameras to be installed at the CBS.	Vientiane City
Mobility as a Service (Maas)	Support private sector with grants or other funding opportunities if they become available. Government should support further studies of the benefits of MaaS and explore future private sector partners.	Lao PDR DOT/Private sector
E-Ticketing	Related to MaaS, E-ticketing applications for intercity transport should be allowed to operate, however they are best left to the private sector.	Lao PDR DOT/Private sector

Medium-Term ITS Priorities (by 2030)

Item	Recommendation	Resp. Org.
Electronic fare collection (EFC) by IC-card	Invest in an IC-card based electronic fare collection system. The IC-card based system would be far superior to the existing QR-code system as it would significantly increase the speed at which customers can board buses, while also providing accurate real-time data to management companies.	VCSBE
Bus Management System (BMS) including Computer-Aided Dispatch (CAD) and new On-Board Units (OBUs) for Automatic Vehicle Location (AVL)	Invest in new Bus Management System (BMS) using proper On-Board Units with advanced capabilities. Invest in expanded data management centre. This system would replace the, now aging, SmartPhone-based OBU system developed by JICA.	Lao PDR DOT
On-board next-stop announcement system (including LED screens)	Invest in on-board next-stop announcements. With increasing ridership, these systems will be worth investing in.	VCSBE
Demand-Responsive Transit (DRT)	Invest in expanded DRT program using 6 vehicles on outskirts of the city, refer to Chapter 8 of this report.	Lao PDR DOT
CCTV on buses	Invest in CCTV cameras for all public buses in Vientiane operated by the VCSBE.	VCSBE

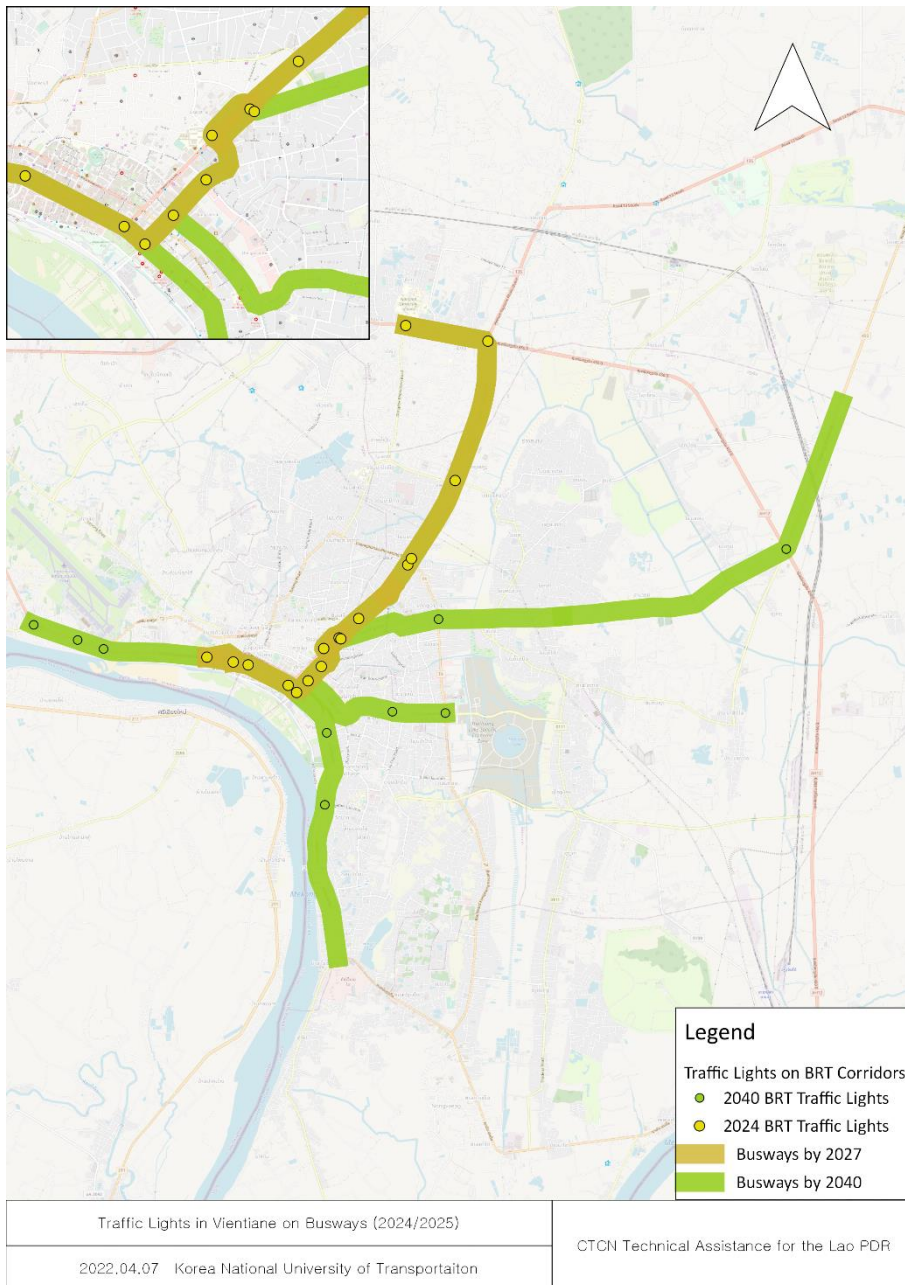
Long-Term ITS Priorities (by 2035)

5.64 The medium-term priorities include all the short-term priorities, plus the following.

Item	Recommendation	Resp. Org.
Electronic fare collection (EFC) by QR-code	Eventually, this system should be phased out as it provides a disutility to passengers as it takes time to use the QR code.	VCSBE
Bus Information Terminals (BIT)	With BMS system in place, target installation of BIT at select bus stops, targeting top 10% busiest of all bus stops in Vientiane area.	Lao PDR DOT
Bus Information Terminal at CBS	Replacement of the monitors at CBS with improved BITs making use of the new BMS system.	Lao PDR DOT
Expanded Transit Service Priority (TSP) signals on BRT corridors	Invest in new traffic light systems at all major BRT corridors (expanded from medium-term priorities).	Vientiane City DOT
Demand-Responsive Transit (DRT)	Replacement of all outer-area Songthaew routes with demand-responsive services (DRT) using vans or trucks with enhanced safety features.	Lao PDR DOT
Provision of Wi-Fi at the central bus terminal (CBS)	Invest in free public Wi-Fi at the Central Bus Terminal (CBS).	Vientiane City
Provision of CCTV at the central bus terminal (CBS)	Invest in visible CCTV cameras to be installed at the CBS.	Vientiane City

Item	Recommendation	Resp. Org.
Bus Information Systems (BIS): Real-time bus information by SMS or ARS	<i>Do not pursue for now.</i>	-
Wi-Fi on buses	<i>Do not pursue for now.</i>	-
Autonomous public transport	<i>Do not pursue, unless technology cost and availability changes drastically.</i>	-

1.1 Corridors for BRT and TSP



Control Information

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Version control/issue number	Date
1.0	December 22, 2022
2.0	May 31, 2023