



Office of Transport and Traffic Policy and Planning

Udonthani Mass Transit Master Plan

รายงานบทสรุปสำหรับผู้บริหาร (Executive Summary Report) ฉบับภาษาอังกฤษ





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Chapter 1

Introduction

Chapter

1 Introduction

1.1 Principles and Reasons

Thailand's 20 year national strategic plan (2018-2037) was aimed at developments of national transport infrastructures in order to increase Thailand's competitiveness in manufacturing and service sectors, enhancing quality of life and diminishing all social disparities. Its main goal is to implement an integrated transport network and to reduce capital investment costs in transportation in the kingdom. This is in accordance to the 12th National Economic and Social Development Plan (2017-2021) as it plans to encourage the use of public transport system, reducing car independence. The public transport system will be obtained vast improvements in quality of service, efficiency, organization, and equity among commuters.

The Ministry of Transport has laid out plan in accordance to the 12th National Economic and Social Development Plan as it follows Thailand's 20 year national strategic plan (2018-2037) to improve Thailand's stabilities in social, economic, and safeties and it will increase the competitiveness of the nation among AEC nations.

Therefore, The Ministry of Transport comes up with an urgent plan to develop an extensive regional transport network connecting regional cities with convenience, safety, reliabilities in travel to all commuters. The transport network will minimize transport costs as all modes of transport will be connected. Traveling within and via regional cities will be achieved with greater efficiency, convenience, and accessibility. Improvements of quality of life will follow with a reduction in traffic congestion, hence increasing travel mobility.

The Ministry of Transport has recognized Udonthani province of its great potential to become a transport center in north eastern of Thailand since Udonthani has had long history of prosperity in term of economics, social, and tourism. As a regional city, Udonthani also suffers from growing demand in travel, causing traffic congestion particularly in the urban area of Udonthani and its surroundings as it lacks adequate public transport service. This chronic congestion has become an obstacle in the development of new transport infrastructures and facilities in the near future.

The Office of Transport and Traffic Policy and Planning (OTP) under the Ministry of Transport has initiate a study concern a new transport master plan for Udonthani and its surroundings in order to develop a sustainable transport system and intermodal transfer facilities with greater efficiency and convenience to all commuters (people, business, and tourism), reducing the need of oversea imported energy. This new transport master plan shall be in to the 12th National Economic and Social Development Plan (2017-2021) and transport policies from the Ministry of Transport.

1.2 Purposes

- 1) To develop a transport master plan for Udonthani and its surroundings as a new transport system will offer efficiency and reliability together with new transport facilities to accommodate travel demand for all commuters.
- 2) To develop traffic management plan for a sustainable transport solution.
- 3) To perform a feasibility study (FS); economic and financial study, environmental impact study, investment and preliminary design study, with a new pilot project of a new public transport service.
- 4) To develop a Transport Oriented Development study (TOD) in the vicinity of stations, including park and ride facilities design.

Chapter 2

Mass Transit Master Plan in Udonthani Urban Area

Chapter

2 Mass Transit Master Plan in Udonthani Urban Area

2.1 Mass Transit Master Plan in Udonthani in Accordance to Relevant Strategic Plans

2.1.1 Thailand's 20 year National Strategy (2018-2037)

This is a new strategy to lead Thailand thru the visions on “stability, prosperity and sustainability”, and Thailand will become “a developed country through developments based on the sufficiency economy philosophy”. with the goals aimed to maintain national security and ensure people's welfare; boost multidimensional national competitiveness to ensure consistent economic growth; empower human capital at each and every stage of life to manifest competent and moral citizenry; broaden opportunities to improve social equality; promote environmentally-friendly growth with improved quality of life; and develop governmental administrative efficiency for greater public benefits.

They are 6 strategies on these issues:

- (1) National security
- (2) Competitiveness
- (3) Human resource development
- (4) Creation of opportunities and social equality
- (5) Environmentally friendly growth
- (6) Public-sector readjustments

“Mass Transit Master Plan in Udonthani Urban Area” is in accordance to Thailand's 20 year National Strategy particularly in 2) competitiveness of the country to enhance Thailand's potentials in the upcoming trend in globalization, infrastructure development in transport sector.

2.1.2 12th National Economic and Social Development Plan (2017-2021)

12th National Economic and Social Development Plan from 2017-2021 states 10 strategies to fulfill:

- (1) Strategy 1: Strategy for Strengthening and Realizing the Potential of Human Capital
- (2) Strategy 2: Strategy for Creating a Just Society and Reducing Inequality
- (3) Strategy 3: Strategy for Strengthening the Economy, and Underpinning Sustainable Competitiveness
- (4) Strategy 4: Strategy for Environmentally-Friendly Growth for Sustainable Development
- (5) Strategy 5: Strategy for Reinforcing National Security for the Country's Progress towards Prosperity and Sustainability

- (6) Strategy 6: Strategy for Public Administration, Corruption Prevention, and Good Governance in Thai Society
- (7) Strategy 7: Strategy for Advancing Infrastructure and Logistics
- (8) Strategy 8: Strategy for the Development of Science, Technology, Research, and Innovation
- (9) Strategy 9: Strategy for Regional, Urban, and Economic Zone Development
- (10) Strategy 10: Strategy for International Cooperation for Development

“Mass Transit Master Plan in Udonthani Urban Area” is in accordance to 12th National Economic and Social Development Plan from 2017-2021, particularly in 7) Strategy for Advancing Infrastructure and Logistics in Section 3.1 part 3.1.2 concerning development of urban transport system in an urban area which consists of 4 criteria as follows:

1) Developing urban public transport systems to match the cities’ economic and social conditions while remaining energy-efficient and eco-friendly. The country should accelerate the construction of mass-transit city-rail projects as planned in the Mass Rapid Transit Master Plan in the Bangkok Metropolitan Region (M-Map). Moreover, the public transport systems in regional cities should be developed according to the characteristics of each city, whether it be a light rail network, bus rapid transit (BRT), or trams. The initial phase of this development should initially take place in major regional cities such as Khon Kaen, Chiang Mai, Songkhla, Hat Yai, and Phuket.

2) Improving the quality of bus services and rerouting bus lines so that they can help connect passengers to the main public transportation network and increase the use of public transportation. Furthermore, local government organizations should be encouraged to increase their role in improving public transportation in order to accelerate the development of public transportation in regional areas.

3) Developing facilities in transportation stations to be in line with the direction of land development, in order to maximize the use of public transportation systems in these areas. To reap full benefits, the country should promote the stricter enforcement of urban planning regulations, the enhancement of urban areas’ unique characteristics, and the pursuit of better transit-oriented development (TOD) at a level suited to the management capability of each city’s local government. All of these efforts will help to facilitate more effective land development that is in accordance with the specific economic, social, and environment features of each area.

4) Expanding infrastructure and facilities to support non-motorized transportation (NMT) in urban areas by focusing on improving crosswalks, footpaths, and bicycle lanes along the local routes leading to the city's public transportation network. Standards for the safety and protection of pedestrians and cyclists in urban areas should also be improved to facilitate the proportional increase in NMT, which in turn will help boost energy efficiency and reduce environmental impacts. Moreover, infrastructure development in the next period must consider the accommodation of all users, particularly the disabled and seniors, by designing new infrastructure and improving the existing infrastructure to facilitate and serve all users under a universal design concept.

2.1.3 Ministry of Transport Strategy

There are 4 strategies as follows:

- 1) **Strategy 1: Develop “Thorough and environmentally friendly” transport system, enhance level of connectivity and competitiveness, and environmental friendliness.**
 - Strategy 1.1: Improve and maintain transport infrastructures in good quality and standard.
 - Strategy 1.2: develop public transport infrastructures with good accessibility to service.
 - Strategy 1.3: Increase transport mobility and intermodal transfer.
 - Strategy 1.4: Develop transport facilities for handicapped people and social service to the public.
 - Strategy 1.5: Develop and encourage the use of green fuels for better environment.
- 2) **Strategy 2: Develop a “Save and Secure” transport system.**
- 3) **Strategy 3: Develop a transport system with “Efficiency and Capabilities” to drive Thailand’s competitiveness.**
- 4) **Strategy 4: Develop a “Strategic Goal” to the Success.**

“Mass Transit Master Plan in Udonthani Urban Area” is in accordance to the Ministry of Transport Strategy particularly in Strategy 1 (1.2) to develop public transport infrastructures with good accessibility to service.

2.1.4 Udonthani Development Plan

Udonthani Development Plan 2018-2021 states Udonthani will be “livable city, center of trade and investment in the Me Kong River Basin”

There are 6 strategies as follows:

- 1) Strategy 1: Enhance investment potentials and competitiveness with new universal technology
- 2) Strategy 2: Support industrial agriculture and elevate standards in safe agriculture and organic agriculture
- 3) Strategy 3: Elevate quality of life to enhance social strength with readiness to the incoming economic, social, and cultural changes
- 4) Strategy 4: Develop ecotourism, service, and cultural and traditional enrichment
- 5) Strategy 5: Manage natural resources and environment for sustainable use
- 6) Strategy 6: Create stability, security, and for the safety of life and property the people

Mass Transit Master Plan in Udonthani Urban Area” is in accordance to Udonthani Development Plan particularly in 3) Elevate quality of life to enhance social strength with readiness to the incoming economic, social, and cultural changes.

2.1.5 Udonthani Municipal Strategy

Udonthani municipal has developed its own strategy (2017-2020) which consists of 5 strategies as follows:

1. Strategy in development of basic infrastructures
2. Strategy in environmental management, land use planning, and land use
3. Strategy in social development with quality of life by using index based on “sufficient economy”
4. Strategy in local identity, art, culture, local economy and tourism
5. Strategy in public service with a good governance, participation, and human development

Mass Transit Master Plan in Udonthani Urban Area” is in accordance to Udonthani Municipal Strategy particularly in 1) Strategy in development of basic infrastructures with traffic and public transport system in Udonthani urban area.

2.2 Relevant Projects

2.2.1 Dual Track Railway from Khon Kaen – Nong Kai

SRT dual track railway starts at 453+955 km in Khon Kaen (beginning at the end of dual track railway from Jira-Khon Kaen) to Nong Kai with the distance of 166 km. It has 16 stations; Khon Kaen, Samran, Non Payom, Nam Pong, Huay Saey, Kow Suan Kwang, Non Sa Art, Huay Kaeng, Kumpawapee, Huay Sam Pard, Nong Ta Khai, Nong Kong Kwang, Udonthani, Na Puu, Na Tha, and Nang Kai as shown in Figure 2.2.1-1.

The section passing thru Udonthani will be an elevated structure for approximately 2 km to reduce congestion caused by rail grade crossing.



Source: The Feasibility Study and Design of SRT Dual Track Railway from Khon Kaen-Nong Kai

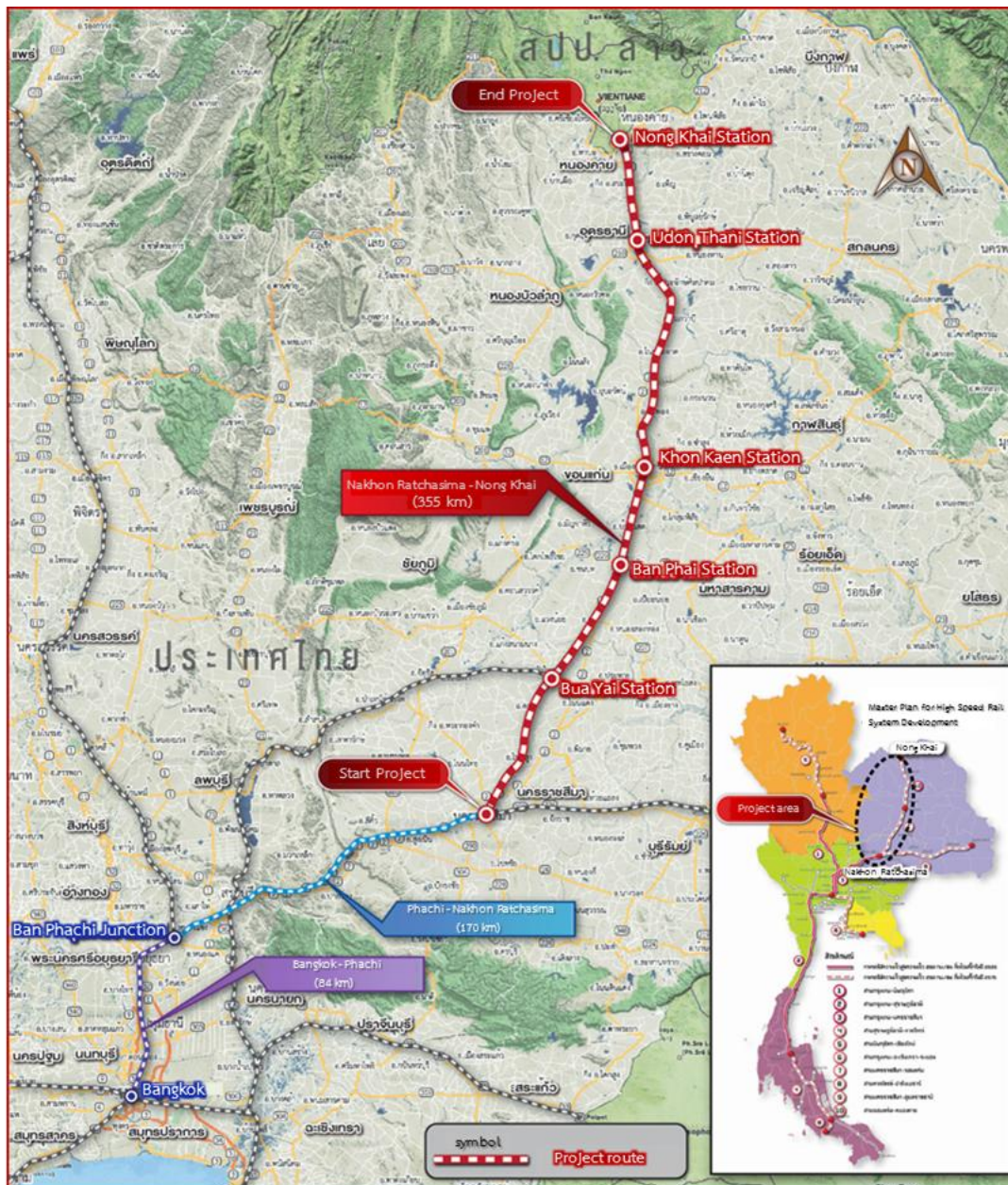
Figure 2.2.1-1: Alignment of the Dual Track Railway from Khon Kaen-Nong Kai

Future ridership of the dual track railway from Khon Kaen-Nong Kai will be 1,220,670 passenger/annum in 2028 or approximately 3,300 passengers/day. It will increase to 1,995,870 passengers/annum in 2053 or approximately 5,500 passengers/day.

Maximum passengers will be at Udonthani and Nong Kai stations. The figure in 2028 will be 400,000-500,000 passengers/annum.

2.2.2 Nakhon Ratchasima-Nong Kai High Speed Train

The project has a total distance of 355 km as shown in Figure 2.2.2-1. There are 5 elevated HST stations; Bua Yai, Ban Pai, Khon Kaen, Udonthani, and Nong Kai.



Source: Ministry of Transport

Figure 2.2.2-1: Alignment of Nakhon Ratchasima-Nong Kai High Speed Train

Future ridership of the high speed train railway from Nakhon Ratchasima - Khon Kaen will be 10,600 passenger/direction/day in 2026. The number will increase to 27,100 and 36,700 passengers/direction/day in 2054 and 2074, respectively.

The number of passengers at Udonthani station will be 3,136 passengers/day in 2026 and 11,724 passengers/day in 2074, respectively.

2.3 Public Transport Service in Udonthani Urban Area

There are 3 modes of transport namely, public bus, SRT rail, and air transport.

1. Public Transport

There are inter provincial bus service from Bangkok to Udonthani municipal area. There are non AC and AC bus service at 1st Bus Terminal on Utit Road and at 2nd Bus Terminal on the Outer Ring Highway.

Within the municipal area, there are tricycles, tuk-tuks, non AC and AC buses, and Song Tao buses.

2. SRT Rail

There is only 1 SRT rail station on Prachak Road. It is located between UD Town and Precha Market. Trips to Udonthani by rail can be achieved by traveling thru 4 districts of Udonthani namely Muang District, Kumpawapee, Non Sa Art, and Prachak Silpakom.

There are 8 rail stations namely Nong Ta Kgai, Kam Kling, Nong Khon Kwang, Udonthani, Hual Kaeng, Kumpawapee, Non Sa Art, and Huay Sam Pad

3. Air Transport

There is only one airport so far. It is Udonthani International Airport which is approximately 7 km from the city center. The airport is under the jurisdiction of the Airborne Division 23 of the Royal Thai Air Force. The airport is a hub in the upper Esan region.

2.4 Socio Economic Study

2.4.1 Socio Economic of Udanthani

- **Gross Provincial Product: GPP**

In 2016 Udonthani has 70,555 million Baht in Gross Provincial Product (GPP) with a continuous growth. During the last 10 years (2007-2016) , Udonthani has an annual growth of GPP at 3.91% per annum.

In 2016, highest GPP of Udonthani was from manufacturing (15.22%), sales & repairs of cars and motorcycles (12.74%), and education (9.75%).

- **Population of Udonthani**

From a 5 year statistics (2013-2017), it shows Udonthani had 1,563,964 people in 2013 and it grew to 1,583,092 people in 2016. The growth is 0.27% per annum.

There were 134,455 people in Udonthani Municipal in 2013, but the number decreased to 130,274 people in 2017. The growth rate is -0.79% per annum as shown in **Table 2.4.1-1**.

Table 2.4.1-1: Population in Udonthani Municipal

no	District	Population				
		2013	2014	2015	2016	2017
1	Udonthani Municipal	134,455	133,429	132,106	131,192	130,274
Growth per Annum (%)		-	-0.76	-0.99	-0.69	-0.70

Source: Department of Local Administration, Ministry of Interior

- **Households in Udonthani**

From 2013-2017, there was a growth number of household in Udonthani from 462,117 households in 2013 to 503,287 households in 2017. The growth rate is 1.78% per annum.

There were 53,993 households in Udonthani Municipal in 2013 and the number increased to 59,544 household in 2017 as shown in **Table 2.4.1-2**.

Table 2.4.1-2: Households in Udonthani Municipal

no	District	Household				
		2013	2014	2015	2016	2017
1	Udonthani Municipal	53,993	56,783	58,451	58,948	59,544
Growth per Annum (%)		-	5.17	2.94	0.85	1.01

Source: Department of Local Administration, Ministry of Interior

- **Per Capita Income (PCI)**

Per Capita Income (PCI) or an average income per person in Udonthani had a continuous growth from 2006-2015 from 38,453 Baht/person in 2006 to 78,095 Baht/person in 2015. The growth rate is 8.19% per annum.

2.4.2 Future Socio Economic Forecast

1) Gross National Product (GDP)

- **Gross National Product (GDP)**

Use based year GDP value (NESDB), then apply GDP values in 2016 and 2017 with 3.2% and 3.8% growth to estimate GDP value in 2018. From 2018, apply a constant growth of GDP at 4.00% per annum.

- **Gross Regional Product (GRP)**

Use the existing GRP statistics during the last 10 years as based values. Compare GRP by region to the total GDP of the country to estimate future GRP values by each region. Total GDP is the sum of GRP values from all regions.

- **Gross Provincial Product (GPP)**

Use the same method above. Total GRP is the sum of all GPP values in the region.

2) Population Forecast

- **Thailand Population**

Use based population value in 2018 to forecast 2017 figure. Apply future annual growth in population by NESDB.

- **Regional Population**

Use 2017 statistics from the Department of Local Administration, Ministry of Interior to estimate 2018 regional population figure. Apply future annual growth in regional population from NESDB. From 2036-2041, the growth per annum equals to the regional growth in population from 2015-2025. Final adjustment was made to the total figure as the sum of regional population will be equal to the total national figure.

- **Provincial Population**

Use 2017 statistics from the Department of Local Administration, Ministry of Interior to estimate 2018 provincial population figure. Apply future annual growth in provincial population from NESDB. From 2036-2041, the growth per annum equals to the regional growth in population from 2015-2030. Final adjustment was made to the total figure as the sum of provincial population will be equal to the total regional figure.

3) Per Capita Income (PCI) Forecast

Use the same technique as GDP and population forecast. However, keep in mind that any change in per capita income also has a linear correlation to a change in GDP per capita. The rate of change in GDP per capita was then applied to PCI forecast. Statistics from NESDB in total GDP was used as based year data divided by number of population.

Table 2.4.2-1 shows forecast figures in 1) - 3) as follows:

Table 2.4.2-1: Socio Economic Forecast from 2018-2056

no	Year							
	2018	2027	2032	2037	2042	2047	2052	2056
GPP (M Baht)								
Udonthani (M Baht)	76,183	104,963	125,418	149,125	177,749	214,306	256,315	295,777
Population								
Udonthan	1,576,441	1,500,333	1,440,148	1,398,596	1,397,671	1,396,746	1,395,822	1,395,084
Per Capita Income (Baht/Person)								
Udonthan	49,092	74,937	95,660	120,515	147,395	180,142	220,045	258,166

Remarks: Without New High Speed Train from Bangkok-Nong Kai (Phase 1: Nakhon Ratchasima-Nong Kai)

2.5 Land Use Study and Future Trend in Development

The 3rd draft of Udonthani Land Use Report has been under revision, but a trend in land use and development can be summarized in **Figure 2.5-1**.

(1) There is a trend of expansions to all directions on Highway 2 (to Penn and Kumpawapee), Highway no 2410 (to Pibulrak), Highway no 2263 (to Kudchap), and on Highway 210 (to Nong Wu Sor). Land use pattern is suburban residential are (code yellow) as city grows from inner core to the suburbs.

(2) A new amendment in land use pattern was added in the 2nd revision of Udonthani Land Use Report as the city will be allowed to expand to the northern direction of Udonthani along Highway no 2 (to Penn) and on Highway 2410. There is also natinal reserved area under flood risks and for irrigation (code-green).

(3) Higher density development is allowed along the Outer Ring Road (Ring 1) as a new outer ring will soon be implemented (Ring 2). The new land use pattern is residential are (code-orange) for the future growth in urban population and employment in the city center.

(4) The role of industries and warehouses will be decreased. The existing commercial zone (code violet) will be changed to residential development in the city center. The existing zone (code purple) will be changed to community service and rural and agricultural economy. All those industies and warehouses will be relocated to the southern location along Highway 2 in Kumpawapee as the new Udonthani will be a center of economy, administration, tourism and service, and transport and logistics.

(5) Land use pattern in the inner core will be for commercial development (code red, service, and recreation.

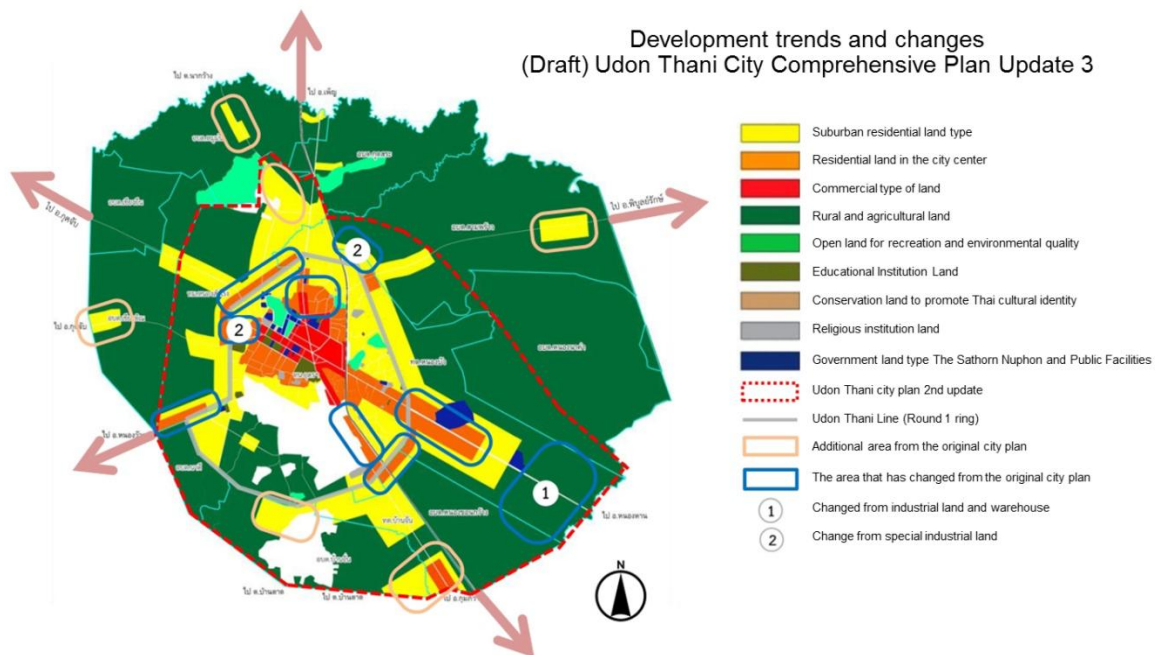


Figure 2.5-1: Land Use Pattern and the Future Trend in Development from the 3rd draft of Udonthani Land Use Report (under Revision)

2.6 Transportation Study and Traffic Forecast

The traffic forecast was studied for the base year 2018 and the future years in 2023, 2027, 2032, 2037, 2042, 2047, 2052, and 2056. The result of the study shows a growing transport demand in person trips/day as the highest demand will be in 2056 at 461,616 person trips/day.

Transport demand with forecast socio economic data from 2018-2056 are as shown in Table 2.6-1.

Table 2.6-1: Socio Economic Data and Transport Demand (2018-2056)

Year	Population		Employment		Daily Demand (Person Trips)
	Udonthani	UD Municipal	Udonthani	UD Municipal	
2017	1,576,242	144,567	583,432	33,056	245,395
2023	1,533,543	145,620	595,816	33,297	260,678
2027	1,499,384	146,462	605,723	33,490	272,905
2032	1,450,965	147,506	617,680	33,729	302,328
2037	1,410,996	148,612	630,948	33,981	335,970
2042	1,372,128	149,996	644,445	34,298	374,915
2047	1,334,330	151,257	657,867	34,586	417,665
2052	1,300,476	151,891	670,367	34,731	461,616

Source: The Consultants' Estimate

2.7 Mass Transit Master Plan in Udonthani Urban Area

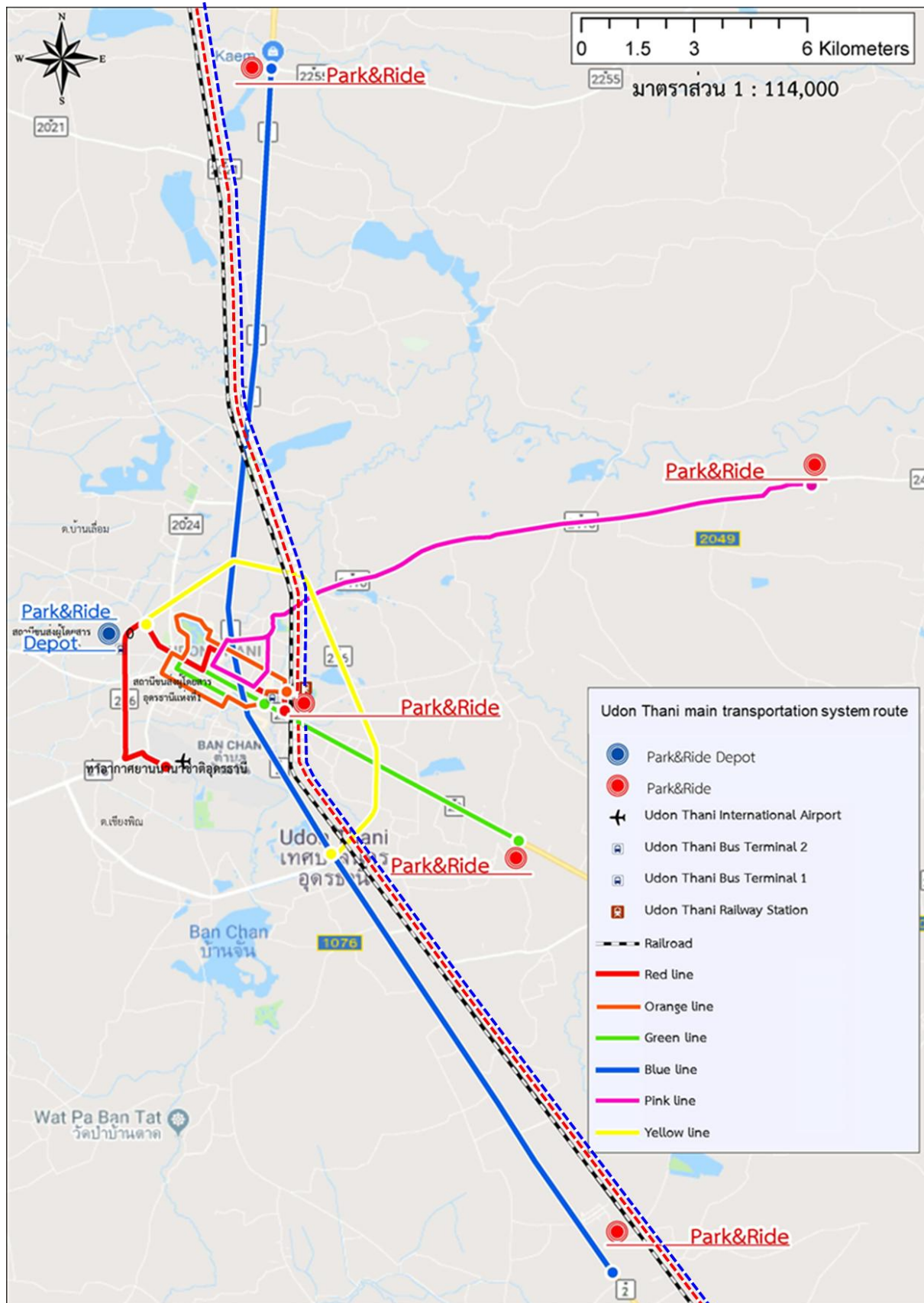
2.7.1 Route Alignment

From our forecast demand, we found Udonthani requires 6 new mass transit lines. The system selection shows they will be all electric buses. The detail is shown in **Table 2.7.1-1** and **Figure 2.7.1-1**.

Table 2.7.1-1: Details of 6 new Mass Transit Lines

no	Line	Distance (km)	No of Stations
1	Red Line	10.80	18
2	Blue Line	34.50	26
3	Green Line	13.10	19
4	Orange Line	9.80	21
5	Pink Line	19.45	18
6	Yellow Line	12.90	12
	Total	100.55	114

Source: The Consultants



Source: The Consultants

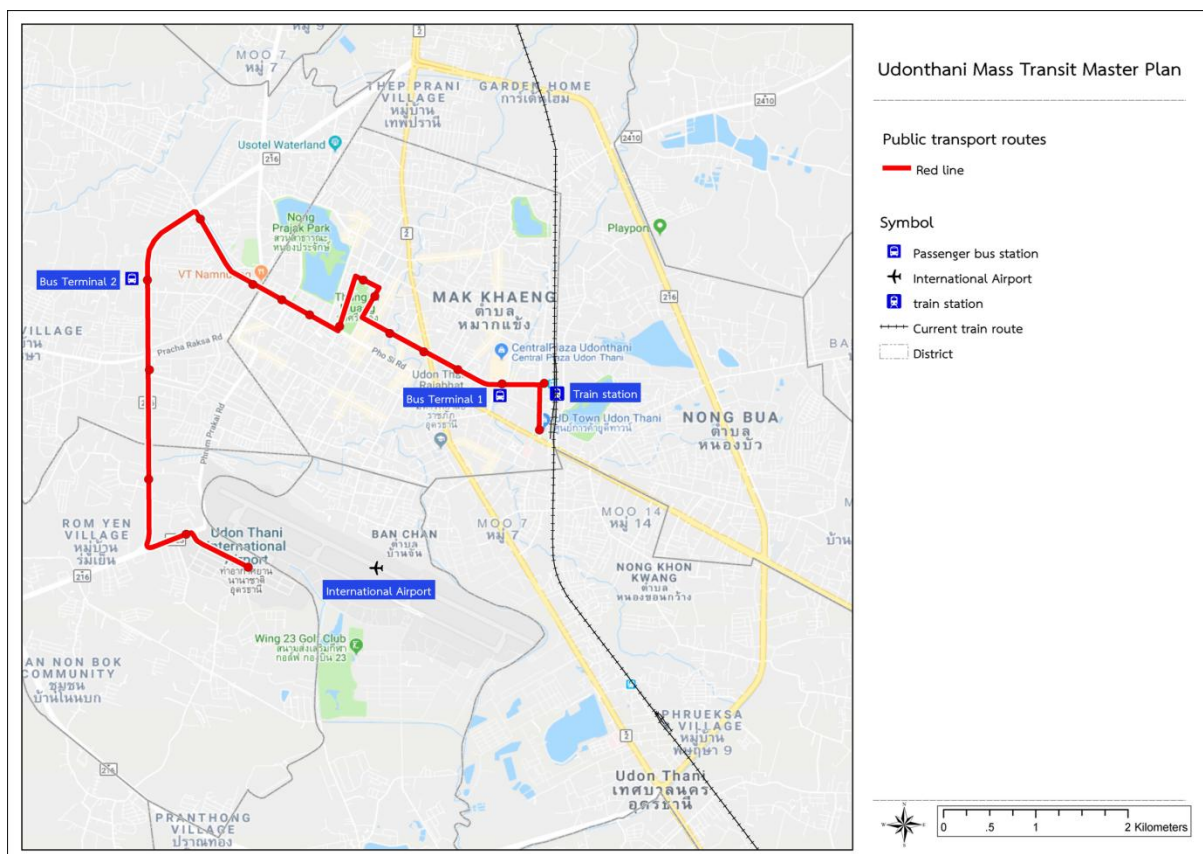
Figure 2.7.1-1: Details of 6 new Mass Transit Lines

Further details of 6 new lines are as follows:

1) Red Line Electric Bus

The beginning of the line is at UD Town on Thong Yai Road passing Udonthani Rail Station. It turns left to Prachak Silpakom Road, passing Central Plaza Udonthani and Watch Tower to Tung Sri Muang and turns right to Pran Prao Road. It passes the City Pillar Shrine and Udonthani Municipal Office and turns left to Atibordi Road. It then passes Provincial Court, Udonthani Municipal Hall and turns left to Muk Montri Road and right at Por Sri Road. It continues as a straight line passing Udonthani Musuem, Som Porpon Temple to Ban Laem Junction. It eventually turns left to Highway 216 (the Outer Ring West) to Udonthani International Airport. The total distance of red line is 10.80 km.

There are several trip attractions along the line namely UD Town, Center Point, Central Plaza Udonthani, Udon Wittaya School, Watch Tower, the Excise Office Branch 4th, Tung Sri Maung, Udonthani Musuem, Som Porpon Temple, Por Sri Village Market, the 2nd Bus Terminal, Thai Samut Mittrapap Scool 187, Buntawon Udonthani, National Sport College, Udon Picharak Pittaya School, and Udonthani International Airport.



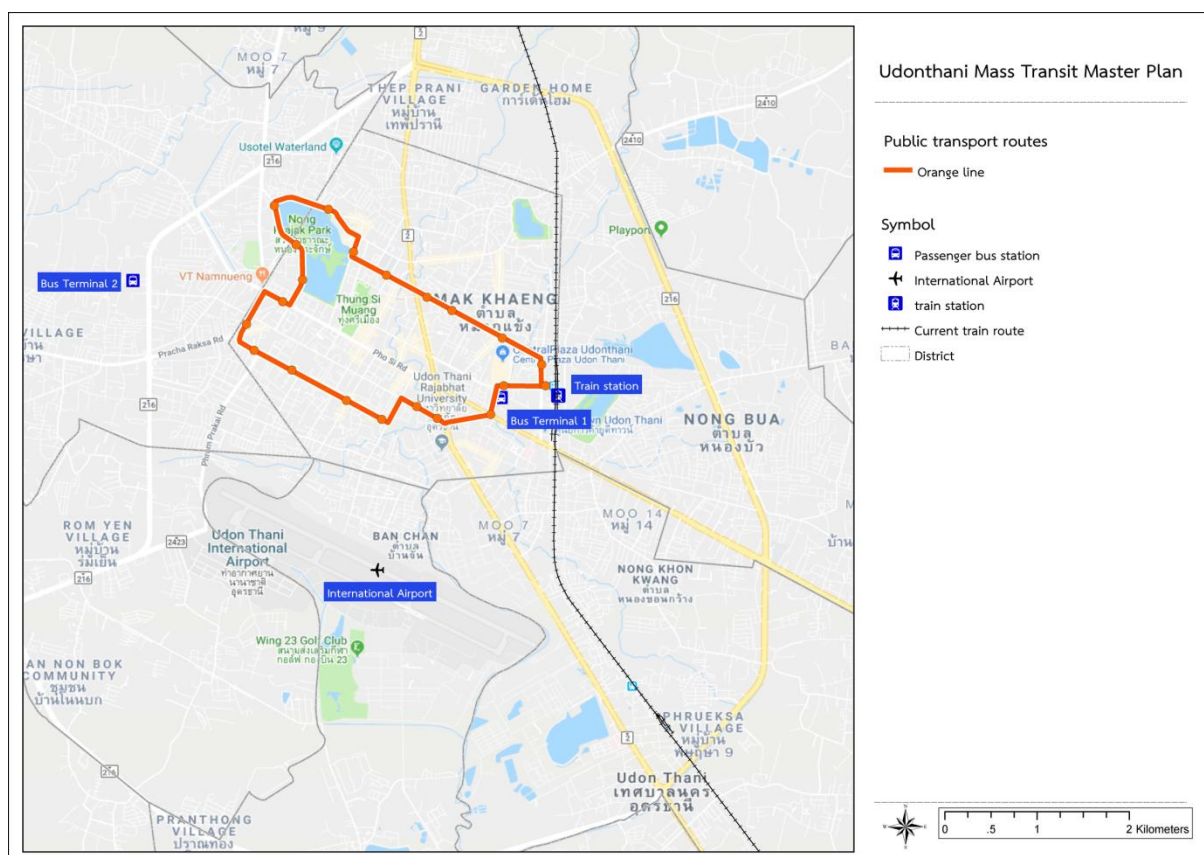
Source: The Consultants

Figure 2.7.1-2: Alignment of Red Line Electric Bus and its Stations

2) Orange Line Electric Bus

The beginning of the line is at Udonthani Rail Station. It turns left to Wattananuwong Road to Udon Dhusadee Road, passing Udonthani Municipal Hall and Udonthani Technical College. It turns right to Tesa Road, passing Tesaban 2 School and then turns left to Supakit Chanya Road. It passes Nong Prachak, Udonthani Hospital, Por Sompon Temple. It then turns right at Por Sri Road, to Thamma Chedi Road, passing Tesaban 5 School to Sri Chom Chaen Road. From Sri Chom Chaen Road it passes Udonthani Provincial Electricity Authority straight to Amphor Road and turns right to Sri Suk Road. It then passes Ratjapat Udonthani, turn left at Prachak Silpakom Road, and turn left again to Utit Road to the 1st Bus Terminal. The ends at Prachak Silpakom Road at Udonthani Rail Station. The line is a circular route with the total distance is 9.80 km.

There are several trip attractions along the line namely UD Town, Center Point, Bangkok Hospital (Udonthani Branch), Udonthani Mucinipal Hall, Tesaban 2 School, North Eastern Wattana Hospital, Nong Prachak, Udonthani Hospital, Som Porpon Temple, Tesaban 5 School, Udonthani Provincial Electricity Authority, Kulaprapruk Grand Park Condominium, Ratjapat Udonthani, Statue of Luang Prachak Silpakom, Charoen Hotel, and UD Town.



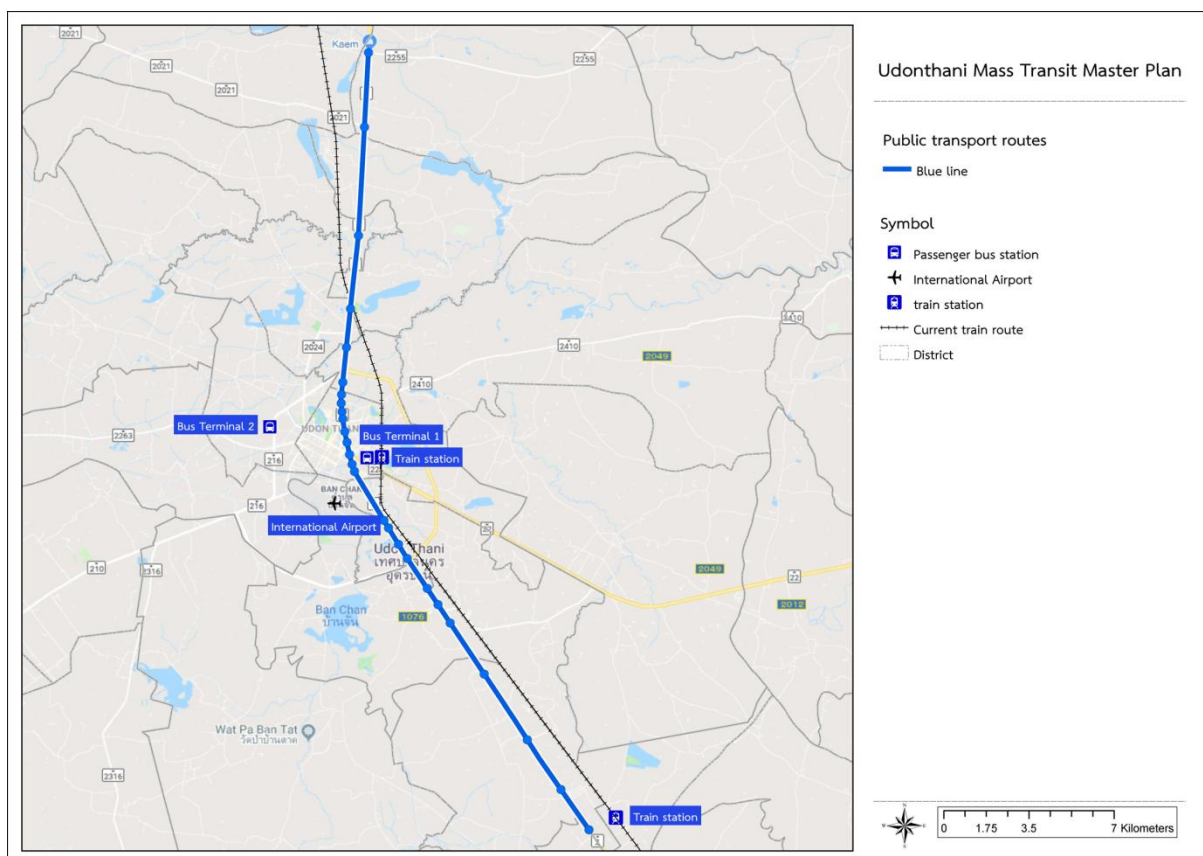
Source: The Consultants

Figure 2.7.1-3: Alignment of Orange Line Electric Bus and its Station

3) Blue Line Electric Bus

The beginning of the line is at Yuttasitr Camp in Tambon Nang Pai. It travels from Nong Soong to Udonthani Industrial Estate, passes Golbal House Ban Tad, and goes straight to Udonthani. It then passes Ban Jan Junction on Tahan Road, Prachak Silpakom Camp Hospital, Ratjapat Udonthani to The Fountain Junction. It then passes the Clock Tower, Udon Dusadee Road, Kao Noi Junction, Nong Kae. It travels north to Nong Dae (to Nong Kai) and ends at Tambon Na Ka. The total distance of blue line is 34.50 km.

There are several trip attractions along the line namely Yuttasitr Camp, Udonthani Industrial Estate, Global House Bad Tad, VT Nam Naeng Food Court, Prachak Silpakom School, Ban Chan Technical College, Prachak Silpakom Camp Hospital, Army District 24, Prachak Silpakom Camp, Royal Air Force Battalion, Royal Thai Airborne 23, Ratjapat Udonthani, Statue of Luang Prachak Silpakom, Nam Pu Junction, Com Landmark, Matchimawas Temple, Talad Huay 1, Udonthani Munucipal Hospital, Rangsin Market, Kao Noi Junction, DOH Branch 2 (Kao Noi), Nong Kae Park, and Na Kha Clothes Market.



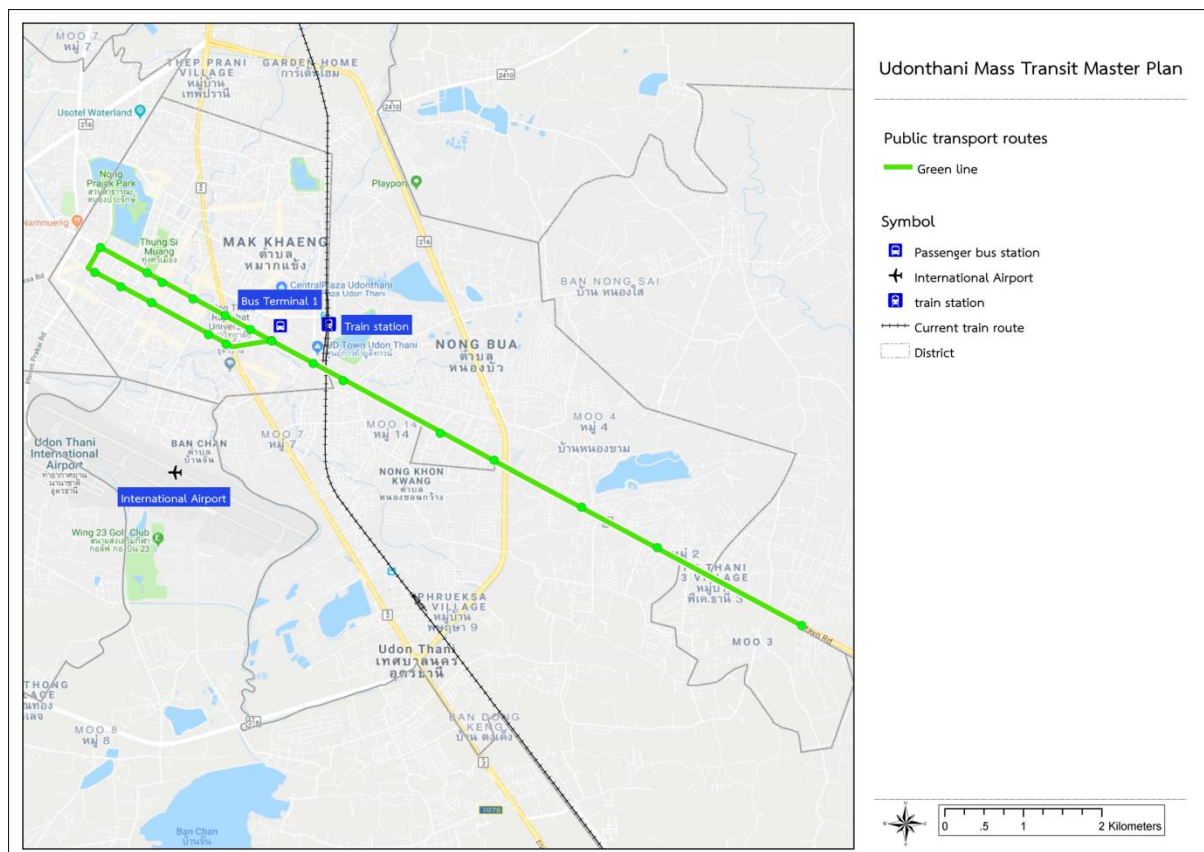
Source: The Consultants

Figure 2.7.1-4: Alignment of Blue Line Electric Bus and its Stations

4) Green Line Electric Bus

The beginning of the line is at Labor Court 4 on Highway 22. It passes Big C Super Center to Nitayo Road to Saint Mary School. It passes Udonthani Municipal Stadium, Nong Bua Market, UD Town, Charoen Hotel, Nam Pu Junction, Tung Sri Muang. It enter Sri Por Road , turns left to Por Niyom Road and turns left again at Sri Suk Road. It passes Udonthani Technical College, Satirachutit School, Udonthani Kindergarden, Udon Pittayanukul School, Udonthani Penitentiary, Mak Khang School, and Ratjapat Udonthani. It finally turns left at Prachak Silpakom Junction to Porkanuson Road, and ends at Charoen Hotel. The total distance of green line is 13.10 km.

There are several trip attractions along the line namely Labor Court 4, Big C Super Center, Udon Muang Thong Market, Makro Super Store, Udonthani Municipal Stadium (Vessuwanna Stadium), Nong Bua Market, UD Town, Charoen Hotel, Nam Pu Junction, Tung Sri Muang, Udonthani Musuem, Por Sompon Temple, Udonthani Technical College, Satri Rachutit School, Udonthani Kindergarden, Udon Pittayanukul School, Udonthani Office of the Attorney General, Udonthani Penitentiary, Udonthani Police District, Mak Khang School, Ratjapat Udonthani, and Statue of Luang Prachak Silpakom.



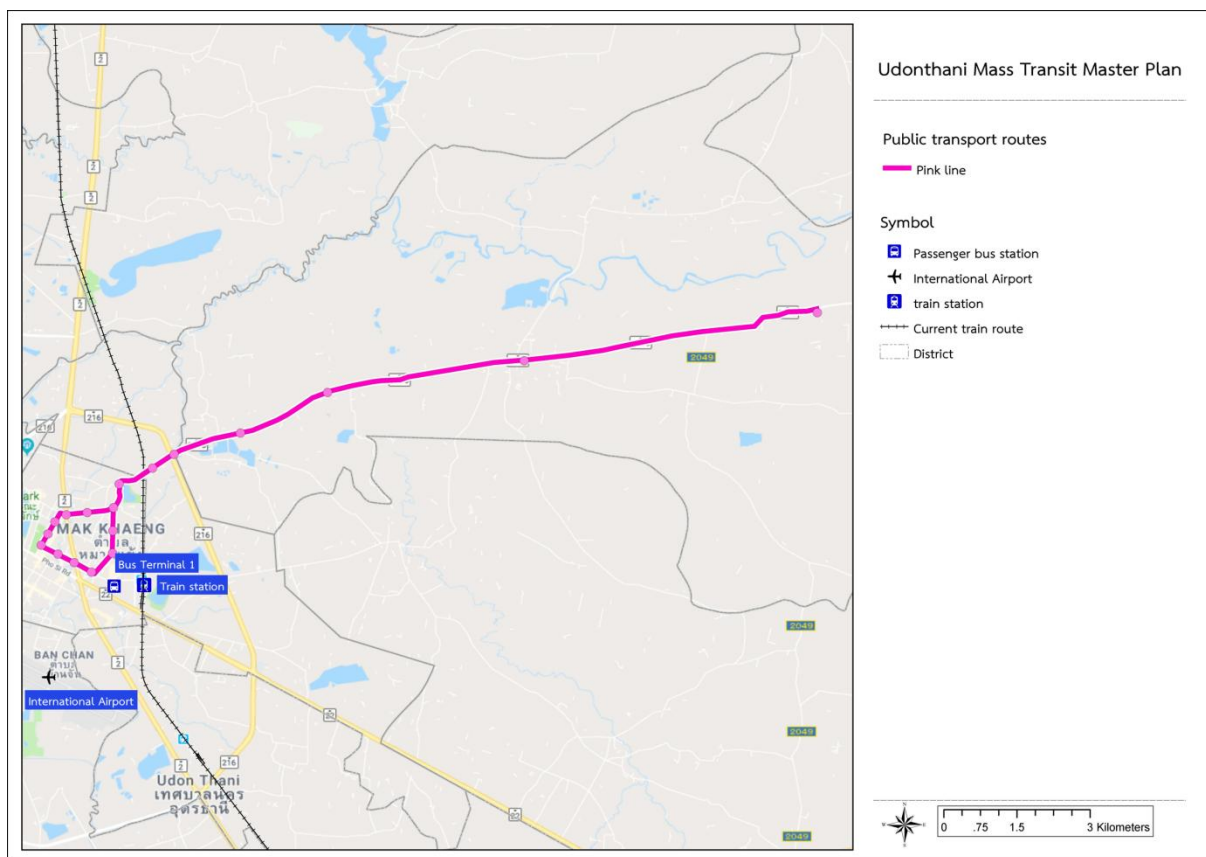
Source: The Consultants

Figure 2.7.1-5: Alignment of Green Line Electric Bus and its Stations

5) Pink Line Electric Bus

The beginning of the line is at Ratjapat Udonthani (Sam Prao Campus). It passes Suan Sunandha Ratjapat Udonthani Campus, Global House, goes straight to Versailles Road and then to Pon Pisai Road. It then passes Machiwamas Temple, Udonthani Mucinipal Hall, Udonthani Pillar Shrine, Udonthani Municipal office, Tung Sri Muang on Pran Prao Road. It turns right to Prachak Silpakom Road, passing the Clock Tower to Adulyadej Road and ends at Pon Pisai Road. The total distance of pink line is approximately 19.45 km.

There are several trip attractions along the line namely Ratjapat Udonthani (Sam Prao Campus), Suan Sunandha Ratjapat Udonthani Campus, Nong Sim, Global House, Machiwamas Temple, Udonthani Provincial Court, Udonthani Pillar Shrine, Udonthani Municipal office, Tung Sri Muang, the Clock Tower, and Don Bosco College.



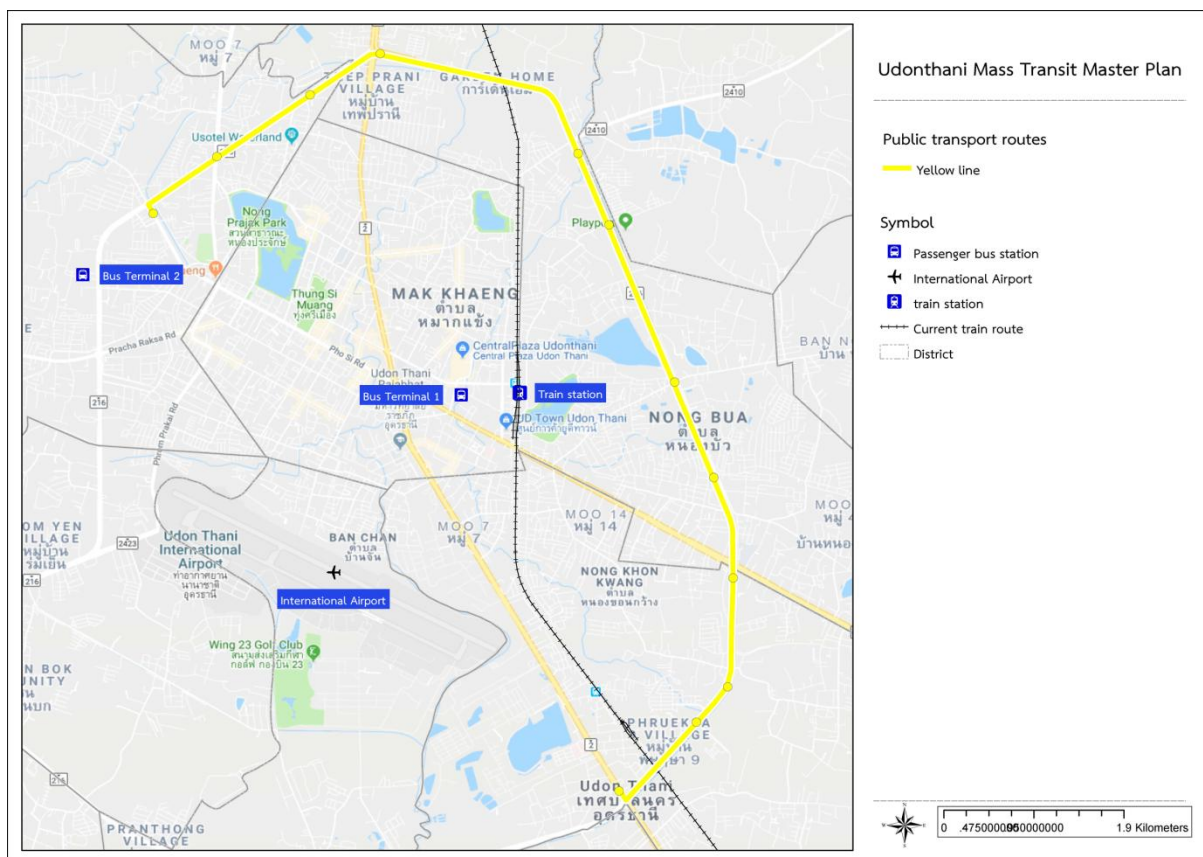
Source: The Consultants

Figure 2.7.1-6: Alignment of Pink Line Electric Bus and its Stations

6) Yellow Line Electric Bus

The beginning of the line is at Ban Laem (Por Sri/Outer Ring West). It travels on the Outer Ring West, passing Tesco Lotus Udonthani, Kao Noi Junction to the Outer Ring East. It passes Toyota Motor, Chin Non Udonthani, Global House, Bor Be Udon, Home Pro, Index Living Mall, Big C Super Store, and ends at Ban Jan Junction. The total distance of yellow line is approximately 12.90 km.

There are several trip attractions along the line namely Udonthani Employment Office, Krachangwit School, Tesco Lotus Extra, Udonthani Chamber of Commerce, Tool Pro Plus, Huay Mak Khang Pumping Station, Global House, Homemart, Home Pro, Index Living Mall, Don Udom Wanaram Temple, Office of General Education Udonthani, Talad Niyom 2, Santipon Technology, Big C Super Store, Siam Grand Hotel, Thai Wasadu, and Ratchathani University (Udonthani Campus).



Source: The Consultants

Figure 2.7.1-7: Alignment of Yellow Line Electric Bus and its Stations

2.7.2 Methods Of public transportation systems

the analysis of the travel From the amount of passengers in each route of the 6 public transport system routes by showing the Line Loading of project and using it as data for analyzing, corresponding to the Line Loading as shown in Table 2.7.2-1

Table 2.7.2-1 : Line Loading

Line		Maximum Line Loading (People / hours / directions)						
		2566	2570	2575	2580	2585	2590	2595
Red Line	AM Peak (In)	1,417	1,774	2,314	2,976	3,514	4,186	4,535
	AM Peak (Out)	714	889	1,188	1,569	1,948	2,265	2,560
	Off Peak	505	628	852	1,172	1,526	1,804	2,135
Blue Line	AM Peak (In)	1,072	1,357	1,661	2,014	2,551	3,127	3,417
	AM Peak (Out)	345	440	541	654	829	1,014	1,111
	Off Peak	275	294	334	408	531	664	778
Green Line	AM Peak (In)	1,163	1,462	1,885	2,345	2,736	3,025	3,891
	AM Peak (Out)	471	601	765	956	1,119	1,341	1,586
	Off Peak	79	169	222	283	330	393	505
Orange Line	AM Peak (In)	570	805	1,200	1,652	2,030	2,487	2,646
	AM Peak (Out)	285	406	603	827	1,017	1,245	1,327
	Off Peak	100	138	169	233	285	347	398
Pink Line	AM Peak (In)	826	1,102	1,625	1,995	2,408	2,997	3,232
	AM Peak (Out)	344	463	683	836	1,011	1,261	1,358
	Off Peak	201	222	271	332	402	499	570
Yellow Line	AM Peak (In)	300	392	498	661	771	1,012	1,182
	AM Peak (Out)	86	110	143	185	216	285	334
	Off Peak	93	102	129	155	183	240	281

Source: The Consultants

2.7.3 Mass Transit Implementation Plan

There are 2 phases of implementations:

- Phase 1: From 2020-2026 (7 year plan) and
- Phase 2: From 2027-2039 (13 year plan) as shown in **Table 2.7.3-1**.

Table 2.7.3-1: Mass Transit Implementation Plan

no	Project	Quantity	Plan (20 years)			
			Phase 1 (7 year plan)		Phase 2 (13 year plan)	
			Urgent Plan (3 Years)	Year 4-7	Year 8-12	Year 13-20
			(2020-2022)	(2023-2026)	(2027-2031)	(2032-2039)
Target 1: Public transport system will cover large coverage area, connecting to other transport modes in Udonthani.						
Strategy 1: Develop a Mass Transit Master Plan for Udonthani City with intermodal transport facilities for all modes of transport						
1	Udonthani Mass Transit Master Plan 1)					
	1.1 Red Line	10.80 km.				
	1.2 Orange Line	9.80 km.				
	1.3 Blue Line	34.50 km.				
	1.4 Green Line	13.10 km.				
	1.5 Pink Line	19.45 km.				
	1.6 Yellow Line	12.90 km.				
	Total	100.55 km.				
2	Depot	1 location				
3	Revision of Feasibility Study of Tram/LRT System	1 project				

Source: The Consultants

2.7.4 Project Investment

Investment costs consists of 1) construction costs and 2) operation costs during service as shown in **Figure 2.7.4-1**.

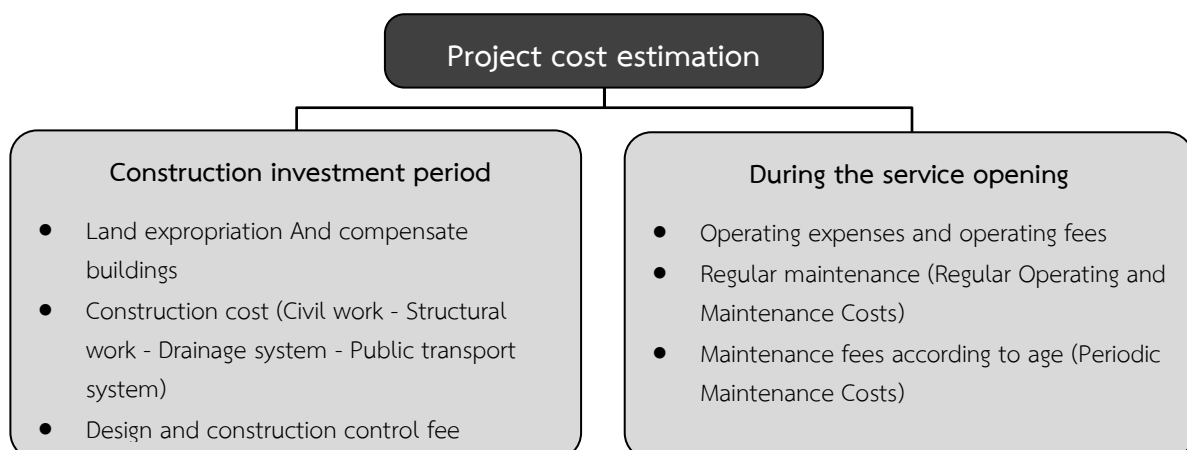


Figure 2.7.4-1: Project Investment Costs

Table 2.7.4-1: also shows investment costs by each line by types of investments.

Table 2.7.4-1: Investment Costs by Each Transit Line by Types of Investment

Description	Investment Cost (M Baht)					
	Red	Blue	Green	Orange	Pink	Yellow
Land Acquisition	123.84	85.59	92.45	74.71	80.33	37.58
Civil	244.87	90.34	61.31	39.13	60.97	32.69
M&E	140.05	61.00	64.41	75.97	51.73	26.19
Rolling Stock	1,040.00	1,605.00	982.50	584.00	1,070.00	247.00
Civil Design	7.37	3.52	3.08	2.28	2.83	1.41
Construction Supervision	9.22	4.40	3.84	2.85	3.53	1.76
Test Run	3.33	3.33	3.33	3.33	3.33	3.33
Total (1-7)	1,568.69	1,853.18	1,210.93	782.26	1,272.72	349.96
Maintenance (M Baht)	462.65	492.53	399.49	270.86	413.99	145.66
Rail Operation (M Baht)	555.14	451.87	418.67	306.75	362.28	142.51
Personnel	742.03	677.01	651.93	610.37	703.25	288.73

Source: The Consultants' Estimate

2.7.5 Economic and Financial Study

(1) Economic Study

Economic Indices of all 6 transit lines are shown in Table 2.7.5-1.

Table 2.7.5-1: Economic Indices of 6 Transit Lines

Economic Index	Result
EIRR	17.10%
NPV (M Baht)	456.01
B/C Ratio	1.19

Source: The Consultants' Estimate

(2) Financial Study

Financial Indices of all 6 transit lines are shown in Table 2.7.5-2

Table 2.7.5-2: Financial Indices of 6 Transit Lines

Financial Index	Result
FIRR	8.02%
NPV (M Baht)	1,351.30
B/C Ratio	1.14

Source: The Consultants' Estimate

(3) Economic Indices by Line

Economic Indices by each transit line are shown in Table 2.7.5-3.

Table 2.7.5-3: Economic Indices by Each Transit Line

Line	Economic Index		
	EIRR	NPV (M Baht)	B/C Ratio
Red	18.44%	225.55	1.31
Orange	17.82%	60.66	1.17
Blue	13.29%	18.46	1.03
Green	15.91%	81.65	1.16
Pink	14.11%	27.90	1.06
Yellow	15.09%	23.55	1.12

Source: The Consultants' Estimate

(4) Financial Indices by Line

Financial Indices of by each transit line are shown in Table 2.7.5-4..

Table 2.7.5-4: Financial Indices by Each Transit Line

Line	Financial Index		
	B/C Ratio	NPV (M Baht)	B/C Ratio
Red	13.59%	1,552.94	1.91
Orange	12.91%	559.45	1.41
Blue	2.95%	-147.07	0.93
Green	9.60%	457.30	1.25
Pink	4.41%	-51.77	0.97
Yellow	5.49%	13.07	1.07

Source: The Consultants' Estimate

2.7.6 Environmental Impact Assessment and Public Participation

1) Preliminary Criteria and Directions of Environmental Impact Assessment and Public Participation

There are 2 types of impact, namely positive impact and negative impact.

- **Positive Impact:** Positive impact in activities or development of the project will not cause damages, but create benefits to environmental resource condition and human use value in the study area the its vicinity.

- **Negative Impact:** Negative impact in activities or development of the project will cause damages to environmental resource condition and human use value in the study area the its vicinity.

The intensity of impacts depend on activities caused by the project before and after the construction and during operation and maintenance. This will be evaluate together with environmental conditions. A comparison is then made between the result and environmental standard. There are 4 levels of environmental impacts ranging from high, medium, low, and non significant as stated below.

- **High Impact (Level 3)**

The implementation of the project will cause high impacts to environmental and related factors. The impacts exceed the environmental standard and will cause severe and permanent damages in the surrounding area. Or the period during impacts may last longer than expected. Impacts to human use value are no significant that they can cause severe changes in way of living, risks, and damages to environment.

- **Medium Impact (Level 2)**

The implementation of the project can cause some medium impacts to environmental and related factors. Impacts to natural resources are very limited without significant damages. Changes are considered not significant to human use value and environment.

- **Low Impact (Level 1)**

The implementation of the project can cause very little impacts to environmental and related factors. Impacts to natural resources are very low without any significant damages. Changes are considered very minimum to human use value and environment.

- **No Significant Impact (Level 0)**

The implementation of the project will cause no impacts to environmental and related factors. Impacts to natural resource, human use value and environment are non existence.

2) Environmental Checklist

Environmental Checklist was carried out for inventory, data collection, environmental impacts as in accordance to Office Of Natural Resources and Environmental Policy and Planning (December 2012).

Environmental related factors for all 6 electric bus line are shown in **Table 2.7-6-1**.

Table 2.7-6-1: Environmental Related Factors for all 6 electric Bus

No	Unit	Red	Blue	Green	Orange	Pink	Yellow
1) No of Lanes	land	4 and 6	4 and 6	4 and 6	2 and 4	2 and 4	4 and 6
2) No of Intersections	location	18	11	24	23	11	7
3) No of Intersections to Water Shred	location	1	2	0	0	1	0
4) Malls/Markets	location	9	3	12	5	3	11
5) Hotels	location	12	4	9	5	5	8
6) Archeological Site/Landmark	location	4	2	4	4	3	2
7) Intermodal Station	location	4	0	0	2	0	0
8) Sensitive Receptors							
8.1 Schools	location	6	9	13	8	5	6
8.2 Religious Sites	location	1	1	1	2	1	1
8.3 Hospitals	location	0	2	1	3	0	0
8.4 Public Offices	location	22	6	21	11	4	7
8.5 Residential	location	3	2	4	1	1	12
Sum (8)	location	32	20	40	25	11	26

Source: The Consultants

3) Preliminary Environmental Impact Assessment

New mass transit projects will be electric buses since they can be operated on the existing right of way (ROW) with limited impacts to the city, its environment and biodiversity, human use value, and quality of life value.

Only activity so far that causes concern in the construction of the depot and stations. The impacts will be short live since stations are small in dimension. Impacts during the construction of the depot will be low since it is a single story building that requires only minimum site preparation.

During the operation, there will be more bus volume in the network, but all of them are electric buses therefore noise and air pollution will be very minimum. Positive impacts to the quality of life, economy, and society will follow.

2.8 The New Pilot Project in Udonthani

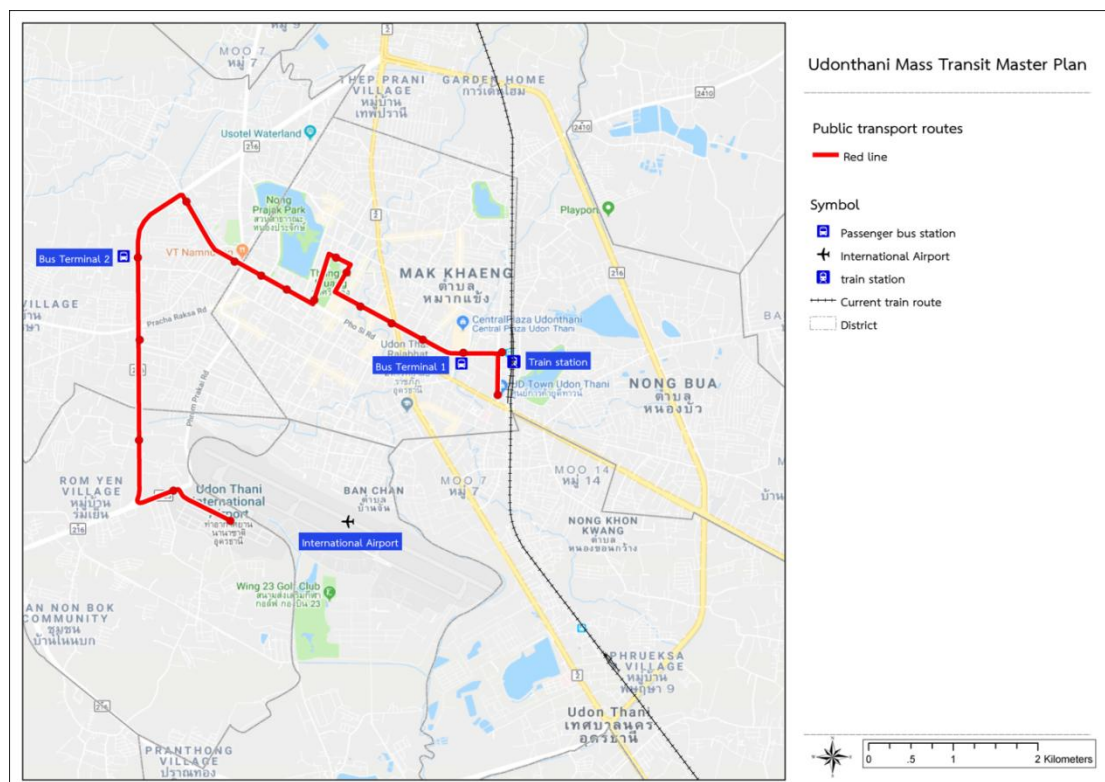
There are 2 new pilots projects in Udonthani. Details in route alignment, investment costs, EIRR, FIRR, EIA, and investment are stated below.

2.8.1 Route Alignment

1. Red Line Electric Bus

The beginning of the line is at UD Town on Thong Yai Road passing Udonthani Rail Station. It turns left to Prachak Silpakom Road, passing Central Plaza Udonthani and Watch Tower to Tung Sri Muang and turns right to Pran Prao Road. It passes the City Pillar Shrine and Udonthani Municipal Office and turns left to Atibordi Road. It then passes Provincial Court, Udonthani Municipal Hall and turns left to Muk Montri Road and right at Por Sri Road. It continues as a straight line passing Udonthani Musuem, Som Porpon Temple to Ban Laem Junction. It eventually turns left to Highway 216 (the Outer Ring West) to Udonthani International Airport. The total distance of red line is 10.80 km.

There are several trip attractions along the line namely UD Town, Center Point, Central Plaza Udonthani, Udon Wittaya School, Watch Tower, the Excise Office Branch 4th, Tung Sri Maung, Udonthani Musuem, Som Porpon Temple, Por Sri Village Market, the 2nd Bus Terminal, Thai Samut Mittrapap Scool 187, Buntawon Udonthani, National Sport College, Udon Picharak Pittaya School, and Udonthani International Airport.



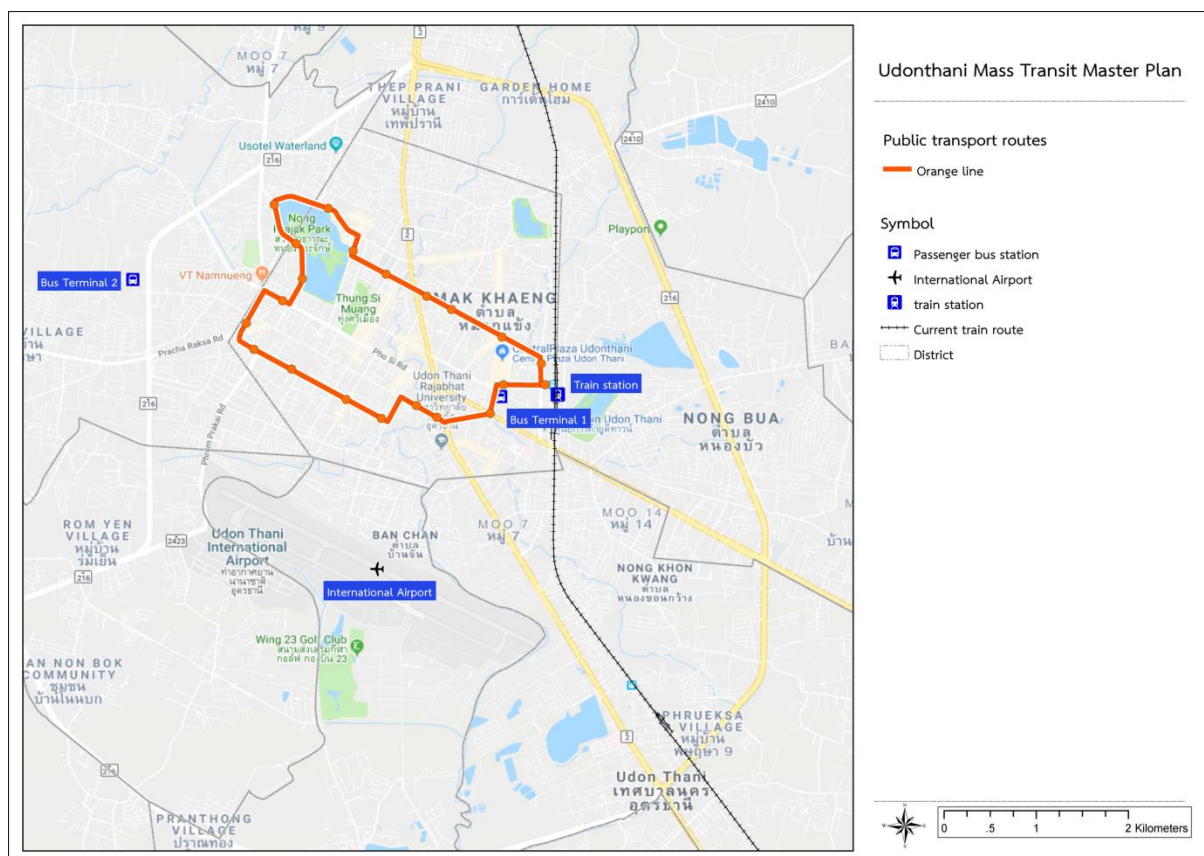
Source: The Consultants

Figure 2.8.1-1: Alignment of Red Line Electric Bus and its Stations

2. Orange Line Electric Bus

The beginning of the line is at Udonthani Rail Station. It turns left to Wattananuwong Road to Udon Dhusadee Road, passing Udonthani Municipal Hall and Udonthani Technical College. It turns right to Tesa Road, passing Tesaban 2 School and then turns left to Supakit Chanya Road. It passes Nong Prachak, Udonthani Hospital, Por Sompon Temple. It then turns right at Por Sri Road, to Thamma Chedi Road, passing Tesaban 5 School to Sri Chom Chaen Road. From Sri Chom Chaen Road it passes Udonthani Provincial Electricity Authority straight to Amphor Road and turns right to Sri Suk Road. It then passes Ratjapat Udonthani, turn left at Prachak Silpakom Road, and turn left again to Utit Road to the 1st Bus Terminal. The ends at Prachak Silpakom Road at Udonthani Rail Station. The line is a circular route with the total distance is 9.80 km.

There are several trip attractions along the line namely UD Town, Center Point, Bangkok Hospital (Udonthani Branch), Udonthani Mucinipal Hall, Tesaban 2 School, North Eastern Wattana Hospital, Nong Prachak, Udonthani Hospital, Som Porpon Temple, Tesaban 5 School, Udonthani Provincial Electricity Authority, Kulaprapruk Grand Park Condominium, Ratjapat Udonthani, Statue of Luang Prachak Silpakom, Charoen Hotel, and UD Town.



Source: The Consultants

Figure 2.8.1-2: Alignment of Orange Line Electric Bus and its Stations

2.8.2 Investment Costs of New Pilot Projects

All Types of investment cost are shown in **Table 2.8.2-1**.

Table 2.8.2-1: Investment Costs of the New Pilot Projects by Types of Investment

no	Description	Investment Cost (M Baht)		
		Red	Orange	Total
1	Land Acquisition	394.71	74.71	469.42
2	Civil	301.62	87.42	389.04
3	M&E	140.05	75.97	216.02
4	Rolling Stock	1,040.00	584.00	1,624.00
5	Civil Design	13.93	3.24	17.17
6	Construction Supervision	17.41	4.05	21.46
7	Test Run	3.33	3.33	6.67
8	Total (1-7)	1,911.05	832.73	2,743.77
9	Maintenance (M Baht)	462.65	270.86	733.51
10	Rail Operation (M Baht)	555.14	306.75	861.89
11	Personnel	742.03	610.37	1,352.40

Source: The Consultants' Estimate

Table 2.8.2-2: Investment costs breakdown of Pilot project

Unit: Million Baht

Investment Cost	Total Cost	Cons. Year 1		Cons. Year 2		Cons. Year 3	
		%	2020	%	2021	%	2022
<i>Preliminary Estimate</i>							
Pre-Construction work							
Detail design fee (as a 2.0% of Land acquisition and Civil work exp.)	17.17	100%	17.17	0%	0.00	0%	0.00
Land acquisition	469.42	50%	234.71	50%	234.71	0%	0.00
Total Preconstruction work	486.59		251.88		234.71		0.00
Consulting Fee							
Land acquisition (as a 2.5% of Land acquisition exp.)	11.74	50%	5.87	50%	5.87	0%	0.00
Civil work (as a 2.5% of Civil work exp.)	9.73	0%	0.00	30%	2.92	70%	6.81
Total Consulting Fee	21.46		5.87		8.79		6.81
Total Consulting Fee (No Inflated)	21.46		5.87		8.79		6.81
Civil work							
Park & Ride	195.75	0%	0.00	30%	58.72	70%	137.02
Depot	121.25	0%	0.00	30%	36.38	70%	84.88
Road improvement, Pedestrian overpass and Bus stop	72.04	0%	0.00	30%	21.61	70%	50.43
Total Civil work	389.04		0.00		116.71		272.33
Total Civil work (Inflated)	415.88		0.00		122.62		293.27
M&E equipment (Including TCS, AFC, PIDs and Tele.) (15 Yrs)	115.05	0%	0.00	0%	0.00	100%	115.05
EV Bus (15Yrs)	367.00	0%	0.00	0%	0.00	100%	367.00
Total M&E equipment and EV Bus	482.05		0.00		0.00		482.05
Total M&E equipment and EV Bus (Inflated)	519.11		0.00		0.00		519.11
Pre-Operating cost	6.67	0%	0.00	0%	0.00	100%	6.67
Total Capital cost	1,385.80	19%	257.75	26%	360.21	55%	767.85
Total Capital cost (Inflated)	1,443.05		257.75		366.12		819.19

Source: The Consultants' Estimate

2.8.3 Economic and Financial Study

Economic Study

Economic Indices of 2 new pilot lines are shown in **Table 2.8.3-1**. It shows EIRR is greater than 12%.

Table 2.8.3-1: Economic Indices of Pilot Projects

Economic Index	Resultant value
EIRR	16.15%
NPV (M Baht)	304.61
B/C Ratio	1.23

Source: The Consultants' Estimate

Financial Study

Economic Indices of 2 new pilot lines are shown in **Table 2.8.3-2**. It shows FIRR is greater than 5%.

Table 2.8.3-2: Financial Indices of 2 New Pilot Projects

Financial Index	Resultant value
FIRR	8.83%
NPV (M Baht)	1,178.60
B/C Ratio	1.30

Source: The Consultants' Estimate

2.8.4 Environmental Impact and Public Participation

Environment Impact

The new pilot projects will be electric buses since they can be operated on the existing right of way (ROW) with limited impacts to the city, its environment and biodiversity, human use value, and quality of life value.

Only activity so far that causes concern in the construction of the depot and stations. The impacts will be short live since stations are small in dimension. Impacts during the construction of the depot will be low since it is a single story building that requires only minimum site preparation.

During the operation, there will be more bus volume in the network, but all of them are electric buses therefore noise and air pollution will be very minimum. Positive impacts to the quality of life, economy, and society will follow.

Public Relation

Public relation was done thru printed media such as posters or booklets and via social media at www.udon-pmp.com. Public exhibition was also prepared for the wider range of audience.

Public participation is also vital to the all public and business sectors. The Consultants managed several seminars, workshops, and focus groups during the period of our study for all participants from public agencies, business sectors, local administrations, local representatives, non-profit organizations, academic institutions, and people as follows:

1. 1st seminar and public participation on June 16, 2018.
2. 1st Focus Group on August 28-29, 2018.
3. Internal meeting on route alignment and system selection with local authorities on September 14, 2018.
4. In Depth Focus Group with public transport operators on August 25-26, 2018.
5. 2nd seminar on December 18, 2018.
6. 2nd Focus Group on March 28-29, 2019.
7. 3rd seminar on May 28, 2019.

2.8.5 Methods of Project Investment

Different methods of investment have different advantages and disadvantages. Most investments for government mega infrastructures are in the form of public private partnership (PPP). This idea somehow started in overseas some time ago. In principle, PPP is a tool for a good economic stimulus and it can fulfill a role in social development.

PPP covers various methods of investment for both public agencies and private concessionaires in construction, procurement, and project management after the commencement of a project.

The Consultants come up with 3 methods of investment for the future mass transit service and the new pilot projects in Udonthani as follows:

Type 1: Government will be responsible for all activities in construction, procurement of rolling stocks, M&E, operation, and maintenance, all about this it is a type of Public Sector Partnership.

Type 2: Government will invest only in land acquisition and civil works. Private concessionaire will be responsible in M&E, procurement of rolling stocks, and maintenance during concession age. Government will obtain farebox revenue from the concessionaire. In return, Government will only pay costs of operation to the concessionaire, all about this case is a type of Gross Cost Concession.

Type 3: Government will invest only in land acquisition and civil works. Private concessionaire will be responsible in further civil works, M&E, procurement of rolling stocks, and maintenance during the concession period. Government will obtain only concessionaire fee, all about this case is a type of Net Cost Concession.

Type 4: The Government Official inverted a demesne of property ,private sector invested about standard structural of construction, vehicle procurement ,maintenance and operate, all of transports income impose by government official and paying for private sector about operating , all about this case is a type of Gross Cost Concession.

These are indices for PPP as stated below.

Table 2.8.5-1 investment approach of Pilot project

	Land acquisition	Civil work	M&E	Rolling stock	Maintenance	Revenue collection
Type 1	Government	Government	Government	Government	Government	Government
Type 2	Government	Government	Private	Private	Private	Government ¹
Type 3	Government	Government	Private	Private	Private	Private ²
Type 4	Government	Private	Private	Private	Private	Government ¹

Remark: 1) Government pays operation costs to the concessionaire

2) Government receives concession fee

Evaluation of financial indices for investment analysis as stated below.

- **Net Present Value (NPV)**

Net Present Value (NPV) is an indicator the shows the difference between the present value of cash inflows and outflows or benefits from the project over a period of time. The highest value in NPV among different methods of investment shows it is the best investment.

- **Financial Rate of Return (FIRR)**

Financial Rate of Return (FIRR) is an indicator that shows the rate of return in term of the present value of revenue or benefits from the project in comparison to the value of investment. FIRR is in percentage. The highest value in FIRR among different methods of investment shows it is the best investment.

Table 2.8.5-2 shows all indicators from 3 types of investment.

Table 2.8.5-2: Indicators from 3 Types of Investment.

Method	Public		Private
	NPV (M Baht)	FIRR (%)	Rate of Return (% per annum)
1	1,178.60	8.83	-
2	-234.90	3.79	12.50
3	-600.24	1.73	13.50
4	-199.08	3.85	12.50

Remark: 1) Government pays operation costs to the concessionaire

2) Government receives concession fee

From **Table 2.8.5-2** Type 1 the government official investing all of project expenses include by land acquisition, civil work, rolling stock, M&E and operating&maintenance. Financial Internal Rate of Return (FIRR) = 8.83

Type 1 have more benefit from project than Type 2 investing all of infrastructure (include land acquisition and civil work) by government official, private sector invested vehicle procurement system and get operating income from the government official.

Type 3 the government official invested all of infrastructure private sector invested about standard structural of construction, vehicle procurement ,maintenance and operate and impose transport income and government official receive concession cost.

Type 4 the government official invested a demesne of property , private sector invested about construction structure operate vehicle procurement system and maintenance and receive operating cost from government official.

According to study public private partnership in type 2, 3 and 4 ,Financial internal rate of return (FIRR) of Type 4 is better than type 2 and Type 3 because government official invested particularly property cost and change income processing paying operate cost to private sector , government official can decreased risks from income can motivated and persuaded people change from private cars to public transportation ,and supported another factors such as cooperate tickets monthly ticket daily Tickets and student ticket and control or set of fare cost for transportation.

Chapter 3

Traffic Management Plan in Udonthani Urban Area

Chapter

3 Traffic Management Plan in Udonthani Urban Area

3.1 Concept and Traffic Management Plan

The concept of traffic management plan in Udonthani urban area is in accordance to urban development for Udonthani province and relevant agencies. For an efficient traffic management, the Consultants reviewed several studies from public and private agencies, including our own site survey, public participation, and congestion problems. Solution was made to relief traffic congestion in Udonthani as stated in the Chapter below.

3.1.1 Purposes of Traffic Condition on Udonthani Network

Most urban cities suffer from traffic congestion and it will get worse over the time. There are some helps from state, but so far the sustainable solutions have not yet been found. There are pro and con (advantages vs disadvantages) of each solution, demanding very much on related factors and its urgency, necessity, and timing.

The Consultants conducted traffic survey in Udonthani and performed traffic forecast for the future for both private and public transport modes. Our main goal is the traffic solutions as follows:

- 1) To lessen traffic Congestion in Udonthani
- 2) To improve travel corridor with better speed and mobility
- 3) To reduce number of accidents and losses in Udonthani urban area
- 4) To prepare and change motorist behaviors to suit the new mass transit system

3.1.2 Traffic Management Plan in Udonthani

This is a purposed traffic management plan from our study. We conducted traffic survey, traffic and ridership forecast of new Udonthani mass transit system. The traffic solutions depend on target groups, severity of the problem, difficulties for implementation as shown in **Figure 3.1.2-1**

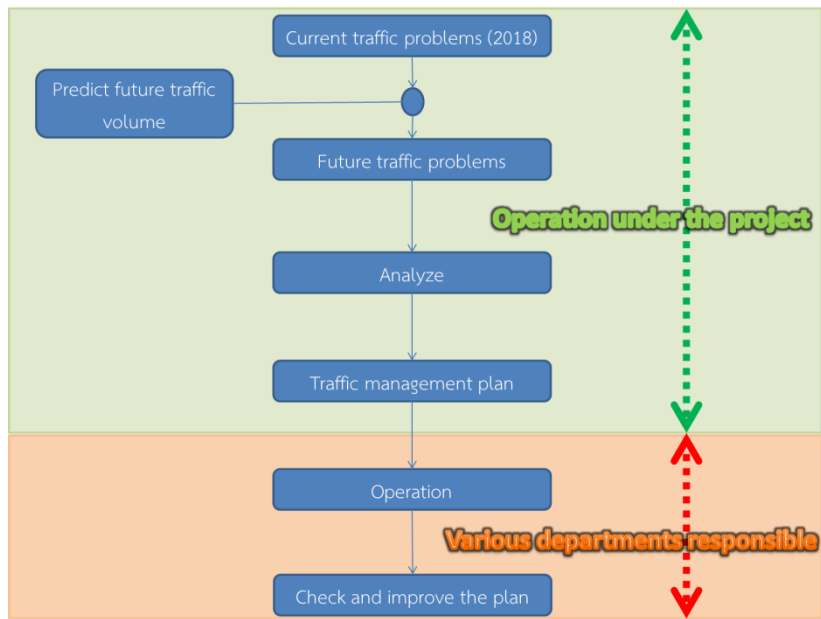


Figure 3.1.2-1: Concept of Traffic Solutions for Udonthani Urban Area

3.1.3 Targets of Traffic Management Plan for Udonthani Urban Area

A different area requires a different solution. For example, a school will attract a great volume of traffic during AM peak and PM rush hours. Parents will drop off children in the morning and pick them up in the afternoon. This results in traffic congestion.

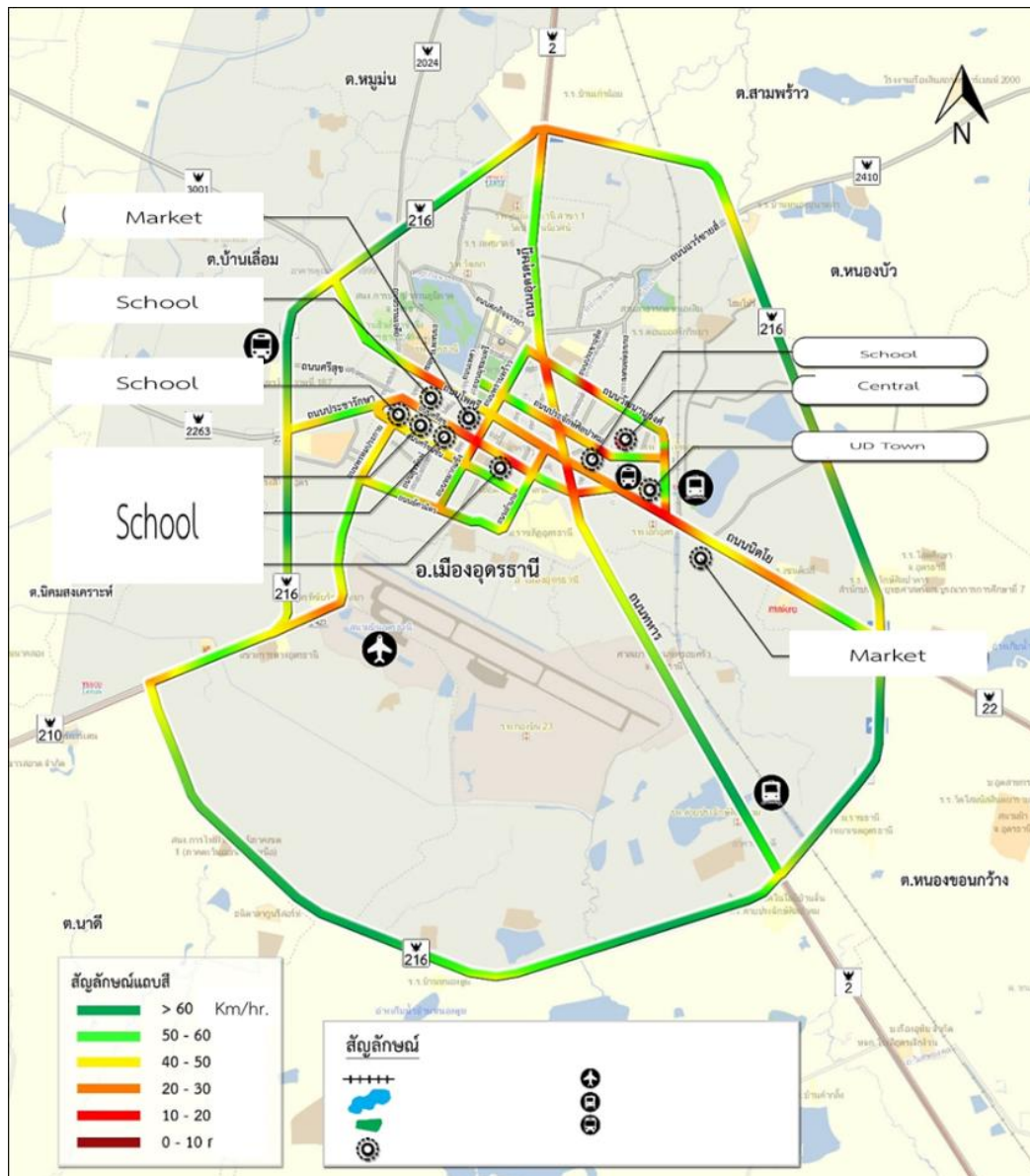
Possible solutions are:

- 1) Reduce the use of cars and motorcycles by 30% in 2042.
- 2) Encourage the use of public transport to 50% of mode share in 2042.

Nonetheless, different types and conditions of traffic congestion may require different approaches. The Consultants did further traffic analysis in the urban area of Udonthani so that a good traffic management plan and a sustainable solution can be achieved.

3.2 Traffic Congestion in Udonthani

Traffic congestion in Udonthani is a result of transport demand that exceeds network capacity. The congestion becomes chronic and causes losses in travel time and economy. Most roads in Udonthani suffer low travel speed, particularly at peak hours as shown in Figure 3.2-1.



Source: The Consultants

Figure 3.2-1: Average Speed during Peak Hours

Based on recent statistics, Udonthani experiences a high rate of traffic accidents and a high fatality index. The main reason is negligence among motorists and also conditions of road network such as insufficiency of street lighting at night time, unavailability traffic control devices (signs and traffic lights), damages to road signs, etc.

From our traffic survey, we can classify locations of traffic congestion.

1. Traffic congestion in the city center
2. Traffic congestion near schools
3. Traffic congestion caused by on-street Parking
4. Traffic congestion caused by rail grade crossing
5. Traffic safety in Udonthani urban area
6. Miscellaneous

3.3 SWOT Analysis

SWOT analysis for internal and external factors. It is designed for any organization or project to determine strengths and weaknesses from internal factors and opportunities and threats from external factors

SWOT analysis for traffic in Udonthani urban area has the outcome in the form of TOW Matrix as shown in **Table 3.3-1**.

Table 3.3-1: SWOT Analysis for Udonthani Traffic Management Plan

No.	Description
Strengths	<u>Strengths</u> - Udonthani municipal has a state of art technology in traffic management. - Udonthani has a international airport with coverage area in upper Esan. - Udonthani urban area has a good road network for travel. - Udonthani connects east-west corridor from Laos-Loei-Nong Bua Lampu-Udonthani-Sakon Nakhon-Nakhon Panom-Laos. - Udonthani has a good human resource in traffic management. - Udonthani has higher economic and population growth than nearby provinces. - Udonthani has a good public transport service with 2 new red and blue buses. - Commuters have different choices of travel by different modes of transport.
Weaknesses	<u>Weaknesses</u> - Limited ROW with narrow lanes. Footpath in bad conditions. Not sufficient street lighting. - High proportion of motorcycles causes it difficult for mode switch to public transport. - Insufficient coverage service area of public transport. Lack of good LOS. Main mode of transport is still passenger car. - Traffic violation such as speeding, riding on footpath, driving in opposite direction. - Some sections of main arterials are actually collector roads. Stripped development along arterials in urban area generates high traffic demand. - More stripped development along travel corridors. Road widening is difficult to achieve. - Most arterials suffer from traffic congestion. Collectors also accommodate too much traffic demand.
Opportunities	<u>Opportunities</u> - Government has a plan to support public transport for Udonthani. - Awareness among motorists concerning traffic congestion. Mutual interest in reduction of car use and ready to switch to public transport. - Udonthani is located in “Central Economic Corridor” in N-S direction. - Udonthani has a potential as “New Economic Corridor” in E-W direction. - Opportunities for rail-road-air intermodal transport for goods and services to nearby provinces. - Potential in urban and land development in the vicinity around the existing Udonthani Rail Station from the incoming dual track and HST.
Threats	<u>Threats</u> - People prefer motorcycles for its convenience. - Development of public transport with convenience, comfort, and punctuality will require great amount of budget and high expertise in management. - Overall improvements of road network will require great amount of budget. - Limited accessibility to airport, rail, and other trip generators via both road and public transport. Lack of coordination among agencies.

3.4 Traffic Management Plan in Udonthani Urban Area

Purposes on the traffic management plan for Udonthani urban area is aimed at increasing more accessibility to road network for the future urban development and a sustainable public transport service. It will encourage the use of non motorized vehicle mode such as walking and cycling.

From visions, strategies, and targets of the development of Udonthani Mass Transit Master Plan and its surrounding in order that Udonthani will transform into “a Hub for Service Sector on the Upper Esan for AEC Economic Corporation”.

There are 3 stages of development.

- First 3 Years Plan from 2022-2025 They are projects after design process
- Next 4-7 Years Plan from 2023-2027. They are projects necessary for the future urban and mass transit development. This should be preceded immediately within the next 10 years.
- Next 13 Year Plan from 2027-2039. They are projects after the urgent plan and intermediate plan. They can be later reevaluated based on the feasibility after the end of 2nd plan.

The detail is shown in **Table 3.4-1**.

Table 3.4-1: Strategic Plans

	Urgent Plan (2019-2022)	Intermediate Plan (2023-2027)	Long Term Plan (After 2027)
Strategy/Target	Encourage a Smart Growth Management for a sustainable urban development	Increase road network efficiency/encourage a suitable urban development	Connectivity to national network infrastructures
Development of Road Network	Solutions to critical locations/traffic hot spots/traffic management while maintaining flow on the Outer Ring Highway	Investments of new roads on the east of the city based on (draft) Udonthani Land Use Master Plan	Limit number of vehicles in road network

Internal and external factors to traffic demand in Udonthani urban area can be used to determine traffic management plan as shown in **Table 3.4-2**.

Table 3.4-2: Traffic Management Plan and Description

No.	Area	Description	Methods
1	Traffic solution in inner core	Along commercial area along Por Sri, Prachak Silpakom, Mak Kang, Pran Prao	- Encourage the use of public transport and walking streets with transfer facilities and convenience - Reduce travel delay between OD and activity center, road improvement suitable with land use
2	Traffic solution for schools	Around Sri Suk, Sri Chom Chaen, Por Sri, and several schools as delay occur during AM and PM peak hours	- Encourage development of intermodal transfer locations and reduce no of student drop off in front of school with more access from different directions
3	Traffic solution to on street parking	Around Udonthani inner core, particularly commercial areas such as Udonthani Hospital, municipal offices, Tung Sri Muang, and other commercial zones	- Control land use density, adding traffic control measures to curb violations with a proper management of on street parking
4	Traffic solution to rail grade crossing	Around rail station, commercial areas along Thong Yai, Wattananuwong, Prachak Silpakom, Utit, Nityo	- Increase accessibility to the east of SRT railway
5	Traffic safety in Udonthani	Area with risks to accidents, without traffic lighting Riding motorcycle on footpath Speed violation	- Improvement of road and footpath surface, add facilities eg. pedestrian crossing or pedestrian bridge, traffic lighting at night, traffic signs and controls, etc
6	Miscellaneous	Along roads in Udonthani urban area	- Landscape improvements - Bike lane with good safety and standard

The Consultants revised our traffic study based on the existing transport network development plan from Udonthani Land Use Master Plan (2010) to determine a diagram of a work flow in traffic management plan in **Figure 3.4-1**.

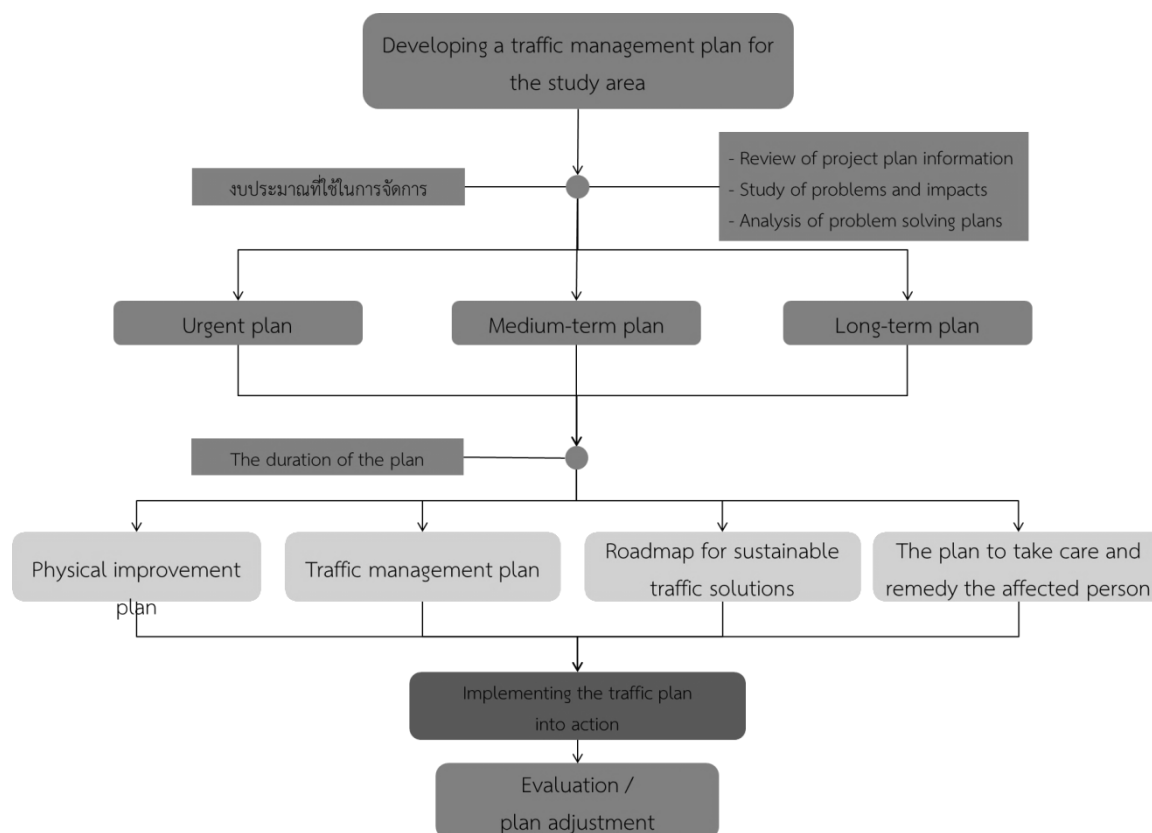


Figure 3.4-1: Traffic Management Diagram Work Flow

3.5 Project Prioritization of Traffic Management Plan

Criteria in project prioritization depend on 2 main factors 1) it is to be in accordance to the master plan and 2) opportunity in the allocation of budget.

Factor 1: It is to be in accordance to the main master plan as it follows land use and land development particularly a high density area that becomes an activity center and generates high traffic demand. Service to people is needed.

Factor 2: Opportunity in the allocation of budget plays a vital role. Low budget project is only suitable for only a few local administrations. High budget project has a good opportunity to allocate high amount of budget, if it is already a committed project. If the project requires several agencies to take action, an opportunity to secure high amount budget will be low.

From 2 factors above, we can determine project by its readiness from very high, high, medium, and low as shown in **Figure 3.5.1**.

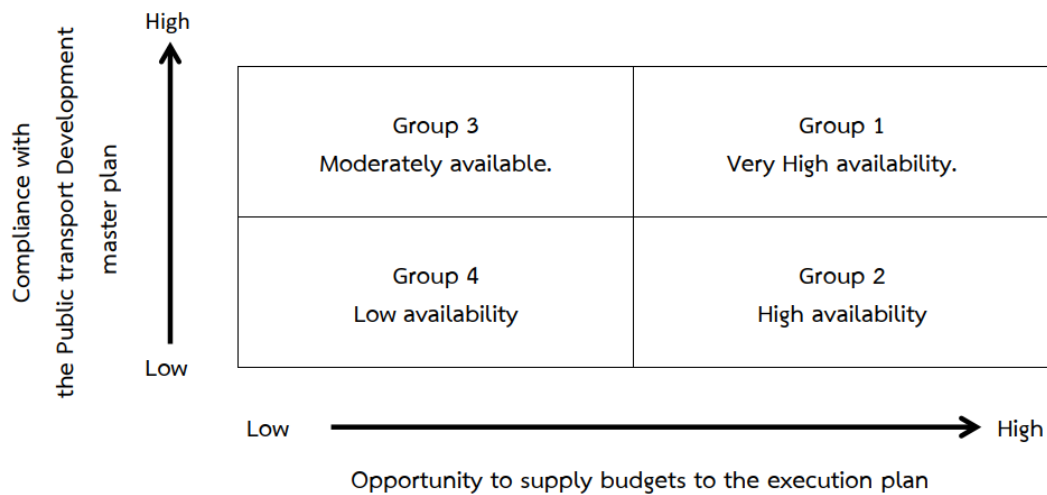


Figure 3.5-1: Readiness of Project Prioritization

Group 1: The project has the highest readiness. The project is in accordance to the land use master plan for mass transit development in a highly dense urban area which generates high amount of traffic. The project requires low budget, only one local administration can take responsibility. Or the project requires high budget, but it is already in the implementation plan.

Group 2: The project has a high readiness. The project is in accordance to the land use master plan for mass transit development in a less dense urban area compare to the project in Group 1. The project requires low budget, only one local administration can take responsibility. Or the project requires high budget, but it is already in the implementation plan.

Group 3: The project has a medium readiness. The project is in accordance to the land use master plan for mass transit development in a highly dense urban area. However, the project has some uncertainty in a macro level. Allocation of project budget is also uncertain. Several administrations need to take responsibility. Such project is considered a long term investment.

Group 4: The project has a low readiness. The project is also in accordance to the land use master plan for mass transit development in a less dense urban area compare to the project in Group 1 and 3. Allocation of project budget is also uncertain. Several administrations need to take responsibility.

3.5.1 Urgent Traffic Plan (Short Term Plan)

Road Network Improvements

- 1) Improvements of physical conditions along the new red and orange bus transit corridors and in the vicinity around the stations.
 - Improvements of footpaths on both sides with a new landscape for pedestrian and non-motorized travel.
 - Improvements of road median to reduce congestion and delay.

- 2) Improvements of road network efficiency
 - Improvements of the quality of Prom Praguay Road, including the shoulders. Prom Praguay Road acts as a short cut from Udonthani International airport to city core.
- 3) Physical Improvements and Installation of Safety Devices
 - New pedestrian crossings and pedestrian bridges at Sri Suk Junction. A new pedestrian crossing is required with pedestrian crossing signal to slow down the traffic.
 - New traffic signals along the new red and orange bus transit.
 - New barriers to prevent on street parking on footpath or riding motorcycle on footpath. This will reduce recurring traffic accidents.
 - New street lighting to reduce accidents.

Traffic Management Plan

- 1) Traffic Signal Setting
 - New traffic signal setting along red and orange bus transit corridors will be changed from 2 phase signals to 4 phase signals to reduce delay from right turn movement.
 - New bus way on one way street. New traffic signals will be installed with a new phase for bus prioritization to increase bus flow. This is a normal practice worldwide.
 - A new ITS will be installed concerning route choices, congestion, and accidents. A new ITS can use solar energy.
 - Management of on street parking to increase traffic flow. New pavement marking are required for car parking, motorcycle parking, and bicycle parking.
 - Dimension for car parking 2.50 x 5.50 m
 - Dimension for motorcycle and bicycle parking 2.00 x 1.00 m

Pattern of Parking: Parallel parking for car and 45 degrees parking for motorcycle and bicycle.

- New “No Double Parking” signs with strict law enforcement from police and local officers to reduce traffic congestion.
- Color “white-red” will be applied to curb for no street parking. The radius at any intersection will facilitate traffic movement. The “white-red” color will be painted at a length of 15-20 m from the intersection for a 4 arms intersection. For a 3 arms intersection, a length of “white-red” color can be approximately 60 m.

2) One way Street

- Convert 2 way roads into 1 way, increase the existing road capacity, and reduce turning conflicts on Sri Suk, Por Sri, Muk Montri, Naresuan, Por Niyom, and Amphor Rd.
- Install new traffic control devices, parking markings, and with new road improvements.

Plan to Support Sustainable Traffic Solution

- 1) New traffic checkpoint.
- 2) Public relation concerning traffic laws.
- 3) Public cooperation from students such helmet for those riding motorcycles.
- 4) Measures in motivation or award to those who use public transport.

Remedy to those under Impacts

- 1) For new channelization for a new bus lane, pavement markings will clear and comprehensible to motorists, particularly center line of the roadway to avoid confusion from motorists.
- 2) Encourage private developers to have their own parking space to curb on street parking. Exception will be made on red and orange bus transit corridors, since on street parking will be allowed.
- 3) On street parking will be allowed at a location with “white-yellow” color during AM and PM rush hours in the vicinity of schools.

3.5.2 Medium Term Plan

Road Network Improvements

- 1) There are 5 locations of park and ride as follows:
 - North Western Location: in the vicinity of 2nd Bus Terminal near the beginning of the yellow line
 - North Location: in the vicinity of Nang Kae Park near the end of the blue line
 - North Eastern Location: in the vicinity of Suan Sunandha Rajabhat University, Udonthani Campus near the end of the pink line
 - South Eastern Location: in the vicinity of Udon Sirisawat Mill near the beginning of red bus service
 - South Location: in the vicinity of Global House, Ban Tad near the beginning of blue bus service

- 2) Development and improvements of road network along new bus transit corridors.
 - Improvements of footpaths on both sides with a new landscape for pedestrian and non-motorized travel.
 - Improvements of road median to reduce congestion and delay.

Traffic Management Plan

- 1) New parking fee for a better traffic circulation. The first 15 minute will be free of charge. The next 15 minutes will be charged at a specific rate.
- 2) Cooperation from local officers and police to strictly enforce the traffic laws.
- 3) Installation of a new ITS to encourage the use of public transport service.

Plan to Support Sustainable Traffic Solution

- 1) New traffic checkpoint.
- 2) Public relation concerning traffic laws.
- 3) Public cooperation from students such helmet for those riding motorcycles.
- 4) Measures in motivation or award to those who use public transport

Remedy to those under Impacts

- 1) New sticker for local residents for free parking. It is to be limited to 1 sticker per household. Tenants are not included. At any congested area, no parking will be allowed, except nearby streets.
- 2) New landscape improvements for public transport commuters.
- 3) Encourage the public to use public transport service.
- 4) Reduce growing discontent from new public transport project from all those relocated local street vendors by providing new locations.
- 5) Encourage parents to drop off children at public transport facilities to reduce traffic congestion.

3.5.3 Long Term Traffic Plan

Road Network Improvements

- 1) Enhance potentials in traffic intersections
 - 3 existing roundabouts namely Wong Wien Nam Pu, Wong Wien Silapa Prachakom, and Wong Wien Clock Tower will be converted into signalized intersections.
 - New access for the existing Udonthani Rail Station to the new urban development for dual track railway and HST.

2) New Road Network

- Increase accessibility of the existing road network
- Improvements of access roads as new collectors.

Traffic Management Plan

- 1) New parking fee at Tung Sri Muang.
- 2) No right turn to reduce turning conflicts and accidents.
- 3) Congestion charge during peak hours.
- 4) New phase setting for the traffic signals at 3 roundabouts to facilitate pedestrian movement.

Plan to Support Sustainable Traffic Solution

- 1) New traffic checkpoint.
- 2) Public relation concerning traffic laws.
- 3) Public cooperation from students such helmet for those riding motorcycles.
- 4) Measures in motivation or award to those who use public transport

Remedy to those under Impacts

- 1) “No Parking” signs will be placed for 1) odd & even day 2) all day, and 3) except public holiday.
- 2) A new ITS will be installed at every single intersection in Udonthani with CCTV to curb crime rates and detect traffic violations.

Chapter 4

Transit Oriented Development (TOD)

Plan around Mass Transit Stations

and Park and Ride Facilities



Chapter

4 Transit Oriented Development (TOD) Plan around Mass Transit Stations and Park and Ride Facilities

4.1 Potentials

1) Potential as a Transport and Logistics Center

Udonthani has a potential in security in The Mekong River basin/Indochina. It is also situated on China's strategic route and Thailand's dual track North-East corridor. Udonthani have regional rail transport and airport infrastructures with a continuous traffic growth. Udonthani is also in 1st and 2nd ranking in term of rail and air passenger demand at a total 4,052 passengers/day or 2,573,977 passengers/annum.

2) Potential as a Commercial/Trade Center

Most land around Udonthani station has a mixed land use pattern. There are commercial buildings, housings, and markets such as Night Market, Night Barza, UD Town, Central Plaza Udonthani, Center Point 2003, etc. There are some nearby markets such as Nong Bua Market, Thai Esan Market, Muang Thong Sri Market, with whole sale and retailed shops for bus and rail transport passengers.

3) Potential as a Tourism Center

Udonthani has countless tourist attractions with beauty and diversity on the upper part of North Eastern region. Its history background and local knowledge has transformed Udonthani into a learning center in North Eastern region of Thailand. Udonthani was also the first settlement of pre historic Ban Chaeng civilization which counts as one among the earliest civilizations in the history of mankind.

4) Potential on an Efficient Land Use Planning and Management

Land use around the rail station is considered mixed land use with high density residential buildings with employment and commercial opportunities. This suits a concept of Transit Oriented Development and urban planning. This will emphasize on a development of new commercial areas within the urban area for a good and unique quality of life, pedestrian movement and facilities and a new mass transit system for better urban environment. The development will conform to historical background of Udonthani.



5) Potential on Project Developments in the Area

- SRT dual track with standard gauge system for the future high speed train (HST)
- DOH Motorway: Chonburi-Nong Kai on North-South Economic Corridor
- Feasibility Study and Construction Design of Bangkok-Nong Kai High Speed Train (Phase 2)

In the analysis of the existing physical conditions along the new mass transit stations, the Consultants conducted an onsite survey along the existing public transit service by considering all factors related to TOD concepts and development.

The locations of all mass transit stations are shown in **Figure 4.1-1**.

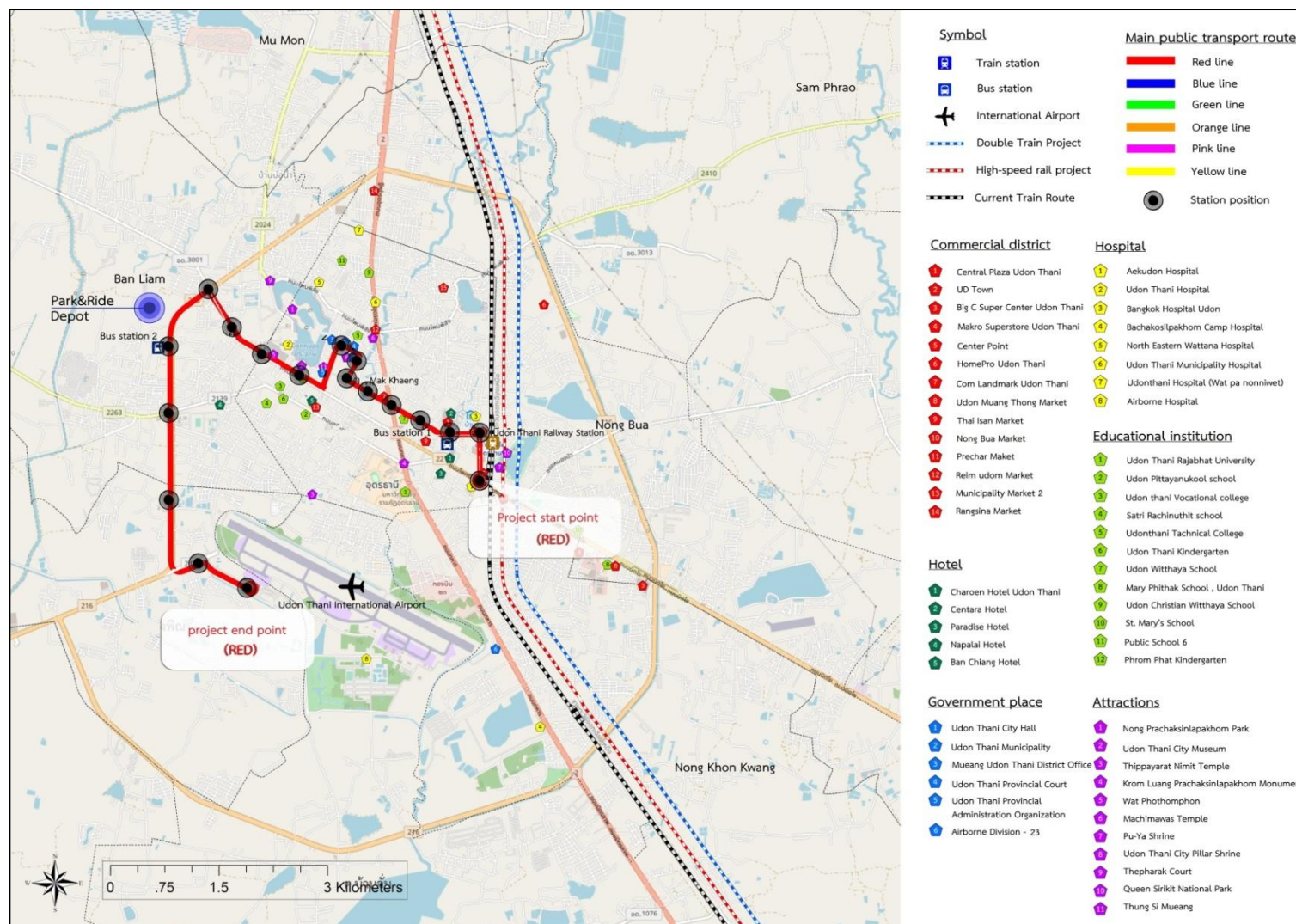


Figure 4.1-1: Mass Transit Route and Stations



4.2 Selection for Transit Oriented Development Area around Stations with Park and Ride Facilities

A suitable area for TOD is based on whether the area is qualified and fit TOD concept and design criteria or not. This follows the concept and design criteria from Phitsanulok Mass Transit Master Plan Study by Naresuan University which is also under the supervision of OTP.

The Consultants applied these criteria together with additional criteria on TOD developed by the Transportation and Development Policy (ITDP), USA which has 4 main steps as follows:

Step 1: A Selection of TOD (High Capacity)

Step 2: High Level Screening

Step 3: Detailed Screening

Step 4: A Selection of Potential TOD by ITDP

1) A Selection of TOD (High Capacity)

A selection of TOD around mass transit stations is of concerning analysis and evaluation of population density, accessibility to public transport service, availability of good public transport service, facilities for pedestrian and cyclists, and mixed land use.

There are 3 levels of evaluation of TOD.

➤ **Transit Adjacent (TA)** This area lacks basic criteria as it has low to medium population density despite that it is located adjacent to a public transport service with minimum road network with low accessibility. It also lacks transport facilities for pedestrians and cyclists with basic transport infrastructures for a livable city.

➤ **Transit Related (TR)** This area somehow follows basic criteria as it has medium population density adjacent to a public transport service with adequate road network and accessibility. It has basic transport facilities for pedestrians and cyclists with basic transport infrastructures, considering greater than TA.

➤ **Transit Oriented (TO)** This area has high population density adjacent to a public transport service with good road network and accessibility. It has good transport facilities for pedestrians and cyclists with basic transport infrastructures, considering the best.



2) High Level Screening

High Level Screening follows the basic criteria of TOD (Transportation Cooperative Research Program, 2004) as follows:

- Medium to High Population Density with housing and employment within 400-500 m radius from a mass transit station with development such as retail and service, housing, and employment.
- The safety and walkability are 2 main elements for a good and vibrant environment for pedestrians. Pedestrian network with good accessibility, safety crossing, visibility, adequate dimension for walking without any obstacles are required.
- The average vehicular speed should not exceed 40 kph for the safety of pedestrians and cyclists. Any area with high (or higher) speed traffic is definitely not suitable for TOD.

3) Detailed Screening

It is a procedure to determine a suitable area for TOD. The detail study will provide valuable data for decision making and design criteria.

4) A Selection of Potential TOD by ITDP

To evaluate the readiness and potential of TOD with highest efficiency, the Consultants applied TOD criteria based on the Institute for Transportation and Development Policy (ITDP), USA.

Our evaluation has 2 groups of highly potential areas as follows:

Group 1: UD Town, Udonthani Rail Station, Udonthani Central Plaza

These 3 locations have approximately the same level of potential as they fit the concept of TOD with good accessibility to the future road and rail transport network and facilities. Further TOD improvements for safety of pedestrians and cyclists will encourage the use of public transport service. This will result in efficiency and sustainability development as high density commercial areas with generate high traffic volume.

Group 2: Won Wei Junction, Udon Clock Tower, Excise Office 4, and Tung Sri Muang

They have less potential than group 1 as most areas are old high density commercial areas. Most of which are scattering around Udonthani Municipality Office surrounded by a large public park, government offices, and academic institutions in the south. Nonetheless, group 2 has a potential for TOD and sustainable urban development.

4.3 Patterns of Transit Oriented Development Area around Stations

Evaluation of potentials within the vicinity of mass transit stations was made in accordance to the main vision from the new Udonthani Master Plan and its Future Vision (2018-2021) as a livable city, a center of commerce and investment of the Greater Mekong Sub Region. It is an extension from the previous study of Udonthani Land Use Master Plan and its Future Vision in 2010 as stated that Udonthani will be the center of administration offices, educational, commercial, transport activities of the upper North East of Thailand.

At the beginning, Udonthani will become a center of trade, commerce, and investment with highly mixed land use such as residential, government offices, academic institutions, and light industrial. Buildings are also planned to be mixed-use such as residential, commercial, and office buildings in order than a development of a compact city can be achieved. To encourage the diversity of all these activities, the Consultants determined proportions of area allocation for pedestrians and cyclists and also for accessibility to public transport. Such area will consist of residential, office, retail and service spaces with an emphasis to vertical land use for both single or cluster development.

The Consultants also initiate a mixed use development for a pilot project in Udonthani and activity centers in the vicinity as they should encourage vertical development for a mixed use of residential, commercial, retail, and open public spaces for communities within the vicinity of mass transit stations.

1) Area 1: TOD around UD Town, Udonthani Rail Station, and Central Plaza Udonthani (Activity Center)

Area 1 will be mixed use and allocated for residential and commercial development with accessibility to the existing and future transport facilities for a good quality of life to all urban dwellers. Proportions of land allocation are 50% for commercial space, 20% for office space, 20% for public space and 10% for recreation on 13 Rai as shown in **Figure 4.3-1**.

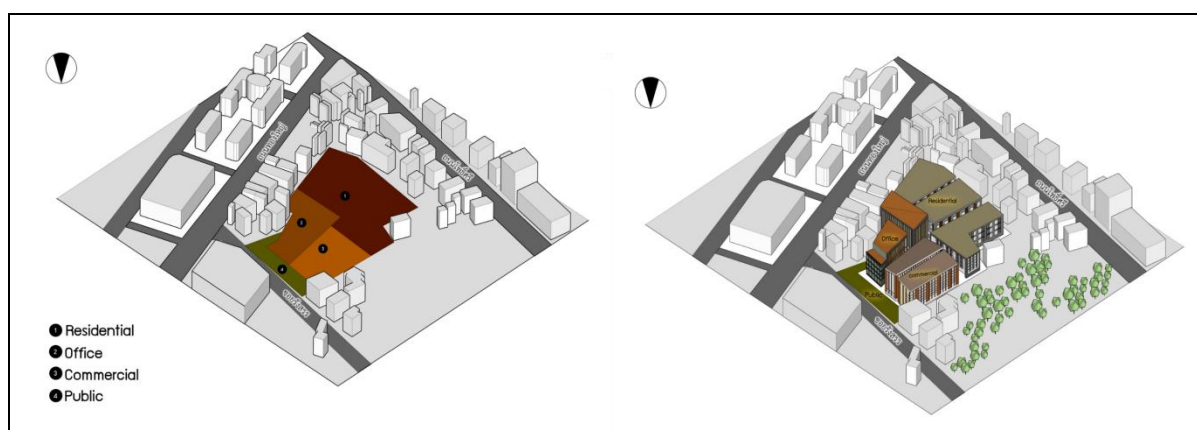


Figure 4.3-1: Land Use Plan and Allocation (Area 1)

2) Area 2: Development of Special Activity Center (Udonthani Rail Station)

Area 2 will also be mixed use and allocated for residential and commercial development with accessibility to the existing and future transport facilities for a good quality of life to all urban dwellers with a park and ride building for public transport commuters. Area 2 is divided into 2 smaller areas, 8 Rai (80%) area and 2 Rai (20%) area, respectively.

Proportions of land allocation of the first area are 50% for commercial space, 30% for office space, 10% for public space and 10% for **recreation**. Land allocation of second area will be 100% solely for a park and ride building as shown in **Figure 4.3-2**.

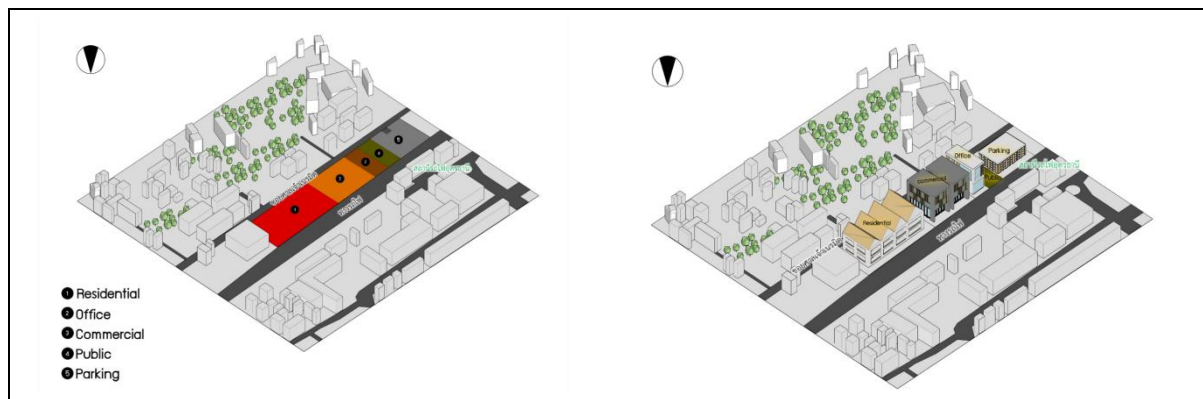


Figure 4.3-2: Land Use Plan and Allocation (Area 2)

3) Area 3: Development of City Center (Udonthani Penitentiary)

Area 3 will also be mixed use and allocated for commercial, residential, and office development. Proportions of land allocation of area 3 are 40% for commercial space, 30% for office space, 20% for public space and 10% for **recreation** on 24 Rai as shown in **Figure 4.3-3**.

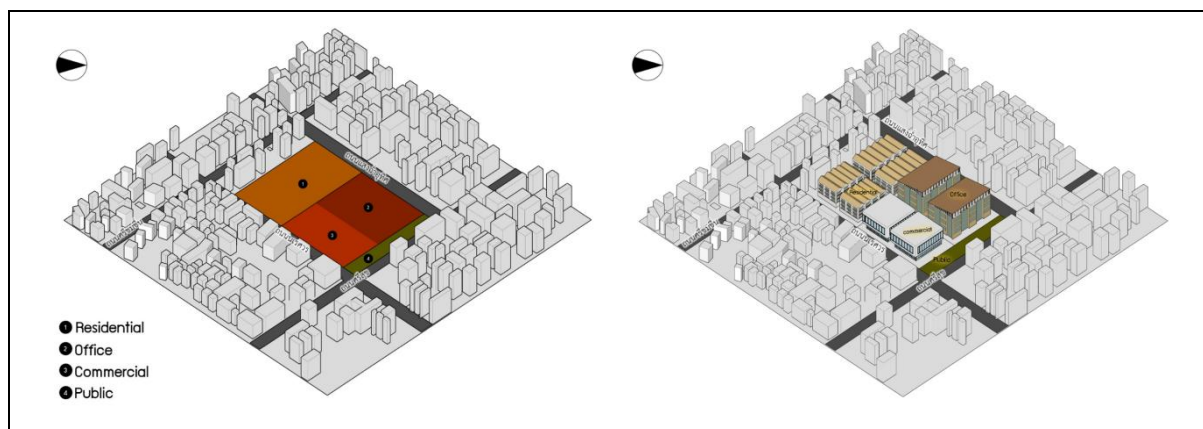


Figure 4.3-3: Land Use Plan and Allocation (Area 3)

4.4 Transit Oriented Development with Park and Ride Facilities

4.4.1 Area and Land Allocation of TOD and Park and Ride Facilities

There are 3 locations for TOD as follows:

1. UD Town, Udonthani Rail Station, and Central Plaza Udonthani
2. The vicinity around Udonthani Rail Station
3. Udonthani Penitentiary

Each location has its own importance to the future land use and transport facilities in order to achieve integrated public transport service and land development around mass transit stations.

The Consultants has summarized land use and proportions of allocation for all 3 locations as shown in **Table 4.4.1-1**.

Table 4.4.1-1: Proportion of Mixed Use Allocation

Type	Mixed Use	Proportions (%)
➤ Activity Center	- Group of retail, commercial, office for large area - Social service and facilities - Large housing, community activity, and open public space - Vertical development next to footpath	- Residential 50% - Commercial 20% - Office Building 20% - Public Space/ Recreational Space 10%
➤ City Center	- High density office buildings - Stores and commercial as main destination - High density housing, community activity, and open public space - Entertainment & recreation - Vertical development next to footpath	- Residential 40% - Commercial 30% - Office Building 20% - Public Space/ Recreational Space 10%
➤ Special Activity Center	- Specific land use for transport; intermodal transfer, park & ride - Residential area with significance to local population, local communities, and local activities. - Shops and services	- Residential 50% - Commercial 30% - Office Building 10% - Public Space/ Recreational Space 10%



4.4.2 Transit Oriented Development Plan

Table 4.4-2-1: TOD and Park and Ride Plans

no	Project	Quantity	Investment Costs in 2019 (M Baht)	Phase 1 (7 year plan)		Phase 2 (13 year plan)	
				Urgent Plan (3 Years)	Year 4-7	Year 8-12	ระยะปีที่ 13-20
				(2020-2022)	(2023-2026)	(2027-2031)	(2032-2039)
Target 2: A new standardized public transport system with great efficiency and adequate service quality to all commuters							
Strategy 2: Development of a standardized public transport system with great reliability and service quality							
1	Development of Park and Ride	6 locations	175.24				
Target 3: A state of art technology, reducing travel costs, energy consumption, and environmental friendliness							
Strategy 3: Development of a mass transit system with a state of art technology with greater accessibility, reducing travel costs, energy consumption, and environmental							
1	A feasibility study of the optimum fare system and e ticketing	1 project	50.00				
2	Transport Oriented Development (TOD)	3 locations	6,753.00				
	2.1 UD Town, Udontani SRT Station, Central Plaza Udonthani		2,356.00				
	2.2 Udontani SRT Station		1,053.00				
	2.3 Udonthani Penitentiary ²⁾		3,344.00				



Park and ride is designed primarily for public transport commuters traveling along the corridor.

There are 6 planned park and ride locations.

1. Park and Ride at Udonthani Rail Station

Access to this park and ride can be achieved from Nittayo – Por Sri Road then thru Soi San Chao Neramitr. It is a 4 story building with the maximum capacity of 355 cars, 60 motorcycles.

2. Park and Ride at 2nd Bus Terminal

Access to this park and ride can be achieved from Highway no 216 adjacent to 2nd Bus Terminal. It is an at grade parking with the maximum capacity of 164 cars, 62 motorcycles.

3. Park and Ride at Labor Court

Access to this park and ride can be achieved from Nittayo Road. It is an at grade parking with the maximum capacity of 268 cars, 147 motorcycles.

4. Park and Ride at Udon Thani Rajabhat University Station (Sam Phrao Center)

Access to this park and ride can be achieved from Highway no 2410. The area opposite the Udon Thani Rajabhat University. It is an at grade parking with the maximum capacity of 150 cars, 82 motorcycles.

5. Park and Ride at Nakha Market Station

Access to this park and ride can be achieved from Mitraphap Road. It is an at grade parking with the maximum capacity of 100 cars, 60 motorcycles.

6. Park and Ride at Yutthasilp Prasit Camp Station

Access to this park and ride can be achieved from Mitraphap Road adjacent to Yutthasilp Prasit Camp. It is an at grade parking with the maximum capacity of 103 cars, 50 motorcycles.

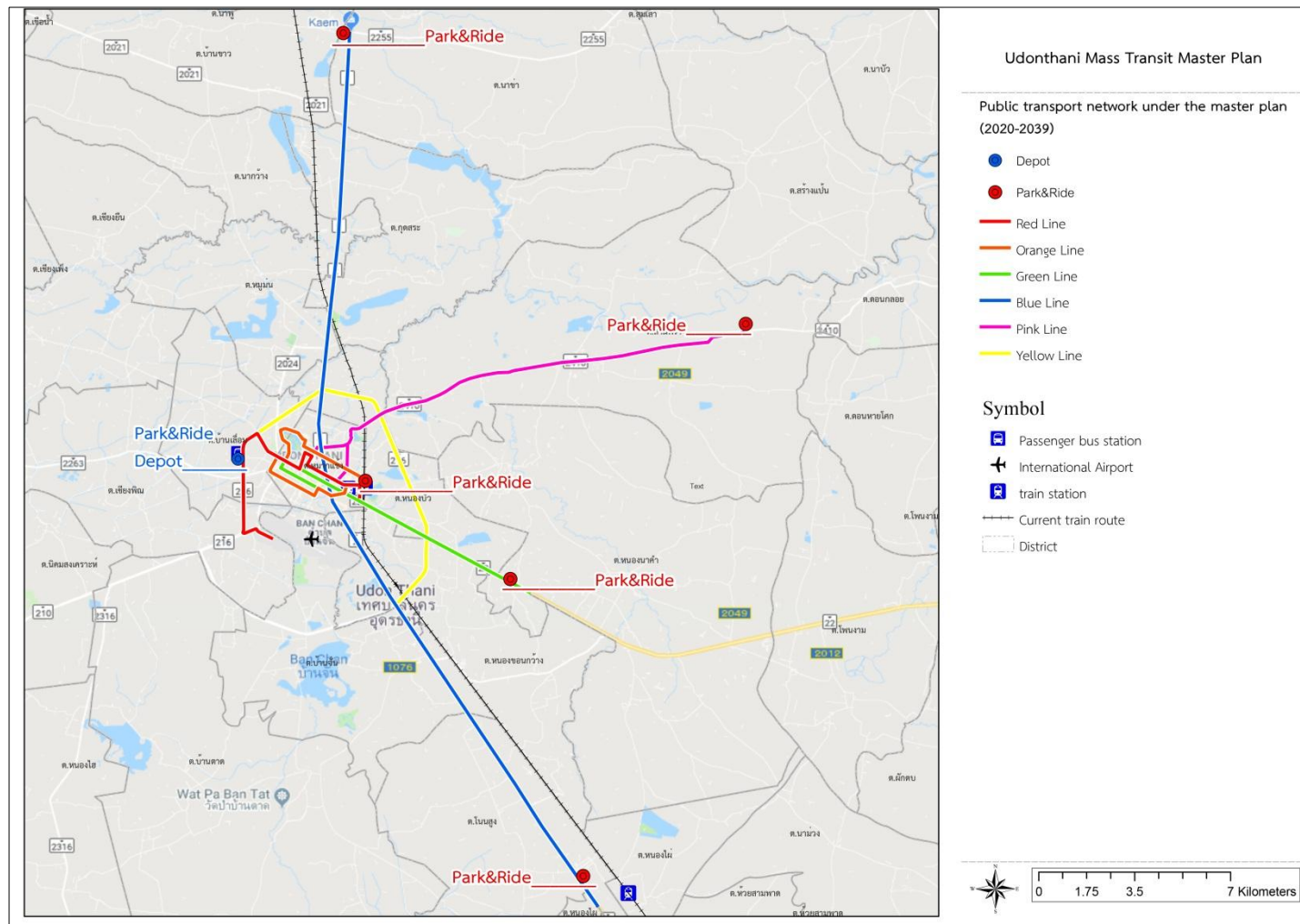


Figure 4.4.2-1 : Park and Ride

Chapter 5

*Summary of Udonthani Mass Transit Master Plan,
Transport Oriented Development (TOD) Plan,
Park and Ride Facilities, and Traffic Management Plan*



Chapter

5 Summary of Udonthani Mass Transit Master Plan, Transport Oriented Development (TOD) Plan, Park and Ride Facilities, and Traffic Management Plan

The implementation of Udonthani Mass Transit Master Plan includes a development of a mass transit network, Transport Oriented Development (TOD) in the vicinities of the new mass transit stations, park and ride facilities, and Traffic Management Plan as follows.

5.1 Vision

Vision: Udonthani mass transit will accommodate the future transport demand with greatest efficiency, mobility, and safety.

5.2 Mission

Mission: Udonthani mass transit system will serve all commuters, encourage the use of public transport system, reduce car dependence and traffic congestion, and offer a sustainable development of Udonthani City.

5.3 Targets

There are 3 Targets:

- 1) A new public transport system will cover large coverage area, connecting to other transport modes in Udonthani.
- 2) A new public transport system will offer a reliable, sufficient, and efficient service to all commuters.
- 3) A new public transport system will offer commuters travel safety with the state of art technology, reducing transport costs. It will act as a new environmental friendly mode of transport as a goal to reduce the carbon footprint.



5.4 Strategy

There are 4 strategies:

1) **Strategy 1: Develop a Mass Transit Master Plan for Udonthani urban area with intermodal transport facilities.**

Strategy 1 will support “Objective 1” as a new transport master plan will provide a sufficient service for the city in association to Udonthani land development in the future.

- To create a new and sufficient public transport service along travel corridors with excellent accessibility.
- To facilitate all intermodal transport activities for the existing 2 bus terminals, Udonthani SRT station, and the Udonthani International Airport with a full integration to other public transport services in the city and any other transport facilities in the future.
- To create economic benefits from the reduction of private transport use, traffic congestion, energy consumption, and greenhouse emission. Hence this will further create a new opportunity for urban development, commerce and investment to all those economic and social activities with greater efficiency.

● **Project Implementation Plan**

Project Implementation Plan based on “Strategy 1” will associate with a new development of an extensive mass transit network in Udonthani with intermodal facilities to maximize transport efficiency. This includes an investment plan for 6 new mass transit routes with the total distance of 100.55 km as follows:

- | | |
|------------------------------|--------------------------|
| ○ Red Line (Electric Bus) | total distance 10.80 km. |
| ○ Blue Line (Electric Bus) | total distance 34.50 km. |
| ○ Green Line (Electric Bus) | total distance 13.10 km. |
| ○ Orange Line (Electric Bus) | total distance 9.80 km. |
| ○ Pink Line (Electric Bus) | total distance 19.45 km. |
| ○ Yellow Line (Electric Bus) | total distance 12.90 km. |

● **Indices/Measures**

- An Increase in number of annual ridership in percentage based on recent transport statics.



2) **Strategy 2: Development of a reliable, sufficient and efficient mass transit service to all commuters.**

- **Strategy 2** supports “Objective 2” as it will elevate the quality of public transport service via a new public mode with new transfer facilities such as bus stations and stops/transfer nodes/ new facilities for children, elderly and handicapped people with enhanced safety measures for public transport travel. This will create equity to all commuters and it will be a new transport attraction in the city.

- **Project Implementation Plan**

Project Implementation Plan based on Strategy 2 will associate with a new transport facility development in Udonthani in order to create better accessibility and mobility. This includes an investment plan for 6 new park and ride facilities as follows:

- Development of park and ride facilities in the vicinities of 1st Udonthani Bus Terminal connecting Udonthani SRT station.
 - Development of park and ride facilities in the vicinities of 2nd Udonthani Bus Terminal.
 - Development of park and ride facilities in the vicinities of Blue Line.(North)
 - Development of park and ride facilities in the vicinities of Blue Line. (South)
 - Development of park and ride facilities in the vicinities of Green Line.
 - Development of park and ride facilities in the vicinities of Pink Line.
- **Indices/Measures**
 - An increase in the number of park and ride users.
 - A reduction in accidents.
 - An Increase in number of annual ridership in percentage from specific groups of commuters (children, elderly and handicapped people).



3) **Strategy 3: Development of a state of art public transport system with greater accessibility, offering a good service quality, energy saving, and environmental friendliness.**

- **Strategy 3** supports Objective 3 as it will provide a **new state of art** public transport system and facilities for environmental friendliness for a sustainable urban development. As it emphasizes on a new IT technology to facilitate a new intermodal movement. A new electrical bus service with an integrated ITS (Intelligent Transportation System) will be a new sustainable transport mode of travel, hence reducing our dependence on internal combustion engines and also traffic congestion.
- **Project Implementation Plan**

Project implementation plan will be based on Strategy 3 as it emphasizes on the development of ITS and intermodal transfer facilities. The system will provide route information such as time table (arrival/departure time), locations of bus in service and bus stations. This includes the future use of e ticketing system as it will offer time and money management and it also encourages a new urban development around bus station (TOD), intermodal transfer facilities which results in economic growth.

There are 2 projects associated with the implementation plan.

- Project 1: A feasibility study of the optimum fare system and e ticketing. Including the use of information technology in public transport.
- Project 2: Transport Oriented Development (TOD) in the vicinity of
1) UD Town, Udonthani SRT station, and Central Plaza Udonthani. 2) Area of Udonthani SRT station 3) Udonthani Prison Area
- **Indices/Measures**
 - Reducing number of complaints concerning public transport service with new follow up measures from transport agencies in Udonthani.
 - Increase in efficiency in fuel consumption as stated in passenger km travel with new follow up measures from transport agencies in Udonthani.



4) **Strategy 4:** Traffic Management Plan in Udonthani and surroundings

The new mass transit system will be implemented together with Traffic Management Plan in the urban area as it will increase transport efficiency in the daily commute, enhance travel speed and safety for all transport modes. Reducing of environmental impacts shall followed with a new transport mode will attract more commuters in the future.

- **Project Implementation Plan**

Strategy 4 will emphasize on Traffic Management Plan in order to increase network efficiency in Udonthani as it also increases efficiency, reliability, and travel speed for public transport service. The projects are:

- One way traffic management
- Forbidden Zones for motorcycle parking
- Improvements of quality of footpath

- **Indices/Measures**

- Increase travel speed
- Decrease delay at intersections
- Increase in number of pedestrians

5.5 **Project Plan**

Udonthani master plan, including park and ride plan, facility design, and Traffic Management Plan for an efficient and sustainable traffic solution associated to the aforesaid visions and strategies in this chapter consist of 20 year plan from 2020-2039 as follows:

- The First 7-Year Plan (2020-2026): It has 2 stages; the urgent plan from 2020-2022 (year 1-3) and the 2nd plan from 2023-2026 (year 4-7).
- The Second 13-Year Plan (2027-2039): It also has 2 stages; the 1st plan from 2027-2031 (Year 8-12) and 2nd plan from 2032-2039 (Year 13-20) as shown in **Table 5.5-1**



Table 5.5-1: Summary of the master plan for the development of public transportation in Udonthani Plan 20 years

no	Project	Quantity	Plan (20 years)				Investment cost (million baht)				The responsible agency	
			Phase 1 (7 year plan)		Phase 2 (13 year plan)		Phase 1 (7 year plan)		Phase 2 (13 year plan)			
			Urgent Plan (3 Years)	Year 4-7	Year 8-12	Year 13-20	Urgent Plan (3 Years)	Year 4-7	Year 8-12	Year 13-20		
			(2020-2022)	(2023-2026)	(2027-2031)	(2032-2039)	(2020-2022)	(2023-2026)	(2027-2031)	(2032-2039)		
Target 1: Public transport system will cover large coverage area, connecting to other transport modes in Udonthani.												Department of Land Transport / Local administrative organization in Udonthani province
Strategy 1: Develop a Mass Transit Master Plan for Udonthani City with intermodal transport facilities for all modes of transport.												
1	Udonthani Mass Transit Master Plan 1)											
	1.1 Red Line	10.80 km.					394.03			662.05		
	1.2 Orange Line	9.80 km.					179.82		47.50	355.92		
	1.3 Blue Line	34.50 km.						307.63		766.95		
	1.4 Green Line	13.10 km.						377.10		233.63		
	1.5 Pink Line	19.45 km.						271.56		289.38		
	1.6 Yellow Line	12.90 km.							112.45	41.87		
	Total	100.55 km.					573.85	956.29	159.95	2,349.80		
2	Depot	1 location					562.14					
3	Revision of Feasibility Study of Tram/LRT System	1 project								50.00		
Target 2: A new standardized public transport system with great efficiency and adequate service quality to all commuters.												Department of Land Transport / Local administrative organization in Udonthani province
Strategy 2: Development of a standardized public transport system with great reliability and service quality.												
1	Development of Park and Ride	6 locations					249.35	31.35				
Target 3: A state of art technology, reducing travel costs, energy consumption, and environmental friendliness.												
Strategy 3: Development of a mass transit system with a state of art technology with greater accessibility, reducing travel costs, energy consumption, and environmental.												
1	A feasibility study of the optimum fare system and e ticketing	1 project					50.00					
2	Transport Oriented Development (TOD)	3 locations										
	2.1 UD Town, Udontani SRT Station, Central Plaza Udonthani						2,356.00					
	2.2 Udonthani SRT Station							1,053.31				
	2.3 Udonthani Penitentiary ²⁾								1,672.00	1,672.00		
Strategy 4: Traffic Management Plan in Udonthani and surrounding areas											Department of Land Transport /Local administrative organization in Udonthani province	
Strategy 4: In accordance to the Master Plan and providing traffic solution for Udonthani												
1	Traffic Management Plan eg improvements of pavement and footpath, park & ride area	3 projects										
	1.1 Urgent Plan						364.49					
	1.2 Medium Plan							367.87				
	1.3 Long Term Plan								278.17			
Investment Costs 2020-2039 (Million Baht)							4,155.83	2,408.82	2,110.12	4,071.80		
Investment Costs (Phase 1 and 2)							6,564.65		6,181.92			
Investment Costs (20 Years)							12,746.57					

Remark. 1) Investment costs are construction cost, M & E cost, rolling stock procurement costs, Detail design fee and preparation fees before (Initial Investment Cost)

— — — — — Purchase cost of the train and additional system work during service opening to accommodate additional passengers

2) Further detailed study for TOD around Udonthani Penitentiary as it is a state agency

Table 5.5-2: Project plan for the development of public transportation in Udonthani Plan 20 years

no	Project	Plan (20 years)																							
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039			
Target 1 : Public transport system will cover large coverage area, connecting to other transport modes in Udonthani.																									
Strategy 1 : Develop a Mass Transit Master Plan for Udonthani																									
1	Udonthani Mass Transit Master Plan 1)																								
	1.1 Red Line	2	3	4	5	6																			
	1.2 Orange Line																								
	1.3 Blue Line																								
	1.4 Green Line				4	5	6																		
	1.5 Pink Line																								
	1.6 Yellow Line								4	5	6														
2	Depot					4	6																		
3	Revision of Feasibility Study of Tram/LRT System														1										
Target 2 : A new standardized public transport system with great efficiency and adequate service quality to all commuters.																									
Strategy 2 : Development of a standardized public transport system with great reliability and service quality.																									
1	Development of Park and Ride	2	3	6																					
Target 3 : A state of art technology, reducing travel costs, energy consumption, and environmental friendliness.																									
Strategy 3 : Development of a mass transit system with a state of art technology with greater accessibility, reducing travel costs, energy consumption, and environmental.																									
1	A feasibility study of the optimum fare system and e ticketing			1	5	6																			
2	Transport Oriented Development (TOD)																								
	2.1 UD Town, Udontani SRT Station, Central Plaza Udonthani	2	3	4	6																				
	2.2 Udonthani SRT Station	2	3		4	6																			
	2.3 Udonthani Penitentiary2)					2	3	4	6																
Strategy 4 : Traffic Management Plan in Udonthani and																									
Strategy 4 : In accordance to the Master Plan and providing																									
1	Traffic Management Plan eg improvements of pavement Traffic management, One way, etc.																								
1.1	Urgent Plan																								
	Improvements of footpaths conditions along the red line and orange line bus transit corridors	2	3	4	6																				
	Improvements of road conditions along the red line and orange line bus transit corridors																								
	Pedestrian crossings conditions along the red line and orange line bus transit corridors																								
	One way Street and Bus lane																								
	Traffic sign on the road network route along the route around the station 500 - 1000 meters																								
	Traffic signs and A new ITS																								
	CCTV and service center for controlling and solving traffic problems																								
	Bicycle route in Udonthani along the public transportation and One-way route																								
	Solving traffic problems at the intersection by traffic Signal Setting																								
	New street lighting in Udonthani Urban Area																								
	Building cooperation with educational institutions in narrowing traffic discipline of students.	7																							
	Public relations and provides concerning in traffic laws.																								
	Training authorities and staffing involved in traffic using and supervision measures																								



no	Project	Plan (20 years)																				
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
	Providing spaces area for people affected by streets trade and stall shops along the route																					
	Motivation and awarded to people who use public transport.																					
1.2	Medium Plan																					
	Improvements of footpaths conditions along the Green line Blue line Pink line and Yellow line bus transit corridors		2	3	4	6																
	Improvements of road conditions along the Green line Blue line Pink line and Yellow line bus transit corridors																					
	Pedestrian crossings conditions along the Green line Blue line Pink line and Yellow line bus transit corridors																					
	Park and ride around of public transport network areas																					
	Car parking Motorcycle parking And bicycle parking spaces on the roadside																					
	Parking and shopping center at Thung Si Mueang area																					
	Extraordinary Transport Systems for all service areas and Control centre																					
	Providing space for those affected by street trade and stall shops Along the route																					
	Improve in the landscape suitable for development in the areas (Red and orange public transport lines)																					
	Development a bicycle network to access the public transport stations.																					
	Promoting the school buses using and staff cars for schools includes government agencies and private sectors	7																				
1.3	Long Term Plan																					
	Development a pedestrian area, Nam Pu Junction Prachaksinlapakhom and the clock tower		2	3	4	6																
	Development of railroad intersection areas In the case of the public development of transportation with rails as a double track train or high speed train																					
	Improvement the landscape suitable with development area (Green Blue Pink and Yellow public transport lines)																					
	Congestion charge system at rush hours																					
	Development a complete pedestrian network for pedestrians.																					
	Development a bicycle network to cover the area.																					
	Routes and traffic systems HOV (High Occupancy Vehicle) lane																					
	Setting up a signaling systems for pedestrians to completely																					

Note.

- Feasibility study
- Detailed design and Prepareing tender documents
- Land acquisition and Property compensation
- Construction
- Testing systems
- Opening
- Implementation of the projects planing