

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

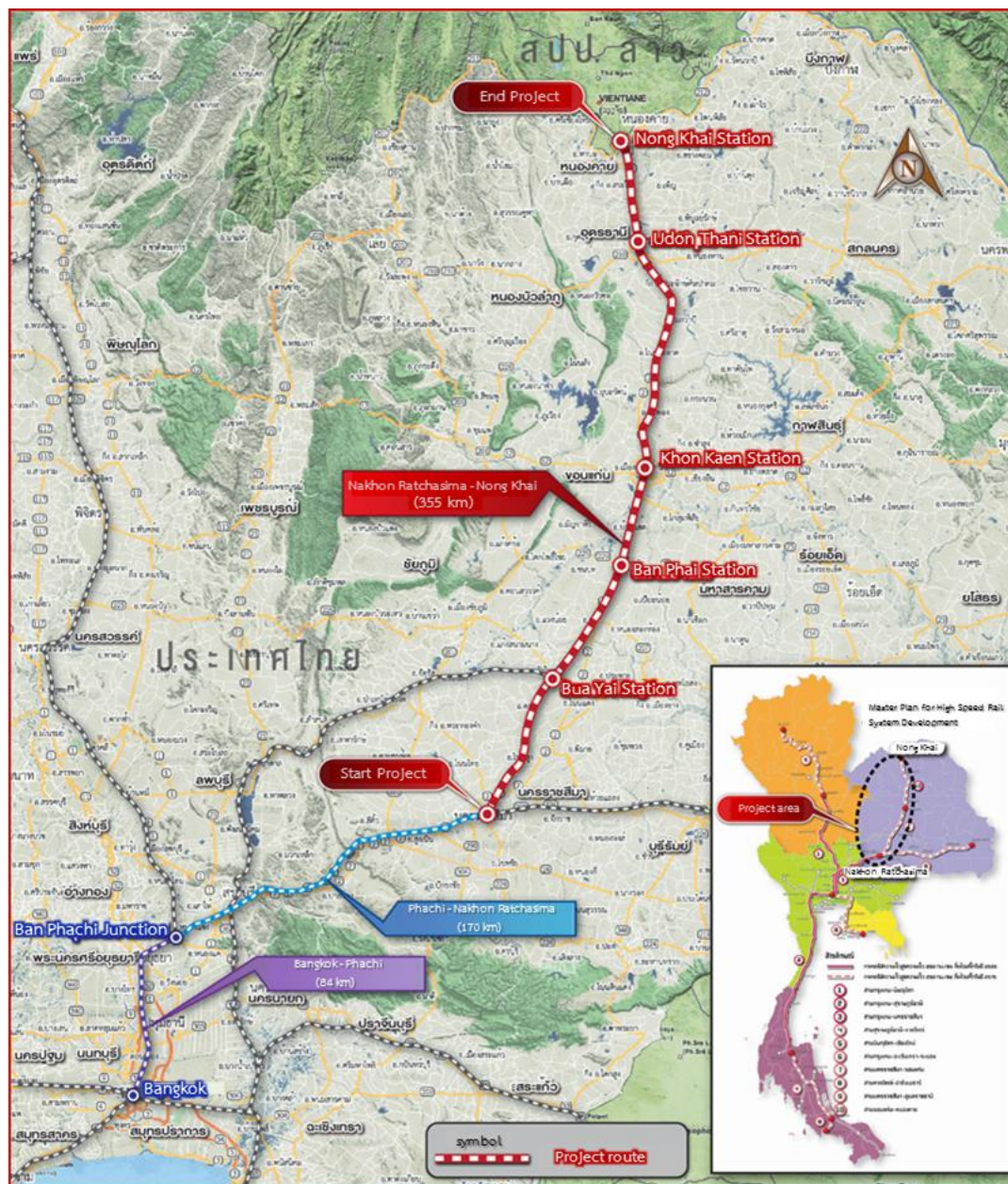
Figure 2.2.1-1: Alignment of the Dual Track Railway from Khon Kaen-Nong Kai

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.

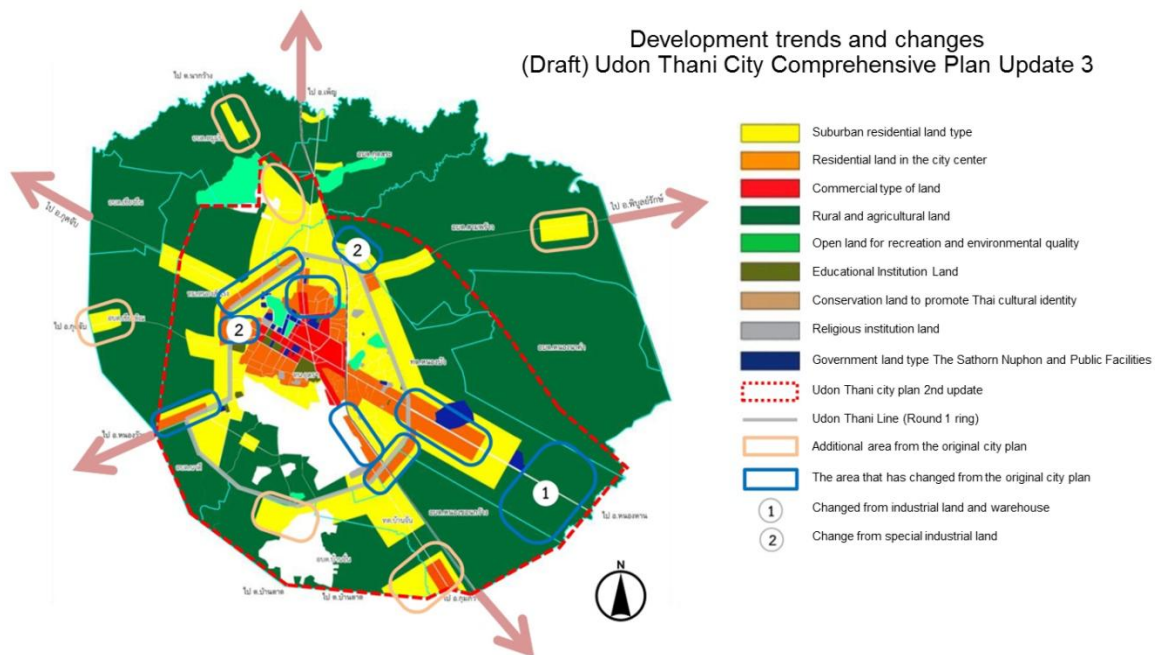


Figure 2.5-1: Land Use Pattern and the Future Trend in Development from the 3rd draft of Udonthani Land Use Report (under Revision)

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

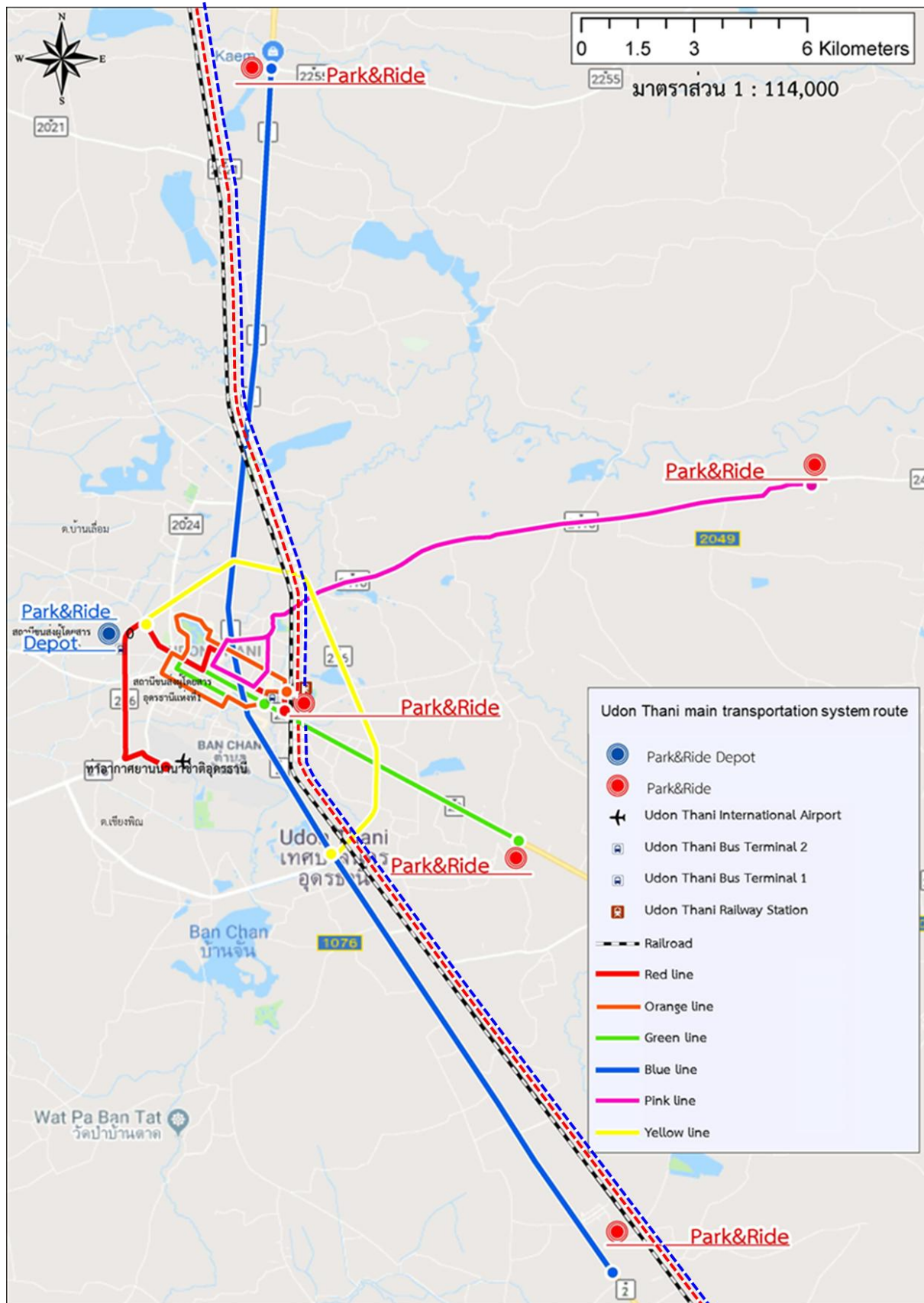
2.7.1 Route Alignment

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

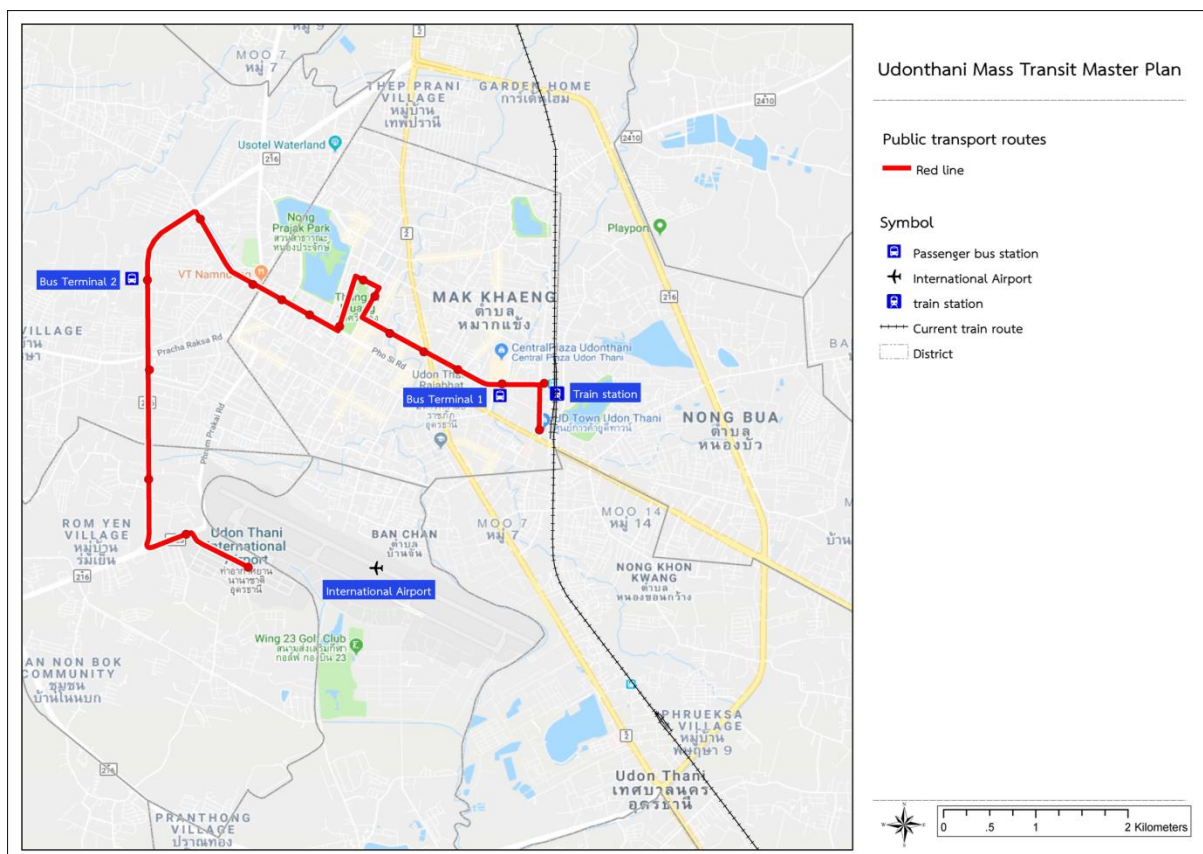
Figure 2.7.1-1: Details of 6 new Mass Transit Lines

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.



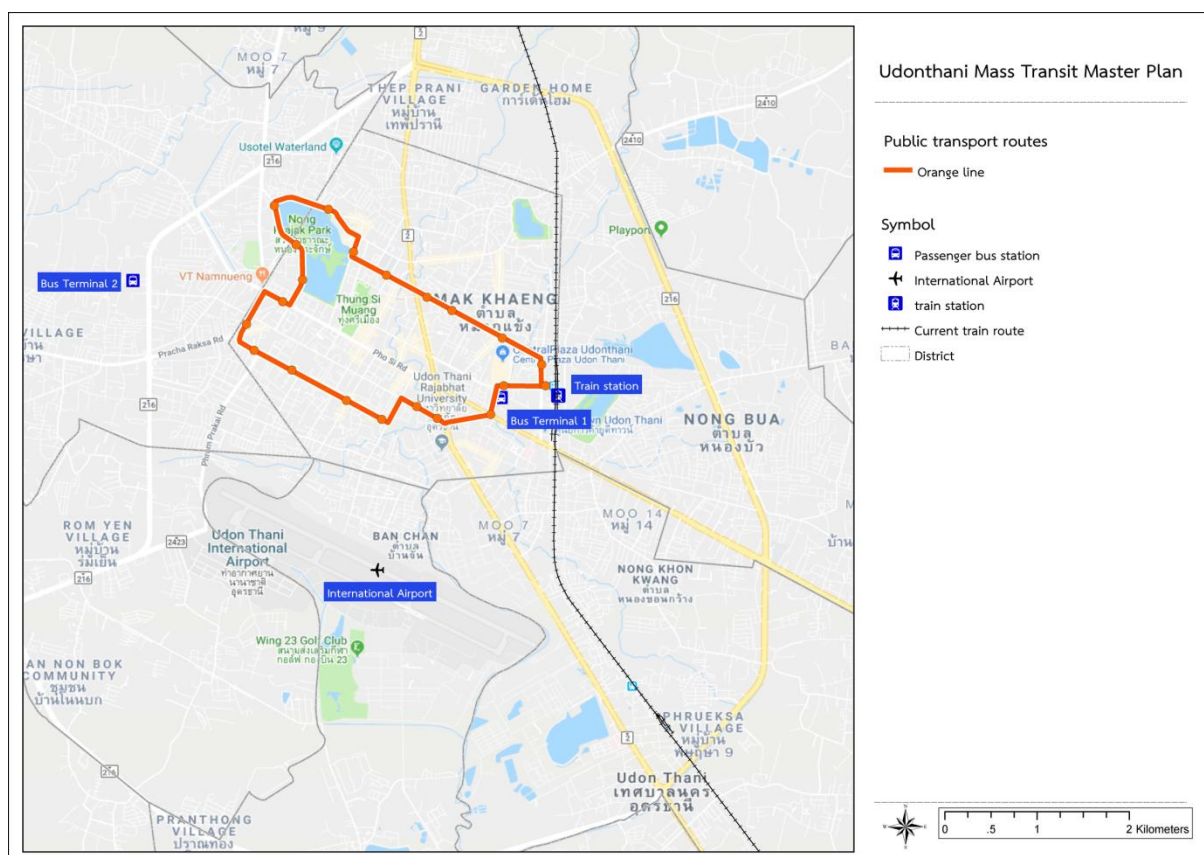
Source: The Consultants

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.



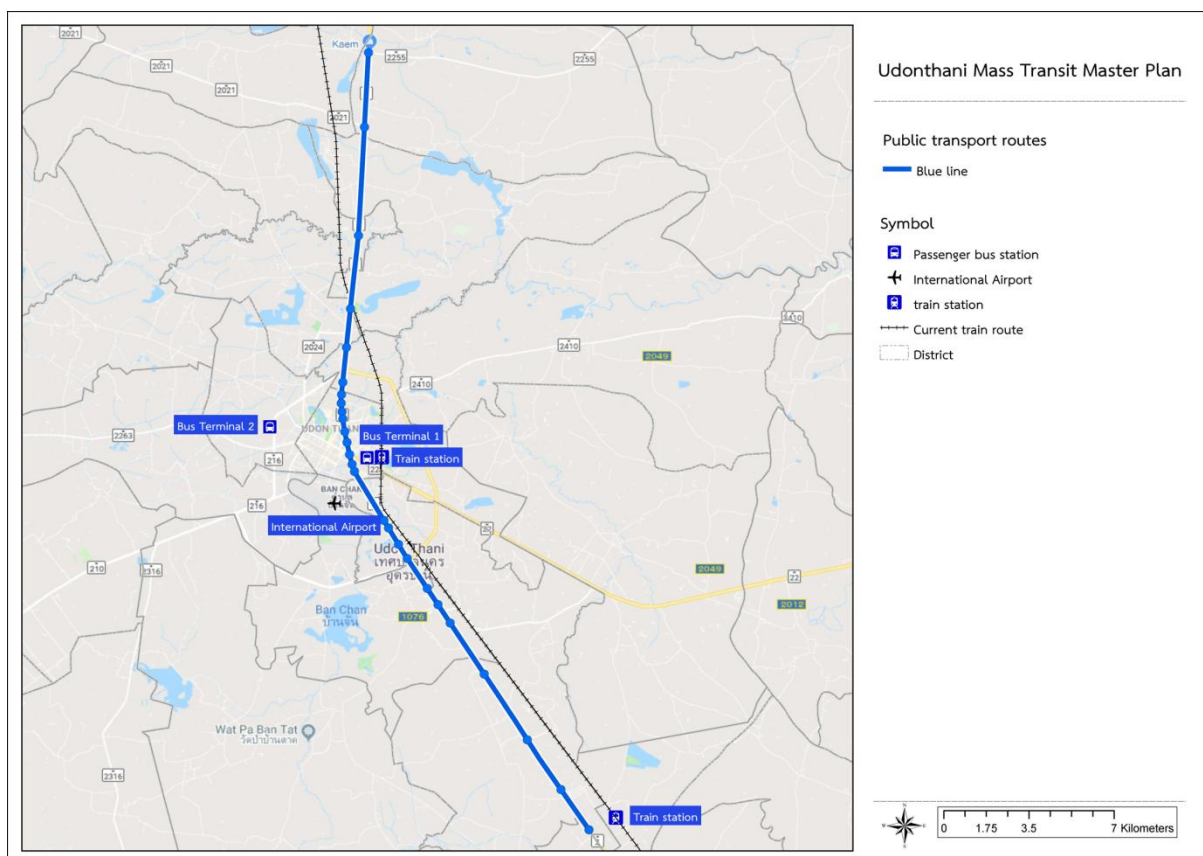
Source: The Consultants

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.



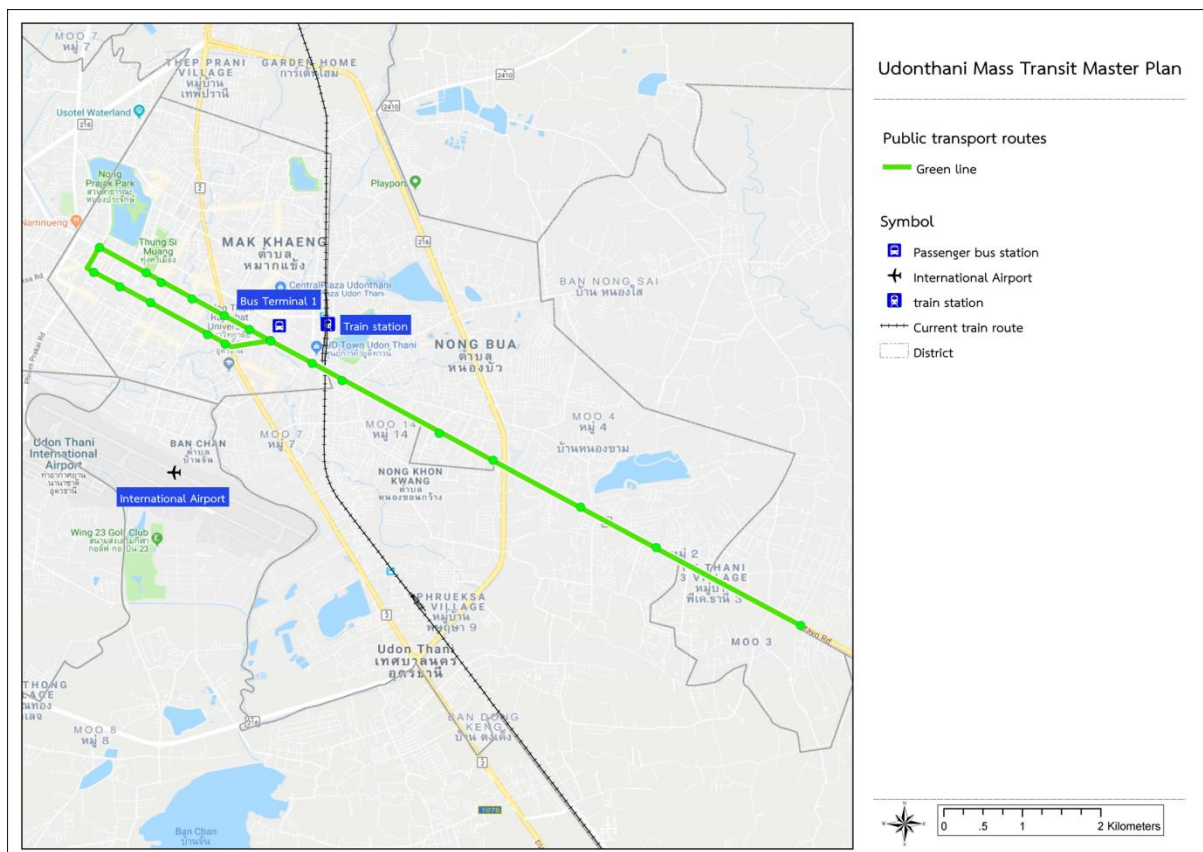
Source: The Consultants

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.



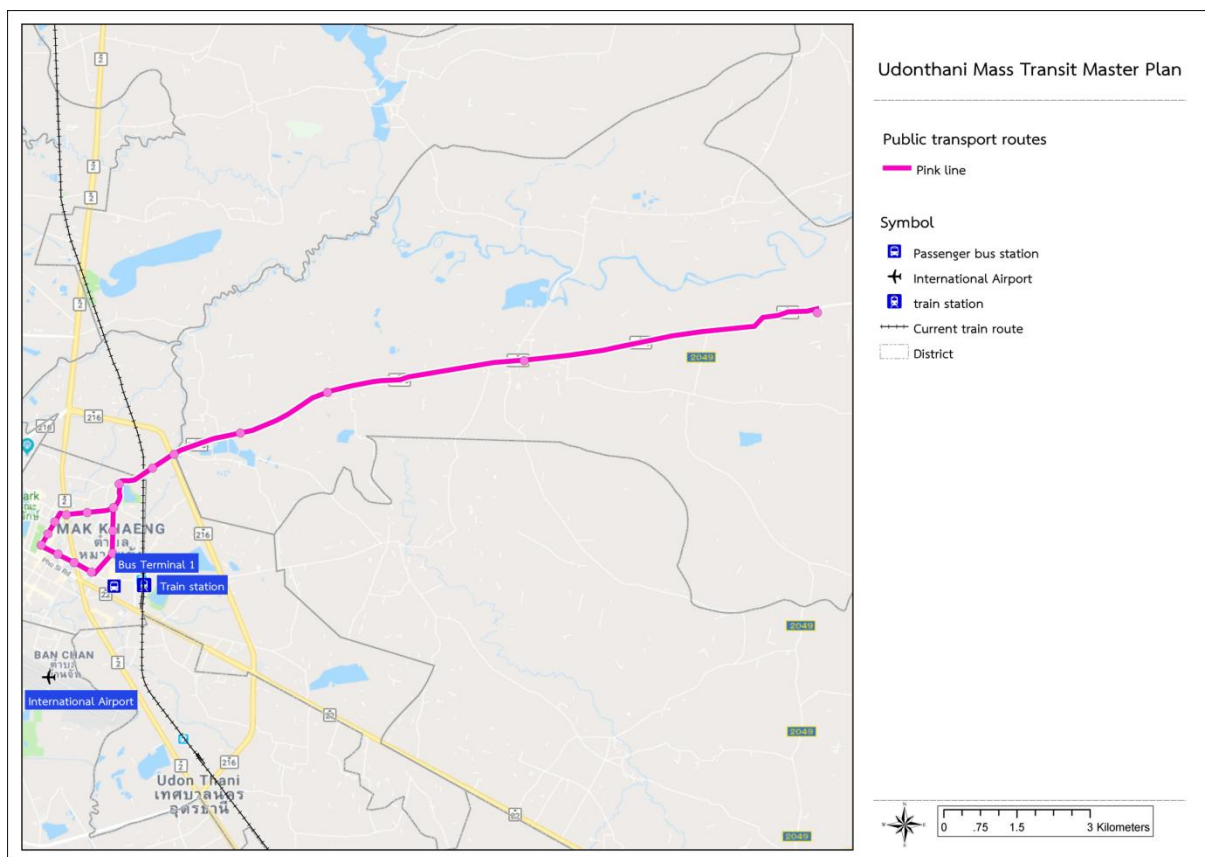
Source: The Consultants

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.



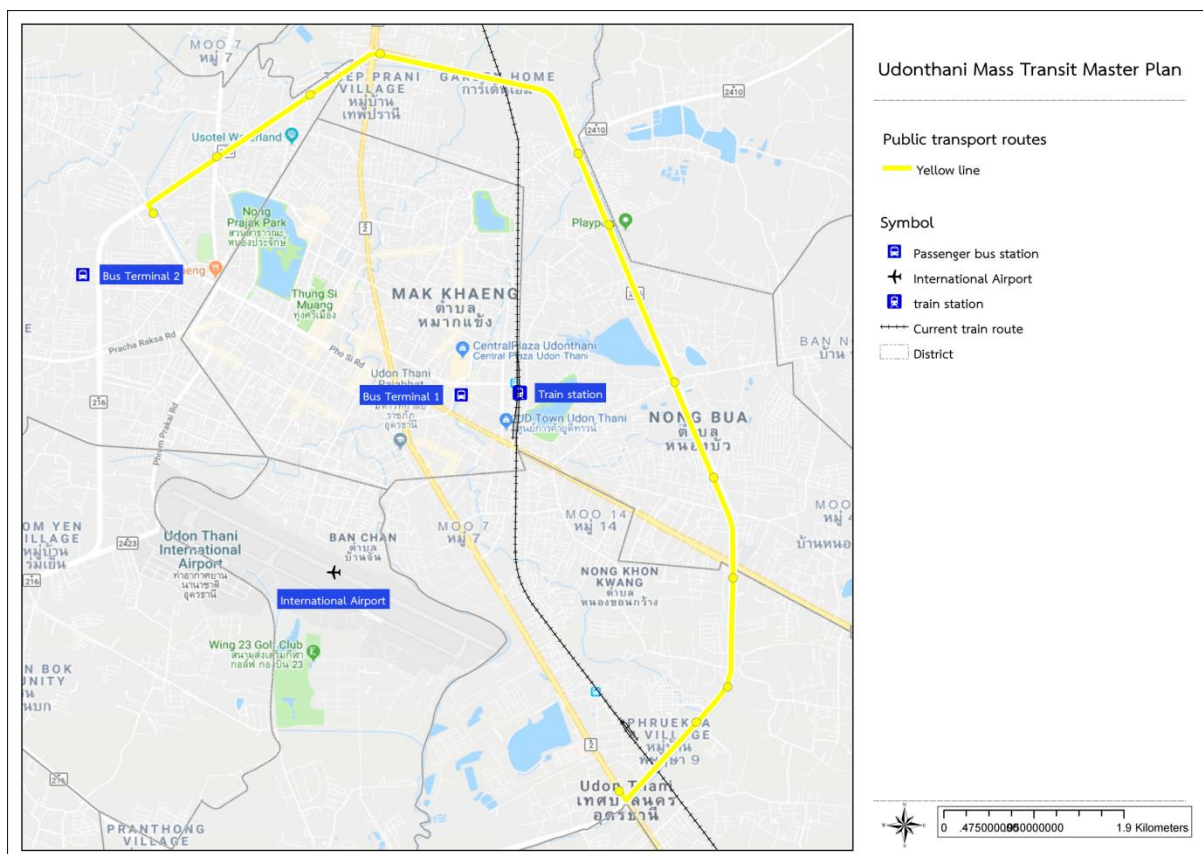
Source: The Consultants

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**.

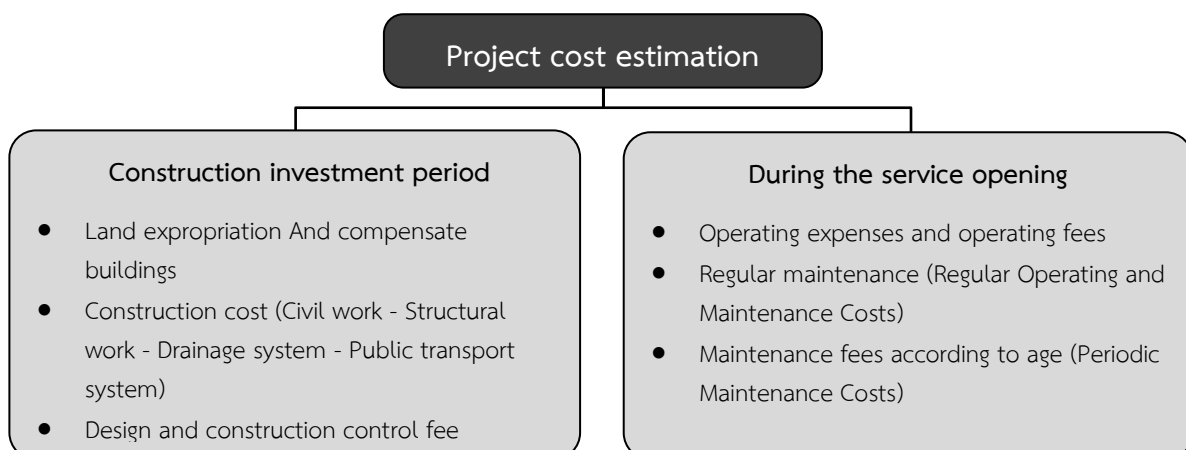


Figure 2.7.4-1: Project Investment Costs

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

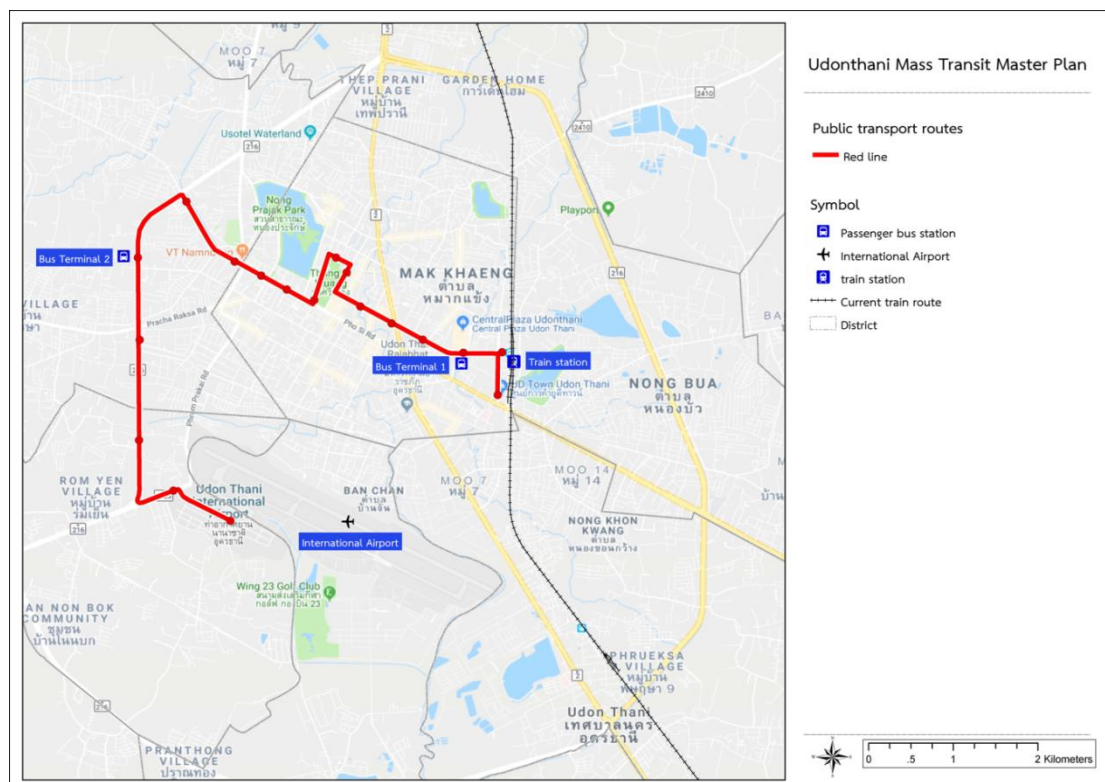
There are 2 new pilots projects in Udonthani. Details in route alignment, investment costs, EIRR, FIRR, EIA, and investment are stated below.

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.

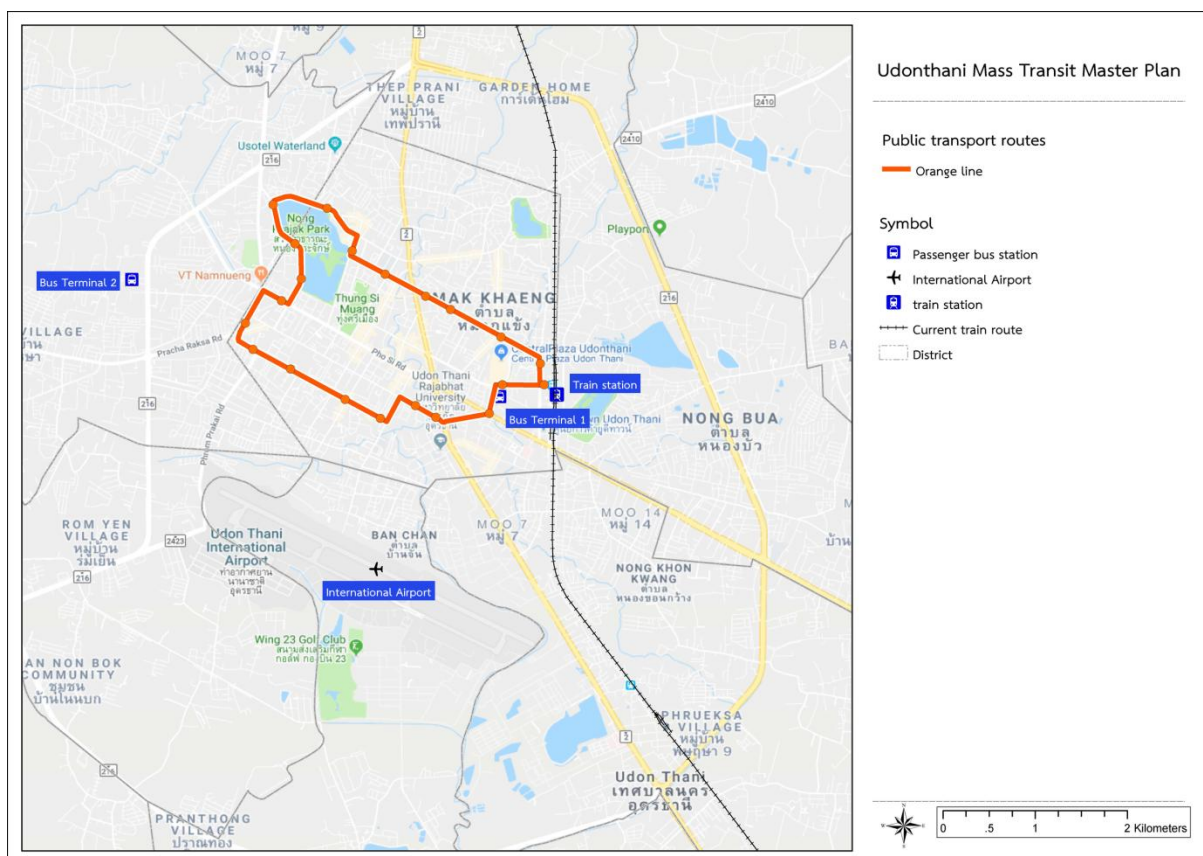


Figure 2.8.1-2: Alignment of Orange Line Electric Bus and its Stations

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.