International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

A Study on Transport Impact Assessment of Vinhomes Grand Park Project, Ho Chi Minh City, Vietnam

Truong Duc Thuat
Ho Chi Minh City University of Transport
2 Vo Oanh Street, Binh Thanh District,
Ho Chi Minh City, Viet Nam.

Nguyen Anh Tuan
Ho Chi Minh City University of Transport
2 Vo Oanh Street, Binh Thanh District,
Ho Chi Minh City, Viet Nam.

Abstract **- This article focuses on transport impact assessment of the urban development projects on the existing transport network. The authors based on current survey data and relevant planning data, thereby building a 4-step transportation planning process, analyzing and assessing transport impacts on the Vinhomes Grand Park Project in Ho Chi Minh City. On the basis of forecasting and analysis results when developing 04 different scenarios, this study has also proposed solutions to improve circulation conditions of major transport routes and intersections when the Vinhomes Grand Park Project comes into operation. Due to current status of the basic transport routes starting to be unstable (level of service D), when additional traffic is generated due to impacts of the Vinhomes Grand Park Project, level of service of these routes will be down to level F. Even the traffic possibility factor is many times higher than that of level of service D. Hence, it is essential to build and expand Nguyen Xien, Nguyen Van Tang and Phuoc Thien roads in accordance with planning to connect to the Vinhomes Grand Park Project synchronously. In addition, it is combined with adding a connection route to Nguyen Xien route (through the bridge over Go Cong canal) and building a new route connecting from Hanoi Highway to the Vinhomes Grand Park Project through the high-tech park.**

Keywords: Vinhomes Grand Park, transport impact, current status, scenarios, solutions

I. INTRODUCTION

A. Theory of transport impact assessment

1) Concept of Transport impact assessment

Transport Impact Assessment (TIA) is a specialized technical study that identifies traffic generating factors that are likely to affect a transportation system. TIA helps to answer these basic questions:

Current transport conditions, expected future transport conditions in case of no urban development is implemented and expected future transport conditions when there is a development project for transport users.

Whether the existing and future planned multimodal transportation system can accommodate the additional traffic volume due to the planned urban development or not.

2) Transport impact assessment process

So as to determine transport impacts affecting to the study area, it is necessary to consider future conditions of the urban construction project, to estimate the possibility of trip generation from the project and determine how to distribute this additional traffic to the regional road network. Scope of this study follows these steps:

(1) Determining purposes and scope of the study.

Determining purposes and study scope of transport impact is to determine the requirements of time, space and study object.

(2) Survey, data collection

In this data collection survey step, to carry out TIA, it is essential to collect data on current traffic volume and current geometry data of the road within the scope of transport impact assessment (defined in step 1).

(3) Calculating and modeling of transport demand

In step 3 of the process, it is necessary to consider at 2 levels which are macro model and micro model.

A typical four-step predictive model in this process is as follows:

+ Step 1: Trip generation model
+ Step 2: Trip distribution
+ Step 3: Modal split
+ Step 4: Traffic assignment

(4) Transport assessment on sections and intersections

Using methods in the Highway Capacity Manual (HCM) in combination with National Vietnamese Standards to calculate and determine level of service at some important locations on the road network around the location of the study area;

With current scenario, re-auditing traffic model compared to the current status, considering error levels, then making adjustments to the current model.

On the basis of the current scenario, making calculations for future scenarios when there is an increase from the project area.

(5) Proposing solutions

Depending on assessment results of the future year, mitigation strategies can be proposed. After proposing solutions to minimize impacts on the subject, the scope, considering whether the requirements are satisfied or not, then making adjustments to the solutions to ensure development requirements for the study area.

3) Transport impact assessment model

The implementation of transport impact assessment is the miniaturization of the four-step model transportation planning process.

In brief, data needed to build the transport demand forecast model include: defining the study area, identifying detailed information about the road network. These data are classified into the following data groups: Study area parameters (boundary, socio-economic characteristics); Parameters of the

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

road network system (length, speed, etc.); Travel characteristics (number of trips, types of vehicles used, etc.); Traffic volume (peak traffic hour on roads).

B. An overview of District 9 in Ho Chi Minh City

District 9 is a district-level administrative unit which is directly under Ho Chi Minh City, now belongs to Thu Duc City of Ho Chi Minh City, located to the east of Ho Chi Minh City, adjacent to the border of Dong Nai Province and is completely surrounded by Dong Nai River, bordering:

East: bordering Bien Hoa City and Long Thanh District, Dong Nai Province;

West: bordering District 2 (now part of Thu Duc City) across Rach Chiec River, Ba Cua Canal and Tan Lap Street;

South: bordering Nhon Trach District, Dong Nai Province across Dong Nai River;

North: bordering Thu Duc District through Hanoi Highway.

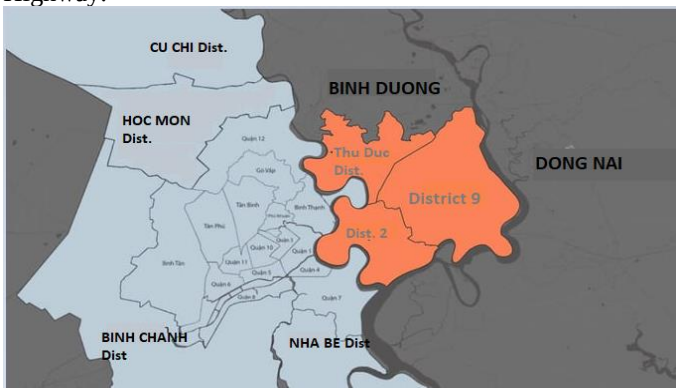

Fig. 1. Location of Thu Duc City of Ho Chi Minh City

1) Natural conditions

District 9 is a district located in the east of Ho Chi Minh City, about 20km from the City center (District 1), therefore, typical natural conditions, climate and meteorology of the City are in the tropical monsoon region, hot and humid all year round, alternately influenced by two main wind seasons which are Northeast and Southwest, and deeply differentiated between the two seasons of the year by rainfall regime.

Hydrological conditions: District 9 in particular and Ho Chi Minh City in general is located in the downstream of Saigon - Dong Nai River basin. District 9 has many large rivers and canals, which are directly influenced by the hydrological regimes of Dong Nai River and Saigon River and influenced by the semidiurnal tidal regime.

2) Socio-economic conditions

a) Population

According to the Statistical Yearbook of the Ho Chi Minh City Statistics Office, population of District 9 as of 2020 (when not yet merged into Thu Duc City) is 310,107 people. Pursuant to the adjusted master plan up to 2020 approved in 2012, the expected population in 2020 is 500,000 people, corresponding to a population density of 44 people/ha [1]

b) Economic development

According to the 2020 socio-economic situation report of the People's Committee of District 9, in the last 5 years, economic structure of District 9 has shifted in the right direction: services - industry, handicrafts – urban agriculture. The average economic growth rate is 110.6%/year, total State budget revenue is about VND 2,268 billion [2]

c) Land use

Pursuant to land use data in 2019 (Decision No. 1072/QĐ-UBND dated November 15, 2021 of the City People's Committee on approving and announcing the results of land area inventory in 2019), total area of District 9 is 11,397 ha. District 9 is one of the developing and newly formed areas, thus, percentage of residential land is not high, population density per area is relatively low compared to other districts, and there are not many long-term residential areas in small alleys [3]

3) Current status of road transport system in District 9

Regarding the road transport system, District 9 has a road transport network that is on the development with main roads, arterial roads connecting inter-districts, connecting Dong Nai Province and especially many roads with high responsibility of transshipment service, playing an important role in the logistics network such as: Nguyen Van Tang, Nguyen Xien, La Xuan Oai, etc. Apart from that, the District has 02 major external routes which are Hanoi Highway and Long Thanh – Dau Giay Expressway.

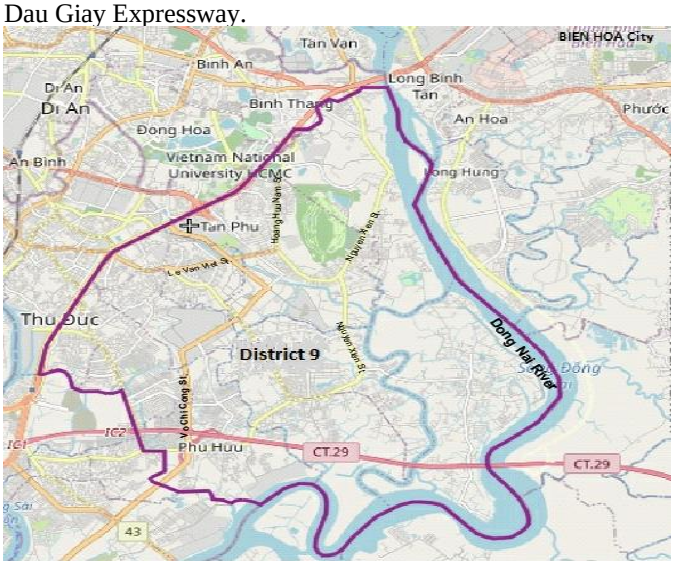

Fig. 2. Transport network in District 9

- External transport routes: With a favorable geographical location, District 9 is a trade gateway connecting neighboring regions and provinces, therefore, there are crucial external routes here such as Hanoi Highway (National Highway 1A).), Ho Chi Minh City - Long Thanh - Dau Giay Expressway, Ring Road 2 which is under construction, and Do Xuan Hop road.

Internal transport routes: District 9 has many internal routes linking inter-wards, connecting with external transport routes and playing an important role in transshipment, logistics network connecting Phuoc Long ports, Phu Huu port, Hi-tech Park, etc., such as Nguyen Duy Trinh, Nguyen Xien, La Xuan Oai roads, etc.

Besides, the roads such as La Xuan Oai, Hoang Huu Nam, etc. are also important internal routes, creating a framework road transport network in District 9. However, the common characteristic of these roads is quite narrow with only 2 lanes and a cross section of 7m - 9m with heavy traffic.

4) Urban spatial development planning

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

According to the approved master plan up to 2020, District 9 has a total area of 11,389.2 ha with the function of a residential, commercial and service area, tourism, culture, training, education and handicrafts area at regional and city level, is part of the City's science and technology urban area.

5) Road transportation planning

With respect to external transport: It is planned to be renovated, expanded and built 6 new external routes, including 2 existing routes: Hanoi Highway (National Highway 52), Hanoi Highway (National Highway 1A) and 4 projected routes: Ho Chi Minh City - Long Thanh - Dau Giay Expressway, Ring Road 2, Ring Road 3, and road connecting to Ring Road 3. Total length is about 46,324 km.

In terms of internal transport: Based on the existing main roads, planning internal road transport routes on the basis of existing main roads is expected to be upgraded and expanded according to the planned building line (roads of Long Phuoc, Nguyen Xien, Nguyen Duy Trinh, Do Xuan Hop, Le Van Viet, La Xuan Oai, Hoang Huu Nam, Nguyen Van Tang, Bung Ong Thoan, Long Thuan, Tam Da, Duong Dinh Hoi, etc.) in combination with the construction of new main roads and inter-regional roads such as extended Long Phuoc road, D1 street, D2 street at high-tech park, extended La Xuan Oai road, extended Bung Ong Thon road, extended Long Thuan road, extended Tam Da road, extended Duong Dinh Hoi road, roads of Long Phuoc 1, 2, 3, 4, 5, riverside road, extended inter-ward road and some other routes. Total length of newly built traffic routes is 250,272 km [4]

C. An introduction of Vinhomes Grand Park Project

Vinhomes Grand Park Project is an urban development project located in Long Binh and Long Thanh My wards, District 9 (now Thu Duc city), invested by Vinhomes Joint Stock Company.

1) Project location

Vinhomes Grand Park Project has a total planned area of 312.12 ha, of which 73.85 ha belongs to Long Thanh My ward and 238.27 ha belongs to Long Binh ward, adjacent to Dong Nai and Tac Rivers, located on the side of Nguyen Xien - Phuoc Thien road.

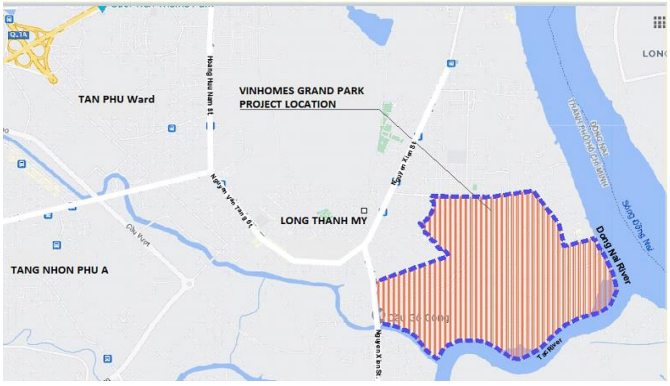

Fig. 3. Vinhomes Grand park Project location

2) Current status of population, land use

Current status of population: The Vinhomes Grand Park project area, when not yet deployed, has a sparse population, not having much impact of urban development.

Current land use status: The planned project area has a total natural area of 312.12 hectares. In which, current status is mainly agricultural land accounting for a high proportion (73%, of which rice land accounts for 51.4%) [5]

3) Land use planning of Vinhomes Grands Park Project

According to the 1/2000-scale zoning planning of Phuoc Thien Residential Area and Park, Long Binh Ward, Long Thanh My ward, the Project is a residential area combined with green parks, public service works and urban green parks.

+ Population: According to the plan, population of the whole Project after its formation is 20,000 people, Population density: 64 people/ha [5]

4) Road transportation planning of Vinhomes Grands Park Project

Vinhomes Grand Park Project is adjacent to 02 main roads, namely Nguyen Xien and Phuoc Thien roads. According to the planning, Ring Road 3 will pass through the Project area. Accordingly, the road transportation network planning for the whole Project area is basically consistent with master plan of District 9, except for expanding Nguyen Xien and Phuoc Thien roads with a width of 30m; planning to build a new Ring Road 3 with a road width of 120.5m; carrying out the extended Long Phuoc with a road width of 40m; connecting road Nguyen Xien - Long Phuoc with a width of 30m and additional regional and internal roads to ensure the connection with external transport.

Pursuant to the approved planning, Nguyen Xien and Nguyen Van Tang roads have a width of 30m with 04 lanes, a median strip, and sidewalks of 7.5m on each side. However, up to the present, these roads have not been built and expanded as planned [5]

II. BUILDING STUDY MODEL FOR TRANSPORT IMPACT ASSESSMENT OF VINHOMES GRAND PARK PROJECT

A. Scope of transport impact study

Vinhomes Grand Park Project is located on two main roads, namely Nguyen Xien and Phuoc Thien.

Scope of study of this thesis determines the scope of transport impact assessment in the thesis, identifies the main object as the section of Nguyen Xien road (section from Phuoc Thien road to Nguyen Van Tang road). Accordingly, assessing potential impacts on the road section and 02 intersections which are Nguyen Xien - Phuoc Thien and Nguyen Xien - Nguyen Van Tang (Go Cong junction).

Fig. 4. Study scope of transport impact assessment

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

B. Survey of existing transport at the study route

Within scope of the transport impact study of Vinhomes Grand Park Project, organizing the survey of current traffic data as an initial database to deploy next steps of the transport impact assessment process includes: Surveying of traffic volume at cross-sections on Nguyen Xien road (section from Nguyen Van Tang road to Phuoc Thien road), Nguyen Xien road (section from Long Thuan T-junction to Nguyen Van Tang) and Nguyen Van Tang road (section from Nguyen Xien to Le Van Viet); Surveying OD (origin, destination) on the route section within the study area.

1) Survey objectives

Survey data serves for determining traffic demand through the route section in the current condition.

2) Survey methodology

The methodology is to collect field data recorded by pre-built forms. Vehicle traffic is counted by manual method. The route has 02 opposite direction lanes of traffic, so the traffic volume should be counted in both 02 directions.

3) Traffic volume survey results

According to the survey results, main traffic routes on the road around the Project area have relatively high traffic volume. In specific, Nguyen Van Tang route (which connects Nguyen Xien with other traffic routes) has over 3,000 motorbikes in rush hour. Beside of large proportion of motorbike traffic, the above routes also have light and medium trucks.

From the results of calculation and conversion, traffic volume on Nguyen Van Tang route is the highest (about 2,250 PCUs), Nguyen Xien road, at the section from Nguyen Xien - Nguyen Van Tang intersection to Phuoc Thien road, has about 1,900 PCUs, the lowest one is Nguyen Xien road, at section from Long Thuan T-junction to Nguyen Xien - Nguyen Van Tang intersection. Vehicle count data accurately reflects actual traffic situation on the existing road network system.

TABLE I. SUMMARY OF PCU COUNTING RESULTS ON THE ROUTES

Converted vehicle type	**Traffic volume after converted** *(Unit: PCU – Passenger car unit)*					
	Nguyen Van Tang (section 1)		**Nguyen Xien (section 2)**		**Nguyen Xien 2**	
	Direction 1	Direction 2	Direction 1	Direction 2	Direction 1	Direction 2
Motorbikes	839	925	866	809	774	739
Cars	79	79	72	50	40	59
Small passenger cars	5	8	3	0	5	5
Large passenger cars	9	9	3	3	3	3
Light and medium trucks	102	93	57	66	57	60
Heavy trucks	0	0	0	0	12	8
Container trucks	0	0	0	0	0	0
Total	**1.034**	**1.113**	**1.001**	**928**	**891**	**874**

C. Building a computational model to forecast traffic volume in the Vinhomes Grand Park Project area

Traffic zoning: it is usually divided based on administrative boundaries, subdivision boundaries, or land use functions such as residential, commercial, healthcare, education, entertainment, etc.

Roads and intersections network: It is built to show characteristics of the roads and intersections in the study model.

1) Traffic areas of Vinhomes Grand Park Project area

The study area is divided into two areas, internal and external based on land use function, main directions connecting to the area. In specific:

(1) internal area includes functional areas of Vinhomes Grand Park Project area. This internal area is divided into 7 traffic zones (corresponding to 06 subdivisions of residential units and 01 subdivision of education and training).

(2) external area includes adjacent areas that are likely to be connected to the study area. This external area is divided into 3 traffic zones:

+ Zone 8: An area with Nguyen Van Tang traffic route connecting to central area of District 9 through Le Van Viet, Hoang Huu Nam, and La Xuan Oai roads.

+ Zone 9: Main route is Nguyen Xien route (section from Nguyen Van Tang - Nguyen Xien intersection to Hanoi Highway). It is a road connecting directly with Vinhomes Grand Park Project area.

+ Zone 10: Main route is Nguyen Xien route, connecting with Nguyen Duy Trinh, Ring Road 2, etc.

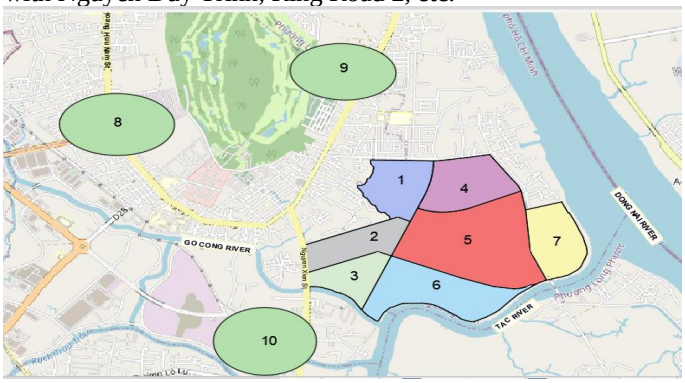

Fig. 5. Traffic zoning map of the study area

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

2) Building of road network

Road network is built based on statistical data of roads in the study area such as length, traffic possibility, speed, starting point and end point, etc.

3) Building of a model of trip generation and attraction

Calculation method used in this step is shown in formula (1).

$$P_i = A_j = S_{GFA} * r \quad (1)$$

In which:

P_i: Number of trips generated

A_j: Number of trips attracted

SGFA: Gross floor area for each type of land use

r: Rate of trip generation [6]

The trip generation coefficient is referenced from "Urban Design Guidelines 2012 - Thu Thiem, Ho Chi Minh City". [7]

Besides, for adjacent areas connected to the study area, using estimated data from actual vehicle count survey data.

4) Building of a trip distribution model

Trip distribution model between regions is built based on the following formula:

$$T_{ij} = P_i * \left[\frac{A_j F_{ij} K_{ij}}{\sum_j A_j F_{ij} K_{ij}} \right] \quad (2)$$

In which:

T_{ij}: Number of trips from zone i to zone j

P_i: Number of trips generating from zone i

A_j: Number of trips attracted to zone j

K_{ij}: Socio-economic adjustment coefficient, (equal to 1).

F_{ij}: Impedance factor.

Principle of balancing the number of trips generated and trips attracted:

$$\Sigma Pi = \Sigma Aj \quad (3)$$

Impedance Factor Fij: Relationship between the trip length distribution and travel costs is represented by the "friction" curve using the following formula:

$$F_{ij} = C_{ij}^{A} exp^{(BCij)} \quad (4)$$

In which:

Cij : Cost of the trip from zone i to zone j

A, B : Calibration constant which is taken as 1

Parameters that are often considered closely related to travel costs are travel time, fuel costs and travel distance. In case of travelling when the traffic volume is not congested, travel time is calculated as the distance divided by the speed. Travel cost in the model is relatively determined as follows:

Travle cost = D_i x VOC

In which

D_i: Travel distance (km)

VOC (vehicle operating cost): consumable cost (operating cost). (VND/km) [6]

Assuming that average vehicle travel 30km/liter, VOC value = 635 (VND/km).

5) Building of a modal split

Using the Binary logit model, in which, this model divides total travel demand into two options: public transport and private transport. Probability of using bus traffic is shown by formula (5).

$$P_{PTij} = \frac{\exp(-\lambda * C_{PTij})}{\exp(-\lambda * C_{CNij}) + \exp(-\lambda * C_{PTij})} \quad (5)$$

In which:

PPT_{ij}: Probability of bus mode between zone i and zone j

CPT_{ij}: General cost of bus mode between zone i and zone j

CCN_{ij}: General cost of private vehicle mode between zone i and zone j

λ: Defining parameter. The larger the value of λ, the closer this Logit model is to the distribution of trips according to general cost function. In the thesis, the author assumes λ=1, so that the Logit model distributes trips according to the general cost function. In which, the general cost is determined by the sum of the cost of time and the cost of traveling between zone i and zone j [6]

6) Network Assignment Model

Relationship between travel time and vehicle volume: An important feature of road transport is that travel time increases proportionally with traffic volume: the more vehicles traveling on the same road, the more the speed of the vehicle stream decreases and the travel time increases.

This relationship is represented by formula (6) [6]

$$T = T_0 \left[1 + 0.15 \left(V / C \right)^4 \right] \quad (6)$$

In which:

T: Travel time interrupted between start point I and end point J

T_0: Free-state travel time between start point I and end point J

V: Traffic volume from start point I to end point J

C: Maximum traffic possibility of the route

Relationship between speed V and traffic volume N: When the traffic increases to the throughput capacity of the route, average speed of the traffic volume will decrease from the free speed (speed of vehicle when it is alone on the road) until the speed when the traffic volume reaches maximum.

Level of Service (LOS: Level of Service): LOS is divided into 6 different levels, denoted by A, B, C, D, E, F. Level A is the best level of service and level F is the worst level of service.

Traffic possibility of routes is the maximum hourly traffic possibility that vehicles can pass through a section in a given assessed environment.

Traffic possibility factor (Z) is one of indicators associated with level of service at a street segment. Traffic possibility factor (Z) is the ratio between vehicle volume (V - Volume) to capacity of the vehicle (C - Capacity). Traffic possibility factor is a parameter representing level of service of a route.

TABLE II.1 CRITERIA FOR DETERMINING LEVEL OF SERVICE (LOS) [9]

LEVEL OF SERVICE (LOS) BY TRAFFIC FACTOR		Delay time (seconds/vehicle) (AVERAGE DELAY)
A	A	≤ 10
B	B	>10 - 20
C	C	>20 - 35
D	D	>35 - 55
E	E	>55 - 80
F	F	>80

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

TABLE III. ASSESSMENT OF LEVEL OF SERVICE ON THE ROUTE [10]

LOS	Rating scale	Coefficient (V/C)
A	Free flow, very high speed	< 0.35
B	Not completely free flow, high speed	0.35 ÷ 0.50
C	Stable flow but the driver suffers from choosing the desired speed freely	0.5 ÷ 0.75
D	The flow is getting unstable, the driver has little freedom in choosing the speed	0.75 ÷ 0.90
E	Unstable flow, working road is in a limited state, any obstacle may cause traffic jam	0.90 ÷ 1.00
F	The traffic flow is completely unstable, traffic jam occurs	>1.00

D. Building of an assessment analysis model at the intersection

Using SIDRA software for analyzing and assessing work at intersections.

Basis to assess on LOS at the intersection in SIDRA software is referred to the software manual.

TABLE IV. LOS USED IN SIDRA SOFTWARE [11]

Level of Service	Control delay per vehicle in seconds (d)		
	Signals (*SIDRA standard default for roundabouts*)	"SIDRA Roundabout LOS" option	Sign Control
A	d ≤ 10	d ≤ 10	d ≤ 10
B	10 < d ≤ 20	10 < d ≤ 20	10 < d ≤ 15
C	20 < d ≤ 35	20 < d ≤ 35	15 < d ≤ 25
D	35 < d ≤ **55**	35 < d ≤ **50**	25 < d ≤ **35**
E	**55** < d ≤ 80	**50** < d ≤ 70	**35** < d ≤ 50
F	80 < d	70 < d	50 < d

III. A STUDY ON TRANSPORT IMPACT ASSESSMENT OF VINHOMES GRAND PARK

A. Analysis and calculation scenario

Analysis scenarios include:

- Scenario 0: Current scenario in 2022, the scenario is built based on current traffic network and the Vinhomes Grand Park Project area has not been completed and put into operation.

- Scenario 1: The 2025 scenario is developed from scenario 0, with the road network as of 2025 which has not been invested and developed yet, and the Vinhomes Grand Park Project area is completed and put into operation.

- Scenario 2: The 2025 scenario is developed from scenario 0. Three main roads of the region include: Nguyen Van Tang, Nguyen Xien, Phuoc Thien which are invested to be upgraded and expanded to 4 lanes according to the planning and the Vinhomes Grand Park Project are is completed and put into operation.

- Scenario 3: The 2025 scenario is developed from scenario 2. It is assumed that in the period to 2025, traffic demand increases by 10% under scenario 2.

B. Assessment on calculation results of traffic demand for scenario 0

1) Assessment on traffic demand on the route under scenario 0

According to the results of building current model (scenario 0), traffic volume in the study area is distributed mainly on main roads connecting from center of the traffic areas to each other.

LOS: Traffic volume on the main road sections and internal sections in some sections starts to be unstable, transportation becomes difficult.

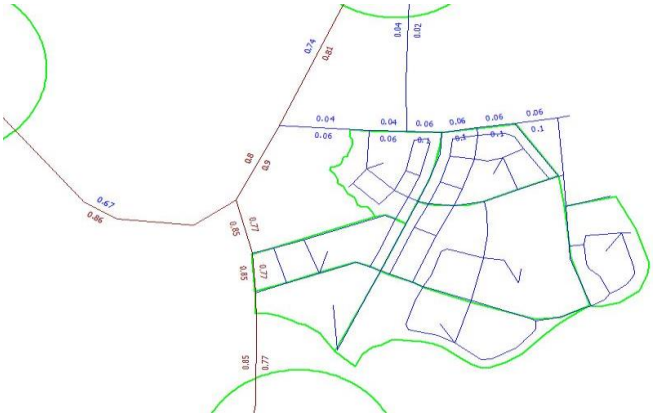

Fig. 6. Traffic possibility factor (V/C) under scenario 0

+ Nguyen Van Tang route: LOS D – Traffic flow starts to be unstable, drivers have little freedom in choosing a speed.

+ Nguyen Xien route: LOS D – similar to Nguyen Van Tang route, the flow starts to be unstable, driver has little freedom in choosing the speed. In which, the section from Phuoc Thien to Nguyen Van Tang intersection has a relatively high traffic possibility factor (Z), averaging from 0.8 ÷ 0.90.

+ Phuoc Thien route: LOS A - Free flow of traffic, good driving condition.

2) Assessment of traffic at major intersections under scenario 0

Intersection 1 (Nguyen Van Tang - Nguyen Xien): According to current status, total traffic volume through this point is 2,219 PCUs/h, the average delay time (Average Delay) when passing through the intersection is 50.6 seconds, rated at LOS D.

Lane Use and Performance

	Demand Flows L veh/h	T veh/h	R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
East: NGUYỄN XIỂN 1																
Lane 1	0	436	273	708	0.0	900	0.787	100	25.4	LOS C	38.9	272.0	500	–	0.0	0.0
Approach	0	436	273	708	0.0		0.787		25.4	LOS C	38.9	272.0				
North: NGUYỄN XIỂN 2																
Lane 1	333	0	338	671	0.0	726	0.923	100	72.3	LOS E	55.0	384.7	500	–	0.0	0.0
Approach	333	0	338	671	0.0		0.923		72.3	LOS E	55.0	384.7				
West: NGUYỄN VĂN TĂNG																
Lane 1	247	593	0	840	0.0	909	0.924	100	54.4	LOS D	68.0	476.1	500	–	0.0	0.6
Approach	247	593	0	840	0.0		0.924		54.4	LOS D	68.0	476.1				
Intersection				2219	0.0		0.924		50.6	LOS D	68.0	476.1				

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all lanes. LOS Method: Delay (HCM).
Level of Service (Worst Lane): LOS E. LOS Method for individual lanes: Delay (HCM).
Approach LOS values are based on average delay for all lanes.

Fig. 7. Assessment results of Nguyen Van Tang - Nguyen Xien intersection under scenario 0

Intersection 2 (Nguyen Xien - Phuoc Thien): Total traffic volume is 1,828 PCUs/h, average delay time (Average Delay) when traveling through the intersection is 34.8 seconds.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

Traffic flow is mainly unstable on Nguyen Xien route. Overall, this intersection, according to current traffic, is rated at LOS C.

Lane Use and Performance

	Demand Flows L veh/h	T veh/h	R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
East: NGUYỄN XIỂN																
Lane 1	0	227	422	649	0.0	724	0.897	100	36.9	LOS D	29.2	204.1	500	–	0.0	0.0
Approach	0	227	422	649	0.0		0.897		36.9	LOS D	29.2	204.1				
North: NGUYỄN XIỂN																
Lane 1	262	0	362	624	0.0	702	0.890	100	38.9	LOS D	25.9	181.0	500	–	0.0	0.0
Approach	262	0	362	624	0.0		0.890		38.9	LOS D	25.9	181.0				
West: PHƯỚC THIỆN																
Lane 1	249	305	0	555	0.0	671	0.826	100	27.7	LOS C	20.9	146.1	500	–	0.0	0.0
Approach	249	305	0	555	0.0		0.826		27.7	LOS C	20.9	146.1				
Intersection				1828	0.0		0.897		34.8	LOS C	29.2	204.1				

Level of Service (Aver. Int. Delay): LOS C. Based on average delay for all lanes. LOS Method: Delay (HCM).
Level of Service (Worst Lane): LOS D. LOS Method for individual lanes: Delay (HCM).
Approach LOS values are based on average delay for all lanes.

Fig. 8. Assessment results of Nguyen Xien - Phuoc Thien intersection under scenario 0

From the above model building results, for current status when the Project has not been put into operation, traffic situation on the main routes and intersections within the Project scope is basically relatively stable. Although the current traffic flow is high, there is no traffic jam. However, there is a risk of traffic jams at any time.

3) Testing model according to current scenario

Once the model has been calibrated against the databases, next step is to verify the accuracy of the study model. Using GEH math function of Geoffrey E. Havers to check and assess the reliability of the study model. GEH algorithm is a popular algorithm, widely used in the field of traffic study.

TABLE V TESTING RESULTS OF TRAFFIC FORECAST MODEL

Route name	Survey (PCU)		Model (PCU)		**GEH**	
	Direction 1	Direction 2	Direction 1	Direction 2	**H1**	**H2**
Nguyen Xien 1	1.180	1.075	1.440	1.275	**7**	**6**
Nguyen Van Tang	1.034	1.113	1.071	1.374	**1**	**7**
Nguyen Xien 2	1.074	1.032	1.367	1.229	**8**	**6**

From GEH calculation results for the Cube Voyager traffic forecast model, the GEH values are all < 10: The assurance level for the study. Thus, the Cube Voyager traffic study model is relatively accurate for this study.

C. Assessment results of traffic demand calculation under scenario 1

1) Assessment of traffic demand on the route

Traffic volume in the study area is distributed mainly on main roads connecting from center of the traffic areas to each other. In specific, traffic generated in the Vinhomes Grand Park residential area increases the traffic volume on the main roads.

LOS: In this scenario, traffic volume through internal routes is relatively stable, LOS in these routes is at levels A, B, and C which are completely safe levels for traffic. However, there is a change in the main roads compared to current scenario because traffic volume in the Project area is connected to the main roads, so traffic flow starts to be unstable. Both of Nguyen Xien, Nguyen Van Tang roads have traffic possibility factor >1.0, traffic congestion occurs.

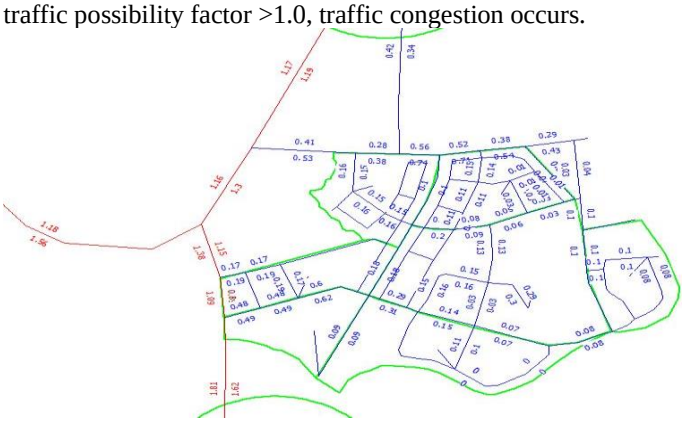

Fig. 9. Traffic possibility factor (v/c) under scenario 1

+ Nguyen Van Tang route: LOS F - The traffic flow is congested and unstable.

+ Nguyen Xien route: LOS F - The traffic flow is congested and unstable. In which, the most congestion is at Go Cong bridge.

+ Phuoc Thien route: LOS A, B, C - Stable traffic flow.

2) Transport assessment at major intersections

Intersection No. 1 (Nguyen Van Tang - Nguyen Xien): Rated at LOS F, total traffic through this intersection is about 6,500 PCUs/h, average delay time is at a very high level of 4,264 seconds, traffic flow is completely unstable, congestion occurs at this intersection (for all traffic directions).

Lane Use and Performance

	Demand Flows L veh/h	T veh/h	R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South: NGUYỄN XIỂN																
Lane 1	1008	0	923	1932	0.0	588	3.286	100	4207.4	LOS F	1240.9	8686.4	500	–	0.0	100.0
Approach	1008	0	923	1932	0.0		3.286		4207.4	LOS F	1240.9	8686.4				
North East: NGUYỄN XIỂN																
Lane 1	974	0	981	1955	0.0	590	3.313	100	4256.0	LOS F	1259.1	8814.0	500	–	0.0	100.0
Approach	974	0	981	1955	0.0		3.313		4256.0	LOS F	1259.1	8814.0				
North West: NGUYỄN VĂN TĂNG																
Lane 1	1275	0	1347	2622	0.0	785	3.339	100	4311.7	LOS F	1713.5	11994.7	500	–	0.0	100.0
Approach	1275	0	1347	2622	0.0		3.339		4311.7	LOS F	1713.5	11994.7				
Intersection				6508	0.0		3.339		4264.0	LOS F	1713.5	11994.7				

Level of Service (LOS) Method: Delay (HCM 2000).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model used.

Fig. 10. Assessment results of Nguyen Van Tang - Nguyen Xien intersection under scenario 1

Intersection 2 (Phuoc Thien - Nguyen Xien): Based on simulation of traffic forecast at Nguyen Xien - Phuoc Thien intersection, total traffic volume through this intersection is 4,250 PCUs/h, delay time (Average Delay) is lower than Nguyen Van Tang - Nguyen Xien intersection but still at a high level of 1028.2 seconds, LOS is rated at LOS F which is a unstable traffic flow and congestion occurs.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

Lane Use and Performance

	Demand Flows L veh/h	T veh/h	R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South East: PHƯỚC THIÊN																
Lane 1	107	0	333	440	0.0	282	1.559	100	1074.7	LOS F	159.8	1118.7	500	–	0.0	80.2
Approach	107	0	333	440	0.0		1.559		1074.7	LOS F	159.8	1118.7				
North East: NGUYỄN XIỂN																
Lane 1	379	1597	0	1976	0.0	1276	1.549	100	1030.9	LOS F	715.8	5010.9	500	–	0.0	100.0
Approach	379	1597	0	1976	0.0		1.549		1030.9	LOS F	715.8	5010.9				
South West: NGUYỄN XIỂN																
Lane 1	0	1679	156	1835	0.0	1198	1.532	100	1014.1	LOS F	673.2	4712.2	500	–	0.0	100.0
Approach	0	1679	156	1835	0.0		1.532		1014.1	LOS F	673.2	4712.2				
Intersection				4250	0.0		1.559		1028.2	LOS F	715.8	5010.9				

Level of Service (LOS) Method: Delay (HCM 2000).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model used.

Fig. 11. Assessment results of Nguyen Xien – Phuoc Thien intersection under scenario 1

Hence, through the results of traffic forecast and LOS analysis under scenario 1, when the Project comes into operation in the current state of roads (not expanded according to the plan), the 02 intersections at Vinhomes Grand Park Project area are congested, traffic flow is unstable (LOS is F). Simulation and analysis results are consistent with the calculation and assessment on traffic on two routes namedly Nguyen Van Tang and Nguyen Xien.

D. Assessment on traffic demand calculation results under scenario 2

1) Assessment of traffic demand on the route

According to this scenario, traffic volume in the Vinhomes Grand Park Project area is distributed mainly on the main roads connecting from centers of traffic areas to each other (directions from zones 8, 9, 10 to Nguyen Van Tang - Nguyen Xien intersection and vice versa). From the forecast results, for traffic volume of Nguyen Xien and Nguyen Van Tang routes, there is no big change compared to scenario 1.

LOS: In this scenario, traffic volume through internal routes is relatively stable, similar to scenario 1. However, there is a significant difference for the main roads.

Fig. 12. Traffic possibility factor (v/c) under scenerio 2

+ Nguyen Van Tang route: LOS C and D - Traffic flow is relatively stable.

+ Nguyen Xien route: LOS C and D - Traffic flow is relatively stable. However, the South section of Nguyen Xien route has the highest traffic possibility factor of 0.96, belonging to LOS E – Unstable traffic flow, working in a limited state, any obstacle may cause congestion.

+ Phuoc Thien route: LOS A, B - Stable traffic flow, good driving condition.

2) Transport assessment at major intersections

Results of traffic demand forecast through intersections under scenario 2 are as follows:

Intersection 1 (Nguyen Van Tang – Nguyen Xien): Total traffic volume through this intersection is about 4,700 PCUs/h, average delay time (Average Delay) is 35.7 seconds, significantly reduced compared to scenario 1, corresponding to LOS D.

Lane Use and Performance

	Demand Flows L veh/h	T veh/h	R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South: NGUYỄN XIỂN																
Lane 1	402	0	0	402	0.0	485	0.829	100	61.9	LOS E	29.4	205.6	500	–	0.0	0.0
Lane 2	312	0	808	1120	0.0	1351	0.829	100	7.9	LOS A	28.1	196.5	500	–	0.0	0.0
Approach	714	0	808	1522	0.0		0.829		22.2	LOS C	29.4	205.6				
North East: NGUYỄN XIỂN																
Lane 1	428	0	0	428	0.0	485	0.883	100	69.3	LOS E	34.1	238.4	500	–	0.0	0.0
Lane 2	213	0	981	1194	0.0	1351	0.883	100	9.3	LOS A	34.0	238.1	500	–	0.0	0.0
Approach	641	0	981	1622	0.0		0.883		25.1	LOS C	34.1	238.4				
North West: NGUYỄN VĂN TĂNG																
Lane 1	783	0	0	783	0.0	866	0.904	100	51.9	LOS D	59.5	416.7	500	–	0.0	0.0
Lane 2	57	0	725	783	0.0	866	0.904	100	67.7	LOS E	59.6	417.5	500	–	0.0	0.0
Approach	840	0	725	1565	0.0		0.904		59.8	LOS E	59.6	417.5				
Intersection				4709	0.0		0.904		35.7	LOS D	59.6	417.5				

Level of Service (LOS) Method: Delay (HCM 2000).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model used.

Fig. 13. Assessment results of Nguyen Van Tang - Nguyen Xien intersection under scenario 2

Phuoc Thien - Nguyen Xien intersection (intersection 2): Total traffic volume through Phuoc Thien - Nguyen Xien intersection under scenario 2 is 4,794 PCUs/h, traffic volume does not much increase compared to scenario 1. However, average delay time (Average Delay) has been significantly reduced to 16.1 seconds (compared to scenario 1 of 1028.2 seconds) and LOS of this intersection according to modelling results is rated at LOS B (compared to LOS F of scenario 1).

Lane Use and Performance

	Demand Flows L veh/h	T veh/h	R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South East: PHƯỚC THIÊN																
Lane 1	52	0	0	52	0.0	87	0.595	100	68.6	LOS E	3.2	22.5	500	–	0.0	0.0
Lane 2	60	0	687	748	0.0	1256	0.595	100	9.7	LOS A	15.8	110.9	500	–	0.0	0.0
Approach	112	0	687	799	0.0		0.595		13.5	LOS B	15.8	110.9				
North East: NGUYỄN XIỂN																
Lane 1	524	498	0	1022	0.0	1222	0.836	100	20.4	LOS C	45.4	318.1	500	–	0.0	0.0
Lane 2	0	1103	0	1103	0.0	1319	0.836	100	17.1	LOS B	46.1	322.7	500	–	0.0	0.0
Approach	524	1601	0	2125	0.0		0.836		18.7	LOS B	46.1	322.7				
South West: NGUYỄN XIỂN																
Lane 1	0	936	0	936	0.0	1228	0.763	100	13.8	LOS B	36.1	252.8	500	–	0.0	0.0
Lane 2	0	772	161	933	0.0	1223	0.763	100	14.9	LOS B	35.5	248.2	500	–	0.0	0.0
Approach	0	1708	161	1869	0.0		0.763		14.3	LOS B	36.1	252.8				
Intersection				4794	0.0		0.836		16.1	LOS B	46.1	322.7				

Level of Service (LOS) Method: Delay (HCM 2000).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model used.

Fig. 14. Assessment results of Phuoc Thien - Nguyen Xien intersection under scenario 2

According to the results of transport assessment, analysis and forecast under scenario 2, it points out that: In the condition that main roads are built and expanded in accordance with the planning, corresponding to 04 traffic lanes, when Vinhomes Grand Park Project comes into operation, the 02 main intersections in the study area have LOS B and D - Traffic flow is relatively stable, meeting circulation needs of people in the Project area.

E. Assessment of traffic demand calculation results under scenario 3

1) Assessment of traffic demand assessment on the route

Scenario 3 is the scenario in 2025 developed from scenario 2. Accordingly, it forecasts traffic demand up to 2025 with a specific traffic network of 3 main roads of the region, including: Nguyen Van Tang, Nguyen Xien, Phuoc Thien which are invested to be upgraded and expanded to 4 lanes according to the plan, the Vinhomes Grand Park Project is completed and put into operation, generating a 10% increase in traffic volume on the route compared to scenario 2.

Level of service:

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

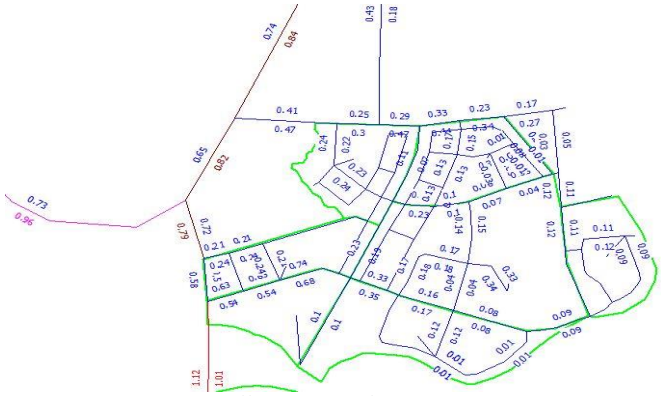

Fig. 15. Traffic possibility factor (v/c) under scenario 3

+ Nguyen Van Tang route: LOS C and E - Traffic flow is relatively stable. Traffic jams possibility starts to occur.

+ Nguyen Xien route: LOS C and D - Traffic flow is relatively stable. However, the south section of Nguyen Xien route has LOS F –Traffic jams occur in the traffic flow.

+ Phuoc Thien route: LOS A, B - Stable traffic flow, good driving condition.

2) Transport assessment at major intersections

The results of traffic demand forecast through the intersections under scenario 3 are as follows:

Intersection 1 (Nguyen Van Tang – Nguyen Xien): Total traffic through this intersection is about 5,159 PCUs/h, average delay time (Average Delay) is 98.3 seconds, significantly reduced compared to scenario 1 but increased by 1 time compared to scenario 2, corresponding to LOS E.

Lane Use and Performance

	Demand Flows L veh/h	T veh/h	R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South: NGUYỄN XIỂN																
Lane 1	467	0	0	467	0.0	531	0.880	100	66.3	LOS E	36.6	255.9	500	–	0.0	0.0
Lane 2	262	0	926	1189	0.0	1351	0.880	100	8.7	LOS A	33.4	234.0	500	–	0.0	0.0
Approach	729	0	926	1656	0.0		0.880		24.9	LOS C	36.6	255.9				
North East: NGUYỄN XIỂN																
Lane 1	523	0	0	523	0.0	531	0.985	100	115.6	LOS F	56.4	395.1	500	–	0.0	0.0
Lane 2	255	0	1076	1331	0.0	1351	0.985	100	62.1	LOS E	95.9	671.1	500	–	0.0	31.8
Approach	778	0	1076	1854	0.0		0.985		77.2	LOS E	95.9	671.1				
North West: NGUYỄN VĂN TĂNG																
Lane 1	825	0	0	825	0.0	820	1.006	100	126.3	LOS F	98.3	688.1	500	–	0.0	34.1
Lane 2	26	0	799	825	0.0	820	1.006	100	128.4	LOS F	88.0	616.0	500	–	0.0	23.9
Approach	851	0	799	1649	0.0		1.006		127.3	LOS F	98.3	688.1				
Intersection				5159	0.0		1.006		76.4	LOS E	98.3	688.1				

Level of Service (LOS) Method: Delay (HCM 2000).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model used.

Fig. 16. Assessment results of Nguyen Van Tang – Nguyen Xien under scenario 3

Intersection 2 (Phuoc Thien - Nguyen Xien): Total traffic volume through Phuoc Thien - Nguyen Xien intersection under scenario 3 is 5,052 PCUs/h. However, average delay time (Average Delay) has significantly dropped to 35.0 seconds. LOS of this intersection based on modelling results is assessed at LOS C (increased compared to scenario 2 which is LOS B).

From the results of transport assessment, analysis and forecast under scenario 3, it indicates that: In the condition that main roads are built and expanded according to the planning, corresponding to 04 traffic lanes, at the same time, traffic volume increases by 10%, when Vinhomes Grand Park Project comes into operation, Phuoc Thien - Nguyen Xien intersection will have LOS C - Traffic flow is relatively stable, meeting the circulation needs of people in the Project area. The remaining intersection of Nguyen Xien - Nguyen Van Tang has LOS E - Congestion may occur in the traffic flow.

Lane Use and Performance

	Demand Flows L veh/h	T veh/h	R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South East: PHƯỚC THIỆN																
Lane 1	118	0	0	118	0.0	358	0.330	60	57.0	LOS E	7.4	51.7	500	–	0.0	0.0
Lane 2	0	0	740	740	0.0	1351	0.548	100	9.6	LOS A	11.1	78.0	500	–	0.0	0.0
Approach	118	0	740	858	0.0		0.548		13.7	LOS B	11.1	78.0				
North East: NGUYỄN XIỂN																
Lane 1	558	385	0	943	0.0	1029	0.916	100	50.6	LOS D	69.9	489.1	500	–	0.0	3.0
Lane 2	0	1300	0	1300	0.0	1419	0.916	100	12.2	LOS B	50.4	352.8	500	–	0.0	0.0
Approach	558	1685	0	2243	0.0		0.916		28.4	LOS C	69.9	489.1				
South West: NGUYỄN XIỂN																
Lane 1	0	977	0	977	0.0	1043	0.937	100	51.4	LOS D	80.1	561.0	500	–	0.0	15.4
Lane 2	0	815	158	974	0.0	1039	0.937	100	52.5	LOS D	79.7	558.1	500	–	0.0	14.9
Approach	0	1793	158	1951	0.0		0.937		51.9	LOS D	80.1	561.0				
Intersection				5052	0.0		0.937		35.0	LOS C	80.1	561.0				

Level of Service (LOS) Method: Delay (HCM 2000).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model used.

Fig. 171. Assessment results of Phuoc Thien – Nguyen Xien intersection under scenario 3

F. Proposal of solutions to improve the transport network

Some proposed solutions are as follows:

Solution 1 - Solution to improve traffic connections: In the period from now until 2025, when Vinhomes Grand Park Project is put into operation, the population will be densely populated, traffic will be generated. Therefore, it is essential to upgrade, improve and expand traffic on Nguyen Van Tang, Nguyen Xien and Phuoc Thien routes to at least 4 lanes. In which, Nguyen Van Tang and Nguyen Xien roads have been planned with a width of 30 m.

Solution 2 - the proposed solution to build a new bridge connecting the South of Vinhomes Grand Park Project area in the direction of connecting through Go Cong canal: According to the planning, Ring Road 3 is across Vinhomes Grand Park Project area. However, this is a road in the City's long-term planning. Thus, in the period of 2021 - 2025, it is crucial to have a solution for investment divergence, adding a route connecting to the section of Nguyen Xien route (from Go Cong Bridge to Nguyen Van Tang) through the bridge crossing Go Cong canal so as to reduce traffic pressure on Nguyen Xien road.

Solution 3 - Proposing to build new D1 route connecting high-tech park to Vinhomes Grand Park Project area and Nguyen Xien road (according to current status, the backbone route connects high-tech park with Hanoi Highway - National Highway 1A is D1 road which is parallel to Nguyen Van Tang route).

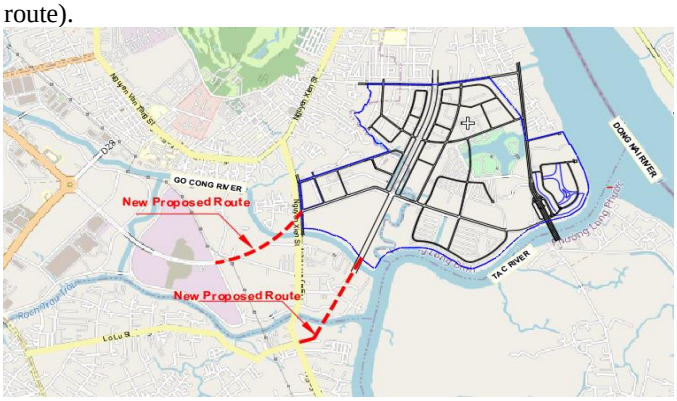

Fig. 18. Proposed route plan for additional construction

Results of transport assessment when renovating in line with the proposed route: based on the combination of solutions 1 and 2 above, students build a model to test the effectiveness of the proposed solutions on traffic situation in the study area.

Level of service: In this solution, after renovating, traffic possibility factor on internal roads reaches LOS from A to C which are completely safe levels for traffic. For main roads, traffic flow is also gradually stabilized, only the southern

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

section of Nguyen Xien route has LOS D, however, at this level, the traffic flow can still be relatively stable.

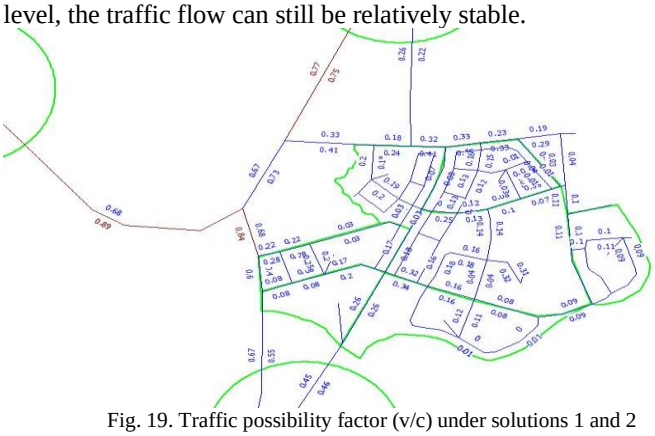

Fig. 19. Traffic possibility factor (v/c) under solutions 1 and 2

+ Nguyen Van Tang route: belongs to LOS C and D - Traffic flow is relatively stable.

+ Nguyen Xien route: belongs to LOS C and D - Traffic flow is relatively stable.

+ Phuoc Thien route: belongs to LOS A, B - Stable traffic flow, good driving condition.

Results of transport assessment when renovating based on adding routes proposal (solution 3):

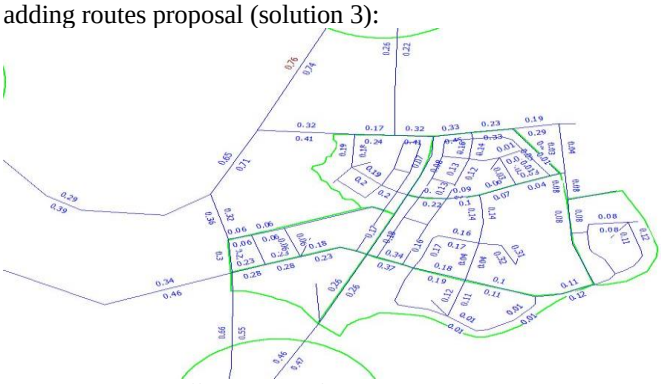

Fig. 20. Traffic possibility factor (v/c) when combining 3 solutions

Level of service:

+ Nguyen Van Tang route: belongs to LOS C - Stable traffic flow.

+ Nguyen Xien route: belongs to LOS C and D - Traffic flow is relatively stable.

+ Phuoc Thien route: belongs to LOS A, B - Stable traffic flow, good driving condition.

+ Assessment result of intersection 1 (Nguyen Van Tang - Nguyen Xien intersection) is rated at LOS D (average delay time - Average Delay is 47 seconds)

Lane Use and Performance

	Demand Flows L veh/h	T veh/h	R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South: NGUYỄN XIỂN																
Lane 1	903	0	0	903	0.0	943	0.957	100	60.8	LOS E	60.5	423.3	500	–	0.0	0.0
Lane 2	159	0	944	1104	0.0	1153	0.957	100	49.8	LOS D	63.9	447.1	500	–	0.0	0.0
Approach	1062	0	944	2006	0.0		0.957		54.8	LOS D	63.9	447.1				
North East: NGUYỄN XIỂN																
Lane 1	889	0	0	889	0.0	943	0.943	100	52.0	LOS D	55.1	385.6	500	–	0.0	0.0
Lane 2	157	0	929	1087	0.0	1153	0.943	100	42.0	LOS D	57.0	398.7	500	–	0.0	0.0
Approach	1046	0	929	1976	0.0		0.943		46.5	LOS D	57.0	398.7				
North West: NGUYỄN VĂN TĂNG																
Lane 1	510	0	0	510	0.0	558	0.914	100	53.6	LOS D	28.5	199.5	500	–	0.0	0.0
Lane 2	202	0	831	1032	0.0	1130	0.914	100	29.5	LOS C	38.8	271.5	500	–	0.0	0.0
Approach	712	0	831	1542	0.0		0.914		37.5	LOS D	38.8	271.5				
Intersection				5524	0.0		0.957		47.0	LOS D	63.9	447.1				

Level of Service (LOS) Method: Delay (HCM 2000).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model used.

Fig. 212. Assessment results of Nguyen Van Tang – Nguyen Xien intersection

+ Assessment result of intersection 2 (Nguyen Xien - Phuoc Thien intersection) is rated at LOS B (average delay time - Average Delay is 12.1 seconds).

Lane Use and Performance

	Demand Flows L veh/h	T veh/h	R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South East: PHƯỚC THIỆN																
Lane 1	93	0	0	93	0.0	390	0.237	67[5]	31.1	LOS C	3.0	21.2	500	–	0.0	0.0
Lane 2	0	0	519	519	0.0	1472	0.352	100	3.9	LOS A	2.3	15.8	500	–	0.0	0.0
Approach	93	0	519	611	0.0		0.352		8.0	LOS A	3.0	21.2				
North East: NGUYỄN XIỂN																
Lane 1	592	362	0	954	0.0	1130	0.844	100	21.3	LOS C	33.6	235.2	500	–	0.0	0.0
Lane 2	0	1305	0	1305	0.0	1546	0.844	100	3.7	LOS A	18.0	126.1	500	–	0.0	0.0
Approach	592	1667	0	2259	0.0		0.844		11.1	LOS B	33.6	235.2				
South West: NGUYỄN XIỂN																
Lane 1	0	917	0	917	0.0	1137	0.807	100	14.4	LOS B	28.9	202.2	500	–	0.0	0.0
Lane 2	0	781	136	917	0.0	1136	0.807	100	14.8	LOS B	28.5	199.4	500	–	0.0	0.0
Approach	0	1698	136	1834	0.0		0.807		14.6	LOS B	28.9	202.2				
Intersection				4704	0.0		0.844		12.1	LOS B	33.6	235.2				

Level of Service (LOS) Method: Delay (HCM 2000).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model used.

Fig. 223. Assessment results of Nguyen Xien – Phuoc Thien intersection after applying the solution

G. *Comments*

Based on calculation results of the scenarios, this study proposes solutions to improve regional traffic situation. Accordingly, apart from the renovation and expansion of two main routes namely Nguyen Van Tang and Nguyen Xien according to the planning to help increase traffic capacity, the additional construction of a southern bridge over Go Cong canal will assist to reduce a part of the load pressure on traffic on Nguyen Xien road; combining the construction of a road connecting high-tech park to Vinhomes Grand Park Project area and Nguyen Xien road (the extended D1 road). This route will be a "parallel" route with Nguyen Van Tang route, when connecting this route with Vinhomes Grand Park Project area, it will open a new traffic direction, reducing the load on Nguyen Van Tang route and Nguyen Xien route, increasing the connectivity between Vinhomes Grand Park Project area and National Highway 1A. The calculation results when applying solutions inicates that traffic situation has been significantly improved, especially at intersections (LOS C, on average). Moreover, it is possible to solve the congestion on Nguyen Xien route from Nguyen Van Tang to Go Cong Bridge (according to scenario 1, when expanding the planned routes, this section will still have LOS E which is a high risk of congestion).

From assessment results of study scenarios, it can be seen that the development of Vinhomes Grand Park urban Project is not synchronized, not suitable with the existing traffic network and development speed of transport infrastructure of the region and have a great impact on the traffic possibility of existing roads. With current conditions, when Vinhomes Grand Park Project is completed and put into operation while current transport infrastructure connected to the Project is still basically unable to meet the existing demand (currently, main roads in the traffic network connecting to Vinhomes Grand Park Project has not been built or incomplete due to various reasons), the possibility of frequent traffic jams in the area is huge, potentially causing traffic accidents on Nguyen Xien, Nguyen Van Tang routes and 02 intersections namely Phuoc Thien - Nguyen Van Tang and Nguyen Van Tang - Nguyen Xien.

IV. CONCLUSIONS - RECOMMENDATIONS

A. *Conclusions*

This study assesses traffic impact of the urban development project on existing traffic network for Vinhomes Grand Park Project. The results obtained during the study are as follows:

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

Survey results: Based on survey results, a current status model has been built and basic survey results reflect current actual traffic situation of the study area.

Based on planning data, this study has forecast traffic demand when an urban development project is built and formed.

Assessment results: This study has focused on building a forecasting model, assessing level of service of the transport network based on the following scenarios:

Scenerio 0: Current scenario. Modeling results point out that, in current condition, Nguyen Van Tang and Nguyen Xien roads themselves, when the Project has not been put into operation, are at risk of traffic jams (LOS D). The modelling results are consistent with current traffic status.

Scenario 1: The 2025 scenario is developed from scenario 0, with the road network up to 2025 not yet invested and developed, and Vinhomes Grand Park Project is completed and put into operation. Main roads connecting to the Project area are Nguyen Van Tang, Nguyen Xien and 02 intersections with high LOS F - Traffic jams occurs and unstable traffic flow. The scenario results reflect a significant impact of Vinhomes Grand Park Project on the existing traffic network.

Scenario 2: The 2025 scenario is developed from scenario 0. By 2025, traffic network - specifically the main route of the region, including Nguyen Van Tang, Nguyen Xien, are invested to be expanded to 4 lanes in line with the planning to improve traffic possibility and Vinhomes Grand Park Project area will be completed and put into operation. In this scenario, internal traffic network is open and stable, similar to scenario 1 but main roads connecting to the Project have markedly improved LOS (from LOS F to LOS C and D, 02 intersections are improved to LOS D and LOS B, average delay time is decreased significantly), and the traffic network is improved better than scenario 1.

Scenario 3: Similar to scenario 2, internal traffic network is open and stable, Nguyen Van Tang and Nguyen Xien routes have an average LOS of C, D – which is a relatively stable traffic flow. However, at the section of Nguyen Xien route (from Nguyen Van Tang to Go Cong bridge) with high LOS (level F), traffic jams occur in the traffic flow. Phuoc Thien route has an average LOS of C – traffic flow and intersections increase to LOS E and LOS C, traffic congestion possibility is higher than scenario 2.

- Solutions proposed: Following forecasting and analysis results when developing the aforementioned scenarios, this study has also proposed solutions to improve circulation conditions of main traffic routes and intersections when Vinhomes Grand Park Project came into operation. In particular, due to the fact that current status of basic traffic routes is getting unstable (LOS D), when additional traffic is generated by Vinhomes Grand Park Project, these routes will reduce ttheir LOS to level F. Even, the traffic possibility factor is many times larger than LOS D. For this reason, it is necessary to build and expand Nguyen Xien and Nguyen Van Tang roads in consistent with the planning to connect with Vinhomes Grand Park Project synchronously. Besides, combining with adding a connection route to Nguyen Xien route (through a bridge over Go Cong canal and building a new route connecting from Hanoi Highway to Vinhomes Grand Park Project through the high-tech park).

B. Reccommentations

For the proposed solutions, theoretical basis is to build and expand traffic routes according to the planning. However, in the current practical conditions, with limited funding from the State budget, and the situation of residential development preceded by infrastructure development, road expansion projects based on planning are very difficult to implement. In case of developing, the prolonged compensation for site clearance directly affects the project implementation progress. In particular, currently on Nguyen Van Tang and Nguyen Xien roads, existing population is very crowded, the concretization of solutions needs to take into account the investment divergence or to have a temporary plan to replace and meet the immediate demands. Apart from that, while implementing the expansion projects as planned, it is essential to have more detailed calculations about intersections, especially Nguyen Xien - Nguyen Van Tang intersection because this is an important intersection of 02 main roads in the region, which is responsible for connecting to center of District 9, center of District 2, existing ports and high-tech park.

Scope of this study is only a research topic, therefore, content of this study is still limited in terms of scale, investment resources for data collection and input data. Hence, content of this study has been referred and studied from some previous results and reports. Therefore, to fully implement a research model, it requires a lot of socio-economic information, development plans of not only the study area but also a large amount of information from surrounding areas, such as land use planning and traffic planning. The study scenarios are also built on the basis of actual survey data and collected documents. This is the biggest limitation of this study.

From the study results, it is indicated that transport impact assessment on urban development projects is very necessary and important in deciding on project licensing. However, until now, it has not been paid enough attention. Hence, in the near future, it is recommended that the competent Authorities should have regulations to project Investors to ensure that when building and developing housing projects, residential areas and urban areas, it should be accompanied by a specific transport impact assessment report and they must provide solutions to improve the circulation of transport infrastructure network in the project area, minimizing negative impacts on the existing transport network. Additionally, there are mechanisms and policies in terms of finance to apply to urban project Investors to minimize pressure on budget capital when developing transport infrastructure network serving people's travel needs.

REFERENCES

[1] Statistical Yearbook of Ho Chi Minh City in 2020;
[2] Report on "Socio-economic situation in District 9 in 2020"
[3] Approve and announce the results of the land area inventory in 2019 according to Decision No. 1072/QĐ-UBND dated November 15, 2021 approved by Ho Chi Minh City People's Committee.
[4] Report on "Adjustment of Master plan in District 9, Ho Chi Minh up to 2020".
[5] Report on "1/2000-scale planning of Phuoc Thien residential areas and parks, Long Binh and Long Thanh My wards" according to Decision No. 5394/QĐ-UBND dated September 30, 2013 approved by Ho Chi Minh City People's Committee.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

[6] Juan de Dios Ortúzar, Luis G. Willumsen “Modeling Transport - 4th Edition”.
[7] Urban Transportation Planning, ITE; Urban design guidelines 2012 – Thu Thiem, Ho Chi Minh City.
[8] Citilabs (2016) “Reference guide Cube Voyager”.
[9] Highway Capacity Manual 2010
[10] National Vietnamese Standard 104- 2007 “Urban road – Specification for design”.
[11] Reference guide Sidra Intersection
[12] Report on “Ho Chi Minh City Construction Master Plan up to 2025” according to Decision No. 24/QĐ-TTg dated January 6, 2010.
[13] Nguyen Xuan Truc (2002) “Transport planning and urban transport design”.
[14] A. Prof. PhD. Bui Xuan Cay - MSc. Dang Minh Tan (2007) ”Research on the application of 4-step model to analyze and forecast travel demand in transport planning".
[15] Trinh Van Chinh (2009) Textbook ”Economic investigation and forecast of transport demand”.