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INTEGRATION OF FACTORS AFFECTING URBAN TRAFFIC TO REDUCE TRAFFIC CONGESTION IN BIG CITIES IN VIETNAM

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ABSTRACT

Urban traffic plays a very important role in the development of big cities and countries. After stating the necessity, objectives, research methods; analyzing and evaluating the current status of urban traffic in Ha Noi, Ho Chi Minh city and some other big cities, the article summarizes what countries have done so far through research projects and paper, to reduce traffic congestion in big cities, through developing public passenger transport and reducing personal vehicles. Next, proposed and implemented measures and solutions, and causes of urban traffic congestion. Next, the paper presents some related concepts, especially the division and characteristics of urban traffic zones to serve the work of forecasting, organizing traffic, and market share in urban traffic. Then, the paper introduces the research results and selects factors/criteria and indicators affecting urban traffic. At the same time, it proposes solutions to integrate factors affecting urban traffic to develop public passenger transport, control the development of personal vehicles, minimize traffic congestion, environmental pollution, reduce urban economic losses and a model to integrate factors affecting urban traffic to reduce congestion, sustainable development, improve urban traffic culture, civilization in major cities in Viet Nam by 2030, with a vision to future.

KEYWORDS: Integrating impact factors, urban traffic, and traffic congestion in major cities.

1.0 NECESSITY, RESEARCH METHODOLOGY

1.1. Necessity of research, objectives, roles

In the development process of countries, transportation plays an important role, considered the blood vessels in the human body. Transportation solves one of the essential needs of people such as travel and transportation. Therefore, transportation must be smooth. Traffic congestion in large cities in Viet Nam is currently a prominent problem, causing frustration among urban residents, making it difficult for people to travel and affecting the development of the city in particular, and

the socio-economic development of Vietnamese cities in general. The situation has not improved much due to the high speed of mechanization and urbanization, so the traffic volume has increased; public passenger transport has not developed reasonable, urban railway transport is slow to be deployed. Long-term solutions are often very costly, depending on other projects in and outside the sector; the immediate measures are less costly but not yet synchronized or have measures that are not feasible, have not received high consensus, have not had close and effective coordination between agencies, organizations, and individuals in project establishment and implementation or for objective reasons. After stating the necessity of researching and analyzing the traffic congestion situation in recent years in some major cities in Viet Nam such as Ha Noi, Ho Chi Minh city and some other centrally-run cities; analyzing and evaluating the proposed, implemented, and applied solutions; pointing out the main causes of traffic congestion; the paper proposes a number of feasible solutions to overcome traffic congestion in some major cities in Viet Nam, especially in the period of high urbanization, motorization, with rapid increase and explosion of motorbikes/motorcycles in the past and in the coming time of personal cars. Viet Nam is increasingly integrating deeply into the regional and world economy; Viet Nam's urban economy is developing strongly and digitally, shifting to digital economy, circular, and green economy. Rapid urbanization, smart cities are starting to develop; income and living standards of urban residents are raised, reaching the low average level of the region. The proposed criteria and indicators affecting urban traffic for integration, although they may still be theoretical and suggestive, need to be considered or consulted for further research by relevant authorities. However, the proposed solution is open, dynamic, inheritable and novel, "independent of existing financial resources" and only needs to implement some solutions to solve the problem of congestion in a number of years, because it is not simply "allocating resources" but "creating resources at the same time". The paper also proposes some recommendations to management levels in the process of implementing integration.

Objective: After selecting criteria (and indicators) affecting urban traffic according to the impact/constituent factors including people, means of transport, traffic infrastructure, other factors and combining 2, 3 or 4 of those factors, the paper proposes a model and solution to integrate factors affecting urban traffic in major cities in Viet Nam; stating the feasibility, effectiveness or loss of integrating those factors and making recommendations to the authorities.

Role and significance: Urban public transport, personal means of transport (hereinafter referred to as personal/private vehicles), traffic infrastructure (infrastructure) and people/traffic participants play an important role in urban development, contributing to meeting the travel needs, passenger and freight transport needs of the city and the people. Due to underdeveloped urban traffic infrastructure, the dominance of personal vehicles and other causes in big cities in Viet Nam, traffic congestion has been created and most countries in the world have to face it. Reducing the number of points and reducing congestion time is of great significance due to reducing economic losses. In addition, it also has social significance; contributing to reducing physical and mental fatigue, stress of urban traffic participants...It helps to reduce environmental pollution, gradually improving urban traffic civilization and culture.

Research methodology: In addition to popular research methods such as analysis, synthesis; statistics, comparison; methods combining qualitative and quantitative; modeling, economic mathematical modeling and integration of factors affecting urban transport, promoting the development of public transport and limiting or controlling the development of personal vehicles, and organizing urban transport, are the methods used in this article.

2.0 RESEARCH WORKS ABROAD

2.1Traffic congestion

Congestion has been recorded in some cities of many countries for a long time, for example Bangkok, Jakarta, Taipei, Tehran, Singapore [1, 2, 10-13, 17, 22], so the goal of most countries is to develop public transport combined with limiting and/or controlling the development of personal vehicles; in developed countries it is private cars, in developing countries it is motor bicycles or prioritizing walking, bicycles, public passenger transport, then private vehicles [19,24]. Many countries have successfully applied TOD-oriented urban development [19], controlling traffic demand, integrating urban transportation and land use, and sustainable development [1,2,10,18,19, 23], including:

- ✓ Synchronously implementing public transport development and limiting personal vehicles such as Taipei-Taiwan, China, some countries in Europe and America.
- ✓ Developing public transport such as the subway in New York, transporting 6 million passengers/day. Paris has the second largest subway system in the world, after Moscow; London has a subway system, transporting more than 1.1 billion passengers per year.

2.2 Traffic congestion costs

Manila contributes to 30% of the Philippines' GDP, but traffic congestion has reduced the country's GDP by about 8% [(1)]. Traffic congestion in the US caused an average economic loss of more than 160 billion USD per year. Without a solution, the loss is about 186 billion USD [(2)]. It is estimated that a car driver in London loses an average of 2,430 pounds per year due to traffic congestion. India spends 22 billion USD per year on rush hour travel in its "capitals" of congestion. According to the Organization for Economic Cooperation and Development - OECD, OECD countries spend an average of 3-5% of GDP per year to overcome traffic consequences [(3)].

2.3 In Viet Nam

2.3.1 Traffic congestion problem

Note: [(1)] Vietnamese' MPI (2022); [(2] Calculation by Texas A&M (2023);[(3]Vietnamese' Finance Magazine (2025).

Congestion is recorded in many big cities, especially in Ha Noi and Ho Chi Minh city. In Ha Noi in 2009, there were 126 congestion points; in 2012, there were 67 congestion points; Ho Chi Minh city had 76 points. In 2016, there were 34 congestion points in Ha Noi; 37 points in Ho Chi Minh city. In 2023, Ha Noi eliminated 15/37 points; in 2024, Ha Noi handled 13/33 points but 16 points arose, leaving 36 points; in Da Nang city, there are 25 intersections and 15 street sections where traffic congestion and conflicts often occur during rush hour. According to the National Traffic Safety Committee-NTSC, eight "black spots" of traffic congestion in Ho Chi Minh city on roads such as:

Nguyen Tat Thanh, Xo Viet Nghe Tinh, Truong Chinh, Nguyen Thi Dinh, Duong Ba Trac - Kenh Xang bridge area; at intersections: Dinh Bo Linh - Bach Dang; An Phu, Thu Duc city; Hang Xanh intersection, Binh Thanh district; an average of 51.06 times/month/spots.

2.3.2 Solutions, measures implemented in large cities

In recent years, Ha Noi has applied many solutions, single or synchronous measures to reduce congestion, traffic accidents, and environmental pollution, including measures and solutions proposed in studies such as:

- Establishing a sustainable urban transport development plan [11,12,13]; building and renovating intersections; constructing overpasses for pedestrians, for motor vehicles and developing public transport by bus, BRT, metro.
- Building and installing traffic signal and light systems; establishing a center: Traffic light control, Urban Transport Management and Operation (Ha Noi), Public Passenger Transport Management and Operation (HCMc)...
- Segregating lanes, traffic flows, regulating operating hours of some types of vehicles in the inner city; banning taxis, trucks, and motorcycles from operating on some road sections during certain hours; moving bus stations to the outskirts; transfer some freight trains from the central railway station to the outskirts of the city.
- Ban pedicab, except tourist pedicab; install cameras at intersections; arrange staggered working hours of agencies, organizations, businesses, schools; use journey monitoring devices, GPS, intelligent transport systems - ITS, etc.
- Limit registration of personal vehicles such as motorcycle in inner-city districts (cancelled); pilot establishment of walking streets, use of electric vehicles to serve tourists; share electric bicycles and bicycles in some areas.
- Propose regulations on the age of use of motorcycles, and private cars (not yet implemented); regulate traffic by hours, routes, and areas. Manage parking in city areas, mainly in the inner city.
- A number of solutions, measures, and proposals with the above contents have been applied, put into implementation, and achieved positive results. However, some are not feasible; others have difficulty in implementation due to limited resources or for other reasons. Most of the measures and solutions proposed in Ha Noi have also been proposed and applied in Ho Chi Minh City and some other major cities.

2.3 Causes of traffic congestion according to factors affecting the urban traffic system

Select factors affecting urban traffic: 4 basic factors are people participating in urban traffic, vehicles participating in urban traffic; urban traffic infrastructure; other factors/undefined factor.

2.3.1 Regarding people participating in urban traffic

Rapid growth rate of mechanical population; high number of immigrants and transients participating in urban traffic.

The awareness of traffic law compliance of some traffic participants has not been improved, especially motorcyclists, students, and pupils; the habit of using personal vehicles.

Coordination in urban traffic management is not continuous; not sustainable; not effective.
Planners do not have a long-term vision, do not meet the requirements.

The arrangement of staggered hours and flexible working hours is not thorough and consistent for organizations, businesses, schools, etc.

2.3.2 Regarding vehicles participating in urban traffic

The number of motor vehicles has increased rapidly and continuously for many years, with some places experiencing an explosion in personal vehicles.

Some old, bad quality vehicles, past their expiry date, causing congestion, accidents, and environmental pollution.

Personal vehicles account for a high proportion, so the demand for travel has increased due to the high speed of motorization, rapid urbanization, transit vehicles, tourism, etc…

The flow of vehicles is diverse, mixed between: motor and rudimentary vehicles; vehicles and motorcycles; passenger and cargo vehicles; bus carrying workers, students, and contracts.

For example, by the end of 2023, the total number of vehicles under Ha Noi managing is over 8 million, of which 13.6% are automobiles; 85.18% motorcycles, the rest are other vehicles; not to mention 1.2 million transit or shuttle vehicles. In 2024, public transport met 19.5% of travel demand, of which urban railways will account for 3.75% of the public share. Land for transport: 12.13%. Current structure in Ha Noi (2024): buses 19.6%; taxis 2.0%; private vehicles are over 70%, the rest are other types of vehicles. Private vehicles increase by 10%/year; motorcycles increase by 8.6%/year in the period 2015-2020. Mechanical population growth rate is 1.4%/year; population density is 2,398 people/km^2, 8.2 times higher than the national population density [(1)].In Ho Chi Minh city (2023): bus 15%, taxi 2.3%, personal vehicle over 70%.

2.3.3 Regarding urban transport infrastructure

Lack of urban transport infrastructure, poore and incomplete; lack of land for urban transport; short, narrow streets, very close distance between nodes, many intersections. *For example, regarding infrastructure:* increase by 0.3-0.6% in Ha Noi; 0.4-0.6% in Ho Chi Minh City. The ratio of land for transportation per urban construction land area is low: Ha Noi reaches 12.13% (2024); Ho Chi Minh city reaches 12.76% (2024), standard 18-26%. Static traffic in Ha Noi reaches a rate of less than 1% (standard 3%) [7,8,9]. Ring roads, radial axes, main axes are lacking or not fully connected. Many existing projects cause stress on urban traffic infrastructure.

Lack of synchronization between traffic and other infrastructure in previous large projects (water supply and drainage, kindergartens, schools, hospitals, etc.).

Traffic space is occupied for other purposes, due to construction, repair of traffic works or other works; many conflict points at intersections, few different-level and multi-level intersections.

Note: [(1)] Ha Noi Department Of Transport - DOT

Many spontaneous-illegal intersections with national railways. Overloaded compared to design traffic volume, disproportionate, not meeting urban development needs.

For example, regarding infrastructure overload, according to the Ha Noi DOT in 2024, compared to the design traffic volume, the traffic volume of bridges and roads increased many times: Thanh Tri bridge 8 times, Chuong Duong bridge 6 times; Nhat Tan bridge 6 times; Nguyen Trai roads 2.5 - 3.2 times; Khuat Duy Tien - Nguyen Xien section 4.3-4.9 times; Le Van Luong roads 2.7-3.3 times...

2.3.4 Regarding other factors or undetermined factors

Higher traffic demand due to stable economic development, rapid urbanization, strong mechanization and green transport.

Slow metro, urban railways; lack of traffic control and monitoring equipment.

Administrative procedures are still cumbersome and complicated. Epidemics, weather, and climate change abnormally.

External impacts such as control/disruption of supply chains; financial and trade conflicts; increased immigration, increased import and export, temporary import and export of goods, vehicles and other force majeure cases.

3.0 INTEGRATING FACTORS AFFECTING URBAN TRAFFIC

3.1The division of urban traffic zones

The division of urban traffic zones in Ha Noi aims to develop public transport, control private means of transport, and sustainably reduce urban traffic congestion. According to the integrated perspective of influencing factors, Ha Noi is divided into 6 types of traffic zones with the following characteristics: width, length, distance between streets, roads; intersections: level or different-grade intersections, distance between intersections; traffic organization: one-way streets, ability to separate lanes between motor vehicles and non-motor vehicles (or between automobiles and motorcycles), population density, number of households, awareness of traffic participants, and are introduced in table 1.

Table 1. Classification of urban traffic zones according to characteristics

Traffic zone	Street, road			Intersections		Traffic organization		Population density	Number of house-holds	Awareness of traffic participant
	Wide	Length	Distance	Level/ differ-rent	Distance	One-way streets, road	Separa- tion of lanes*			
Classic	x	x	x	0	x	0	0	xxx	xxx	xxx
Old	x	x	x	x	xx	x	x	xx	xx	xx
New, newly	xx	xx	xx	xx	xxx	xxx	xx	xx	xx	xx

developed										
Town	xx	xx	xx	xx	xx	x	xx	xx	xx	xx
Adjacent to new urban, rural	xx x	xx	xx	xx	xx	x	xx	x	x	xx
Newlydevelo pedrural	x	xx	xx	x	xx	x	x	x	x	x

*Note: * Separation of automobiles-motorcycles or motor vehicles-non-motor vehicle lanes; 0 is no;* x: *is narrow, short, low;* xx*: average, satisfactory;* xxx*: long, wide, high, good.*
Source [The author's compilation from the reports of Ha Noi DOT]

Ho Chi Minh City and 4 other large cities directly under the Central Government can apply the above urban traffic zone division. However, due to the lack of a classic/ancient zone, there are only 5 types of urban traffic zones, which will be studied in detail when there are plans or projects.

3.2 Concepts related to the development of public transport, control of personal vehicles

Regarding the development of public passenger transport, including criteria and development indicators on the number of routes, means of transport, etc., linking and integrating between types of vehicles, modes of transport and improving the quality of urban transport.

Regarding the management of public passenger transport, including criteria and indicators on the organization and management of traffic; on techniques; on administration; on policies to restrict/encourage development, and criteria, indicators related to urban transport policies.

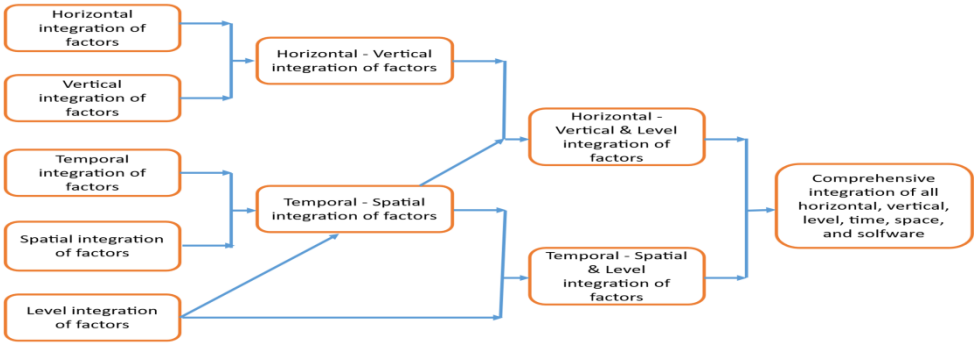
Regarding the management of public passenger transport, there are specific criteria and indicators on the management of one aspect or aspects in a country, a territory, an urban area (city) that are put forward to control/develop, guide vehicle owners and users of public passenger transport in registration, exploitation, operation and use within their scope of management.

Integrating related factors to develop public passenger transport and control the increase of personal vehicle is the connection and integration between a number of single factors or all influencing factors, according to criteria, targets and specific contents to achieve the set goals.

3.3Integration model

The general model for integrating factors affecting urban traffic is introduced in figure 1. Figure 1 shows that, step 1 is the mixed integration of factors horizontally (2-4 factors), vertically (multiple levels), and level (multiple levels). Step 2 is the integration of mixed horizontal & vertical, and spatial & temporal integration. Step 3 is the mixed integration of horizontal & vertical and level, time & space and level; and step 4 is the synthesis integration of all factors and software in urban traffic of Viet Nam's large cities.

Figure 1. Integrated diagram of factors affecting urban traffic congestion



Source [By the author]

3.4Multi - criteria ladder and formulas for integrating factors affecting urban traffic

3.4.1 Integration of affecting factors with multi -criteria ladder

An example of a multi-level, multi-criteria, multi-dimensional model, specifically applied to urban transport, is introduced in figure 2.

Figure 2. Multi-ladder of integration factors in urban transport in big cities in Viet Nam

Source [14, p.8, applied by the Author to multi-criteria urban transport in large cities in Viet Nam]

Explanation of figure 2. Multi-ladder integration:

At the 0 ladder, urban transport has not been integrated and is not sustainable, for example, any city in Viet Nam before.

At the 1st ladder is the integration of information, meaning information about urban transport, for example, buses, metro, route numbers, terminal stations, stops, etc.

At the 2nd ladder is the integration of urban transport services, for example, buses, BRT, urban railways, metro, etc.

At the 3rd ladder is the integration of fares, fees, for example, single-trip and daily fares.

At the 4th ladder is the integration of public urban transport and private transport in the sub- sector, for example, buses and electric bike sharing; parking of motorcycles.

At the 5th ladder is the integration of freight transport and passenger transport, for example, at Noi Bai airport, at Ha Noi railways station.

At the 6th ladder is the integration between the urban transport authority and other authorities in the transport sector, for example, between the Ha Noi Urban Traffic Operation Center and the Ha Noi Department of Transport-DOT, and the Viet Nam Road Administration-VRA.

At the 7th ladder is the integration between urban transport and the environment, land using for example, the Planning and Urban Transport Projects of Ha Noi and Ho Chi Minh City.

At the 8th ladder is the integration of urban transport with health, education, social policies, for example, priority ticket reduction for pupils/students, free public transport for people over 60; and public transport means, urban traffic infrastructure for the disabled.

At the 9th ladder is the integration of urban transport elements with economic and social policies, for example, taxes, land use fees for public transport enterprises; assemblies, spare parts of public transport vehicles that are not yet produced domestically; VAT, import and export...

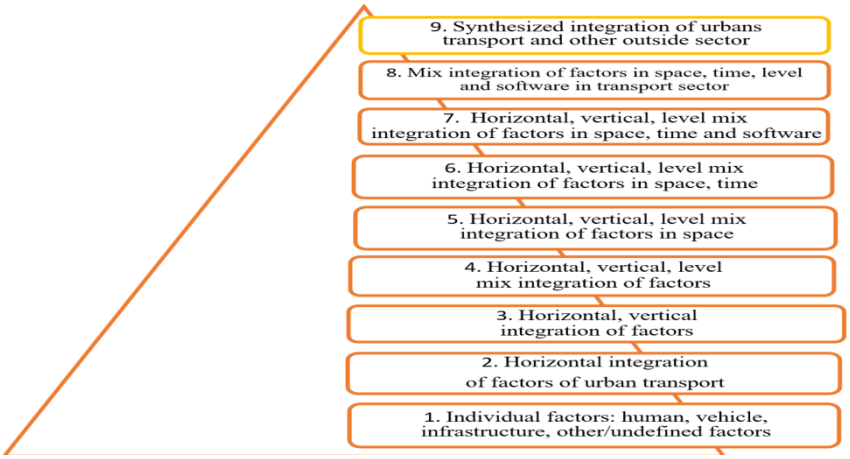
At the top ladder is integrated, sustainable urban transport, which is the goal of urban traffic.

From the 6th ladder up, the order can be changed, because the integration at this time is relative and flexible, the elemental connections are at a high level, macro, rarely expressed directly, and the main tool is invisible, indirect impact.

3.4.2 Pyramid on integration of factors affecting urban transport and mathematical formulas for integration models

a).Pyramid on integration of factors affecting urban transport is introduced in figure 3.

Figure 3.Pyramid on integration of factors affecting urban transport



Source [By author]

Explanation of figure 3:

At the 1st level, there is no integration, meaning that there are only individual factor or at a lower level of integration, which is the connection and linkage of 4 elements: i) People participating in traffic; ii) Urban means participating in traffic, iii) Urban traffic infrastructure, iv) Other/Unknown factors.

At the 2nd level, there is horizontal integration of 4 elements affecting urban traffic. Horizontal integration between organizations and individuals has a higher level of connection, for example, between: urban infrastructure and non-urban infrastructure; urban infrastructure and urban buses; urban buses and long-distance passenger buses; and between types of public transport tickets...

At the 3rd level, there is horizontal - vertical integration of 4 factors. Vertical integration is between levels of urban traffic management, for example, between: public transport enterprises; transport enterprises and bus stations or urban traffic management and operation centers; and between the bus station and the Department of Transport-DOT, Vietnam Road Administration-VRA, Ministry of Transport-MOT, now MOC.

At the 4th level is the horizontal-vertical mixed integration, according to the level of 4 factors. Here, the institutional factor (organization, policy) is present but not yet strong, the hardware/material factor accounts for the majority such as the connection between road systems, routes, road levels in and out of urban areas, at level intersections, different levels/stereo intersections; vertically between: road systems, road levels in the same system; between central and local management levels. According to the level, it can be according to urban/extra-urban road level; vertically: between road systems such as national highways, provincial roads, urban roads, district roads, commune roads...

At the 5th level is the horizontal, vertical, level, and spatial integration of 4 factors. Space here is understood as the national, regional, and provincial territory. Spatial integration of transport is between transport routes of different transport modes in large cities such as between road transport and railway, aviation; between urban public transport and long-distance inter-provincial transport.

At the 6th level is the horizontal, vertical, level, spatial, and temporal integration of 4 factors. Over time, hardware is clearly shown in the construction of intersections, terminals, transit points, TOD points, etc., and software is between the operating charts, schedules of different modes/means of transport, between modes of transport, management levels, etc.

At the 7th level, there is a mixed integration of horizontal, vertical, level-wise, in space, in time and software on factors. Software here is clearly shown in policies, institutions, introduced in the organizational structure; on human resources/high-quality human resources; tax and fee exemptions and reductions for urban means of transport; land rental fees, land use rights taxes, etc., for example, ticket price exemption and reduction policies for people with meritorious services, war invalids, the elderly, students, and pupils; taxes on public transport enterprises, etc.

At the 8th level, there is a mixed integration of horizontal, vertical, level-wise, in space, time and software in the transport sector. The Commander of the industry/Mayor of the city has little impact on urban transport activities because the functions and tasks of each agency, organization, enterprise, and individual are quite clear; there is an assignment of a presiding organization and coordination organization to ensure sustainable effectiveness and efficiency. Specifically: taxes on vehicles, materials, and urban public transport vehicle assemblies; for example, land for public transport enterprises to use as parking lots, garages, warranty stations, etc.

On the 9th level is the integration of factors affecting urban transport in the transport industry and/or with other sectors such as land, environment, finance; irrigation, agriculture, etc. Urban transport strategies, plans, and projects (infrastructure development, public transport, etc.) all have the participation and contribution of many agencies, organizations, and individuals; there is close and effective participation and coordination of agencies, organizations.

From the 6th level up, the order can be changed, because the integration at this time is relative and flexible, the elemental connections are at a high level, subtle, macroscopic, and rarely expressed directly.

b). *Mathematical formulas for integration models*

Horizontal integration between factors affecting urban traffic:

$$\sum_{i=1}^{m} F_{\text{hor}} \quad (3.1)$$

Vertical integration between factors affecting urban traffic:

$$\sum_{j=1}^{n} F_{\text{ver}} \quad (3.2)$$

Horizontal-vertical mixed integration between factors:

$$\sum_{i=1}^{m} \quad \sum_{j=1}^{n} F_{\text{horvermix}} \quad (3.3)$$

Horizontal, vertical and level mixed integration between factors:

$$\sum_{i=1}^{m} \quad \sum_{j=1}^{n} \quad \sum_{j=1}^{n} F_{\text{horverlevmix}} \quad (3.4)$$

Mixed horizontal, vertical, level & spatial mixed integration between factors:

$$\sum_{i=1}^{m} \quad \sum_{i=1}^{m} \quad \sum_{j=1}^{n} F_{\text{horverlevspacemix}} \quad (3.5)$$

Horizontal, vertical, level, temporal mixed integration between factors:

$$\sum_{i=1}^{m} \quad \sum_{i=1}^{m} \quad \sum_{j=1}^{n} F_{\text{horverlevtimemix}} \quad (3.6)$$

Horizontal, vertical integration & level mixed integration between the influencing factors in space and in time:

$$\sum_{i=1}^{m} \quad \sum_{j=1}^{n} \quad \sum_{k=1}^{o} F_{\text{horverlevspacetimemix}} \quad (3.7)$$

Horizontal, vertical & level integration between the influencing factors in space, time and software mixed integration:

$$\sum_{i=1}^{m} \quad \sum_{j=1}^{n} \quad \sum_{l=1}^{p} F_{\text{horverlevspacetimesolfwaremix}} \quad (3.8)$$

Mixed horizontal integration, vertical integration and level integration between the influencing factors in space, time and software mixed integration in the urban transport sub-sector:

$$\sum_{i=1}^{m} \quad \sum_{j=1}^{n} \quad \sum_{k=1}^{o} \quad \sum_{l=1}^{p} F_{\text{horvesoftwareS3}} \quad (3.9)$$

Comprehensive integration between urban public transport and external/other sectors:

$$\sum_{i=1}^{m} \quad \sum_{j=1}^{n} \quad \sum_{k=1}^{o} \quad \sum_{l=1}^{p} \in . Fhorverlevspacetimesoftware_{\text{horverlevsoftwareS3}} \rightarrow \max \quad (3.10)$$

Where:∈ is an empirical coefficient; Int $F_{horverlevspacetimesoftwaretransmixSy1}$; Int $F_{horverlevspacetimesoftwaretranSy2}$ is a binary variable depending on the horizontal integration between urban passenger transport and other sectors; vertical integration between management levels in urban passenger transport; level integration in urban passenger transport; mixed integration between horizontal, vertical & level in space, time and synthesis integration between all the above factors and integration with software.
This is a function with binary variables:

$$IntF_{horverlevspacetimesoftwareSy1/2} = \begin{cases} 1, if\ x \exists\ [horverlevspacetimesoftwaretranSy2] \\ 0, if x \nexists\ [horverlevspacetimesoftwaretranSy2] \end{cases} (3.11)$$

Where:
F is the factor affecting urban passenger transport; *other* is other sectors (such as environment, land, etc.); *hor* is horizontal integration; *ver* is vertical integration; *lev* is level integration; *horvermix* is horizontal and vertical mixed integration; *Sy* is horizontal, vertical, level, spatial, temporal and software synthesis integration; *m* is the number of factors; *n* is the number of management levels in urban passenger transport; *y* is the number of a type levels of integration; *l* is the level of integration of the urban transport sub-sector; with the following constraints:

m,n,o,p > 0; min $\leq$ horizontal, vertical, level integration; mixed integration, synthesis integration $\leq$ max;
In which,
Int $F_{horverlevmix}$→min = minimum integration (no integration, discrete, separate or newly connected/linked elements $\geq$ 0); $IntF_{horverlevspacetimesoftwareSy}$ max =>horizontal, vertical, level mixed integration and maximum synthesis integration, both in terms of software and hardware.

That is a multi-factors or multi-criteria, multi-dimensional model, specifically applied to urban traffic in large cities in Viet Nam, so the integration model must to develop further.

3.5 Assessment of feasibility and sustainable economic efficiency

a) Feasibility: In terms of preliminary assessment of feasibility, it can be seen that the proposed integration/solutions are quite feasible, especially the solutions integrating 4 criteria and indicators affecting urban traffic. Criteria and indicators such as urban traffic organization and organizational structure are being implemented during the implementation process of government members according to the laws, which are both low-cost and can be implemented immediately. Urban infrastructure development within the locality is carried out according to the law on local government organization. Urban traffic infrastructure is being implemented according to approved planning, projects to renovate, upgrade and build new infrastructure are being implemented and continue to be implemented, and including projects to respond to floods and prevent sedimentation, except for some newly approved ones that will be slower. Regarding means of transport, most of them also follow approved programs and projects such as the green transport program, developing urban public passenger transport in big cities. Regarding people or traffic participants, the awareness of obeying urban road traffic laws of youth, students and pupils, it is necessary to have feasible measures and solutions that are breakthrough, special, suitable, effective, efficient.

b) ***Effectiveness:*** According to the middle model [18], sustainable includes 4 criteria: economy and development, land and environment, culture and heritage, society and people with a system including many criteria and indicators to assess the sustainability of urban transport.

Assessment of the effectiveness of sustainable development of urban transport according to the above 4 a criterion is shown as follows:

- *Regarding land and environment:* the goal is to save land and reduce pollution. New policies combined with promoting the digital revolution 4.0, innovation can be seen, the criteria on land and environment will be significantly improved such as reducing the use of land on the ground by taking advantage of underground space, space above the ground in urban transport, combined with reforming traditional craft villages, reforming livestock and farming in rural zones, newly developed rural zones and rural adjacent zones. These will reduce greenhouse gas emissions -GHG, reduce emissions of old means of transport, overdue use, increase the use of environmentally friendly vehicles, eliminate polluting fuels, reduce emissions of toxic gases such as CO, CO_2, dust PM_5, PM_{10} and noise pollution...Therefore, in the long and medium term, pollution in big cities will be gradually reduced. This will be carried out through specific programs, projects, and plans developed and implemented by cities.
- *Regarding society and people:* the goal is to improve the sustainable social and human efficiency of the urban transport policy, so its efficiency is quite high due to improving labor distribution, production-consumption locations, moving factories and enterprises outside the urban center or outside the 3rd ring road of large cities; creating more new jobs, redistributing income more fairly; arranging and redistributing residential areas and points, thus contributing to increasing productivity and income of workers; sustainably reducing poverty in rural zones, newly developed urban zones, liberating direct labor, applying new technology, new types of vehicles in urban transport. The assessment of the social and human sustainability of the urban transport policy can be done by both qualitative and quantitative methods.
- *Regarding culture and heritage:* the goal is to preserve and protect existing cultural works and heritages, so in addition to preserving heritages, it is necessary to search for, discover, and excavate undiscovered heritages and cultural works that need to be protected in order to properly and fully implement current policies; amend and modification when necessary, especially in implementing and bringing urban transport policies into life.
- *Regarding economy and development:* the goal is to meet the needs of economic development, reduce investment costs in construction and exploitation of urban traffic infrastructure, and rationalize the process to serve the sustainable development of large cities. People often evaluate economic and development efficiency or economic feasibility by the EIRR indicator [11] with the requirement that EIRR $\geq$ 12%. Economic efficiency by 2030 can increase significantly, from 10-20% at the normal level, when applying a few criteria individually, and when integrating horizontally, vertically, and at the level of many criteria and indicators, it can increase to 25-30% or more. Development of urban transport infrastructure such as expressways can reach over 15% for some routes and sections with high traffic volume when evaluating some individual criteria/indicators, and for mixed integration, it is higher, because economic feasibility can be more than 20%, and financial feasibility is at least more than 0% (more than 5% is good, the higher the better). In reality, the current economic development efficiency reaches a minimum of about 10%, and the maximum can be up to 45-50%, which

means more than the damage caused by urban traffic congestion. Similarly, for financial feasibility (FIRR), few urban transport projects and proposals are highly financially efficient (>10%) and are more difficult to predict. If combined with the strong trend of transition to digital, circular economy, combined with the aim of taking advantage of the strengths of existing resources combined with promoting the application of the 4.0 industrial revolution, then it can reach 44-50%. In short, it can be seen that the basic criteria will be significantly improved.

Preliminary estimates when applying the solution of integrating the influencing factors according to the multi-levels of pyramid: 1st level according to individual factors can reduce congestion by 1-3%; horizontal integration – 2nd level: reduces from 4-5%; horizontal and vertical mixed integration – 3rd level: reduction from 6-10%; horizontal, vertical, level mixed integration - 4th level: reduction from 11-20%; horizontal, vertical, level, spatial mixed integration – 5ft level: reduction from 21-30%; horizontal, vertical, level, spatial, temporal mixed integration - level 6th: reduction from 31-35%; horizontal, vertical, level, spatial, temporal and software mixed integration – 7th level: 36-40%; integration of 4 factors in the transport sector – 8th level; and comprehensive integration of transport with other sectors - 9th level: reduction from 41-50%. However, the efficiency of the impacting factor in GRDP will be 2-3% lower. The effectiveness achieved depends on the implementation level in a special or category 1st central city, whether it is implemented in the year or after 2025, and the implementation conditions, barriers, and support of urban leaders and residents.

- ✓ *General economic efficiency:*
- Contribution to urban GRDP growth (%): the proposed solution contributes to increasing the city's GRDP income by reducing losses due to traffic congestion, reducing additional investment costs; increasing rest time of people, contributing to labor productivity; increasing the dynamism and creativity of workers, minimizing environmental pollution...
- ✓ Economic losses [7,17,21] caused by urban traffic congestion are calculated according to the formula:

$$L_{pax} = N_{pax} x\ t_{con} x 365\ x\ I_{day/hour}\ (12),$$

In which:

- *o L_{pax}:* loss of congestion (VND, USD);
- *o t_{con}:* is the average number of hours each passenger and driver have to stop on the urban road due to traffic congestion (hours/day);
- *o N_{pax}:* is the average number of passenger and driver stuck in traffic congestion per day, per hour (pax);
- *o $I_{day/hour}$:* is the average time value of passenger and driver or the economic value that a driver and passenger create on average in a day or an hour of work (VND, USD).

Efficiency: preliminary calculations can reduce 25 - 35% of economic losses due to congestion, so Ha Noi still loses 2 billion USD; Ho Chi Minh City still loses 4 billion USD annually. This is a huge amount of money. Thus, residents can use the money to invest in other areas or rest and recuperate; the country and city can invest in other urban transport projects.

4.0 CONCLUSION, RECOMMENDATIONS

***Conclusion*:** The paper has used appropriate research methods to develop a mathematical model, integrating factors affecting urban traffic after analyzing the current status of urban traffic congestion in some cities in the world and in Ha Noi, Ho Chi Minh City and some other large cities in Viet Nam, selecting impact factors, criteria, indicators; proposing models, solutions to integrate those factors and quickly assess the efficiency and economic losses. Integrated solutions have been applied by many countries, especially developed industrial countries for a long time due to economic development, urban traffic, favorable resource conditions, allowing. In Vietnam, up to now, there has been almost no in-depth, complete, comprehensive research on solutions to integrate factors affecting urban traffic and apply them to the specific traffic conditions of the capital Ha Noi, Ho Chi Minh City and 4 other large centrally-run cities. Hopefully, in the coming time, some solutions integrating factors affecting urban traffic mentioned above will be further specifically studied, implemented, and put into practical application to partially solve the problem of urban traffic congestion, thereby contributing to reducing environmental pollution, minimizing traffic accidents, and raising legal awareness of urban traffic participants in big cities. On the other hand, accelerating the construction of mass rapid public transport such as metro and urban railways is a necessary and sufficient condition to meet travel needs, contributing to the development of public transport, controlling the development of personal vehicles, prioritizing walking and rudimentary vehicles, which is an indispensable condition for Vietnamese urban areas today and in the future to develop sustainable urban areas, preserve cultural and historical heritage; linked with strategies, planning, regulations, urban traffic standards, towards building civilized, modern, smart urban areas; developing science and technology associated with digital transformation, innovation; building urban traffic culture; raising awareness of innovation and creativity; innovating thinking, science and technology; building cities with little/no traffic jams, net zero emissions, and significantly reducing urban environmental pollution in large cities.

Recommendation: The Vietnamese Government, ministries, branches, and People's Committees of large cities should soon issue regulations for piloting the application of some integrated solutions while there are no regulations; recommending the Vietnamese Government and the Prime Minister to promptly issue other legal regulations to create a complete legal corridor for the implementation of the proposed integrated solutions for factors affecting urban traffic.

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