Applying forecasting demand for traffic model at Hai Phong, Vietnam

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Abstract

Traffic demand forecasting is a crucial step in the process of urban transportation planning, management, and operation. In developed countries around the world, the application of forecasting models is almost mandatory and brings significant benefits. However, in Vietnam, there have been relatively few studies on the application of traffic demand forecasting models. This research introduces the application of such a model in Hai Phong City and identifies the challenges and solutions to improve the implementation of traffic demand forecasting models in Vietnam. We believe that these results will support policymakers and researchers with a basis for enhancing the effectiveness of urban transportation planning, management, and operation. By applying forecasting models, decision-makers can make more informed choices, leading to better traffic management and more efficient transportation systems in Vietnamese cities. The study's insights are expected to contribute to the overall improvement of transportation policies and practices in the country.

Key words: *public transport; modelling transport; Hai Phong*

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1. Introduction

The forecasting of transportation demand plays a crucial role in urban transportation system planning. Currently, there are several methods for forecasting transportation demand, including extrapolation method, Fratar method (USA), Detroit method used in the city of Detroit, USA, and the gravity model, also known as the 4-step model [1]. In Vietnam, some projects have used a four-step transportation model, such as:

1. The Urban Transport Support Project in Vietnam in 1993, supported by the Swedish International Development Cooperation Agency (SIDA).

2. The Comprehensive Transportation Master Plan Study for Hanoi in 1996, supported by the Japan International Cooperation Agency (JICA).

3. The National Strategy for Transport Development in the Socialist Republic of Vietnam (VITRANSS).

4. The Comprehensive Urban Development Program for Hanoi, Socialist Republic of Vietnam (HAIDEP).

5. The Transportation Master Plan for Hanoi until 2030 with a vision until 2050, conducted by the Transport and Transportation Design Consultancy Corporation.

Transportation demand forecasting is a critical step in the process of urban transportation planning, management, and operation. Across the world, the use of various forecasting models has led to better planning, construction, and management of transportation systems. In Vietnam, there has been some initial progress in applying transportation demand forecasting models. However, on the whole, these models are not yet widely used, resulting in transportation systems' development not meeting expectations, reduced service levels, and various adverse effects such as traffic congestion and environmental pollution. As of 2020, the transportation sector accounted for approximately 27% of global greenhouse gas emissions [2], leading to increased transportation costs and significant pressure on the economy, society, and the environment.

In the Vietnamese Construction Standards 01: 2008/BXD, it is stipulated that urban planning must forecast the demand for passenger and cargo transportation as well as various types of transportation within the city to determine the land allocation for future transportation development [3]. On May 19, 2021, the Ministry of Construction issued the standard 01: 2021/BXD, which also requires urban transportation planning in general planning projects to forecast the demand for passenger and cargo transportation and the composition of transportation means [4]. Over the past 10 years of applying these standards, the forecasting of transportation demand has not been implemented uniformly nationwide. One of the main reasons is the lack of sufficient databases and human resources for conducting transportation demand forecasting. Additionally, the costs of forecasting software and surveys are relatively high.

Hai Phong is one of the five centrally-governed cities in Vietnam. It holds the following characteristics: It is a type I urban area directly governed by the central government, a significant economic hub for the country's coastal region in the North, and a center for education, healthcare, and scientific and technological research in the North Coastal area. Hai Phong is a green, modern, and civilized port city that serves as a transportation and communication hub for both domestic and international exchanges. It also holds a strategically important position in terms of national defense and security [5]. Given its role as a transportation hub, forecasting transportation demand becomes crucial for providing guidance in planning and formulating policies.

Based on these characteristics, the research team has initially applied a transportation demand forecasting model in Hai Phong City, Vietnam. The model utilized is the 4-step model. (These are: trip generation, trip distribution, modal split and traffic assignments).

Fig. 1. Illustration of the Four-step transportation model, [7]

The four-step transportation model is a ubiquitous framework for determining transportation forecasts that goes back to the 1950s. It was one of the first transportation demand models that sought to link land use and behavior to inform transportation planning [6]. Originally applied in the highway planning context, the model was expanded in the 1970s and 1980s to include multimodal trips and improved modelling techniques [6].

We believe that the results of this study will contribute to a better understanding of the application of the transportation demand forecasting model in Hai Phong City, as well as the challenges faced during its implementation. The study also proposes some solutions to overcome these difficulties, ultimately improving the effectiveness of urban transportation planning, management, and operation.

The remaining parts of the study consist of four sections. Section 2 presents the steps involved in constructing the forecasting model. Section 3 presents the main results. We will discuss these findings in Section 4 and provide our conclusions in Section 5.

2. 4-step transportation model

There are many methods of forecasting transportation demand such as: Extrapolation method, Fratar method (USA), Detroit method (Detroit city of USA), Gravity method, also known as 4-step modeling method which are applied in the results this study:

2.1. Step 1: Generate and attract trip

Regression analysis is a statistical method in which the mean value (mean) of one or more random variables is predicted based on the conditions of other (calculated) random variables.

The general regression model involves:

$$Y_i = a_i + p_1X_1 + P_2X_2 + \ldots + P_nX_n + S_i \quad (1)$$

Of which:

Y_i = the number of itineraries arising in i;

a_i = real number;

$p_1 \ldots p_n$: = regression coefficient; $X_1 \ldots X_n$ = random variable (variables representing a factor affecting the number of trips such as population, household...;

S_i = correction coefficient (balance); a_i, p_I, $p_2 \ldots P_n$, S_i are determined by regression method.

2.2. Step 2: Trip Distribution Model

$$T_{ij} = P_i \left[\frac{A_j F_{ij} K_{ij}}{\sum_j A_j F_{ij} K_{ij}} \right]$$

The most common method to determine the journey distribution is to use Gravity mode, which specifies the number of journeys between the origin and the destination as a function of inbound and outbound calculation (OD attribute) and transportation cost between them.

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

Of which:

T_{ij}: Itinerary from region i to region j;

P_i: Total journeys arising from region I;

A_j: Number of journeys absorbed into region j;

F_{ij}: Impedance coefficient, usually a function inversely proportional to the transportation time between i and j;

K_{ij}: The socioeconomic adjustment coefficient for journeys originating from i and to region j, usually is 1.

2.3. Step 3: Modal Split Model

The most popular method is the Logit model.

The general formula is:

$$P_i = \frac{e^{U_i}}{\sum_j e^{U_j}} \quad (3)$$

Of which:

P_i: Ability to choose method i;

U_i: The utility function of the method i, the function has the form;

$U_i = \alpha + \beta_1 . X_1 + \beta_2 . X_2 + \ldots + \beta_n . X_n$

Of which:

$X_1 \ldots X_n$, are the attribute variables depending on model I;

α is a constant;

β_1, $\beta_2, \ldots$, β_n are the coefficients representing the components it incorporates in utility functions. This constant, coefficients can be determined by regression method.

2.4. Step 4: Trafic Assignment

To assign traffic on traffic networks use the function BPR (Bureau of Public Roads) which is a function of traffic delay used commonly. The variables used in this function are traffic volume, traffic capacity α, β. The formula for the traffic delay function is as follows:

$$T = T_0 \left[1 + \alpha \left(\frac{V}{C} \right)^{\beta} \right] \quad (4)$$

Of which:

T_o = Free Flow Trip Time;

V = Link Trip Flow;

C = Link Capacity;

α, β = Parameter.

3. Results

To forecast the transport demand, it is necessary to follow 3 phases: input data preparation stage, 4-step forecasting model application stage, output completion stage (see figure 2).

- Zoning, building and simulating transportation network:

Hai Phong is divided into 158 regions. Of which, 113 regions are based on administrative boundaries, land use planning; 12 regions are neighboring localities; 25 are industrial zones, 8 are towns.

The need to generate and attract from 158 regions is shown through the origin-destination (O-D) matrix. From this O-D matrix the traffic will be concentrated to the center of the region (centroid) and then will form virtual links. Road network is built based on the current status and general planning orientation of Hai Phong city until 2025.

- Cruise distribution: A common method to determine the trip distribution is to use an attractive distribution model.
- Method devision

According to the development orientation of the public transport use rate in 2025, Hai Phong city is expected to be 10%. The most common method used is the Logarithmic model.

Result: Determine the number of itineraries from each region to another which are organized by different traffic patterns.

- Transportation assignment

To assign traffic on traffic networks, people often use BPR (Bureau of Public Roads) which is a function of traffic delay commonly. The two parameters α and β used to be taken into account by the results this study are 3.59 and 0.4. After being put into the model, the results of traffic distribution on the road network are shown (see Figure 6).

4. Discussions

The urban transportation model of Hai Phong City is built on a 4-step model. In this model, the city is divided into 158 zones: including 113 zones within the city, 12 zones in neighboring localities, 25 zones in industrial areas, and 8 zones representing towns. The Transcad software, which was previously used in the Urban Transport Development Project in Hanoi, was employed for the analysis [9]. After running the 4-step model, the study generated traffic flow results distributed across the city's road network.

The results of traffic flow analysis using the 4-step model have revealed that many future planned road networks exceed the traffic capacity. If the research results are highly accurate, it will be valuable for policymakers to consider and implement solutions to alleviate future traffic congestion.

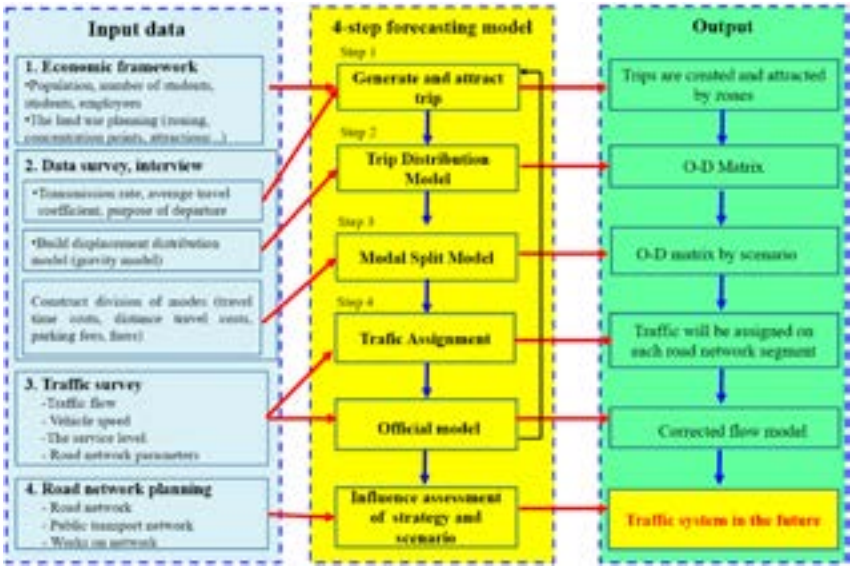

Fig. 2. Transport demand forecasting diagram

Fig. 3. Traffic Zoning in Hai Phong City

Fig. 4. Length of some roads in Hai Phong City

Collecting the necessary data for transportation demand forecasting indeed requires a relatively long period of time and significant financial resources. In this study, some of the traffic demand survey data were obtained through surveys conducted by the Department of Transport of Hai Phong City [8]. Some data used include household interview data, vehicle count data at traffic hubs, average travel

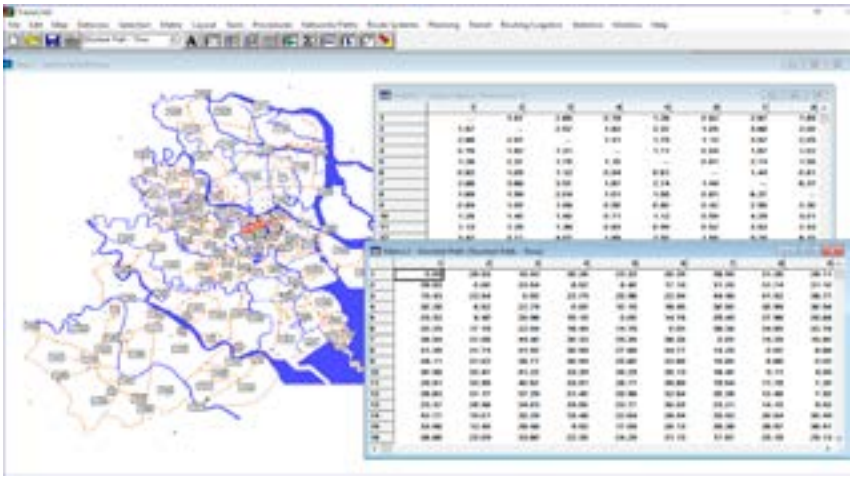

Fig. 5. Itinerary matrix among regions

Fig. 6. Itinerary matrix among regions

coefficient...The lack of a comprehensive database is a critical issue faced not only by Hai Phong City but also by other municipalities in Vietnam. To achieve higher accuracy in applying the traffic demand forecasting model in Vietnam, it is essential to collect and survey the following key data:

1. Economic Framework Data: This includes population data, the number of students, workers, etc. Economic data provides insights into the transportation patterns related to work, education, and other activities.

2. Transportation Survey Data: Conducting transportation surveys and interviews to gather information about the percentage of trips completed, average trip rates, trip purposes, etc., are essential for developing trip distribution models on the current transportation network.

3. Traffic Survey Data: Gathering data on traffic flow, vehicle speed, road capacity, level of service, network characteristics, and traffic resistance is necessary for trip assignment and evaluating transportation network performance.

To achieve good results in applying the traffic demand forecasting model in Hai Phong specifically and Vietnam in general. We need to tackle the following problems:

Firstly: Complete the mechanism of policies and laws, which make it mandatory to apply the traffic demand forecasting model in the planning, management, and operation of the transportation system.

Secondly: Train a highly specialized workforce in the fields of planning, management, and operation of the transportation system. Prepare them to utilize and operate the forecasting models for controlling the traffic system effectively.

Thirdly: Establish a digital traffic data survey database with regular annual updates in various areas, such as population, household age structure, occupation, average income per capita, traffic participation habits, traffic flow, and transportation volume on urban and suburban roads, and so on. These data will serve as the foundation for urban planners to determine crucial parameters for land use planning and transportation planning. Vietnam currently lacks mandatory laws and regulations requiring the collection of annual statistical data in these areas, making it challenging to apply the forecasting model effectively.

Fourthly: Establish a roadmap for constructing the network data: To incorporate the network into the calculation and application of the Geographic Information System (GIS) for the urban transportation network, it must be represented in an appropriate format. In Vietnam's planning law of 2017 [10], it was mandated to establish a provincial planning database. However, in the urban planning law of 2009, which has not been amended, there is no compulsory requirement for establishing a database to serve future planning, management, and operation [11].

Fifthly: It is necessary to conduct regular socioeconomic surveys at the commune and ward levels, including information on the socioeconomic status, population, income, ownership, and vehicles in these areas.

5. Limitations and conclusions

The application of the traffic demand forecasting model in Hai Phong City, Vietnam, using Transcad software, involves a large dataset with 158 zones. The results of applying the model indicate that many city road networks in the future will exceed their traffic capacity. Additionally, the issue of data collection for running the model poses challenges specific to Hai Phong and Vietnam in general. Furthermore, the study highlights the necessity of surveying and gathering essential databases.

The research also provides recommendations for the improved application of the forecasting model in urban transportation planning, management, and operation in Vietnam. The findings of the current study contribute to both practical and academic aspects. Firstly, they serve as a valuable reference for policymakers and researchers in the transportation field to enhance the quality of urban transportation planning, management, and operation. Secondly, the study opens up avenues for further research related to the application of traffic demand forecasting models in Hai Phong and other Vietnamese cities.

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on residential and construction business, land use rights business, real estate project transfers, real estate business contracts, real estate service business, the establishment and management of information systems and data related to housing and the real estate market, and state management of real estate business.

b. Regulations on businesses dealing with future-formed construction projects

Establish a legal framework for this type of real estate to ensure transparency and protect the legitimate rights of investors, customers, and buyers while complying with the principle of non-retroactivity. Introduce new prohibited acts, including collecting money for the sale or lease-purchase of future-formed real estate that does not comply with regulations. Prohibit using illegal means to secure the future-formed real estate payment from the buyer or lessee, ensuring consistency and coherence with the Civil Code, Investment Law, and better alignment with practical conditions.

Clarify the necessity and grounds for proposing regulations, especially based on practical conditions and where necessary. Avoid duplicating content already stipulated in the Civil Code regarding the "deposit" in future-formed real estate transactions.

Improve the legal basis for the operation of professional and efficient real estate trading floors. Research provisions to allow parties to choose whether to transact through the trading floor or not, to ensure their interests due to the lack of practical basis and uncertainty about the necessity. [5]

6. Conclusion

The Fourth Industrial Revolution, also known as Industry 4.0, is gradually permeating every aspect of life, and the real estate market is no exception to this trend. A stable and healthy real estate market will have a positive impact on the country's economic and social development. On the other hand, an unstable real estate market, irrational prices, or prolonged stagnation will have negative effects on economic development, creating difficulties in providing housing for the population and leading to various social issues.

Studying the current situation of the real estate market in Vietnam, many businesses and investors are concerned, and individuals with actual needs are also uncertain about whether this is the right time to invest in land or housing.

In the coming time, the Vietnamese real estate market will undergo filtration and adjustment, and investors' capital allocation will be carefully calculated and more rational. Along with the improvement of policies to develop a healthy real estate market, promising opportunities for high-profit investments will emerge for both customers and the real estate market as a whole./.

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However, the study has certain limitations, including the quality of the input dataset and the consideration of various scenario divisions for different transportation modes, which might affect the model's accuracy. Nevertheless, despite these limitations, the application of the forecasting model has shown promising results compared to not using any forecasting model. Therefore, future studies are proposed to involve surveying and collecting data with multiple years' worth of data, running the model with various scenarios (such as with and without public transportation, and different planning stages) to further enhance the accuracy and robustness of the research.

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