DESIGNING ENVIRONMENTAL INFORMATION MANAGEMENT SYSTEM ON ROAD TRAFFIC ACTIVITIES IN VIETNAM

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Summary: *The urbanization and construction of transportation system in our country has been growing explosively in recent years. On the other hand, the ever-increasing number of vehicles, especially used cars and motorbikes, as well as the rapid deterioration of old roads has resulted in a high level of pollution. This alarmning situation has significantly affected the quality of life of people who live on the deteriorated roads and in crowded urban areas. Hence, there is an urgent need of innovative solutions for managing and controling transportation infrastructure including roads, highways, boulevards, sidewalks, and bridges so that the air pollution level can be reduced. The aim of this paper is to propose an efficient system design for environmental information management in road traffic activities. The proposed system will help collect, store, and provide accurate, timely, and realiable information served for enviromental management and protection policy planning activities in Vietnam.*

Key words: *Environmental information management, road traffic, database system.*

I. INTRODUCTION

There are a wide range of different types of transport available to people in Vietnam, including: 255,739 km of roads, 2,995 km of railways, 15,000 km of rivers exploited, 49 seaports and 22 airports. Along with the process of industrialization and urbanization, there has been a rapid increase in means of transport, especially in urban areas. According to latest statistics from the Vietnam Ministry of Transport, there are nearly 30,000 cars and 700,000 motorcycles registered every quarter in Vietnam. It is estimated that there are currently more than 2 million cars and 43 million automobiles, and motorcycles all over the country. According to the Vietnam Register, there were almost 2.5 million of motor vehicles technical safety inspected in 2016 and the annual number of inspected motorcycles continues to decline. In the past 4 years, it is calculated that there are about 3 million motorcycles sold every year. Thus, there will be additional 18 million motorcycles taking part in traffic until 2020.

Meanwhile, in urban areas, public transportation has not been adequately invested to meet

the travel demand and to reduce the number of personal vehicles. Additioally, most of personal vehicles in Vietnam are powered by gasoline and/or diesel. There is only a very small number of peronal vehicles that use clean fuel. Moreover, the quality of vehicles is another issue. For example, most of the vehicles are old and not regularly maintained. This will significantly increase the air pollution. Also, a large number of roads are narrow, degraded, unplanned and unsynced, which fails to meet the travel demand. Furthermore, the low awareness of traffic participants causing traffic jams is another significant factors exacerbating the air pollution problem, especially in large cities such as Hanoi and Ho Chi Minh. The air pollutants are mainly generated by emissions from the combustion of motor fuel consisting of CO, NO_x, SO_2, fuel steam (C_nH_m, VOC_s), PM10 ... and dust swept by sand flying from the surfaces of roads during the moving process (TSP). Therein, motorcycles account for a large proportion in the emissions of pollutants CO, VOC, TSP; cars and other categories of automobile account for a large proportion of the emissions of SO_2, NO_2. The amount of emissions, dust,…and pollutants is increasing every year along with the growth in the number of road vehicles. Specifically, the concentration of dust in the air in cities such as Hanoi, Ho Chi Minh City, Hai Phong, Da Nang, ... at the intersections is from 3 to 5 times as high as the standard allowed; the daily average concentration of CO, NO2 at some major intersections has exceeded the permissible standard from 1.2 to 1.5 times [2].

II. AIR POLLUTANTS

The air environment in urban areas is affected by aggregate emission sources. For the past five years, urban air quality in has not been considerably improved. In general, the high dust concentration is one of the most worrying problems, especially in urban areas. At the near-road monitoring stations, the number of days with the air quality index (AQI) under the recommended safety threshold for public health (because PM10 dust concentration exceed the limit QCVN 05:2013/BTNMT - National Technical Regulation on Ambient Air Quality [3]), still takes a large proportion. Besides, the concentration of NOx in the air exceeds the permitted standard QCVN, which also contributes significantly in the days with AQI value over 100 [1].

2.1. Particulate Matter:

Particulate Matter is an indicator for air pollution in Road Traffic activities. Particle pollution in urban areas can be reflected in Total Suspended Particles (TSP), PM_{10} and fine dust ($PM_{2,5}$ and PM_1). It is noticeable that fine dust particles are usually acidic, small diameter long-lasting in the atmosphere, scatter in the large area and has more impacts on human health than dust (neutral). Particle pollution is concentrated in urban areas with high traffic density and sometimes the pollution level exceeds the permitted threshold from 2 to 6 times according to QCVN 05:2013/BTNMT. The concentrations of PM_{10}, $PM_{2,5}$ and PM_1 often increase in rush hours because the number of vehicles at this time is usually the highest of a day.

2.2. Gas Emissions:

NO, NO_2, NO_x gases: They are mostly released from transportation activities, therefore, the changing trend of these parameters is similar to dust parameter's. Specifically, the concentration of NO tends to increase in morning and afternoon rush hours. NO_2 is a metabolic compound of NO in the air environment, as the result, NO_2 concentration usually rapidly increases when NO scatters in the air. NO_x is the combination of these two gases and reflects the general pollution level of both.

SO_2, CO *gases:* SO_2 is emitted from sulfur fuel oil (for instance, buses) while CO is released from car and motor engines. Both of them have negative effects on human health. The concentration of CO usually has the maximum value in morning and afternoon rush hours. The results of the continuous air monitoring station show that SO_2 tends to decrease in every province and city all over the country. To the provinces with developed traffic, the concentration of SO_2 is usually higher.

Lead in Air: The recent results of air quality monitoring show that the annual average of lead concentration in ambient air is below allowable limits according to QCVN 05: 2013/BTNMT. This is because the government has banned the use of leaded gasoline.

2.3. Noise

Noise pollution is generated in arterial roads with high density of vehicles. The noise levels measured in the main traffic routes in Vietnam all exceed the allowable level QCVN 26:2010/BTNMT - National Technical Regulation on Noise [4] regarding the time between 6pm and 9pm (70dBA). In small and medium cities, the noise levels measured in most traffic roads neither make considerable differentiation nor ensure the QCVN limits. The results of noise measurement in residences still stand somewhere in the standard threshold of QCVN.

III. THE ENVIRONMENTAL INFORMATION MANAGEMENT SYSTEM (EIMS) IN ROAD TRAFFIC

In the recent years, environmental pollution has caused bad effects to the ecosystem and community health. Thus, Government has paid much attention to managing and supervising environmental pollution in the ecosystem generally and in urban environment particularly. To support managing and supervising the extent of environmental pollution caused by road traffic activities, the research group would like to recommend the method of designing database system for environmental information management in road traffic activities as follows:

The Environmental Information Management System (EIMS) model in Road Traffic activities is respectively identified with the State Administrative management model. Accordingly, the model consists of two levels (Fig. 1) namely a central level EIMS (called the national level) and a local-level EIMS (also known as the provincial level). Additionally, depending on the objective of the management, it may have a regional level EIMS (includes some provinces).

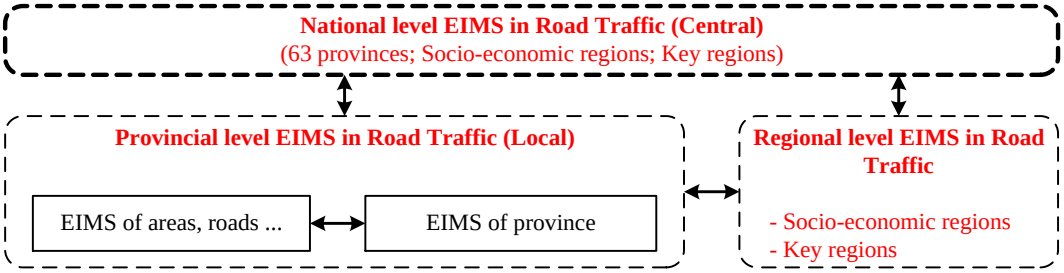

Fig. 1. *The Environmental Information Management System model in Road Traffic.*

The management of environmental information uses these following 8 environmental management indicators: TSP concentration; NO concentration; NO_2 concentration; NO_x concentration; SO_2 concentration; CO concentration; Pb concentration and noise indicators. The EIMS was build on the information system of each province. The overall architecture of the EIMS in Figure 2.

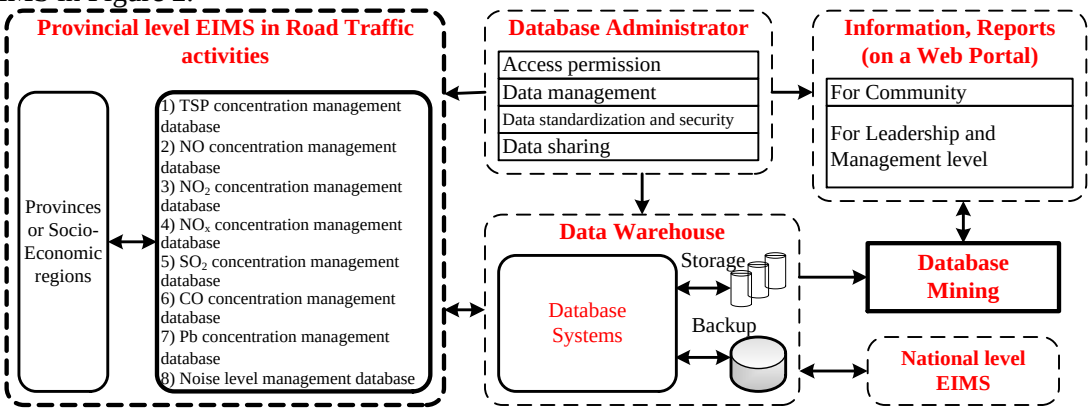

Fig.2. *The overall architecture of the database system for Environmental Information Management.*

The kernel of the EIMS is Data Warehouse in which the information system is used to analyze and assess the impact of environmental pollution in Road Traffic activities. These data are the basis for management decisions and executives process of all levels and branches.

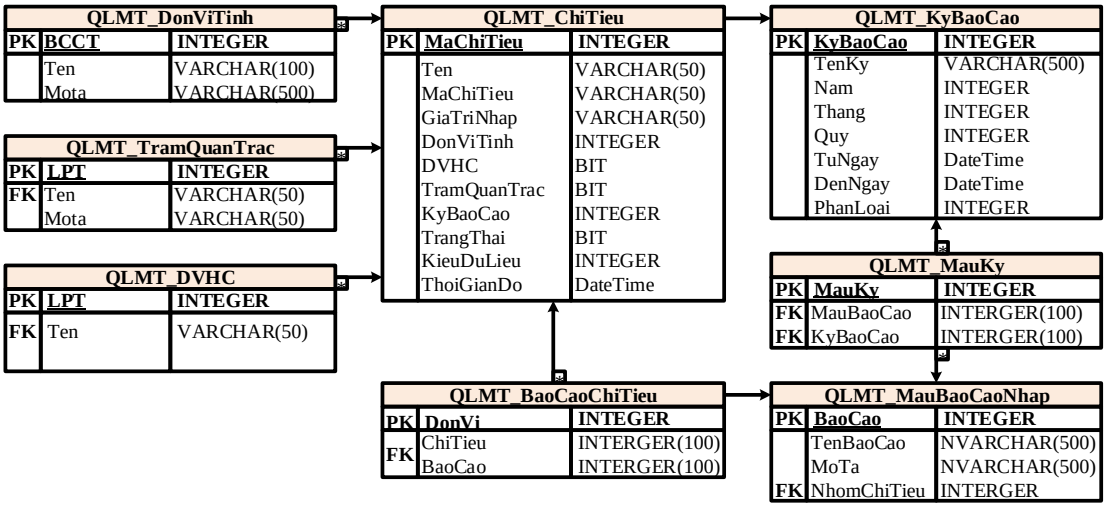

Fig. 3. *The database structure of the environmental information management in Road Traffic activities.*

All of the environmental management information in Road Traffic activities, represented by the environmental management indicators, is collected, updated from the road side stations and is stored in a standard database format. Data Warehouse is synchronized with the national EIMS (including other provinces or regions). Furthermore, Data Warehouse extracts data provided to the Leadership and Management level and the community through Data Mining. The provincial management database systems, Data Mining, Data Warehouse, environmental management information in Road Traffic activities is managed by the database management system with the following functions: access permissions, standardization, security and data sharing. Figure 3 describes the database structure of the environmental information management in Road Traffic activities.

The database system of environmental information management in Road Traffic activities which stores the past, present and future data, help users to exploit information on a regular and systematic. This requires that all information in the database must be kept status quo at the moment it exists.

Table 1. *List of data table for the environmental information management.*

Roll	Table name	Description
	QLMT_ChiTieu	Indicator table
	QLMT _DonViTinh	Indicator value unit table
	QLMT _DVHC	The list of Administrative units table
	QLMT _TramQuanTrac	Monitoring stations table
	QLMT_MauBaoCaoNhap	Input report template
	QLMT _BaoCaoChiTieu	Index report configure table
	QLMT _KyBaoCao	Periods of report table
	QLMT _MauKy	periods and report of configure template

The EIMS has the following main functions:

- *Administrator function:* this function is used to log on to the system, manage and control user privileges in accessing and working with data layers, folders and functions of the system and implement backup operations for the database.

- *The Map function:* this function is used to manage background map data layers and layers of thematic data used for environmental management information for authorized users. Users can select to show the data layer on the program to carry out the relevant works.

- *Search function:* the size of environmental information management database is large and it contains many layers of information. Therefore, to manage and exploit the information quickly and efficiently, the software program provides a search engine and data query functions classified by attributes and object classes.

- *Update function:* this function enables the User who has been granted the right to update the spatial data and the properties of the data layers which contain the local level environmental information management database.

- *Statistics & Report function:* this function enables the user, who has been granted the appropriate right, to perform operations on statistical data and information in the management process and create reports according to the templates in word and excel formats. The User can save reports and allow other users to view the reports.

- *Display function:* This function displays the shared information. It allows the users to display information and the data being able to publish to public communities so that all people can use the published information and data according to the specific purposes and requirements.

III. CONCLUSION

The overall model of the database system for environmental information management in road traffic activities as recommended above is designed under the combinded model of the centralised management model at centre (national/regional/provincial level) with the decentralised management model at local (provincial/county/district level). The model ensures the united and through regulatory between the administrative management levels in Vietnam, which is suitable for adminsistrative organisation. Thereby, database is collected from the lowest level (county/district level or lower) to the upper level or the middle level (provincial or regional level) and to the centralised level (national level). Data collected in this way will be assured to meet the demand of the precision, consistent and anti-overlap. Corresponding to the overall model, the design of the database system for environmental information management in road traffic activities also has the decentralised structure and is assured to meet the demand of centralised data admistration at centre and decentralised data administration at local.

Pollution and environmental degradation is the concern of the whole society. It requires the management of environmental indicators and pollution warning to be very fast, accurate and convenient. The the database system for environmental information management in road traffic activities will support the process of summarizing, timely updating data and modernizing specialized state management activities of pollution supervision. The proposed system, which integrates GIS technology with a simple and easy-to-use management software, will help simplify the State management of environmental pollution caused by traffic activities and improve the accuracy and consistency of data management.

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