Optimization Strategy of Intelligent Transportation System in Road Transport Management

Haixia Zhang[1,*]

[1]*Shandong Jiaotong Vocational College, Weifang, Shandong, 261206, China*
*corresponding author

Abstract: With the rapid development of road transportation industry and the improvement of road transportation management functions, while ensuring the integrity of corresponding management policies, it is also necessary to ensure safe and green travel. At the same time, the supply and demand of the transportation industry need to be continuously adjusted through road transportation safety management to achieve the goal of stable development. With the popularization of intelligent transportation systems and the role of intelligent traffic lights in road traffic management, it is no longer a single type in the past. At the same time, a large number of technical methods are also used to achieve security management of the system. On this basis, through the analysis of the test results, this article concluded the main factors that could effectively reduce traffic pollution on different levels of urban roads. At the same time, a large number of technical methods were used to achieve safety management of the system, and road traffic pollution experiments were analyzed and explained to identify important factors that had an impact on road traffic pollution in different levels of cities, thereby promoting the resolution of traffic pollution issues. This paper measured the PM2.5 concentration, vehicle flow, temperature, wind speed, and wind direction of four typical secondary trunk and branch highways and trunk roads. By analyzing the data using the least squares method and principal component regression method, the results showed that the degree of traffic pollution on highways, secondary arterial roads, arterial roads, and bypass roads gradually decreased, but the important factors affecting traffic pollution were the same. This paper conducted comprehensive road pollution detection experiments on traffic volume, temperature, and wind speed. Firstly, the connection of intelligent transportation systems required an overall design process and thinking for the research of intelligent transportation system frameworks. In terms of road transportation methods, it was necessary to establish safe transportation guarantee, including safe transportation management and emergency transportation guarantee.

1. Introduction

Road transportation is a basic industry that affects the quality of people's lives and plays a pivotal role in economic development [1-2]. Therefore, it is of great significance to improve and

perfect the highway transportation system. In order to promote rapid economic development and achieve connectivity between villages, efforts should be made to develop highway transportation, which has promoted the economic construction of a region and puts forward higher requirements for transportation management [3-4]. Currently, the focus of transportation work has shifted from road construction to the implementation of intensive transportation management. On this basis, according to the specific characteristics of the region, a corresponding road transportation traffic control system should be established, and the interaction between various industries should be fully considered. To achieve better development of road transportation, it is necessary to optimize the transportation system [5].

For urban road traffic, the generation methods and emission pathways of atmospheric pollutants and greenhouse gases are basically similar, so there is relatively high collaborative control space. However, in the formulation of relevant policies in the road transport sector, some scholars focused on single emission reduction, but did not reasonably formulate public policies from the perspective of maximizing comprehensive emission reduction or optimizing comprehensive emission reduction costs [6]. Environmental issues during the construction phase of road projects are inevitable. If protective measures can be taken, environmental pollution caused by construction can be reduced to a certain extent. Environmental protection during the construction phase needs to be carried out as much as possible based on the actual situation of the project construction [7]. A closed-loop management strategy for the safety of road transportation of hazardous goods should be conceived based on the existing industry issues and national policy trends. A set of mechanisms should be established that link and restrict production, loading and unloading, shipping, and signing for delivery. Hazardous goods transportation has been transformed from passive supervision to an active closed-loop management model based on improving standardization construction, thus ensuring the activation of multi department collaboration mechanisms, and focusing on the application of information technology and innovative credit supervision systems, so as to promote the steady development of the hazardous goods road transportation industry [8]. However, the above research on road transportation is not perfect and needs to be improved.

This article believed that the road transportation industry was an important branch of the transportation industry, and the optimization of the road transportation management system was also the top priority of the optimization of the transportation system. This paper analyzed some problems existing in the current road transportation management system, including the following: The road transportation management mechanism was not flexible enough; the road transportation management system was backward; the management means were single. Finally, the reasons for these problems were analyzed, and the new road transportation management system was adjusted and improved.

2. Method of Road Transportation

2.1. Intelligent Transportation System

As an emerging technology application field, intelligent transportation systems have not yet formed a development model. All countries can only explore and summarize in the development process [9-10]. The development of an intelligent transportation system framework clarifies the goals and scope of research and development, and avoids unplanned development research and repetitive research, which is beneficial to its development. The system architecture framework is the basic structure of the system. The system framework of an intelligent transportation system is mainly to build a system with certain functions based on the needs of users in a certain geographical area. Through information exchange between functional areas and the exchange, sharing, and collaborative processing of processing processes, the same specifications are followed to ensure

communication and collaboration among functional modules of the intelligent transportation system, thus making communication and collaboration among various modules possible. The complete system framework of intelligent transportation systems mainly includes user services and logical representations, which contribute to road traffic. As shown in Figure 1, the flowchart of the intelligent transportation system architecture is as follows:
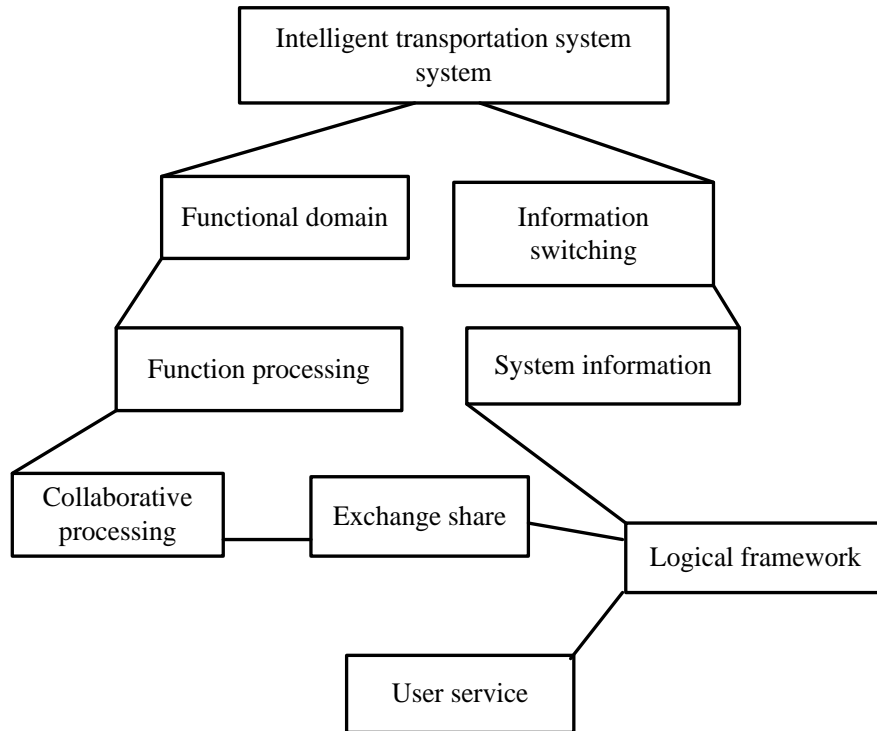

Figure 1: Basic process diagram of intelligent transportation system framework.

2.2. Intelligent Signal Lamp

Currently, there are a large number of traffic congestion phenomena in road traffic management, which have brought serious impact on the urban environment. Numerous studies have proven that unreasonable signal control is the main factor causing urban traffic congestion [11-12]. Therefore, it is necessary to introduce intelligent technology into traffic management and intelligently control signal lights. The use of intelligent signal lights can provide scientific and intelligent management of signal lights, thus effectively improving urban traffic flow and alleviating urban congestion. Specifically, the working principle of using an artificial intelligence system in a signal is that the artificial intelligence system has a sensing function that can collect the traffic flow at each intersection of the road and detect vehicles passing through the intersection in real time. The collected data and monitoring images are transmitted to the monitoring center. Through the data analysis function of the artificial intelligence system, in-depth analysis is conducted on the intersection traffic flow data to determine the specific color change time of the signal lights, thereby avoiding traffic congestion. Therefore, artificial intelligence systems can perform distributed intelligent control of signals to ensure that vehicles at intersections can drive in an orderly manner to avoid traffic congestion [13-14]. Figure 2 shows the intelligent signal flow chart:
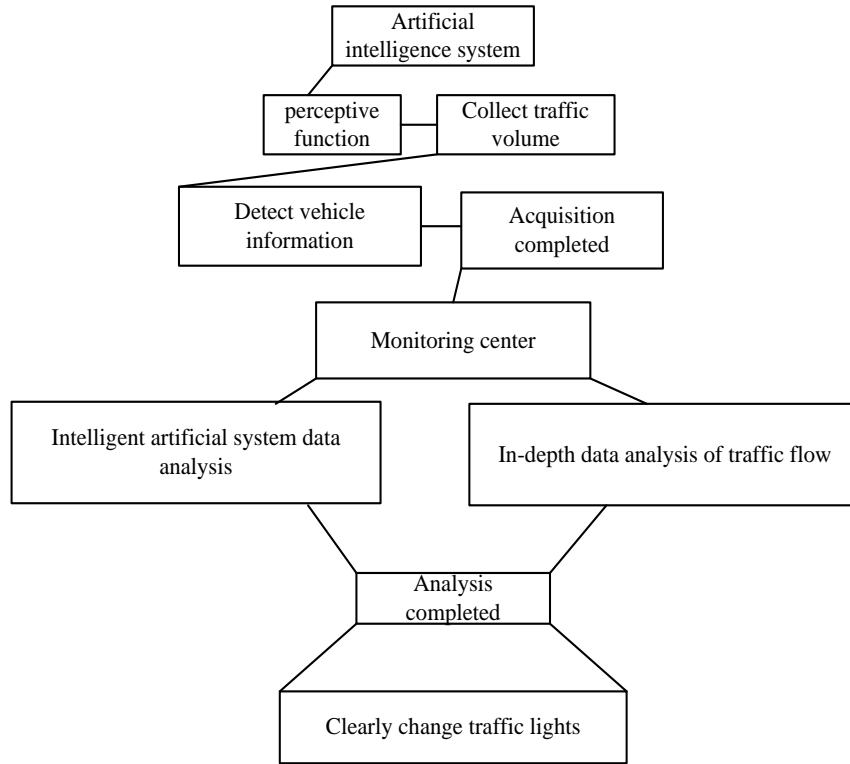
Figure 2: Overall process of intelligent signal lamp.

2.3. Traffic Management

With the development of society, the number of cars is increasing. However, the increase in the number of roads used to drive cars is far from being matched by the increase in the number of cars. This has led to serious road congestion in modern cities. In this case, the flow in the control area is managed based on the scale of the control area, but the flow variation rules within the control area 365 days a year are not consistent. Due to the impact of different months, climate, and other factors, daily traffic flow would vary to varying degrees. Therefore, the setting of the moderation time cannot be determined. For example, excessive control time and congestion periods, too narrow control time, and too long control time can have an impact on congestion mitigation. In corresponding congested areas, failure to conduct timely traffic management can also increase traffic control costs [15-16]. Therefore, it is necessary to develop a set of algorithms that can accurately calculate the road traffic control time [17-18]. The calculation formula is used to derive the following safe and reasonable solutions:

To ensure the calculation result, a continuous formula is usually used. The specific calculation steps are as follows:

A calculation method of road traffic control time is provided. The relationship between vehicle flow speed V and travel time T is determined through $S1$ as follows:

$$S1 = V + T \tag{1}$$

$f(t)$ represents the functional relationship between the vehicle flow speed v and the travel time t on the road;

$$f(t) = a0 + 2a1t + 3a2t2 + ... + (n+1)ak \tag{2}$$

14

The relationship between road segment time occupancy rate R_s and space occupancy rate L_n is determined as follows:

$$R_s = \frac{1}{L}(L_A + L_B + L_C + L_D + L_E)$$

(3)

This formula can efficiently and quickly solve the problem of controlling time and safety in traffic management [19-20].

3. Road Traffic Pollution Experiment

Motor vehicle exhaust is currently one of the important sources of air pollution, and this would lead to the formulation of reasonable travel plans and pollution reduction measures. Therefore, the project planed to select four representative expressways, main roads, secondary roads, and branch roads in Xi'an. Through real-time observation of PM2.5 concentration, vehicle flow, temperature, wind direction, and other data, and using least square analysis, the correlation between PM2.5 concentration and various factors was established.

3.1. Current Situation of Traffic Pollution in Xi'an

Xi'an Expressway: South 2nd Ring Road (south entrance of Wenyi Road), Chang'an Middle Road trunk road (entrance of Conservatory of Music), secondary trunk road Cuihua Road (east entrance of Provincial Museum), and branch road Yucai Road (entrance of Yanta Campus of Chang'an University). Monitoring time: 8:30 to 12:30, and 16:30 to 20:30. Each slice was observed repeatedly for 2 days. The PM2.5 concentration monitoring instrument was a 1.109 aerosol spectrometer, and the meteorological condition monitoring instrument was a Kesstrel handheld meteorological station. The manual counting method was used to investigate the traffic volume, which was counted every 5 minutes. The vehicles surveyed included cars, taxis, buses, trucks, garbage collection vehicles and sprinklers.

3.2. Data Processing Methods

Firstly, the SPSS software and the least square method were used to conduct statistics on the experimental data of roads in Xi'an. With PM2.5 as the variable, the variables were vehicle flow, temperature, wind speed, and relative humidity. The study found that no matter which road type, the Sig value was not significant, with a value of 0. There might be multiple collinearity problems between variables in sections such as the Second Ring Road, Chang'an Road, Cuihua Road, Yucai Road, etc. On this basis, in order to eliminate the impact of multicollinearity, a relatively satisfactory result was obtained through statistical analysis of regression correlation coefficients. Principal component analysis was a statistical method that converted related variables into new autocorrelated variables.

3.3. Traffic Pollution Consequences and Evaluation

The average PM2.5 content, traffic flow, wind speed, temperature, and relative humidity of Shuanghuan Road, Chang'an Road, Cuihua Road, and Yucai Road were shown in Table 1:

Table 1: Mean value of various variables of urban roads of different grades.

place	PM2.5 concentration (g/m)	Traffic flow (vehicle/h)	Wind speed (m/s)	Temperature (C)	Relative humidity (%)
Second Ring Road	126.3	743	0.59	17.1	24.1
Chang'an Road	53.8	397	0.33	20.4	12.5
Cuihua Road	75.9	150	0.58	20.0	24.2
Yucai Road	17.8	51	0.93	28.5	36.5

From Table 1, it could be seen that the PM2.5 content in the Double Ring Road section was the highest, and the traffic flow in this section was also the highest. However, the wind speed, temperature, and relative humidity were relatively low, which was not suitable for the transmission of pollutants. Therefore, the PM2.5 content in Chang'an Road was lower than that in Cuihua Road due to factors such as temperature and wind speed. The pollutants in the Chang'an Road section were relatively easy to spread, while the pollution level in the Yucai Road section was also relatively low. On urban roads, the traffic flow was the smallest, and the wind speed, temperature, and relative humidity were relatively large, which was conducive to the diffusion of pollutants, so the content of pollutants was also the lowest.

Principal Components Analysis (PCA) was conducted on the monitoring data of the four roads, namely, the Second Ring Road, Chang'an Road, Cuihua Road, and Yucai Road. Figure 3 showed the results of the PCA for the second loop. When the intrinsic root value was large, its effect on the factor was also large, so the intrinsic root value could be considered as the principal component of the factor. According to the sum of the proportions of each factor, several were selected as the main factors.
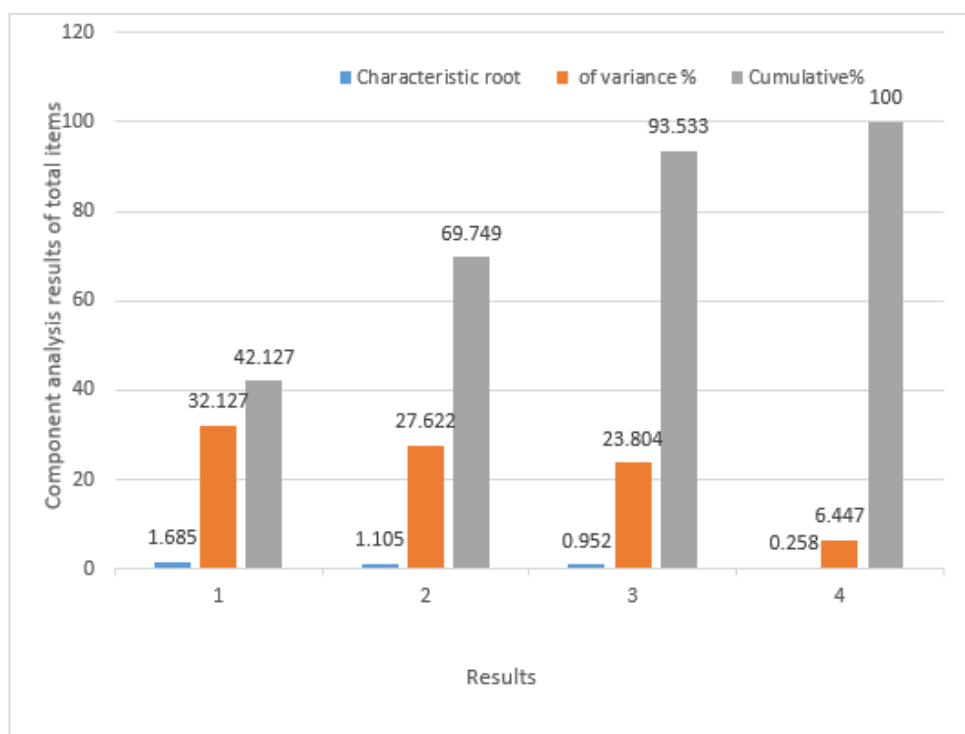

Figure 3: Analysis results of main components of the Second Ring Road.

As shown in Figure 3, from the 1-4 component pair of the second loop, the cumulative variance of component 1 was 42.172, and the variance was 32.172. The cumulative variance of component 2 was 69.749, and the variance was 27.622. The cumulative variance of component 3 was 93.533, and the variance was 23.804. The cumulative variance of component 4 was 100, and the variance was 6.447.

4. Results and Discussions in Road Transportation Management

4.1. Adjustment and Improvement of the New Road Transport Management System

In the past two decades of China's road transportation management system reform, especially since its comprehensive launch in 2004, the road transportation management system has undergone tremendous changes. Currently, the development of the road transportation industry is facing new situations and tasks, especially the large-scale adjustment and integration of road transportation institutions in various regions. The new situation and new problems brought about by the reform of the road transportation management system should be carefully analyzed, so as to actively respond, adjust and improve the road transportation management system.

1. The transformation of government functions guided by administration according to law is the core and key of the reform of road transportation management system.

The goal of deepening the reform of the road transportation management system is to establish a new transportation management model that meets the needs of the socialist market economic system and modern transportation system. Under this goal, it is necessary to correctly handle the relationship between the government and the market, as well as between the government and society, and promote the separation of government and enterprise, and between government and affairs, so as to form a system of administration based on the rule of law with clear powers and responsibilities and in accordance with the law. In the development of the road transportation industry, the government should always adhere to the principles of "simplifying administration and delegating power," "combining decentralization with management", and "optimizing services", thus effectively transforming functions and changing work style; the relationship between the government, enterprises, and the market in the field of road transportation should be properly handled, and administration according to law should be the basic principle of reform. Based on the Constitution and laws, it is necessary to ensure that laws, regulations, and rules are strictly implemented in the field of road transportation, and promote the effective implementation of administrative tasks according to law.

2. The rationalization of the management system is the prerequisite and foundation for deepening the reform of the road transportation management system.

Currently, large-scale highway construction is being carried out, especially in rural areas, as well as the construction of urban bus networks and public transportation facilities is accelerating. In the new round of "road network" planning, all regions should strengthen the construction of urban public transportation infrastructure.

4.2. Construction of Safety Transportation Guarantee System

The safety transportation guarantee system consists of traffic safety management and emergency traffic safety guarantee. Road transportation operates with various groups of people. The more people, the more trouble. In this way, there would inevitably be various accidents. Therefore, highway traffic administrative agencies must strictly comply with relevant regulations on highway traffic safety, and strictly regulate certain illegal and criminal acts to safeguard the social and public interests. When an emergency occurs, managers should promptly respond in accordance with

relevant regulations such as the Traffic Safety Management Regulations and the Emergency Security Regulations. In road traffic safety management, life safety is the top priority. In order to ensure all aspects of people's work and life, it is necessary to formulate a set of safety regulations jointly composed of highway transportation administrative authorities and operating units to ensure people's life and safety. Relevant rules and regulations should be established, and a relevant supervision and inspection system should be established to promote the implementation of safety management responsibilities and relevant systems for employees at work. The establishment of a traffic safety guarantee system requires both the implementation of the regulatory system and continuous improvement based on actual conditions. At the same time, road traffic management departments should also conduct regular safety training for operators, thus focusing on safety awareness and how to handle complex emergencies. In the process of carrying out safety awareness education for employees and users, it is necessary to give full play to the role of high-tech talents in the field of road transportation, and improve the level of information security technology in the road transportation system, so as to ensure the safe operation of road transportation through information technology to prevent accidents in transportation. For example, global satellite positioning systems, traffic recorders, and urban surveillance systems can all be used to monitor the operations of operators. At the same time, attention should be paid to using public and social supervision to enhance the safety awareness of enterprises. Figure 4 shows a management chart for highway traffic safety.

Figure 4: Road safety transportation diagram.

4.3. Strategies in Road Transportation Management

The comprehensive management level of road traffic and transportation safety should be improved. According to the current situation and requirements of road transportation, professional and technical teams should be trained as soon as possible. Its professional knowledge should be used to gradually improve the traffic safety and transportation management level, and carry out unified planning for it, so as to fully exert transportation efficiency, and promote the overall construction of road traffic and transportation safety measures to achieve perfect cooperation and development between all parties. The combination of personal interests and social interests should be realized, and all aspects of road safety transportation should be standardized to standardize the entire transportation process. The transportation management mechanism should be further improved to achieve coordination and cooperation among various departments. It is necessary to

fully trust and rely on the leaders and employees of various departments to establish practical rules and regulations.

5. Conclusions

To sum up, its safety management is a very important part of transportation and cannot be ignored. This article discussed and analyzed road traffic safety regulations. Based on previous experience, the road traffic safety regulations were summarized, which was conducive to reducing the risk level of road traffic accidents. Based on the corresponding system, the method of comprehensive governance was discussed, and the responsibility should be assigned to individuals. In addition, it was necessary to continuously improve the traffic safety action standards and promote the development of the transportation industry and road transportation safety management to a higher level. Intelligent transportation systems could greatly help traffic management. The traffic management formula had reasonable safety in road transportation as a whole, and could calculate the road traffic control time. Finally, a reliability experiment was conducted on urban road traffic pollution.

References

[1] Ismail Z A. Optimising the safety of road transport workers on IBS building construction projects: a review. Social Responsibility Journal, 2019, 15(6):837-851.

[2] Luo X G, Zhang H B, Zhang Z L, et al. A New Framework of Intelligent Public Transportation System Based on the Internet of Things. IEEE Access, 2019, PP (99):1-1.

[3] Sodhro A H, Rodrigues J, Pirbhulal S, et al. Link Optimization in Software Defined IoV Driven Autonomous Transportation System. IEEE Transactions on Intelligent Transportation Systems, 2020, PP (99):1-10.

[4] Yang C, Zha M, Wang W, et al. Efficient Energy Management Strategy for Hybrid Electric Vehicles/Plug-in Hybrid Electric Vehicles: Review and Recent Advances under Intelligent Transportation System. IET Intelligent Transport Systems, 2020, 14(7):702-711.

[5] Rudolf T, Schurmann T, Schwab S, et al. Toward Holistic Energy Management Strategies for Fuel Cell Hybrid Electric Vehicles in Heavy-Duty Applications. Proceedings of the IEEE, 2021, PP (99):1-21.

[6] Magli L, Krljan T, Grubii N, et al. Estimating Urban Road Transport Vehicles Emissions in the Rijeka City Streets. Promet - Traffic - Traffico, 2021, 33(2):165-178.

[7] Nevett G, Goodrum P M, Littlejohn R L. Understanding the Effect of Bid Quantities, Project Characteristics, and Project Locations on the Duration of Road Transportation Construction Projects during Early Stages:. Transportation Research Record, 2021, 2675(2):121-134.

[8] Rany B, Domagaa K. Educational activities of the Road Transport Inspection. Kultura Bezpieczeństwa Nauka – Praktyka - Refleksje, 2021, 39(39):44-64.

[9] Akhter S, Ahsan N, Jafor S. Modeling Ant Colony Optimization for Multi-Agent based Intelligent Transportation System. International Journal of Advanced Computer Science and Applications, 2019, 10(10):277-284.

[10] Khan M Z. Analyzing Road Transport (Passenger and Freight) Demand in Pakistan with Auto-Regressive Distributed Lag Co-Integration Approach:. Transportation Research Record, 2021, 2675(4):155-170.

[11] Harrison J E, Balasubramaniyan R, Job S, et al. Estimates of road traffic deaths in Tanzania. Injury Prevention, 2022, 5(N):79-84.

[12] Miroshnichenko A G, Rakhmanov R M, M. A. Bolshakova, et al. A Study of the Effectiveness of Different Methods of Anesthesia in Victims of Road Traffic Accidents with Thoracoabdominal Trauma in Pre-Hospital and Hospital Periods. Emergency medical care, 2021, 22(1):46-52.

[13] Angelis E D, Carnevale C, Marcoberardino G D, et al. Low Emission Road Transport Scenarios: An Integrated Assessment of Energy Demand, Air Quality, GHG Emissions, and Costs. IEEE Transactions on Automation Science and Engineering, 2021, PP (99):1-11.

[14] Khan M Z. Analyzing Road Transport (Passenger and Freight) Demand in Pakistan with Auto-Regressive Distributed Lag Co-Integration Approach. Transportation Research Record, 2021, 2675(4):155-170.

[15] Dul D, Limmeechokchai B. Greenhouse Gases Mitigation in the Road Transport towards 2050: Analyses of Selected Greater Mekong Sub-region (GMS) Countries. International Energy Journal, 2021, 21(3):305-322.

[16] Chavhan S, Gupta D, Chandana B N, et al. A Novel Emergent Intelligence Technique for Public Transport Vehicle Allocation Problem in a Dynamic Transportation System. IEEE Transactions on Intelligent Transportation Systems, 2020, PP (99):1-14.

[17] Pramesti A L, Sumiyati S, Ramadan B S, et al. Optimization of Waste Transportation System in Tembalang District, Semarang City. Jurnal Presipitasi Media Komunikasi dan Pengembangan Teknik Lingkungan, 2020, 17(2):128-137.

[18] Tang C, Zhu C, Wei X, et al. Intelligent Resource Allocation for Utility Optimization in RSU-empowered Vehicular Network. IEEE Access, 2020, 8(1):94453-94462.

[19] Vaali D, Vujanovi D, Ivkovi I. The Role of Preventive Maintenance of Fleets Powered by Conventional and Alternative Fuels in Road Transport of Dangerous Goods. International Journal for Traffic and Transport Engineering (IJTTE), 2021, 11(1):143-160.

[20] Cunha L, Barros C, Baylina P, et al. Work intensification in the road transport industry: An approach to new working scenarios with automated vehicles. Work, 2021, 69(3):847-857.