TRAFFIC CONTROL STRATEGIES TO MITIGATE NOISE POLLUTION

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Abstract: Road traffic noise contributes significantly to outdoor environmental noise, especially in urban areas. The pressure of traffic noise is influenced by many factors such as types of engines, exhaust systems and tires interacting with the road, weather and road conditions. The tire/pavement interaction noise has been proven to be the major source of the traffic noise, especially for cruising driving conditions, which is highly influenced by surface characteristics of road pavement. Traffic flow is also a factor – apart from vehicles, tires and road surface characteristics – in affecting traffic noise pressures. The noise level can increase by about 3 dBA when traffic flow doubles, if the traffic composition, speed and driving patterns are constant. Consequently, it is required to investigate the effects of road pavement conditions and traffic flow on traffic noise emission, and further explore the interactive effect of operation time of pavement and traffic flow for traffic noise control and mitigation. In this research, a series of field experiments are conducted on highways of new and old pavements. The variations of traffic flow and traffic noise pressure levels together with the functional relationships between them are analyzed based on the noise data collected from the highways in an urban area. With the collected data, the maximum traffic flow and traffic noise pressure levels are determined in a specified time manner. Logarithmic functional relationships are found between traffic noise pressure level and traffic flow for both old and new pavements. It is also found that the improvement in pavement material of highway may promote the absorption of traffic noise. A single value index is developed for quantitatively and conveniently evaluating the acoustic quality of highways.

Key words: Traffic Noise, Noise pollution, Mitigation Strategies, Optimization.

I. INTRODUCTION

Noise is derived from the Latin word "nausea" implying 'unwanted sound' or 'sound that is loud, unpleasant or unexpected'. The noise is originates from human activities, especially the urbanization and the development of transport and industry. Noise pollution has become a serious problem for the society. In India, with expanding vehicular population traffic noise levels have increased, which can cause serious health effects. The World Health Organization (WHO) recognized noise as one of the major pollutants affecting the health of the human population. The major sources of noise pollution are: Transportation systems are the main source of noise pollution in urban areas. Construction of buildings, highways, and roads cause a lot of noise, due to the usage of air compressors, bulldozers, loaders, dump trucks, and pavement breakers. Industrial noise also adds to the already unfavorable state of noise pollution. Loud speakers, plumbing, boilers, generators, air conditioners, fans, and vacuum cleaners add to the existing noise pollution as per environmental protection bureau.

1.1.1Traffic noise is of two types.

Noise generated by individual vehicles and by continuous flow of vehicles of all types. noise from engines and transmission depends upon the design of vehicles and particularly upon the method of support used for its moving parts. More expensive vehicles employ more elaborate damping system so that noises are not transmitted to the body of the vehicle.

1.2 Control and mitigation of noise pollution

Technical know-how on noise at source, its transmission, attenuation and amelioration is well advanced and a reasonably understood phenomenon. However, the solutions to the problem rest with the collective and shared responsibility of the stakeholders. The polluter pay approach only works well, when and if polluter has the mandated to design the most effective solution and implement it at the most optimum place. In traffic noise mitigation, it can neither pinpoint the polluter nor does it have the authority to commission the optimum Amelioration solution off-site.

1.2.1 **Control of indoor noise**

The places where outdoor noise levels have been high, the following, and methods can be applied for reducing their effect. Locate in the building as far as possible from noise source. The noise level drops about 6dB each time the distance is doubled. Trees and shrubs may be planted in front of building to provide some absorption for the sound. Locate non-critical areas such as corridors kitchens, bathrooms, elevators and service spaces in the noisy side and critical areas each as bedrooms and living spaces on the quiet side. Back to back bathrooms or toilets should be avoided unless they are effectively sound isolated. Bathrooms, kitchen and laundry rooms should not be adjacent to the floor. Bathroom walls, floor and ceiling should be sound insulated using construction of high sound insulation glasses. Noisy toilets, is bettered by quiet siphon jet type flush toilets should be installed to reduce the noise from the source. To make building acoustics more accessible to the design community, two fundamental principles must be understood: (1) the source-path-receiver model and (2) the classification of building acoustics into six interrelated areas: exterior noise, interior room finishes, interior room noise levels, sound isolation between rooms, alarms and other electro acoustical systems, and building vibration. Although understanding these principles does not eliminate the need for special expertise, it does encourage the inclusion of someone with acoustical expertise on the design team.

1.2.2 **Urgent need for legislation to control noise pollution**

There has been no doubt that the available provisions in various branches of law are adequate, unscientific and crude. In most of the developed countries specific legislations have been made and scientific methods for investigation of noise pollution have been invented. The science of audiometer and other branched related to sound have been developed and it becomes comfortable to device various legal provisions to control and prevent noise pollution. At present, there is no specific and detailed legislation to control the noise pollution. However, there is an urgent need that the Central Government of India should manage to get a legislation passed for the control of noise pollution. Some legislation regarding water and air pollution has been made in India. Government should pass the ‘Noise Pollution control Act’ to meet special India condition. Apart from such kind of a Central Legislation, there should be a city noise control code for all major cities in India Creation of unnecessary noise has to be prohibited and should be punishable under law.

1.2.3. **Public awakening education and the control**

It is important that public awakening is very essential for the control and prevention of the noise pollution. In India, most of the persons lack any idea about the ways in which noise pollution could be controlled. In this regard television, radio, internet and newspapers should give a campaign for wide publicity. It is also true that in the present set up of industrialization one should be able to face the noise pollution to a certain extent. The ambient noise level to be maintained as per Environment Protection Rules, 1986 .

1.3. Control technologies available for noise pollution

1.3.1**Speed Control**

Speed control is also an effective way to check noise pollution, since the lowest sound emission arise from vehicles moving smoothly at 30 to 60 kilometers per hour. Above that range, sound emissions will almost double with each five miles per hour of speed. At the lowest speeds, braking and acceleration noise dominates.

1.4 Laws and legislative rule as per Indian government related to noise pollution

1.4.1 **Indian penal code**

Control of noise has been covered in three major legislations: Factories Act 1948, Motor Vehicles Act 1988 and Environment

Protection Act 1986 (Environment Protection Rules 1986 and Noise Pollution (Regulation and Control) Rules (2000).

1.4.2 **Motor vehicles Act**

Every motor vehicle manufactured shall be fitted with an electric horn or other devices(Confirming to the requirements of IS- 1884-1992 specified by the bureau of Indian standards) for use of driver of the vehicle and capable of giving audible and sufficient
Warning of the approach or position of vehicles.

1. Rule 119(1), the Central Motor Vehicles Rules, 1989
   Not having a functional horn would be violative of above mentioned rule and would thus be an offence. No motor vehicle shall be fitted with any multi-toned horn giving a succession of different notes or with any other sound producing device giving an unduly harsh, shrill, loud or alarming noise. Vehicles used as ambulance, fire fighting purpose, salvage purpose, vehicles used by police officers or officers of the motor vehicles department in the course of their duties or on construction equipment vehicles, may use such sound signals as may be approved by the registering authority in whose vehicles are kept.

2. Rule 119(2)(3), The Central Motor Rules,1989
   A drivers of a vehicle shall not Sound the horn needlessly or continuously or more than necessary to ensure safety; Sound the horn in silence zone; Fit or use any multi toned horn giving harsh shrill ,loud or alarming noise . Regulation 21(1)(2)(4) the Rules of the Roads Regulation, 1989 No driver of a motor vehicle shall sound the horn or other device for giving audible warning with which the motor vehicle is equipped shall cause or allow any other person to do so. Rule 170(1), Haryana Motor vehicles Rules, 1993 Rule 178(1), Chandigarh Motor vehicles rules,1990 No vehicles shall be permitted to have musical horn. All vehicles, buses, trucks and cars shall not be fitted with power, pressure or musical horns. Such vehicles with any such horns shall be chicaned and such horns shall be got removed by the enforcement officer so authorized to chicane the vehicle, under his supervision.[1]

RELATED WORK

Min Chen et.al (2018) studied that with the development of intelligent applications(e.g., self-driving, real-time emotion recognition, etc.), there are higher requirements for the cloud intelligence. However, cloud intelligence depends on the multi-modal data collected by user equipment's (UEs). Due to the limited capacity of network bandwidth, offloading all data generated from the UEs to the remote cloud is impractical. Thus, in this article, we consider the challenging issue of achieving a certain level of cloud intelligence while reducing network traffic. In order to solve this problem, we design a traffic control algorithm based on label-less learning on the edge cloud, which is dubbed as LLTC. By the use of the limited computing and storage resources at edge cloud, LLTC evaluates the value of data, which will be offloaded. Specifically, we first give a statement of the problem and the system architecture. Then, we design the LLTC algorithm in detail. Finally, we set up the system test bed. Experimental results show that the proposed LLTC can guarantee the required cloud intelligence while minimizing the amount of data transmission.[3]

Lauren H. McWhinnie et.al (2018) studied that warming weather conditions in the Arctic are already resulting in changes in both sea ice extent and thickness. The resulting extended 'open water' season has many implications for vessel traffic and marine life. For example, an increase in vessel traffic due to ice-free waters will most likely lead to an increased risk of impact on cetaceans through increased noise pollution, strike risk for some cetacean species, and the possibility of exposure to chemical pollutants. The objective of this study was to pre-empt a predicted increase in vessels by investigating and exploring possible management scenarios, with the aim of mitigating negative impacts on locally important species such as bowhead and beluga whales. Utilizing insights gained from established vessel management schemes in more southerly regions, this paper evaluates the current suite of tools being implemented and their appropriateness for implementation in a more extreme Arctic environment.[4]

Karina Mary Paiva et.al (2018) studied that one of the major environmental problems of the modern world is noise. A health-related marker of environmental noise exposure that can be considered a predictor of

annoyance is noise sensitivity. The aim of this study was to ascertain the correlation between levels of exposure to road traffic noise in residential areas and the resulting annoyance based on the perception and sensitivity reported. Methods: The study involved noise assessment, with the creation of noise maps of the neighborhood in the city of São Paulo, Brazil, and application of a questionnaire to ascertain the perception of the residents of the neighborhood, regarding the effects of this exposure.
Results: The noise levels at all the measured points were found to exceed the critical level for the area, 55 dB(A). A total of 225 interviews were conducted. Noise-related annoyance was reported by 48.4% of the respondents. Associations were observed between living in areas exposed to traffic noise and feeling annoyed with this noise (p b0.001).
Conclusions: These findings suggest the importance of reviewing and updating Brazilian public policies regarding environmental noise. We found a high prevalence of annoyance reports, as well as aspects indicative of sensitivity to noise exposure.[5]

Luigi Ranieri et.al (2018) studied that in this paper, a review of the recent scientific literature contributions on innovative strategies for last mile logistics, focusing on externalities cost reduction, is presented. Transport is causing problems in urban areas, in particular in freight transport: modern cities need solutions to reduce externalities costs such as congestion, pollution and others, which have increased in the last few years, especially due to the growth of goods delivery. Online sales and globalization lead to new trends in freight transport, and moreover, a larger quantity of goods is expected to be delivered in the next future. In this context, most of the delivered goods end up in the city centers. Last mile logistics is the least efficient stage of the supply chain and comprises up to 28% of the total delivery cost. Therefore, the improvement of last mile logistics and a significant externalities reduction are very important challenges for researchers. New technologies and transport means, innovative techniques and organizational strategies allow handling in a more effective way the last mile delivery in urban areas. Based on the Systematic Literature Review (SLR) method, recent papers that significantly contributed, with original proposals, to the reduction of externalities in urban logistics are identified and analyzed in this work. Furthermore, a classification of the papers dealing with the externality reduction problem is presented. It is consistent with a general formulation proposed to evaluate external costs in urban area. The innovative contributions are classified into five main categories: innovative vehicles, proximity stations or points, collaborative and cooperative urban logistics, optimization of transport management and routing, innovations in public policies and infrastructures. The new paradigm of smart logistics is based on the combination of these concepts and on the proposed innovations.[6]

SiyuanGong et.al (2018) studied that vehicle-to-vehicle communications can be unreliable as interference causes communication failures. Thereby, the information flow topology for a platoon of Connected Autonomous Vehicles (CAVs) can vary dynamically. This limits existing Cooperative Adaptive Cruise Control (CACC) strategies as most of them assume a fixed information flow topology (IFT). To address this problem, we introduce a CACC design that considers a dynamic information flow topology (CACC-DIFT) for CAV platoons. An adaptive Proportional-Derivative (PD) controller under a two predecessor-following IFT is proposed to reduce the negative effects when communication failures occur. The PD controller parameters are determined to ensure the string stability of the platoon. Further, the designed controller also factors the performance of individual vehicles. Hence, when communication failure occurs, the system will switch to a certain type of CACC instead of degenerating to adaptive cruise control, which improves the control performance considerably. The effectiveness of the proposed CACC-DIFT is validated through numerical experiments based on NGSIM field data. Results indicate that the proposed CACC-DIFT design outperforms a CACC with a predetermined information flow topology.[7]

Mercedes Sanchez et.al (2017) studied that the increased standard of living in our society has raised the level of concern regarding eco systemic degradation of natural resources due to a greater demand for goods and services. In fact, noise, air pollution and traffic congestion are the main environmental concerns when we consider transportation externalities. Thus, in the European Union, 30% of the population is exposed to noise levels greater than55 dB, being road transportation responsible for 93% of the environmental costs produced by transport. Similarly, European Commission has calculated that the costs from road and rail traffic reach the amount of V40 billion per year in Europe. Sometimes this collective distress is not translated into individual actions for the reduction of environmental impact. Therefore, there has been an increasing use of social and psychological models to explain individual behavior towards the environment. Specifically, this study makes use of an extended Theory of Planned Behavior (TPB) which includes personal values to determine the influential variables in willingness to pay (WTP) for the reduction of noise pollution generated by road transportation. Thus, we have applied a Structural Equation Model (SEM) in the European Pyrenees region (located between Spain and France), an area with high traffic pollution due to road transport. The results highlight the importance of psychological aspects in contamination actions and show that positive attitudes towards the environment and adequate perceived behavioral influence can increase WTP. Moreover, there is an indirect effect of biosphere and altruistic values on WTP by means of other variables such as the perceived behavioral control. Therefore, public performances and educational policies that improve environmental sensitivity and reduce environmental impact could help to achieve a collective effect on the environment and a unified struggle in favor of environmental protection.[8]

Mohammad Reza Jabbarpour et.al (2017) studied that vehicle traffic congestion is an increasing concern in metropolitan areas, with negative health, environment and economical implications. In recent times, computational intelligence (CI), a set of nature-inspired computational approaches and algorithms, has been used in vehicle routing and congestion mitigation research (also referred to as CI-based vehicle traffic routing systems—VTRSs). In this paper, we conduct a critique of existing literature on CI-based VTRSs and discuss identified limitations, evaluation process of existing approaches and research trends. We also identify potential research opportunities.[9]

Enda Murphy et.al (2017) studied that this paper assesses four methods for estimating population exposure to road traffic noise within the terms of the strategic noise mapping process laid down in the Environmental Noise Directive (END). Employing a case study in central Dublin, Ireland, the methods – MAX, MIN, VBEB/CNOSSOS and AVE – are tested utilizing the L den and L night indicators. The study first investigates the extent to which exposure estimates may vary depending on the method utilized while controlling for the noise calculation method. Second, it investigates how estimates of exposure vary depending on the calculation method used; in this case, CRTN and NMPB. The results show that controlling for noise calculation method and employing the same input data, estimations of population exposure differ substantially depending on the exposure method employed. Furthermore, the potential variability in estimated night-time exposure and the potential for under or over-estimation of the health effects of environmental noise on a given population when different methods are utilized is clearly demonstrated. The results also show that the method of noise calculation employed has an effect on estimated exposure, particularly for L den measures. Values for L night were found to be very similar regardless of the calculation method employed. The results therefore suggest that it is the exposure estimation method rather than the noise calculation method which has the greatest effect on population exposure estimation and should therefore be of greatest concern for understanding population health impacts and for achievingconsiste0nt results.[10]

PROPOSED APPROACH

1. Pollutants are monitored outside for 24 hours (4-hourly sampling of gaseous pollutants and 8-hourly sampling of particulate matter) with frequency of two times a week in order to have 104 observations per year.
2. Out of various strategies such as Adaptive, Predictive, Statistical and Optimization, the later one is used in this study in order to achieve more accuracy.
3. Optimization algorithm is used to achieve more accuracy to predict noise pollution level and thereby devise cost-effective solution for the same.
4. The sample station is placed such that it has free exposure and should be kept away from large buildings which may interfere in free air circulation.
5. It should be located at the height between 1.5 m to 15 m above the ground. The sample is preserved and send to the laboratory for analysing.
6. The sites selected for study purpose are commercial areas and have rush of road transportation.

PARAMETERS USED

Input parameter:

- Velocity.
- Traffic density.
- Number of vehicles.

Output parameter

- Noise in PPM in specific area.
- Traffic congestion in that area.

In PSO algorithm, every bird is denoted as a particle and have their own intelligence and some social behavior which coordinate their activities toward food or a destination. Initially, the process is started from swarm of particles. Each particle contains a solution to the related problem that is generated randomly and in every iteration it generates an optimal solution. The i^{th} particle is bounded with a position in an s-dimensional space, in which s is the no. of particles involved in the problem. Position is determined by the values of s variables and possible solution to the problem after optimization. Ach particle i is determined by three vectors that are Current position L_i, its best position in the previous cycles, M_i, and its velocity by N_i.

Current position $L_i = (l_{i1}, l_{i2}, l_{i3} \dots \dots .. l_{is})$ (1)

Best position in previous cycle $M_i = (m_{i1}, m_{i2} \dots \dots \dots m_{is})$ (2)

Flight velocity $N_i = (n_{i1}, n_{i2}, n_{i3 \dots\dots\dots}, n_{is})$ (3)

This algorithm is based on the communication between the birds during the search of the food. Each bird look at the specific direction (its best ever attained position M_i) and later, when they communicate themselves thy go to the bird which is in the best position from the food. All the birds move towards the best position bird with a velocity that depends on the present velocity. Search space is examined by each bird from its current position.

In each iteration, eq 4 calculate the current position and velocity

$$l_i' = l_i + N_i' \quad (4)$$

The new velocity is given by the equation 5.

$$N_i' = \omega N_i + a_i rand(\quad)(M_i - L_i) + a_2\, rand(\quad)(M^* - L_i) \quad (5)$$

Here,

- a_1, a_2 are two positive elements which show the learning factors.
- Rand () function generates the random number in eq 5
- ω is factor of inertia. Local and global search controls by it and it changes in every iteration of search.
- M_i best present solution among all.

Algorithm

Step 1: Generate random solutions.

Step 2: Search the best solution from the random solutions.

Step 3: Repeat the following step until the condition is not stopped.

3.1 Calculate the ω.

3.2 Loop i =1,2…..n

Begin

- Compute the value of objective function for solution i.
- If particle I gives the better value for the objective function, let I is the best solution.
- Compute new velocity for particle i using equation 5.
- Compute the new position for particle i using equation 4.

END

RESULT AND ANALYSIS

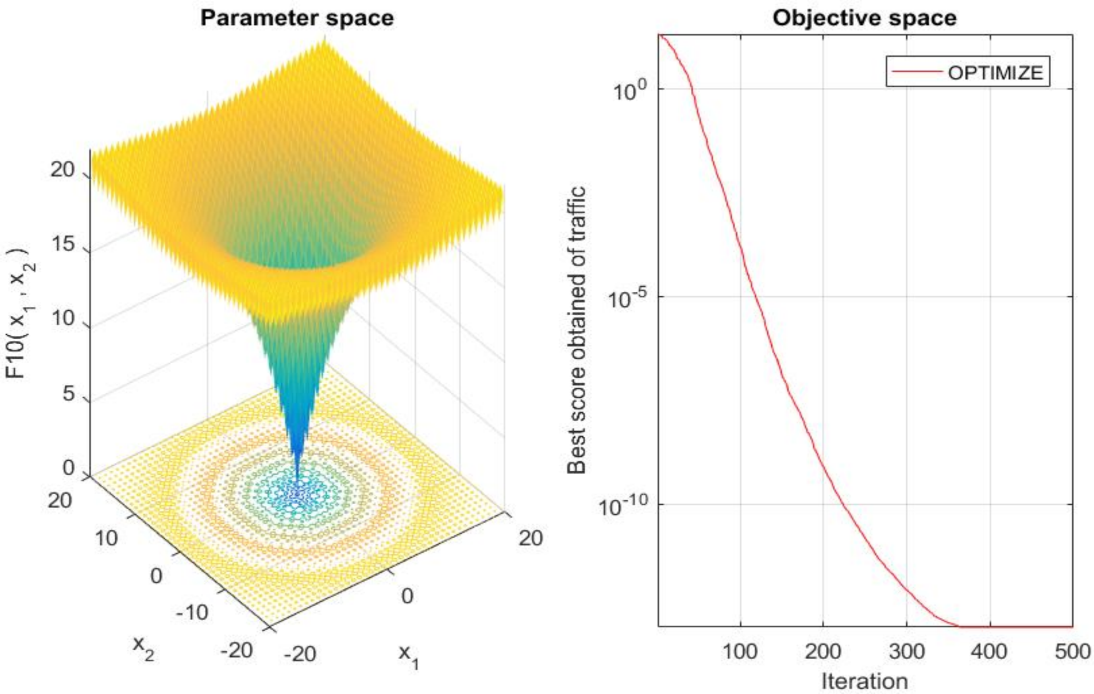

Fig 5.1 optimization process on traffic flow and noise

In fig 5.1 to 5.3 show the different road network at simulate environment. These map analyses by proposed regression base optimization approach and existing prediction base approach. In fig 5.2 analysis of safety parameters converge by cost parameters. So reduce these parameters indicate reduce cost and high show improve

Traffic FLOW (numbers/hr.)	traffic COST (proposed)	Traffic COST(existing)
50	130	120
100	120	107
150	123	114
200	156	134
250	134	123
300	100	89
350	56	34
400	67	45
450	70	50
500	73	54

Table 5.1 optimization process on cost traffic flow and noise

In table 5.1 compare the existing and proposed cost parameters prediction. Prediction method does not improve in different iteration of different traffic flow but Proposed approach improve in all iteration traffic of different type iteration. In these results take average of all map of different approaches but different flow indicate different tests of proposed approach which show in table 5.1 and fig5.2.

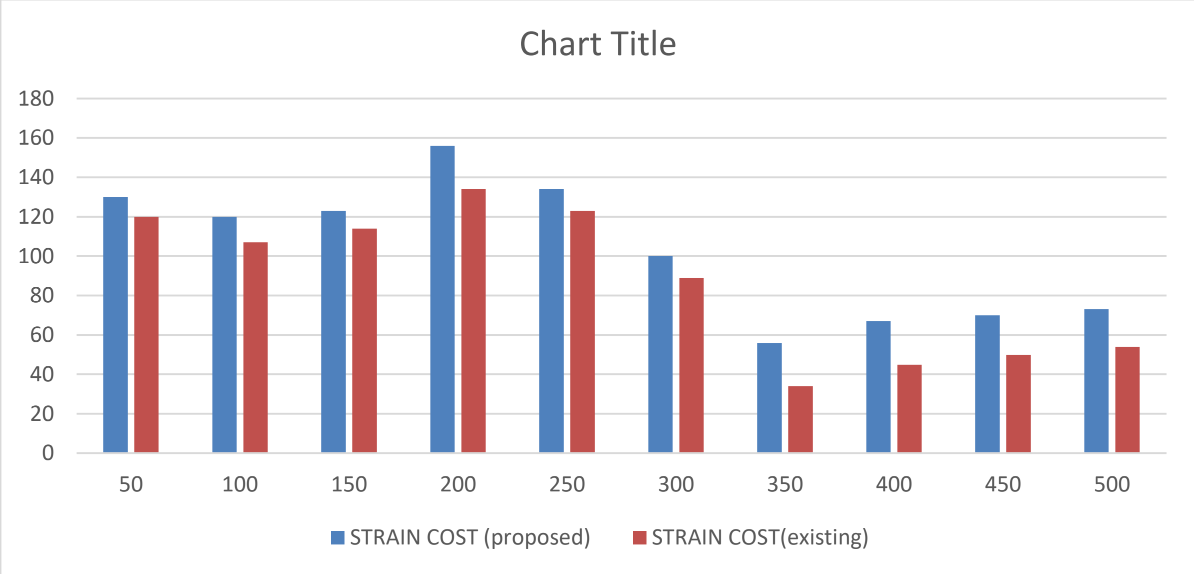

Fig.5.2 optimization process on cost traffic flow and noise

In table 5.2 compare the existing and proposed Cost parameters prediction. In prediction not improve in different iteration of different traffic flow but Proposed approach improve in all iteration traffic of different type iteration. In these results take average of all map of different approaches but different flow indicate different tests of proposed approach which show in table 5.2 and fig5.3.

Traffic Iteration	PSO strain cost(a=0.4)	PSO strain cost(a=0.6)	PSO strain Cost(a=0.8)	PSO strain Cost(a=1)
50	125	125	113.5	121.166667
100	121.5	113.5	110.5	115.166667
150	139.5	118.5	124	127.333333
200	145	145	128.5	139.5
250	117	128.5	106	117.166667
300	78	94.5	61.5	78
350	61.5	45	39.5	48.6666667
400	68.5	56	47.5	57.3333333
450	71.5	60	52	61.1666667
500	73	63.5	54	63.5

Table 5.2 optimization process on regression cost traffic flow and noise

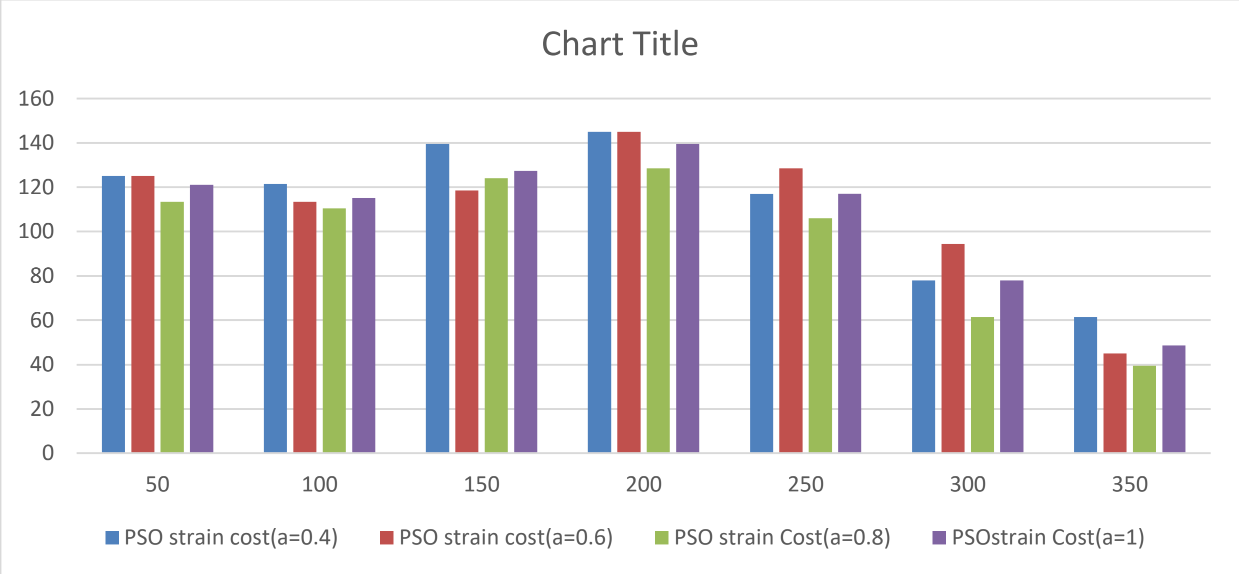

Fig 5.3 optimization process on regression cost traffic flow and noise

CONCLUSION AND FUTURE SCOPE

In noise studies, several types of weighting networks are performed on sound spectra to calculate the equivalent sound level for different objectives. At low noise levels, the "A" weighting networks have been proven to correlate well with the sensitivity of human hearing and widely accepted as the sound level parameter in noise studies (Dai et al., 2008). Tire-pavement or traffic noise is rated as moderate sound, and thus it is usually measured as "A" weighted equivalent continuous sound level (Sandberg and Ejsmont 2002, Bruel and Kjaer 2007; Ahammed, 2009). In the present study, the equivalent traffic noise levels and the corresponding requirements are collected in the form of "A" weighted equivalent continuous sound level (LAeq). In order to explore the noise reduction effect of pavement, reliable acoustical measurements are necessary for tire and pavement with respect to traffic noise emission. Several methods have been developed for measuring the tire/pavement noise in recent years. According to the test location, the noise measurement methods can be classified into three groups: roadside measurements, on-board measurements and laboratory based measurements (Lou, 2007). In detail, the roadside measurements include the Statistical Pass by, Controlled Pass by, and Time-averaged Traffic Noise methods.

REFERENCES

1. Retrieved from www.researchgate.net on 1 Feb 2018.
2. Retrieved from http://www.environmentalpollution.in.
3. Chen, M., Hao, Y., Lin, K., Yuan, Z. and Hu, L., 2018. Label-less learning for traffic control in an edge network. IEEE Network, 32(6), pp.8-14.
4. McWhinnie, L.H., Halliday, W.D., Insley, S.J., Hilliard, C. and Canessa, R.R., 2018. Vessel traffic in the Canadian Arctic: Management solutions for minimizing impacts on whales in a changing northern region. Ocean & Coastal Management, 160, pp.1-17.
5. Paiva, K.M., Cardoso, M.R.A. and Zannin, P.H.T., 2019. Exposure to road traffic noise: Annoyance, perception and associated factors among Brazil's adult population. Science of the Total Environment, 650, pp.978-986.

6. Ranieri, L., Digiesi, S., Silvestri, B. and Roccotelli, M., 2018. A review of last mile logistics innovations in an externalities cost reduction vision. Sustainability, 10(3), p.782.
7. Gong, S., Zhou, A., Wang, J., Li, T. and Peeta, S., 2018. Cooperative adaptive cruise control for a platoon of connected and autonomous vehicles considering dynamic information flow topology. arXiv preprint arXiv:1807.02224.
8. Sánchez, M., López-Mosquera, N., Lera-López, F. and Faulin, J., 2018. An extended planned behaviour model to explain the willingness to pay to reduce noise pollution in road transportation. Journal of cleaner production, 177, pp.144-154.