2nd Conference on Sustainability in Civil Engineering (CSCE'20)
Department of Civil Engineering
Capital University of Science and Technology, Islamabad Pakistan

EFFECT OF TRANSPORT INFRASTRUCTURE DEVELOPMENT ON HEALTH OF NATIVES: A CASE STUDY OF LAHORE ORANGE LINE METRO TRAIN PROJECT

Zeeshan Ullah[a]*, Engr. Shah Jahan[b], Engr. Sami Ullah[c], Engr. Muhammad Irfan[d], Engr. Tallat Habib[e]
a: PhD student, Dept. of Construction Engineering & Management (CE&M), NUST, Islamabad, zeshan880@gmail.com
b: Assistant Professor, University of Lahore, Gujarat Campus, Shahjahan1002@gmail.com
c: Assistant Director, TEPA, LDA, samigondal.lda@gmail.com
d: Lab Engineer, Civil Engineering Department, KFUEIT Rahim Yar khan, engr.mirfan1992@gmail.com
e: SDO DG Khan, Irrigation Department, Punjab, talathqureshi@gmail.com

Abstract: Development of Transport infrastructure is an essential necessity for evolution of economic growth and continuing improvement in living standards of citified occupants. However, it causes environmental contamination also lead by several factors. Construction activities yield inorganic dust, noise, vibrations, and volatile organic compounds. Natives along the urban project sites are exposed frequently to multiple health hazards including immunological, neurological, hematological, and respiratory diseases. Implementation of environment management plan (EMP) is considered mandatory for infrastructure projects and is followed by all stake holders in developed countries but there are so many challenges in developing countries like Pakistan. Environmental impact assessment (EIA) is obligatory part of the construction projects according to Pakistan Environmental Protection Act (PEPA), 1997. But unfortunately, EPM is not implemented and followed in its true sense. This research is comprised of Effects of Lahore Orange Line Metro Train project to the health of natives along the project sites regarding construction phase of project. 142 respondents are selected randomly along corridor i.e. from stabling yard to Depot. Data collected through questionnaire survey and analyzed by descriptive analysis using statistical tools. Specific sensory nervous system i.e. Sight (vision), Hearing (audition), Taste (gustation), Smell (olfaction), Touch (somatosensorial), skin (dermatological) and respirational effects are the special areas of research. Distress due to obtrusion of utility lines and general living of natives of project have also been investigated. The study framed guide lines to identify the health hazards for natives of project and concluded logical severity level against each hazard. This will be helpful to adopt realistic approach to distinguish the concerning nuisances individually in connection with remedial measures for future projects to enhance sustainable urban infrastructure development trends in developing countries like Pakistan.

Keywords: Bus Rapid Transit System, Environment Management Plan, Lahore Orange Line Metro Train, Health Effects.

INTRODUCTION

Infrastructure development is the essence of modernized civilization to meet prime necessities of community. It plays vital role to upgrade wellbeing of society and boost economy as well. Concurrently, environmental deterioration caused by infrastructure construction is utmost argued discipline regionally and globally. Construction is one of the major origins of environmental pollution. Effectual arrangements for environment friendly infrastructure are an explanatory public policy issue internationally [1]. Development of a large project take account of multidimensional courses which involve several tasks and activities. Massive engineering machines, equipment, concrete batching plants, asphalt plants, heavy vehicles for transportation of construction materials are the primary needs. Execution of activities comprised of excavation, Earth works, backfilling/sand filling, brick works, drilling, fixation of scaffolding, welding, drainage structures and concreting etc. are compulsory elements. All these factors contribute to pollute the environment somehow or the other. Construction machines and plants are originators of toxic gases and emissions. Ponding of water for drilling of reverse rotary piles put its share to contaminate the surrounding and cause various health hazards. Air pollution due to dust, smoke or composite originate consequential health concerns to humans. Pollution due to noise and vibrations cause annoyance, sleep distress and generate reasons for day time sleep. In conjunction with construction teams at work sites, natives are sufferer exposed to such polluted environment and have to face numerous health issues if pollutants not addressed accordingly [2].

Environmental protection is a dominant issue all around the world. Researchers define human health impacts as inclusive of not only specific health problems but also the consideration of general well-being. It implicates illness, injury, psychosocial belongings such as community severance and disturbance. 190 members of United Nations out of 193 have legislated the systematic process of EIA for development projects notwithstanding the considerations to comprehensive health impacts within EIAs endured impoverished [3]. World Health Organization (WHO) articulated serious concerns that healthy transportation policy has not been fully acknowledged seriously. EIA system was initially established as National Environmental Policy Act (NEPA) in US and instantly the procedure of EIA has been accompanied by more than 100 countries. Aspects of social costs including health impacts related to construction projects have been recognized and regulated in developed countries but unfortunately there is meagre research in this domain in developing countries [4]. Health impact assessment practices in UK are actively dominant by Merseyside model [2]. Unfortunately, in Asia the situation is frightening where two thirds of the cities are failing to meet the air quality standards of European Union i.e. 40µg/m3 of PM10. 34 ponderous polluted cities of the world among 57 with 100µg/m3 level of PM10 are Asian [5]. Construction of mass rapid transit system in large cities of Pakistan have been started since last few years. It is very important to understand that such projects in urbanized areas cause several health issues for natives' community. In feasibility study of the project it was recommended that priority timings of construction will be evening and night but construction works were proceeded round the clock to complete the project within due time. Being Fast Track Project, construction activities were executed simultaneously with full swing generating more originators of environmental pollution. So, natives of the project were exposed to health hazardous frequently [3].

Pakistan environmental protection authority and provincial EPAs are the responsible for surveillance of air quality pollution. Prior to start the inception of any project, EPA, under section 12 of PEPA 2012, publish a notice in local newspapers to assess if community has concerns about construction of proposed project (EPD, GOP). However, it is unfortune that government of Punjab did not take into consideration the precondition fulfilment of admissible legislation to reduce the acerbity of negative effects of environment caused by development works.

LITERATURE REVIEW

Lahore is the capital city of Punjab Province. It's the 2nd largest populated metropolitan city of Pakistan and 16th of the world. According to 6th population census conducted in 2017, population of Lahore has exceeded to 11.126 Million (PBS Govt. of Pakistan) with density 6279 person/square kilo meter. Lahore is among top twenty most polluted cities in the world. Brisk increase in population, upsurge vehicle ownership and growing trends of urbanization have intensified traffic congestion in Lahore. Moreover, this sizable city is expanding at the rate of 4% per annum. Being the capital city of most populated province, people from other districts have to travel for their employment, social, health, educational and other necessities. Keeping in view the situation, it was need of the time to develop a sustainable urban transport system to cope the requirements. To mitigate the extensive congestion of on-road vehicles, rapid mass transit system is significant solution. The Orange Line Mass Rapid Transit (MRT) is the 1st project among network of four lines of Mass Rapid Transit. The other proposed three lines are Green Line, Blue Line and Purple Line (PMA Govt. of Punjab). Feasibility study of Lahore orange line project was done in 2007 by MVA Asia Ltd (Consultant) and updated in 2014 through addendum to feasibility by NESPAK (Renowned consultant firm in Pakistan) on direction of Punjab Mass transit Authority Lahore (PMA, Govt. of Punjab) [6].

More than two million demises are estimated globally because of direct effect of air pollution damaging to lungs and respiratory system. Among particular factors related to health concerns due to dust emission of infrastructure development projects, smog is esteemed one. The word smog attribute to the blend of pollutants and environmental factors like fog. Smog exposure leads to numerous health issues like respiratory diseases, labored breathing, eyes hypersensitivity, irritability in nose and throat etc. On 3rd of December, 2018 Lahore ranked at number 1, worst air quality in the world. Receptiveness, lucidity and liability is rapidly being encouraged by individuals, groups, organizations and governments around the globe to improve the human health by outcomes of public infrastructure construction. The significance of health impact assessment has been recognized and being implemented in developed and developing countries. Guidelines captioning several facets of environmental impact assessment have been formulated and strengthened extensively [7].

In Pakistan environmental protection assessments were initiated as Environmental Protection Ordinance 1983 and intensified as Environmental Protection Act Pakistan 1997 then reformed and was operative as Environmental Protection Assessment Regulations-2000. Pakistan environmental protection authority and provincial EPAs are the responsible for surveillance of air quality pollution. Prior to start the inception of any project, EPA, under section 12 of PEPA 2012,

publish a notice in local newspapers to assess if community has concerns about construction of proposed project (EPD, GOP). However, it is unfortune that government of Punjab did not take into consideration the precon dition fulfilment of admissible legislation to reduce the acerbity of negative effects of environment caused by development works. Unfortunately, health considerations regarding health concerns of natives of projects are disregarded brutally. Untoward condition is that these natives even have no concept of their principal deserving. Studies have proven that residents of these projects are entangled by considerable health issues like coughing, dust vulnerability, sneeze issues, asthma, skin problems and others [8].

IMPACT OF CONSTRUCTION INDUSTRY ON COMMUNAL HEALTH

Among different industries the construction industry is the most dangerous industry. In accordance to the EU-OSHA, "The deteriorating health and mortality rate due to the construction industry is greater than that of any other industry." Construction and site activities are primarily responsible different types of diseases such as hypertension (HBP), hypertension (cardiovascular disease, pneumonia, breathing diseases, cough, asthma, cardiovascular disease, stroke, premature death and type 2 diabetes [9]. These are the main diseases. contaminated by construction contaminants. In the estimation global pollution that can be attributed to buildings and polluted air quality in construction activities is affected the city is 23% responsible for climate change through gas 50%, drinking water pollution by 40%, landfill pollution through construction activities occur 50% ozone depletion pollution by pollution is 50% [10].

RESEARCH METHODOLOGY

The research is considered as logical when cessation is accurate, research design is visionary representation and not beyond the area within which research is carried out. It comprised of an action plan established to framework collection, determine and analyze data. Considering the factors that are being utilized in scientific research and learning the way forward to conduct research, make findings for which statistics is to applied and analyze statistical results are the objectives of researchers in current scientific based era. In research designing, it is considered mandatory to concede the sort of evidence to response the research question in logical way. Owing to investigate the effects of transport infrastructure development on health of natives of Lahore orange line metro train project four main phases were categorized i.e. Fundamental study, Collection of data, Analysis of collected data and write up of the study.

SAMPLING PROCEDURE

Surveys are very conventional techniques to organize the research. These are considered as systemized tool to extract explicit information. Interview technique is extensively being used for knowledge building purpose in human sciences. Face to face interviews with closed ended questions are done by random survey technique to collect primary data from respondents living along both sides of corridor of Lahore orange line metro train project Lahore. Two numbers volunteers were deployed after due training for this purpose. Samples were collected from Stabling yard (Start of the project) to Depot (End of the project) [11]. The data is shown in table-1:

Table 1: Detail of sampling

Sr. No	**Data collected along both sides of corridor**		**No. of samples collected**	
	Initial Point	**Final Point**	**Left Side**	**Right Side**
1	Stabling Yard (Start of Project)	Pakistan Mint Station	9	13
2	Pakistan Mint Station	Railway Station	15	13
3	Railway Station	Gulshan Ravi Station	9	13
4	Gulshan Ravi Station	Sabzazar Station	14	13
5	Sabzazar Station	Thoker Niaz Baig Station	15	15
6	Thoker Niaz Baig Station	Depot (End of project)	7	6
Total Collected Sample			**69+73=142**	

For assessment of health effects caused by development projects, participation of community is considered as convenient and befitting procedure**.** Population for sampling was 142 respondents/ natives of Lahore orange line metro train project. The route of project passes through most congested areas of Lahore city. On both sides of corridor there are shops, fuel pumps, workshops, food points etc. Commercial activities are running day and night in these areas. 125 respondents out of 142 were from the same community. Seventeen respondents were permanent residents of project periphery.

RESULTS AND DISCUSSIONS

Transportation is one area where change is possible and provides a good example of the opportunities for positive synergies between the environment and health. This sector is one of the fastest growing greenhouse emitters in many countries, including Pakistan and transportation infrastructure affect health in many ways. A key challenge in the future is to meet the basic health and wellbeing needs of the large section of populations in developing countries that are currently living in 'energy poverty' while protecting the environment and human health. This chapter describes the results obtained from questionnaire analysis of the effect of Orange Line Metro Train Project on health of people in locality. Following the detail of respondent's characteristics and criticality indices of health factors.

CRITICALITY INDEX OF HEALTH FACTORS

Criticality index for 19 variables of all 3 sections have been determined. Criticality index for each variable was calculated. Criticality Index is extensively used by researchers due to its reliable & effectual results specifically in ranking the variables. It has also been utilized to itemize the relative significance of common problems and concerns of stakeholders in construction industry. Importance index was used to assess the factors affecting efficiency of workers in construction industry. Criticality Index has also been practiced in ranking the dominant challenges to the functioning of program management auspiciously in construction field. Criticality Index of 19 variables have been determined by using the following formula.

$$\mathbf{C.I= \sum i=1\ Wi\ Xi}$$

Where C.I is the Criticality Index, i expresses the response by respondent i.e. No effect, Mild, Medium, High & Very High in terms of 0, 1, 2, 3 & 4, W_i is the weight allocated to i^{th} response, X_i is the frequency of i_{th} response given as percentage of total responses. The values of Criticality Indices lie between 0 and 1. More tendency of C.I values towards 1 represents the more criticality of variables. Any variable with value greater than 0.5 will be considered as 'More Critical'. Cronbach's alpha values to evaluate the reliability and correlation of significant variables have been calculated. Cronbach's alpha is considered as extensive measure for reliability of data. It is one of utmost frequently used method to evaluate the internal consistency of data. Mean values and Standard deviations have also been computed

The data collected to perceive the effects of Orange line metro train on health of people living in its locality is ordinal data which is best possibly can be viewed in the form of indices of each health factor to determine which one is more critical. The criticality index of each factor has been calculated and results are shown in Figure-1. It represents that out of total 19 selected health factors, 13 are more critical as their C.I are greater than 0.5, three factors are considered critical provided their C.I is greater than 0.4. three factors have CI equal to zero or less than 0.3 and hence these are considered non-critical.

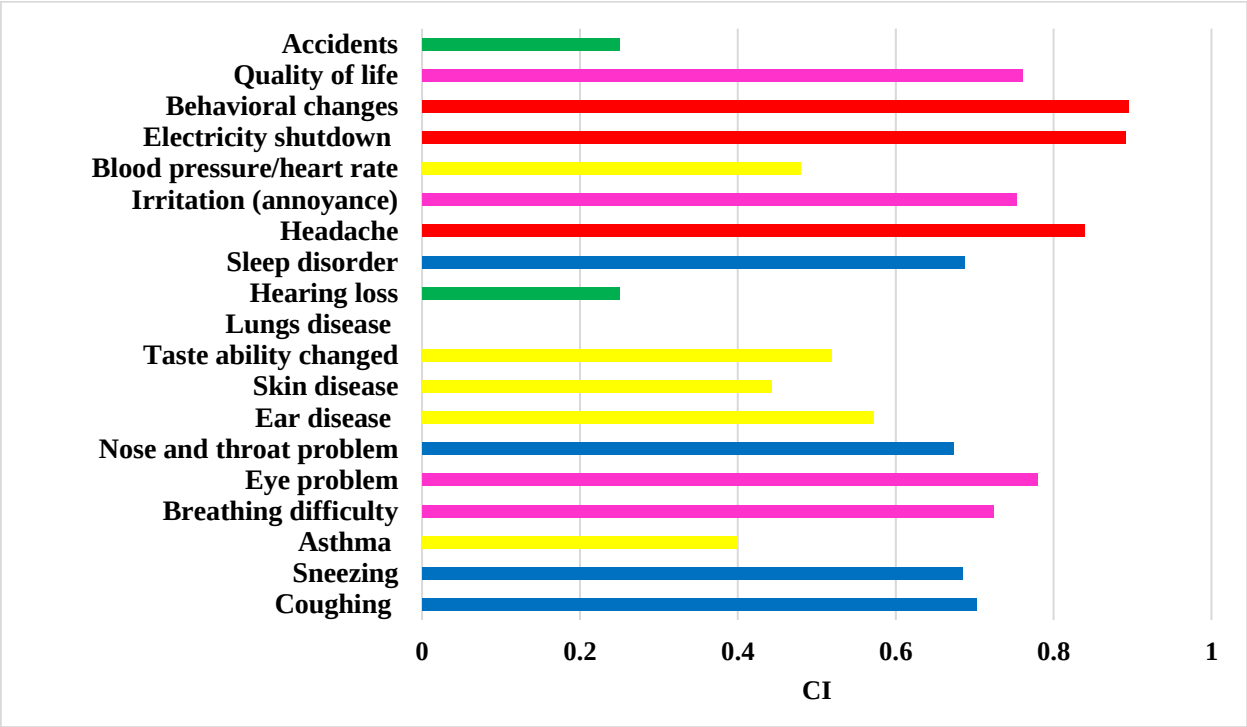

Figure.1: Criticality index of Health factors

ANALYSIS BASED ON AGE AND DISTANCE OF RESPONDENTS

The data was categorized based on the age and distance of respondents. Four age groups were selected which are 19-25year, 26-35year, 36-45year and 46-55year. Their response was segregated and C.I was calculated for these groups separately to determine whether the ae of respondents has any impact on the response. Similarly, it has also been questioned from the respondents that how far away they live from orange line metro train and response range was from 5km to 80km where the number of people who lived more than 30km away from train were grouped as >30km. hence it gives five groups as 5-10km, 11-15km, 16-20km, 25-30km and >30km. Based on these groups, C.I of health factors was calculated to determine the role of distance in criticality of responses.

DESCRIPTIVE STATISTICS

The following table 2 and 3 represents descriptive statistics of data grouped by location or remoteness of respondents and age groups of respondents. It includes Mean, Standard Error, Median, Mode, Standard Deviation, Sample Variance, Kurtosis, Skewness and Range of response.

Table 2: Descriptive statistics of C.I value varied by remoteness of respondents

Criticality Index by Distance of Respondent	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Minimum	Maximum	Sum	Count	Confidence Level (95.0%)
5-10km	0.6	0.06	0.71	0.25	0.25	0.06	0.23	-0.92	0.91	0	0.91	11.47	19	0.12
11-15km	0.6	0.06	0.67	0.25	0.24	0.06	0.43	-0.93	0.89	0	0.89	11.39	19	0.12
16-20km	0.58	0.06	0.66	0.25	0.27	0.07	-0.65	-0.57	0.92	0	0.92	11.06	19	0.13
25-30km	0.59	0.06	0.68	0.5	0.27	0.07	0.87	-1.2	0.89	0	0.89	11.28	19	0.13
>30km	0.35	0.07	0.31	0	0.31	0.1	-1.37	0.23	0.84	0	0.84	6.25	18	0.15

Table 3: Descriptive statistics of C.I value by different age groups of respondents

Criticality Index by Age of Respondents	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Minimum	Maximum	Sum	Count	Confidence Level (95.0%)
19-25yr	0.59	0.06	0.68	0.25	0.28	0.08	0.28	-1.04	0.93	0	0.93	11.23	19	0.14
26-35yr	0.56	0.06	0.64	0.25	0.28	0.08	-0.13	-0.83	0.89	0	0.89	10.68	19	0.13
36-45yr	0.61	0.06	0.71	0.45	0.25	0.06	0.34	-0.98	0.9	0	0.9	11.5	19	0.12
46-55yr	0.61	0.07	0.77	0.25	0.3	0.09	-0.15	-0.99	0.93	0	0.93	11.54	19	0.14

It is obvious from the results that values of standard deviation are less which shows data is closer to mean values. Here it is not clear either these groups have significance difference in their responses or not.

RESOURCEFULNESS OF RESPONSE BY AGE AND DISTANCE

The CI of health factors were distinguished based on the age groups of respondents and the distance from train at which they reside. Figure 2 shows a correlation analysis performed on health factors. It represents that as the distance increases, the health factors appear less critical for respondents but age has no impact on it.

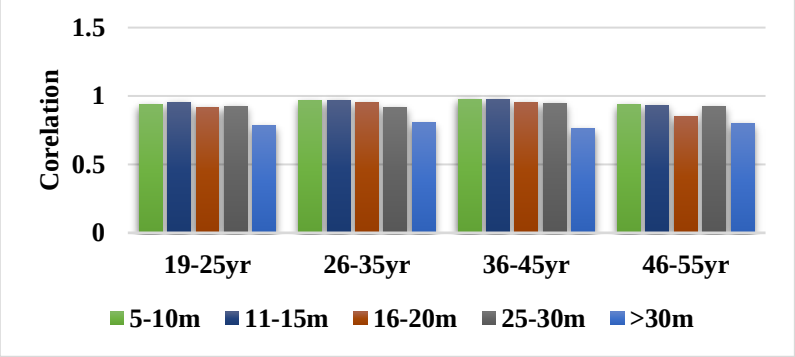

Figure.2: Correlation of Health factors by age and distance of respondents

CONCLUSIONS AND RECOMMENDATIONS

Construction of infrastructures are important for the development of any country. But during the construction of these infrastructures will also damage the environment and health of community of those area. After grouping data analysis was carried out by using useful statistical analysis tests like ANNOVA and t-tests. After that conclusions and recommendations were made and discussed below.

1. During the construction of road infrastructures, dust and dirt particles sustained in air causing breath problems.
2. The lungs disease, hearing loss and accidents were caused by dust particles in air but these diseases also non-critical health factors based on this research.
3. In the light of statistical analysis, it is clear that age of respondents has no effect on response and criticality index as criticality index of respondents of all age groups remains the same based on covariance and ANOVA statistics whereas it varies for distance of respondents.
4. Un-seasonal smog will be caused in the area where infrastructures are constructed which increase the accident and death rates.
5. Based on results obtained by t-Test, the people who live more than 30km away from metro train stated these health factors less critical and their responses are significantly different from that of closely resided people.
6. Cough, throat and sneeze problems were critical during the construction of road infrastructures. Acid rains were caused by the population in environment during construction of infrastructures.
7. Asthma, skin disorder blood pressure was caused by environmental damages and production of lots of noises. But these effects were less critical as critical index of these diseases was very less.

8. During construction of road infrastructures lots of noise produced that caused sleeping disorder, headache, irritation and also behavior of human being changed with this noise. Asthma, skin disorder blood pressure was caused by environmental damages and production of lots of noises. But these effects were less critical as critical index of these diseases was very less.

Infrastructures are the key construction components that define the progress of any country and also improve the economy and growth of the country. Following are the recommendations of this study:

1. The negative impacts of infrastructures can be controlled or reduced by using a proactive approach that preserves natural corridors will help with long-term sustainability of the transport infrastructure and the environment to protect.
2. Timely medical tests of surrounding community should be conducted to investigate any physical problem caused by construction process of that structure. Periodic medical treatment should be carried out for the people living in the locality of construction project.
3. Successful and sustainable projects require collaboration between governments, policy makers, infrastructure planners, environmentalist, and the community.
4. In order to control the suspension of dust and dirt particles in surrounding air, timely showering should be done during the entire period of construction of infrastructures.
5. Concrete batching plants and other machinery should be installed far away from community to the diseases produced by noise.
6. The construction of any type of infrastructure should be properly planned as a fast track project and execute it by using extra resources like machinery and man power.
7. Future research can be carried out by considering domestic people in the sample as there would be wide range of people would be there including students and job holders who spend partial time near project site and remaining time in offices or school.

REFERENCES

[1] R. Chen, B. Hu, Y. Liu, J. Xu, G. Yang, D. Xu, *et al.*, "Beyond PM2.5: The role of ultrafine particles on adverse health effects of air pollution," *Biochimica et Biophysica Acta (BBA) - General Subjects*, vol. 1860, pp. 2844-2855, 2016/12/01/ 2016.

[2] J. H. Kim, D. H. Lee, Y. Joo, K. D. Zoh, G. Ko, and J.-H. Kang, "Identification of environmental determinants for spatio-temporal patterns of norovirus outbreaks in Korea using a geographic information system and binary response models," *Science of The Total Environment*, vol. 569-570, pp. 291-299, 2016/11/01/ 2016.

[3] R. Rückerl, R. Hampel, S. Breitner, J. Cyrys, U. Kraus, J. Carter, *et al.*, "Associations between ambient air pollution and blood markers of inflammation and coagulation/fibrinolysis in susceptible populations," *Environment International*, vol. 70, pp. 32-49, 2014/09/01/ 2014.

[4] F. Al-Bahar Jamal and C. Crandall Keith, "Systematic Risk Management Approach for Construction Projects," *Journal of Construction Engineering and Management*, vol. 116, pp. 533-546, 1990/09/01 1990.

[5] D. G. Karottki, G. Bekö, G. Clausen, A. M. Madsen, Z. J. Andersen, A. Massling, *et al.*, "Cardiovascular and lung function in relation to outdoor and indoor exposure to fine and ultrafine particulate matter in middle-aged subjects," *Environment International*, vol. 73, pp. 372-381, 2014/12/01/ 2014.

[6] J. M. Bryce, G. Flintsch, and R. P. Hall, "A multi criteria decision analysis technique for including environmental impacts in sustainable infrastructure management business practices," *Transportation Research Part D: Transport and Environment*, vol. 32, pp. 435-445, 2014/10/01/ 2014.

[7] Å. Jevinger and J. A. Persson, "Consignment-level allocations of carbon emissions in road freight transport," *Transportation Research Part D: Transport and Environment*, vol. 48, pp. 298-315, 2016/10/01/ 2016.

[8] T. Münzel, F. P. Schmidt, S. Steven, J. Herzog, A. Daiber, and M. Sørensen, "Environmental Noise and the Cardiovascular System," *Journal of the American College of Cardiology*, vol. 71, pp. 688-697, 2018/02/13/ 2018.

[9] A. Papapostolou, C. Karakosta, and H. Doukas, "Analysis of policy scenarios for achieving renewable energy sources targets: A fuzzy TOPSIS approach," *Energy & Environment*, vol. 28, pp. 88-109, 2017.

[10] C. Ambrey and C. Fleming, "Public Greenspace and Life Satisfaction in Urban Australia," *Urban Studies*, vol. 51, pp. 1290-1321, 2014/05/01 2013.

[11] R. Close and M. Loosemore, "Breaking down the site hoardings: attitudes and approaches to community consultation during construction," *Construction Management and Economics*, vol. 32, pp. 816-828, 2014/08/03 2014.