

**Effects of Infrastructure Development on Health of Ecology***(A Case Study of Lahore-Sialkot Motorway Project)*¹Engr Saeed Jan, ²Dr Ammad Hassan Khan, ³Engr Kashif Ali*The Superior Colleg, Lahore, Pakistan*

Abstract — The project under observation is of Lahore-Sialkot Motorway that is a north-south motorway currently under construction in Pakistan. The 91 km long motorway will connect Lahore to Sialkot via Sambrial and is expected to be completed by 30th December 2019 at a cost of Rs 44 billion (US\$420 million). Once completed it will reduce travel time between Sialkot and Lahore to 50 minutes. The motorway is consisting of 4 no of lanes, having 7 - interchanges, 6 - flyovers, 29 - bridges, 36 - underpasses, 33 - cattle creeps and 252 - culverts. In Lahore, the motorway will be linked to the Lahore Ring Road, which will allow motorists direct access to the M2 and N5. The Interchanges given at different locations connects the cities mainly the link roads emanating from N-5. The major cities along the route of the motorway are Lahore, Muridke, Narowal, Wando, Gujranwala, Pasroor, Dhaska, Sambrial and Sialkot. Assessment is needed to be carried out for evaluating the significant effects since it will plays a central role in future safe planning, designing and execution of such infrastructure projects. A worksheet is specially designed for this purpose, applied on the specific LSM Project and a Compliance Index is obtained which clearly indicate the safety level of the particular structure under observation against health of Ecology. A value of overall compliance index is obtained as a result of different compliance indexes for Land use, Crops, Animals & Birds and Environment (Air & Water). Effects on Land use, Crops, Animals & Birds and surrounding environment depends on the physical condition of the project and their design level. The Weighted Compliance Index obtained is calculated automatically with help of the worksheet. The Weighted Compliance Indexes are then combined to give Overall Compliance for each category. Further, the Overall Compliances Indexes of four categories give the Multiple Compliance Index for the whole Project. The value obtained in this context for Multiple Compliance Index is 0.59, that is greater than the Mean Compliance Index (i.e Greater than 0.5). It shows that keeping in view the key questions that were designed to assess effect of infrastructure development on ecology, shows that the project is not good for health of Ecology. Therefore needs close consideration.

Keywords- Lahore-Sialkot Motorway (LSM), Ecology, Infrastructure Development, Health, Ecology, Evaluation, Motorway, LSM, (M11), Criticality Index, Pakistan

I. INTRODUCTION

As a matter of fact, the importance and need of infrastructure development can't be denied, also transport infrastructure is most important for a country's economic growth and alleviates poverty, but it also have attractive effects on the surrounding ecosystems and wildlife. Green infrastructure provides more natural or semi-natural space for various ecosystem services, wildlife, and humans. Since the project is located in Punjab, therefore its EIA procedure will be governed by the existing policies, legislation and administrative framework in place in Punjab.

The subject and awareness of effects on ecology and pollution has been devolved to all the provinces. Punjab has enacted its own environmental protection act. Yet the policies, guidelines and regulations framed prior to devolution at the federal level are still relevant and obligatory to meet in Punjab. To achieve proper control over the effect of transport infrastructure development over environment and health of ecology. National Environmental Policy is launched by the Government of Pakistan in 2005. That provides a basic central framework for the issues such as contamination in the water bodies and seaside beach water, de-forestation, toxic ingredients of air, absence of appropriate way for management of the wastes and also climate change to be addressed as facing Pakistan. In addition agriculture, worms, Birds and Species is also in upmost priority consideration. Wildlife crossings can be overpasses or underpasses that lessen the barrier effects of transport infrastructure.

In many species, especially larger wildlife, the transport sector has responsibility for the survival of offspring and immigration. Survival is directly linked with the death of the wildlife due to road and railroad traffic. Millions of animals are killed annually as they enter or cross transport infrastructure facilities, but statistics are limited (often only to those that are of immediate traffic safety concern) and despite legal requirements on a monitoring system for incidental mortality (i.e. road kills), empirical data is scarce. Immigration, on the other hand, is dependent on the permeability of transport corridors for wildlife. Many if not most terrestrial species experience significant movement barriers in roads and railroads. This barrier effect often increases with traffic volume and is thus linked to mortality, but in many species it also contains behavioral components (avoidance) that prevent accidents but increase the barrier effect. Also here, empirical data is often scarce and the functional relationship with traffic or road design mostly theoretical.

II. RESEARCH METHODOLOGY

Below listed steps involved during the study work of the Project.

- Literature Review
- Objectives of the research and the risk factors involved against Health of Ecology
- Area selection and limitations, pilot survey with establishment of Questionnaire
- Data Collection with random surveying
- Analysis of the collected data
- Results with conclusion and Recommendations

III. PROJECT ISSUES

The project main issues and anxieties that are measured in this context during various phases of the project are listed as under:

- Trees and bushes fall within ROW of the project site.
- Restrictions and diversions that disturbs the public movements along the roads crossing LSM Project during construction and execution.
- Disturbance due to construction, of the locals living in the vicinity of the project area.
- During operation of the heavy construction machinery, producing air and noise pollution/contamination.
- During the tenure of execution activities of the project, solid wastes generation also happens.
- HSE (Health, safety and Environment) assurance of workers and public.
- Adulteration of the resources of water due to soil erosion and also due to construction activities
- Land acquisition.

IV. TOOLKIT FOR ANALYSIS

4.1 Discussion:

Criticality Index of the project as can be easily understandable in the excel worksheet is attained by giving answers to the checklist given in the next 4 worksheets. They are: i) Land use, ii) Crops and plants, iii) Birds & Animals and iv) Air & Water. The surveyor of filling the worksheet questions is bound to fill only those questions in the entire worksheet that are related to the project and locality of the area. Take a worksheet, i.e, Land Use: Go through Column B “KEY QUESTIONS...” one by one then pick up that value from Column “C” and write in Column “D” which suit w.r.t site condition. Compliance Status of Column “E” came from “if” command which depend on the value of Column “D” and applied automatically.

Issue Importance VI, I, LOW of Column “F” depend on importance of the question and their value came from issue Importance table

ISSUE IMPORTANCE	
Very Imp =	27
Imp =	9
Low Imp =	3
Compl Index Cutoff Level =	1

Table 3.1: Issue Importance

Weighted Compliance of is the multiplication of Compliance Status and Issue Importance, clearly understandable by the columns of the toolkit as formulated. Compliance Index is obtained by using the following formula.

$$\text{Compliance Index} = \frac{\Sigma(\text{Weighted compliance})}{\Sigma(\text{Ideal case})}$$

After duly filling of all the worksheets by completing the process, then finally open the last “summary” page. The summary page have automatically drawn graphs and charts that is the summarized result of the surveyed question answers. NA will be written next to the cells that is not relevant to the project particular area.

SAFETY COMPLIANCE MATREX				
Is This Hazard Applicable or Not	Applicable	Applicable	Applicable	Applicable
	Multiple Weighted Compliance			
	Land Use	Plants & Crops	Animals & Birds	Environment
Section – 1	0.82	0.75	0.47	0.49
Section – 2	0.75	0.75	0.63	0.68
Section – 3	0.83	0.25	0.75	0.75
Section – 4	0.86	0.00	0.38	0.25
Multiple Compliance Index	0.59			
Overall CI	0.81	0.44	0.56	0.54
	1.00	1.00	1.00	1.00

The value of Multi Weighted Compliance Index for each category. i.e, Sec-1, Sec-2, Sec-3 and Sec-4 of every worksheet (e.g. Land Use) originated from the corresponding worksheet (e.g. Land Use).

- Overall Compliance Index (Overall CI) is calculated by the given formula

$$\text{Overall CI} = \frac{\Sigma(\text{Multi weighted compliance index} \times \text{Category weights})}{\Sigma(\text{Category weights})}$$

- Multi-Weighted Compliance index is calculated by the given formula

$$\text{Multi Weighted CI} = \frac{\Sigma(\text{Overall CI} \times \text{Applicability} \times \text{Cat weights})}{\Sigma(\text{Applicability} \times \text{Cat weights})}$$

4.2. Calibration test of the Toolkit Worksheets:

For calibration purpose the toolkit is applied on Orange Line Metro Train Project Lahore (OLMTP Lahore). The results obtained, after applying the Toolkit Worksheets, are the following:

The Multi-Weighted Compliance Index obtained for Orange Line Metro Train Project Lahore (OLMTP Lahore) is 0.33. The resulted above value is less than 0.5 (which was considered as a critical limit), shows that the Orange Line Metro Train Project Lahore (OLMTP Lahore) was designed and executed safe against health of ecology.

SAFETY COMPLIANCE MATREX				
Is This Hazard Applicable or Not	Applicable	Applicable	Applicable	Applicable
	Multiple Weighted Compliance			
	Land Use	Plants & Crops	Animals & Birds	Environment
Section – 1	0.25	0.00	0.25	0.50
Section – 2	0.00	0.00	0.06	0.43
Section – 3	0.25	0.50	0.25	0.31
Section – 4	0.25	0.25	0.38	0.38
Multiple Compliance Index	0.25			
Overall CI	0.19	0.19	0.23	0.40
	1.00	1.00	1.00	1.00

4.3. Data Collection:

The data collection is the most important activity to complete the study with precision and in time. Therefore for data collection, four basic study spaces were kept fixed for analyzing the infrastructure developmental effect on ecological health and that is to be answered by the respondent, that are 1) Land Use, 2) Crops and Plants, 3) Animals & Birds and 4) Air & Water.

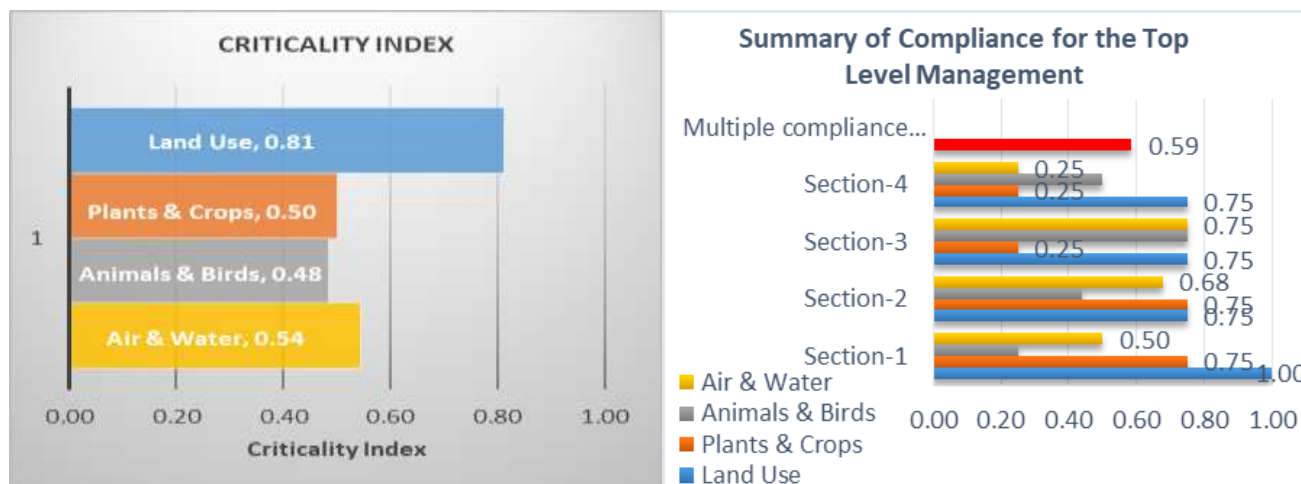
4.4. Sampling Procedure:

Surveys are very conventional techniques to organize the research Face to face interviews with closed ended questions are done by random survey technique to collect primary data from respondents living along Lahore Sialkot Motorway project. 4 x volunteers (AMs) were deployed after due training for this purpose. Duly filled multiple choice answer sheets were collected from different sites of the project 4 x sections (i.e; from start of the project to Depot).

4.5. Results:

There are four Sections of the Project in which the project is divided according to Kms. 1) LSM Sec-1 is the first section that starts from the KSK interchange Lahore from RD 0+000 to 22+100 end aligning near Mureedke, 2) LSM Sec-2 is considerably starts from RD 22+100 to 45+000 nearly aligned to Narowal. Similarly 3) LSM Sec-3 starts from RD 45+000 to 66+584 aligning near Gujranwala & Daska. The Last Section is the 4) LSM Sec-4 from RD 66+584 to 91+000 ends at Sialkot via sambrial. After collecting data and substituting in the worksheets of the Toolkit gives us results for the four different locations as described above, are given in the form of tables and graphs with detailed explanations as follow.

SAFETY COMPLIANCE MATREX				
Is This Hazard Applicable or Not	Applicable	Applicable	Applicable	Applicable
	Multiple Weighted Compliance			
	Land Use	Plants & Crops	Animals & Birds	Environment
Section – 1	1.00	0.75	0.25	0.50
Section – 2	0.75	0.75	0.44	0.68
Section – 3	0.75	0.25	0.75	0.75
Section – 4	0.75	0.25	0.50	0.25
Multiple Compliance Index	0.59			
Overall CI	0.81	0.50	0.48	0.54
	1.00	1.00	1.00	1.00



SUMMARY OF THE RESULTS FOR LSM:

S.No	Catagory	Compliance Index Value	Avg Range	Criticality	Remarks / Importance
1	Effects on Land Use	0.81	0.5	Most Critical	Important
2	Effects on Crops & Plants	0.50	0.5	Critical	Very Important
2	Effects on Animals & Birds	0.48	0.5	Critical	Very Important
4	Effects on Air & Water	0.54	0.5	Critical	Important

Sec-1 (RD 0+000 to 22+000) has Multi-hazard Compliance Index which is more than the corresponding other Sections of the LSM Project. Sec-4 (RD 66+584 to 91+000) has the lowest value among others. Compliance Index table of Toolkit shows that all the four Sections have Median to High Compliance values. Among the four areas limited under study of Land Use, Crops & Plants, Animals & Birds and Air & Water. The condition of these Sections of the Project is critical for all and also severe for Land Use but safe a little against crops & plants as due to recovery/recoup of green environment by plantation practice.

V. CONCLUSION & RECOMMENDATIONS

5.1. Conclusion

As 0.5 is kept the mean level standard below which the result shows that the project does not have severe impacts on ecological health. Whereas if the resulting multiple CI value more than 0.5 shows the severity level of the project against ecological health. More the CI value tends to 1, more will be the severity level of the project.

From Observations, Toolkit results and Supplement data, it has been resulted that as the Overall Multiple CI Value (i.e; 0.59) for LSM Project is more than 0.5, the severity level of the whole project against ecological health is high.

5.2. Recommendations

Keeping in view the above results obtained, as a whole LSM Project is kept as in non-satisfactory condition. Therefore, as a result it is recommended that:

- There is solemn need of focusing on mitigation measures for recoup of the pleasing environment and making the project environment friendly by adopting ecological needs/standards. Also to achieve the goal for which the project was designed as to be constructed without any ecological damage/disruption.
- Many of the other infrastructure developmental projects are on track/ developing stage and are in progress currently for which such analysis should have to be done, either once or on regular basis and mitigation measures to recoup the environment that is fair for health of ecology, is severely desired.

REFERENCES

- [1] Baubinas, R. Physical aspects of the quality of urban environment and their influence on some social phenomena (a case of Lithuanian cities), 2003. <https://core.ac.uk/download/pdf/82619514.pdf>
- [2] Burinskiene, M.; Griškevičiūtė-Gečienė, A. Towards creating the assessment methodology for urban road transport development projects, Technological and economic development of economy, 2012.
- [3] <https://journals.vgtu.lt/index.php/TEDE/article/download/4729/4050>

- [4] Burinskienė, M.; Rudzkienė, V. Assessment of sustainable development in transition, *Ecology* 53: 27–33, 2007. <https://www.tandfonline.com/doi/pdf/10.3846/tede.2010.32>
- [5] De Groot, R.S., Wilson, M.A., & Boumans, R.M.J. A typology for the classification, description and valuation of ecosystem functions, goods and services, 2002. <https://www.researchgate.net/publication/>
- [6] Dhakal, K.P., & Chevalier, L.R. Managing urban stormwater for urban sustainability: Barriers and policy solutions for green infrastructure application. *Journal of Environmental Management*, 2017. <https://www.ncbi.nlm.nih.gov/pubmed/28783013>
- [8] Griskeviciene, D. The influence of the passengers' transport system convenience on the living standards in Vilnius city. 8th international conference "Reliability and statistics in transportation and communication", 15–18 October 2008. <https://www.sciencedirect.com/science/article/pii/S1877705816000655>
- [9] Herzog, C.P. A multifunctional green infrastructure design to protect and improve native biodiversity in Rio de Janeiro. *Landscape and Ecological Engineering*, 12, 141-150, 2016. <https://www.academia.edu/11372581>
- [10] Horizon 2020. Work Programme 2014–2015 "Smart, green and integrated transport" Revised. European Commission Decision, C(2014)4995, 22 July 2014. http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/main/h2020-wp1415_transport_v2.0_en.pdf
- [11] Jakovlevas-Mateckis, K. The Principles of Systematic formation of Town and Its Dwelling Environment, 2004. <https://www.liberquarterly.eu/articles/10.18352/lq.7767/>
- [12] Karlson, M., Mortberg, U., & Balfors, B. Road ecology in environmental impact assessment. *Environmental Impact Assessment Review*, 48, 10-19, May 23, 2014. <https://www.diva-portal.org/smash/get/diva2:866686/FULLTEXT01.pdf>
- [13] Lovell, S.T., & Taylor, J.R. Supplying urban ecosystem services through multifunctional green infrastructure in the United States. *Landscape Ecology*, 2013. <https://www.researchgate.net/publication/257504191>
- [14] Mandle, L., Bryant, B., Ruckelshaus, M., Geneletti, D., Kiesecker, J., & Pfaff, A. Entry points for considering ecosystem services within infrastructure planning: How to integrate conservation with development in order to aid them both, 2015. <https://onlinelibrary.wiley.com/doi/abs/10.1111/conl.12201>