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Identifying Positive & Negative Impacts of Mumbai Metro Line IV by Leopold Matrix

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ABSTRACT

The Environmental Impact assessment of any Infrastructure work is carried out for determining the Environment and Socio-Economic impacts prior to the commencement of construction. This thesis work assesses the Environmental impacts for the upcoming Metro Line 4(Wadala-Ghatkopar-Teen Hath Naka (Thane)-Kasarwadavli). The study mainly aims at quantifying the maximum positive and negative impacts on the Environment during and after the construction. For achieving public participation and ensuring transparency, a survey of the professionals, students, and local people from the surrounding area of work location having the background in the field of Environment was conducted. The answers to the survey questionnaire are tabulated with regards to maximum and minimum impacts and interpreted using the concept of 'Leopold's Matrix'. Based on the result from the 'Leopold's Matrix' critical impacts are decided & study with respect to those factors will be done in the future aspect of the work.

Keywords: Environmental Impact assessment, MoEF, Metro Line 4, Leopold's Matrix.

I. INTRODUCTION

An Environment Impact Assessment is an official process used to predict the environmental consequences (good or bad) of a plan, policy, program, or work prior the implementation decision. It proposes measures to adjust impacts to acceptable levels or to investigate new technological solutions. Assessments are done to ensure that decision makers consider the environmental impacts when deciding whether or not to proceed with a work. The International Association for Impact Assessment (IAIA) defines an environmental impact assessment as "**the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made.**" EIAs are unique, the reason being, they do not require adherence to a predetermined environmental outcome, but rather they require decision makers to account for environmental values in their decisions and to justify those decisions in light of detailed environmental studies and public comments on the potential environmental impacts. [1]

The metro corridor, which stretches from Wadala to Kasarwadavli via Ghatkopar and Thane, was approved in the 140th Authority Meeting of Mumbai Metropolitan Regional Development Authority (MMRDA). The proposed metro line 4 will connect Mumbai to Thane via Wadala-Ghatkopar-Teen Hath Naka (Thane) - Kasarwadavli. The Detailed Work Report (DPR) prepared by the Delhi Metro Rail Corporation (DMRC) estimates the completion cost to be around Rs. 14, 549 crores. However, a detailed synopsis of the work released by MMRDA pegs the completion cost at Rs. 19, 097 crores. According to the synopsis, the metro will cover 32 stations with a 25-hectare car depot planned in Owale and a 16-hectare one in Ghatkopar. According to the official press release, the car depot in Owale spans around 30 hectares. The work aims to reduce the use of private vehicles and auto rickshaws, which can subsequently

ease congestion on roads. It also targets to bring down noise and air pollution by facilitating a "comfortable, speedy and air-conditioned journey."

The work, which is expected to be complete by 2021, has been proposed to the state government for approval. Government clears Mumbai Metro 4 line Wadala-Ghatkopar-Thane-Kasarwadavli to be complete by 2021. (https://mmrda.maharashtra.gov.in/metro-line-4)

II. Literature Review

Mumbai Metropolitan Region (MMR) is one of the fast growing metropolitan regions in India. In MMR, public transport systems are overcrowded and the road network is congested as there is a large gap between the demand and supply. To decongest the existing public transport systems and increase mobility across the Region, MMRDA through MMRC commissioned the services of RITES to prepare a DPR and Environmental/Social Impact Assessment study for the corridor of Colaba – Bandra – SEEPZ covering total length of 33.508 km. MMRDA has planned to get fund from Japan International Cooperation Agency (JICA) for the construction of Mumbai Metro Line III. The scope of the study is framed as per JICA guidelines for Environmental and Social considerations, 2011.The detailed study of Environmental report of Mumbai Metro Line-III signifies the following negative & positive impacts which has been studied in depth. The aspects & parameters to be followed for the proposed metro line are taken from the Metro Line-III EIA report.

The Leopold matrix was conceived by geologist Luna B. Leopold and his colleagues in 1971, as a response to the US Environmental Policy Act of 1969, which didn't give clear instructions to the Federal Government agencies for preparing an impact report or for examining the environmental effects of the works that an agency plans. The Leopold matrix addressed this challenge by 'providing a system for the analysis and numerical weighting of probable impacts'. As pointed out by the creators of the Leopold matrix, there is a clear advantage of using the matrix 'as a checklist or reminder' of the large scope of actions and impacts on the environment that can relate to the proposed actions (Leopold et al., 1971). According to the Leopold matrix method, EIA should consist of three basic elements: a) a listing of the effects on the environment that the proposed development may induce, including the estimate of the magnitude of each of the effects; b) an evaluation of the importance of each of listed effects (e.g., regional vs. local); and c) a summary evaluation, which is a combination of magnitude and importance estimates

III. Methodology

Keeping in view the nature of activities envisaged and environmental quality guidelines of Metro works, the area around proposed metro site was studied for the purpose of environmental impact assessment studies. The procedure for carrying out the environmental impact assessment is being followed in the subsequent section.

3.1 Screening

According to the EIA Notification, 2004 and the New EIA Notifications, 2006, the EIA of Mumbai Metro Line 4 (Wadala-Ghatkopar-Teen Hath Naka (Thane)-Kasarwadavli) has to be carried out due to the following reasons:

- This work is a complete new one i.e. it does not contain expansion of an existing construction.
- The schedule 1 of the EIA notification 2004 has been divided into two main categories: Category A and Category B.
- Category A: All works and activities require EIA study and clearance from central government.
- Category B: Application reviewed by the State Level Expert Appraisal Committee into two Categories - B1 (which will require EIA study) and B2, which does not require EIA study. This work is categorized under Category B1.
- Rather size or capacity of the work determines whether it is cleared by the central or state government.
- Wadala-Ghatkopar-Teen Hath Naka (Thane)-Kasarwadavli will be built at an estimated cost of Rs. 19,097 Cr. which is much higher to the budget of Rs. 50crores above which an EIA should be carried out.
- The area requirement for the completion of this work is more and hence an EIA becomes mandatory.
- According to the EIA Notification, 2006, a revised list of works and activities has been redrawn that requires prior environmental clearance.

According to these guidelines, all the works under Mass Rapid Transport Systems in Metro Cities have to carry out an EIA.

3.2 Scoping

3.2.1 Survey

To identify the environmental impacts of the work, a survey was being carried out along the route of the metro line 4 with the help of Google form. The places covered during this survey were chosen keeping in mind the ones which will have more effect on the environment. The places covered were basically six stations:

- Bhakti Park Metro
- LTT Metro
- Vikhroli Metro
- Shangrila
- RTO Thane
- Manpada
- Kasarwadavli

3.2.2 Questionnaire

A questionnaire was being prepared considering all the possible impacts on the environment both during and post construction. A sample of the questionnaire included the form which was being circulated among professionals, students, people from the Environmental background & were asked to rate the following aspects from highly negative to Highly Positive effect.

The residents living nearby these stations along the route of the metro line filled up the questionnaire based on their personal opinion as to what they think would be the impact of the Upcoming metro on their lives as well as on the environment which includes the air, water, noise and land environment. Around 34 residents gave their opinions, based on which a Leopold's Matrix is drawn out. This will help in determining the governing positive and negative impacts on the environment purely on the basis of the survey which was being carried out.

IV. Results

4.1. Responses of Questionnaire

The responses of questionnaire given were quantified without the weighted factors. The overall impacts visible from the questionnaire were positives based on the public opinion. However, there were concerns related to water, air and noise. An internet based survey was being done among the students, engineers, environmentalist & people from environment background. The response obtained from 34 people was being taken into view.

4.2 Leopold's Matrix

Leopold Matrix is most commonly used quantitative tool for quantifying impacts of work on environment. The system consists of a matrix with columns representing the various activities of the work, and rows representing the various environmental factors to be considered. The intersections are filled in to indicate the magnitude (from -10 to +10) and the importance (from 1 to 10) of the impact of each activity on each environmental factor.

The responses were categorized as positive & negative impacts. The affects were multiplied based on the factors from most to least effect and it was observed that there were more of positive impacts as compared to negative impacts as depicted in table 1 and table 2 respectively. It is seen from the below table that the air quality and dust generation have a greater impact than the rest. Also, there is a positive on mobility due to metro work. These factors need be measured on field using the standard environmental indicators.

Aspects	**Positive Effects**											
	Multiplying Factor											
	1	2	3	4	5	**Total**	1	2	3	4	5	**Total**
Due to Work Location												
Impact on Local Transport Utilities	0	1	2	17	14	**34**	0	2	6	68	70	**146**
During Service Stage of Mumbai Metro Line 4												

Employment Opportunities	0	0	1	24	9	**34**	0	0	3	96	45	**144**
Benefit to Economy	0	0	2	22	10	**34**	0	0	6	88	50	**144**
Mobility	0	0	1	18	15	**34**	0	0	3	72	75	**150**
Safety	0	0	2	22	10	**34**	0	0	6	88	50	**144**
Traffic Congestion Reduction	0	0	4	18	12	**34**	0	0	12	72	60	**144**
Less fuel Consumption	1	3	2	17	11	**34**	1	6	6	68	55	**136**
Reduced Air Pollution	1	4	1	16	12	**34**	1	8	3	64	60	**136**
Carbon dioxide Reduction	1	4	6	14	9	**34**	1	8	18	56	45	**128**
Traffic Noise Reduction	1	2	2	18	11	**34**	1	4	6	72	55	**138**
Reduction in Buses	0	0	5	20	9	**34**	0	0	15	80	45	**140**
Reduction in Infrastructure	0	0	5	20	9	**34**	0	0	15	80	45	**140**
Total												1690

Table 2 Quantifying Negative Effects by Multiplication Factor

Aspects	**Negative Effects**											
	Multiplying Factor											
	1	2	3	4	5	**Total**	1	2	3	4	5	**Total**
Due to Work Location												
Displacement of People	0	3	11	16	4	**34**	0	6	33	64	20	**123**
Change of Land Use	1	1	10	19	2	**34**	1	2	30	76	10	**119**
Loss of Trees	7	20	5	1	1	**34**	7	40	15	4	5	**71**
Loss of Cultural & Historical Structures	2	1	15	14	2	**34**	2	2	45	56	10	**115**
Due to Work Design												
Metro Stations	0	1	4	17	12	**34**	0	2	12	68	60	**142**
Ventilation and Lighting	0	1	10	21	2	**34**	0	2	30	84	10	**126**
Railway Station Refuse/Waste	0	1	6	16	11	**34**	0	2	18	64	55	**139**
Risk due to Seismic Vibrations	0	2	6	15	11	**34**	0	4	18	60	55	**137**
During Work Construction												
Soil Erosion	1	0	4	23	6	**34**	1	0	12	92	30	**135**
Traffic Diversions and Risk to Existing Buildings	1	1	4	11	17	**34**	1	2	12	44	85	**144**
Water Pollution	1	1	2	16	14	**34**	1	2	6	64	70	**143**
Air Pollution	2	0	1	11	20	**34**	2	0	3	44	100	**149**
Noise Pollution	1	1	2	15	15	**34**	1	2	6	60	75	**144**
Impact due to Vibration	1	0	5	9	19	**34**	1	0	15	36	95	**147**

Health risk at construction site	0	1	4	16	13	**34**	0	2	12	64	65	**143**
Problem of excavated soil disposal	1	0	1	11	21	**34**	1	0	3	44	105	**153**
Dust Generation	1	0	2	10	21	**34**	1	0	6	40	105	**152**
During Service Stage of Mumbai Metro Line 4												
Noise & Vibration	1	0	2	19	12	**34**	1	0	6	76	60	**143**
Water Demands	1	1	12	14	6	**34**	1	2	36	56	30	**125**
Refuse disposal and sanitation	0	2	5	20	7	**34**	0	4	15	80	35	**134**
Total												2684

Quantifying Positive Effects by Multiplication Factor

Aspects	**Positive Effects**											
	Multiplying Factor											
	1	2	3	4	5	**Total**	1	2	3	4	5	**Total**
Due to Work Location												
Impact on Local Transport Utilities	0	1	2	17	14	**34**	0	2	6	68	70	**146**
During Service Stage of Mumbai Metro Line 4												
Employment Opportunities	0	0	1	24	9	**34**	0	0	3	96	45	**144**
Benefit to Economy	0	0	2	22	10	**34**	0	0	6	88	50	**144**
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Reduction in Buses	0	0	5	20	9	**34**	0	0	15	80	45	**140**
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Total												2684

From the Leopold's Matrix, it has been seen that the negative impacts exceed the positive impacts by margin. During the work construction phase, the issues of air pollution, dust emission, noise pollution, vibration can be much higher & forms a part of future concern. However a detail study has to be done considering more parameters & responses.

V. CONCLUSION

The Mumbai Metro Line-4 has a significant impact on the infrastructure of the city and serves an example of development. Taking a cue from the existing metro line, the new model intends to give benefits to the economy, traffic congestion reduction, quick and safety transport, employment opportunities, fuel consumption reduction, and air quality improvement. It does have various adverse impacts on the environment like, environmental impacts on air quality (during construction phase), water environment, noise and vibration, solid waste, ecology, population resettlement which are also taken under constant consideration during the construction. Based on these detailed potential adverse environmental impacts, appropriate mitigation measures can be developed for consideration. The study concludes that work will have impacts from both construction and operation which should be mitigated through the use of prevailing current practices and appropriate technologies. The

implementation of the EMP and the monitoring plan, should be done to minimize the negative impacts of the work & thus have maximum utilization of resources.

VI. Future Scope of study

The future scope of the work will be dealing with the collection & analysis of baseline data which will help in clarifying the positive & negative impacts of the work on the environment. Also it will include the Aspect-Impact Analysis, mitigation plans, Environment management plans, cost benefit analysis of the Mumbai metro line 4 work.

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