

Impact of construction for the expansion of National Highways on the local environment in India

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Abstract:

Increased traffic has led to a higher demand for construction and expansion of National Highways (NH) in India. Along with positive transformations, the construction of NHs create environmental ailments in the vicinity of the road construction sites and impacts the local environment. However, the impact of construction or expansion of NHs on the local environment and measures to alleviate the ill effects are undermined in India. Therefore, using the study context of National Highway expansion projects in the Odisha state of India, the study assessed the various environmental impacts of construction and explored strategies to mitigate environmental ailments. Data was collected by using survey research methods. A perception survey among the local communities and stakeholders and a Delphi survey among experts were conducted to collect data. Both descriptive and inferential statistics were used to analyse the data. Findings suggested that severe health ailments and air, water, noise pollution and land severance are experienced. The Environmental Impact Assessment (EIA) process has significant gaps and does not adequately consider the local environment. The current mitigation measures adopted are marginal and not sufficient to meet the challenges of environmental degradation. Appropriate strategies related to procedural, socio-economic, wildlife-related, land and road alignment and technical aspects would likely assist in mitigating or preventing environmental degradation at the local level because of NH construction or expansion. The identified gaps could strengthen the EIA process, and the implementation of the suggested strategies could alleviate the local environmental challenges because of the impacts of NH construction.

Keywords:

Construction, Environmental Impact, National Highways, Pollution, Technology

Introduction

National Highways (NH) bring significant socio-economic and mobility benefits across the Globe (Asturias, Garcia-Santana and Ramos, 2019). However, they are the major reasons for environmental degradation at the local and global levels (Chandra and Thompson, 2000; Handa, Aggarwal and Bhardwaj, 2019). So, it is essential to create and operate the NHs without hampering the environment. In India, the increase in population and socio-economic activities created a significant rise in the demand for movement of good and traffic at city, regional and national scale. Consequently, a huge increase in traffic on the major roads, including NHs and State Highways (SH) is experienced. This situation created a necessity to build new National Highways and upgrade the existing ones. As a result, construction activities in terms of new construction, expansion, and upgrades of the roads were undertaken in the last few years.

While this new construction and up-gradation of the roads are expected to positive transformations in the socio-economic and mobility scenarios, it has created significant socio-economic, spatial and environmental ailments in and around the road construction sites. Specifically, from the environmental point of view forests and hills and wildlife were observed to become vulnerable because of the construction activities. Furthermore, the environmental pollution created not only endangered the environment but also caused health ailments among the people living in the villages and towns in the vicinity of road construction sites (Handa, Aggarwal and Bhardwaj, 2019)

India enacted several laws and rule and regulations for environmental protection, which also apply to road construction as relevant. Environmental Impact Assessment (EIA) is generally conducted and environmental clearance is obtained before implementing any highway projects. However, field observations and according to the perceptions of the stakeholders, it is found that several environmental and ailments are experienced during and after the road construction, specifically where large scale construction activities are undertaken for a considerable period (Handa. Aggarwal and Bhardwaj, 2019; Solanki, Ahamed, Gupta, and Nongkynrih, 2016; Walia, Aggarwal and Bhardwawaj, 2017). Despite the availability of elaborate environmental protection laws and rule and regulations, the impact of construction on the local environment and measures to alleviate the ill effects are undermined in India. In the absence of understanding and assessing the impact of road construction on the local environment, both the environment and the people continue to suffer unabated, which needs investigation. Therefore, using the study context of a National Highway expansion project in the Odisha state of India, the study assessed the various environmental impacts of construction and explored strategies to mitigate environmental ailments.

The National Highway 55 was used as the study context for data collection. The NH 55 connects two important cities of Odisha state of India such as Cuttack and Sambalpur, passing through several major district headquarters, towns, and industrial centres. Also, it provides access to the coal mines of Talcher and NH149. The length of expansion work constitutes about 151 Kilometers. The major expansion work includes expansion of the lanes and road to make it a four-lane road. Moreover, other associated works include constructing both major and minor cross drainage works, including bridges. Since,

Literature Review

1.1 Impact of road construction on the environment

The construction of highways or roads in addition to offering both accessibility and mobility as relevant in the context depending on the type of road constructed, assists in bringing changes into the structure of the settlement pattern and land uses, creating more significant economic opportunities, employment generation, etc. (Asturias, Garcia-Santana, and Ramos, 2019; Chandra and Thompson, 2000; Sengupta, Coondoo and Rout, 2007; Walia, Aggarwal and Bhardwawaj, 2017). However, the construction activities for new highways or expansion or up-gradation of the highways may lead to significant environmental ailments if its impacts are not appropriately assessed and measured for the mitigation or prevention of the adverse effects are not taken (Walia, Aggarwal and Bhardwawaj, 2017). One of the significant and direct consequences is the destruction and removal of existing ecosystems and the reconfiguration of local landforms. The construction engenders diverse ecological effects on both terrestrial and aquatic ecosystems (Hansen, Knight, Marzluff, 2005). Similarly, highway construction,

specifically through land clearing, ground excavation, cut and fill, and pavement construction, is a major source of particulate matter into the atmosphere, impacting the air quality adversely.

Moreover, road construction also creates significant noise pollution (Kumar, Mulheron and Claudia, 2012). Furthermore, pollutants emerging out of construction activities cause physical, chemical and biological degradation of the natural water bodies such as rivers, lakes and streams (Aslam, Khan and Khan, 2011; Qian, et al., 2011; Walia, Aggarwal and Bhardwaj, 2017). Also, it was found that as a consequence of the construction activities and consequent pollution, the health risk of the people living and working close to the construction increases significantly (HEI, 2010). Thus, the construction of new highways of expansion has significant environmental impacts at the local level, which need to be taken care of.

1.2 Environmental protection laws and regulation for road construction

Countries across the world have enacted laws and regulations and developed regulations for the protection of the environment. These laws and regulations are also valid for the construction of roads as relevant. Environmental Impact Assessment (EIA) is generally conducted and environmental clearance is needed before implementing any transportation project (ARBITA, no date; European Transport Agency, 2020; Handa, Aggarwal and Bhardwaj, 2019). For example, every transportation project must undergo an environmental review and approval process in the USA before any construction is permitted. The various acts which govern such review and approval process include Clean Air Act (CAA), the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA) and climate change (ARBITA, no date). In Europe, similar provisions are available in different countries to reduce the adverse effect of transportation including road construction (European Transport Agency, 2020).

In most Asian countries, including South Asia, similar acts and rules and regulations are available in some form or other. India particularly has promulgated a series of environmental legislations between 1980 and 2005 to ensure that adverse impacts on the environment remain under control and timely mitigation measures are taken (Handa, Aggarwal and Bhardwaj, 2019; Walia, Aggarwal and Bhardwaj, 2017). The laws also established detailed procedures for assessing the environmental impacts of the proposed projects and how clearances for the projects should be given. In recent years one of the most important enactment is the Environment Impact Assessment Notification, 2006 (EIA 2006), which lays out a detailed process for obtaining prior environment clearance for any new projects or activities or the expansion or modernisation of existing projects and projects seeking capacity addition with change in strategy or technology (Sharma, Dhyan, and Gangopadhyay, 2013).

However, the challenge is that most of the acts and rules and regulations are considered effective at the macro level. For example, according to these new regulations, environment clearance is not required for road development projects other than State Highways and National Highways, State Highway widening projects located below an altitude of 1000m MSL, State Highway widening projects not located in an ecologically sensitive area, National Highway widening projects of up to 100km length, National Highway widening projects of more than 100 km length involving the additional right of way or land acquisition up to 40m (at any place) on existing alignment and 60 m (at any place) on re-alignments or bypasses IRC (2017). Such restrictions have been made to facilitate and expedite infrastructure development. However, on the other hand, the environmental challenges and adverse impacts at the local habitation level have been undermined. Moreover, studies on such aspects in the Indian context are scarce.

2.3 Mitigation measures – challenges

Across the world, several mitigation strategies have been developed to reduce the adverse impacts of highway construction. For example, in the USA, Canada and Europe, the environmental assessment and landscape-scale planning process of its roads are conducted to address road system development, maintenance, and funding to meet current and future land and resource objectives and uses (Reed et al., 1996). However, in many countries worldwide, the mitigation measures include taking a strategic approach, using structured assessment and planning, undertaking on-the-ground mitigation techniques, effective monitoring, etc. Similarly, site-level field techniques such as staying away from vulnerable sites, giving extensive thought to road routes, road design, drainage, and road-stream crossings, relocating or realigning roads to avoid vulnerable areas and human habitations, use of appropriate construction, upgrading, and maintenance methods, provision of buffer zones, etc., have been proposed (Daigle, 2010). In developing countries, local and appropriate technologies have been argued to make road construction sustainable and reduce environmental impact (Newman, Hargroves, Desha, et al., 2012). In India, EIA is conducted based on the Environmental Protection Act as a prevention measure before the project is implemented and construction is undertaken (IRC, 2017). However, most mitigation or prevention measures are considered at the macro level and impact on the local level or areas in and around construction sites have been undermined.

Research Methodology

3.1 Data

Data on the environmental consequences of road construction, current mitigation measures, challenges and gaps in the EIA process to protect the local environment and plausible strategic measures from mitigating the challenges and protecting the local environment were collected. For this purpose, two kinds of the survey were conducted. First, a perception survey was conducted among the people engaged in road construction and local communities to explore the perceptions of these stakeholders on the consequences of road construction on the local environment and the current mitigation measures adopted. The stakeholders include the local communities and construction workers, project managers, site engineers, supervisors, technician, and contractors. This was done to get a balanced view and perception of stakeholders on the issues related to the local environment. A questionnaire was prepared and then administered among 160 respondents, of which 120 belonged to local communities and 40 belonged to construction. A Likert scale with pointer ranging between 1 and 5 (1 indicates very low, 2- low, 3- average, 4-high, and 5 indicate very high) was adopted to collect the data. The survey was conducted by using a random sampling process from 8 construction sites and local villages and small towns around the construction sites.

Further, a Delphi survey (Ludwig, 1997) was conducted among 30 experts related to the environment (5), law (4), road construction (7), public service (4), academicians (4), NGOs (3), health and medicine (3) and technology (3). This survey was conducted to obtain the expert opinion or perception of the experts on the challenges and gaps in the EIA process to protect the local environment and plausible strategies to improve the situation as these aspects are specific and need adequate understanding and knowledge. For this purpose, a questionnaire survey was also conducted. The same Likert scale ranging between 1 and 5 was adopted. The survey was undertaken iteratively in two rounds.

3.2 Data Analyses

Relevant descriptive and inferential statistics were used to analyse the data collected from both types of survey. A Cronbach α test was first conducted to find the reliability of the data and then standard deviations were calculated to observe the consistency in the responses. Followed by perception indices on the various attributes and variables were computed to evaluate the level of influence of the variables on the concerned aspects. The perception index was calculated by considering the mean value of the responses obtained on the Likert scale. However, the mean Likert scale values were supported by Z-probability values and p-values obtained from the Z tests conducted. The evaluation of the various parameters was conducted on the concurrent consideration of perception indices and statistical significance observed from z-probability and p values. A perception index of more than 3 was considered fairly influential and more than 4 was considered highly influential. However, a p-value <0.05 was considered statistically significant for a 95% confidence level.

Findings and Discussion

The results are presented under four aspects: health and environmental consequences of the road construction, current mitigation measures adopted, gaps in the EIA and implementation process, and plausible strategies to prevent or mitigate the adverse environmental impacts of road construction. These aspects are presented in the following subsections.

1.3 Environmental consequences of road construction

The health and environmental consequences of road construction at the local level are presented in Table 1. According to the people surveyed, respiratory diseases are the most important adverse health impact on people at the local level. This occurs because of the heavy amount of dust particles, smoke and other gases generated from the construction site and float towards the human habitations around the construction site, which people inhale continuously for the whole construction period. This ailment is followed by a sleep disorder, waterborne diseases and deafness. Sleep disorder occurs because of air and noise pollution. Waterborne diseases occur because of water pollution due to the mixing of gas and oil in the water the bodies located in the local area. Although deafness is relatively less, it primarily occurs because of persistent noise generated from the road construction sites. According to the respondents' perception, air pollution and noise pollution are the two most important environmental impacts, followed by water pollution and land severance. Furthermore, road construction also causes landslide and soil erosion, loss of flora and fauna and adversely impact the wild animals to a certain extent.

Table 1. Health and Environmental Consequences of Road Construction

Consequences	PI	SD	Z score	Z test p-value
Human health-related				
Respiratory diseases	4.30	0.81	1.62	0.000
Water-related diseases	3.72	1.08	0.68	0.000
Deafness	3.21	1.04	0.20	0.004
Sleep disorder	3.77	1.0	0.76	0.000

Physical harm due to accidents	2.96	0.99	-0.04	0.699
Other health-related issues	2.88	0.92	-0.12	0.947
Environmental degradation				
Air pollution with dust and smog	4.39	0.69	1.99	0.000
Water pollution	3.81	1.01	0.80	0.000
Noise Pollution	4.02	0.87	1.17	0.000
Land severance	3.78	0.95	0.83	0.000
Landslide and soil erosion	3.34	0.83	0.41	0.000
Loss of flora and fauna	3.31	0.82	0.38	0.000
Impact on wild animals	3.17	0.83	0.21	0.002
Pollution of cultivable lands	2.93	0.62	-0.11	0.924

4.2 Current mitigation measures

Table 2 presents various current measures that have been adopted by the relevant authorities and companies to mitigate the adverse health and environmental impact of road construction in the local area. The results revealed that only two measures, such as information and awareness of the work zone, and soil stabilization, were conducted albeit to a certain extent. However, other measures such as water spraying in work zones, shifting and rehabilitation, use of technology and anti-pollution measures were not likely undertaken. This indicates that no significant mitigation measures at the local level are taken to mitigate or prevent the adverse environmental impacts of road construction.

Table 2. Current mitigation measures

Current mitigation measures	PI	SD	Z score	P values
Information and awareness of the work zone	3.21	0.81	0.27	0.000
Soil stabilization	3.09	0.74	0.13	0.044
Water spraying in work zones	2.91	0.73	-0.11	0.936
Shifting and Rehabilitation	2.69	0.89	-0.34	0.998
Use of technology and anti-pollution measures	2.54	0.85	-0.53	0.998

4.3 Challenges and Gaps in the EIA process to protect the local environment

EIA is generally conducted to observe the environmental challenges and explore mitigation measures. However, the EIA for road construction is generally done at a macro or regional scale. Therefore, in this study, the challenges and gaps in the EIA process are explored and presented in Table 3. According to the perceptions of the respondents, there lies a gap in the EIA process which includes a lack of consideration of local context, not making the process inclusive with participation and consultation among all the stakeholders, including local people. The EIA is perceived to be too bureaucratic and a technical exercise with consultants, bureaucrats and other technical and administrative stakeholders. It is more or less procedural. The role of civil society and people at large is undermined.

Table 3. Challenges and gaps in the EIA process

Challenges	LI	SD	Z Score	P values
Consideration at the macro level and undermining of local contexts	3.98	0.85	1.16	0.000
Lack of consideration of human health at the local level	4.09	0.79	1.39	0.000
Lack of consideration of wildlife at the local level	3.74	0.93	0.79	0.000
Lack of clarity on the use of preventive or mitigation measures	3.67	0.88	0.75	0.000
Lack of direct and adequate consultation with local stakeholders	4.23	0.77	1.60	0.000

Too bureaucratic and technical with consideration of the impact on civil society	3.62	0.89	0.69	0.000
Lack of clarity on the use of advanced technology	3.56	0.85	0.66	0.000

4.4 Strategic measures to mitigate the challenges and protect the local environment

Strategic measures belonging to five different aspects, such as procedural, social and economic, wildlife, flora and fauna, land and road alignment, and technical, were evaluated to examine the most appropriate measures that should prevent or mitigate the environmental challenges that occur road construction at the local level. The results of the evaluation are presented in Table 4. It is found that procedural strategies such as the inclusion of local context in the EIA and more direct consultation with stakeholders are the two most important strategies that should improve the situation and meet the environmental challenge at the local level. However, a strategy to include a local leader in the EIA appraisal committees will not likely be beneficial.

Table 4. Plausible strategies to improve the local environmental protection

Strategies	PI	SD	Z score	P values
Procedural				
Inclusion of local context in EIA	4.16	0.91	1.28	0.000
More direct consultation with stakeholders	4.06	0.87	1.23	0.000
Inclusion of local leaders in the EIA appraisal committees	2.87	0.89	-0.15	0.791*
Social and economic				
Temporary relocation and rehabilitation	2.93	0.91	-0.08	0.656*
Adequate health facilities and compensation to deal with ailments related to pollution and accidents	4.07	0.86	1.22	0.000
Dissemination of information and creation of awareness	3.77	0.94	0.82	0.000
Liaison between local people and construction companies to protect environment	3.9	0.75	1.19	0.000
Wildlife, flora and fauna				
Alternative pathways for the movement and crossing for wildlife	3.13	0.73	0.18	0.156*
Creation of protective barriers for wildlife	2.73	0.78	-0.34	0.968*
Identifying and avoiding zones with significant wildlife and flora	3.53	0.68	0.78	0.000
Land and road alignment				
Alternative alignment to avoid both important forest area and human habitations	3.56	0.73	0.77	0.000
Restrictions on severing major agricultural, horticultural and protected forest area	4.07	0.83	1.29	0.000
Avoiding areas requiring significant cuts in hills and mountains	4.03	0.81	1.27	0.000
Preference to tunneling	3.73	0.91	0.81	0.000
Technical				
Adoption of advanced technology to reduce water and air pollution	4.1	0.80	1.37	0.000
Advanced soil stabilization and construction methods	3.6	0.85	0.70	0.000
Use of low noise equipment	3.57	0.81	0.69	0.000
Use of technology to clean polluted air and water	3.96	0.81	1.12	0.000

Under the social and economic strategic measures, provision of adequate health facilities and compensation to deal with health-related ailments because of road construction-related pollution and accidents is the most important preferred strategy. Followed by liaison between local people and construction companies to protect the environment, disseminate information, and create awareness could be beneficial. However, temporary relocation and rehabilitation as

a strategy to mitigate the environmental challenges due to road construction may not be effective. As wildlife, flora and fauna is an important constituent of the local environment, a strategy that could identify the zones with significant wildlife, flora and fauna and avoid such areas from large-scale road construction is likely to help prevent the local environment.

However, alternative pathways for the movement and crossing for wildlife and protecting wildlife barriers may not be useful. It is also found that two strategic measures such as restrictions on severing major agricultural, horticultural and protected forest area, and avoiding areas requiring significant cuts in hills and mountainous regions would assist enable protection land and, consequently, the local environment. Also, preference to tunnelling and alternative alignment to avoid both important forest area and human habitations could be beneficial. As found out from the evaluation, the adoption of advanced technology to reduce water and air pollution and the use of technology to clean polluted air and water are the two most important strategies that need to be considered to meet the environmental challenges at the local level. Also, advanced soil stabilization and construction methods to reduce dust and air pollution and the use of low noise equipment to prevent noise from the construction zones are essential.

Conclusions

Environmental degradation at the local level due to the construction or expansion of Highways in India is a significant concern. Although EIA was conducted before implementing the projects, it is largely conducted at the macro level and the local areas remained outside its purview. In this study, assessing the various environmental impacts of the construction of national highways was conducted and plausible strategies to mitigate the environmental ailments were explored. Findings revealed that two crucial environmental-related consequences, such as health ailments and environmental pollution, occur in the study area because of the construction activities of the highway. The major health ailments include respiratory diseases, sleep disorder, waterborne diseases and deafness. Air pollution with dust and smog, water pollution, noise pollution, land severance, landslide and soil erosion, loss of flora and fauna, and impact on wild animals are the major environmental problems experienced. Scarcely any significant mitigation measures are undertaken to improve the scenario. Also, important gaps in the EIA process was found such as the local environment is not largely considered and direct consultation with the local communities are not conducted.

However, the major strategies that should help mitigate or prevent environmental degradation at the local level include the inclusion of local context in EIA, more direct consultation with stakeholders, adequate health facilities, and compensation to deal with pollution and accidents. Other strategies include liaison between local people and construction companies to protect the environment, dissemination of information and creation of awareness, identifying and avoiding zones with significant wildlife and flora, restrictions on severing major agricultural, horticultural and protected forest area, avoiding areas requiring significant cuts in hills and mountains, preference to tunnelling, adoption of advanced technology to reduce water and air pollution and to clean polluted air and water, advanced soil stabilization and construction methods and the use of low noise equipment. The study's findings contribute to identifying the gaps in the EIA and strategies needed to alleviate the challenges of environmental impacts of road construction at the local level in the Indian context.

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