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Examining Effects of Highway Expansion on Community Health: A Case Study of Aanbukhaireni-Pokhara Road Section of Prithvi Highway

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Abstract
In Nepal, the construction of roads has significantly accelerated in recent years due to the country's new constitution, implemented in 2015, which prioritizes decentralized economic growth. However, it's worth noting that construction projects conducted without effective management can have detrimental environmental consequences, ultimately leading to adverse health effects on the nearby population. This paper aims to examine the effect on community health during the road expansion using Aanbukhaireni-Pokhara road section as a case study. Primary data was gathered by conducting questionnaire survey (August, 2023) with 146 individuals along the road section, which sought their perspective on the construction activities and their associated health effects. Additionally, secondary data were obtained from three hospitals situated within the road section to validate and enhance the community's understanding of these health impacts. The research revealed fluctuations in cases during 2019/2020 which is attributable to COVID-19, as only some hospitals were operational during that period. The community members overwhelmingly recommended accelerating construction progress and water sprinkling dusty road regularly. The results of this study revealed that the Upper Respiratory Tract Infection(URTI) were on the rise due current road expansion project and the measure contributor to URTI is air pollution.

Keywords
Construction activity, Pollution, Health effect, Community perception, SPSS Tool, URTI

1. Introduction

Transportation plays a crucial role in a country's economic growth, especially in nations with lower ratios of infrastructure to output, where investing in transportation projects can yield returns of over 40%, driving economic development[1]. The new constitution of Nepal, enacted in 2015, has had a significant impact on road connectivity, emphasizing decentralized economic growth. This includes the upgrading of the Muglin-Pokhara Phase-1 project. The road is currently undergoing expansion from existing 2-lane to 4-lane under the National Highway Upgradation and Expansion Programme[2]. The project is categorized as Class B under ADB's Safeguard Policy Statement (2009) because it is not anticipated to have any significant and irreversible environmental impacts resulting from its components[3]. The project is also an integral component of a major trade route, connecting to the feeder roads of SAARC and SASEC corridors that link Kathmandu with Dhaka and Chittagong through India. Its purpose is to enhance the domestic connectivity between the touristy provincial capitals of Gandaki Province and the central capital, Kathmandu[4]. Despite the positive impact, the technological process of construction and road repair processes have a notable effect on the atmosphere. This effect includes increased air pollution due to additional emissions of exhaust gases from vehicles, elevated noise levels from vehicle traffic, and the release of dust when transporting and unloading bulk materials[5]. Though road construction project typically have temporary nature due to the construction duration, the projects often take place near residential areas in urban settings. Thus, the construction of roads and highways is becomes source of impact on public health[6]. The primary dust-related diseases impacting construction workers and residents include lung cancer, silicosis, chronic obstructive pulmonary disease (COPD), and asthma[7]. Study found that social costs can account for up to 400% of construction costs on certain projects[8]. Of all social impact factors, health impact should be regarded as the foremost consideration because it directly affects the well-being and quality of life for individuals and communities affected by the construction project.

Despite the completion of Environmental Impact Assessments (EIA) or Initial Environmental Examinations (IEE), there is still a noticeable deficiency in carrying out the recommended mitigation actions in many projects of Nepal. Moreover, the delay in completing the road construction project escalates health consequences to nearby residents. During road construction, the groups most significantly impacted are the construction workers and the residents living nearby. Although there has been substantial research devoted to assessing the health effects on construction workers, there is a noticeable lack of research focused on the well-being of the local community members.The community is considered an external stakeholder of construction projects[9]. So, consideration to their issues is a must in order to attain proper construction management in the project. Thus, my research aims to address this by assessing effects on community health during the expansion of the Aanbukhaireni-Pokhara road section as a case study.

1.1 Problem Statement

The project, with the Western section (Pokhara-Jamune) being contracted on May 17, 2021, and the Eastern section

(Jamune-Aanbukhaireni) on April 15, 2021 [10] has an anticipated completion date at the close of 2025[11]. However, as of August 14, 2023, construction progress stands at just 8% in the western section and 32% in the eastern section[12]. So, it is clear that project cannot meet its originally planned completion date, potentially compounding health effects for community members.

1.2 Limitation of Study

- Many locals go to Pokhara for medical check-ups, but Pokhara Hospital is not within the study area.
- Data collection was done only from three hospitals in the road section.
- Due to the absence of landslide data cross-reference with community data was not possible.

2. Literature Review

2.1 Previous research related to road construction and upgradation projects

Sakey's research [13] examines the impact of Atonsu Lake road construction on health and socioeconomic aspects. Employing a mixed-method approach, it used questionnaires for quantitative data collection, assessing residents' perceptions of the construction's effects. Qualitative data from Kumasi South Hospital was also analyzed to gauge health impacts. The study revealed adverse health effects from road construction, though there was a decline in hospital cases due to COVID-19 restrictions and stigma, hindering reporting. These findings emphasize the importance of implementing effective dust control measures and phase-by-phase road construction to mitigate negative impacts.

Celik's research [14] highlighted the negative impact of construction projects on nearby residents. A comprehensive survey involving 266 participants assessed the extent of these issues, with data collected through questionnaires and subjected to descriptive analysis. Noise, household cleanliness problems, and environmental degradation were the primary concerns for residents, with high standard deviations across all adverse impacts. Interestingly, health hazards from construction activities were identified as the least significant concern. It was because they tend to manifest in the long term, making residents less aware during the construction phase.

Powell et al. [15] investigated into the consequences of the construction of the interoceanic highway (IOH) on the subjective well-being (SWB) of communities located in the Madre de Dios region of Peru employing a combination of qualitative and quantitative methodologies. The research found that the IOH's impact on health to negative consequences such as an increase in dengue cases and road accidents. In interviews and focus group discussions, various infectious diseases were also brought up but were less discussed including: diarrhea, colitis, leishmaniasis, fungal infections, and tuberculosis. It also resulted in positive outcomes, including improved access to healthcare services.

Ihuoma research [16] explores the environmental effects of noise, dust, and other factors during road construction. Primary data was collected via questionnaires, interviews, and focus groups with guided questions, while secondary data came from various publications and documents. Adverse impacts were assessed using a six-item response scale on a five-point Likert scale. The study identified dust pollution and building damage as primary environmental impacts of road construction, along with issues like waste mismanagement, noise disturbances, and soil erosion. Implementing Environmental Impact Assessments (EIA) faced barriers like negative perceptions by consultants and contractors, limited awareness and audit capacity, and weak institutional connections. Poor engagement with affected communities and stakeholders was a critical obstacle to EIA implementation. To minimize adverse effects and boost positive outcomes, construction contractors should adhere to essential safeguard documents like EIA and raise awareness among affected communities and key stakeholders throughout all project phases.

2.2 Health Impact Assessment (HIA) and its application in road widening project

The processes involved in Health Impact Assessment (HIA) closely resemble those employed in other types of impact assessments like environmental impact assessment or social impact assessment. HIA is typically characterized as adhering to the outlined stages,though many practitioners break into smaller stages or label them differently:

a) Screening: evaluating if HIA is necessary or not b) Scoping: determining which impacts to include and plan for HIA c) Identification and assessment of impacts: assessing the magnitude, nature, extent, and likelihood of potential health impacts using different methods or data source d) Decision-making and recommendations: clearly stating the decision-making trade-offs and developing recommendations based on evidence e) Evaluation, monitoring and follow-up: assessing the HIA process and its effects, along with monitoring and management of health impacts[17].

The North Houston Highway Improvement Project (NHHIP) Health Impact Assessment (HIA) aims to help inform decision makers about the potential health impacts to communities. The HIA proposes recommendations to mitigate any potential adverse health outcomes identified and enhance positive outcomes based on the design of the NHHIP project. It conducted screening to define project goals, scoping to establish parameter and methodology, assessment to identify benefit and harm to impacted communities. Also, provided recommendation based on assessment results and feedback from stake holders, developed reports and distributed to stakeholders and finally monitoring and evaluation was done to evaluate the effectiveness of the HIA[18].

3. Research Methodology

3.1 Study Area

The alignment passes through settlement areas of Aanbukhaireni, Bimalnagar, Dumre, Damauli, Tharpu, Jamune, Khairenitar, Gagangaunda, Taal chowk, Bijaypur, and Pokhara, while the remaining part of the route crosses a mix of

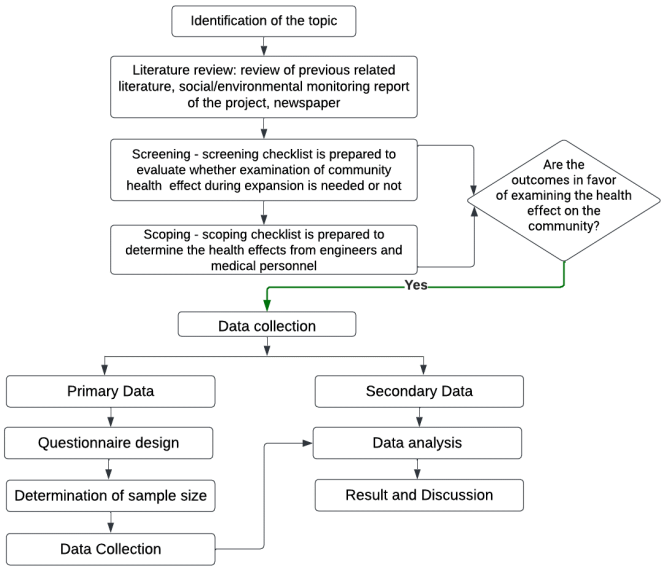

Figure 1: Resarch Framework

dispersed settlements, open land with commercial potential, cultivated areas, and open grazing lands [19].

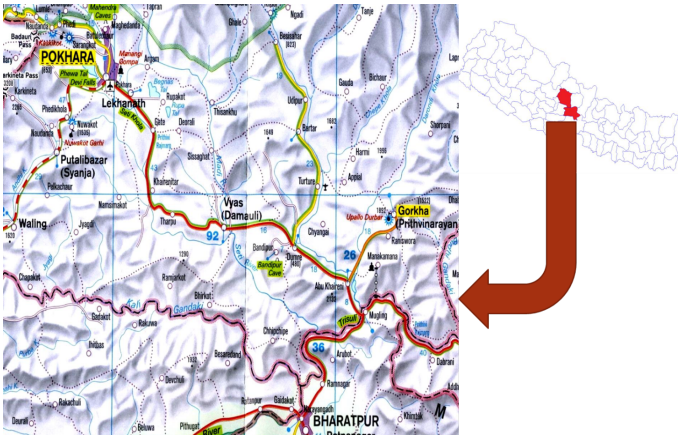

Figure 2: Study Area: Map of Aanbhukhareni-Pokhara road section

Closer proximity to the road is associated with a higher likelihood of negative health effects on the local population. To address this, buffer zones are defined at intervals of (0-50)m, (50-100)m, (100-200)m, and (200m to 1km) across the road section. Furthermore, the road alignment is divided into two sections, Western and Eastern, each managed by separate contractors. Due to varying construction progress, the alignment in this study is further divided into four clusters: Pokhara to Jamune , Jamune to Musekhola, Musekhola to Bandipur gate, and Bandipur gate to Aanbukhaireni along the road section.

Despite two years having passed, the east section (Jamune-Aanbukhaireni) has achieved only 32 percent progress, and the west section (Jamune-Pokhara) has seen a mere 8 percent development[20].

3.2 Sample Size

The population data for the affected group was obtained from the Initial Environmental Examination report dated June 2019 and the District Development Profile of Nepal published by CBS in 2021. N = 599504 (Kaski)+ 327620 (Tanahun) = 9,27,124 (affected district population of Gandaki Province)

Slovin's formula [21] is used to determine the sample size. This sample size was chosen to ensure sufficient data for analysis and generalization to the entire population.

$$\begin{aligned} n &= N/(1+Ne^2) \\ &= 927124/(1+927124(0.1)^2) \\ &= 96 \qquad\qquad \approx 100 \end{aligned}$$

where N is the total population, $e = 10\%$ is the margin error.

Hence, The Sample size to be considered be taken as at least 100 respondents.

4. Result and Discussion

4.1 Demographic Description

The method in this field survey involved informing local residents about the survey's purpose, securing their consent for participation, and systematically distributing questionnaires. Each participant completed their questionnaire individually, with on-site clarification provided to address any questions or concerns, ensuring a comprehensive understanding of the questions. In this manner, questionnaires were distributed to 146 individuals who agreed to participate in this survey. 98 number of respondents were male and 48 were female. Additionally, not all respondents completed every questionnaire, and certain questions were not relevant to all participants. As a result, the findings are presented in percentage format rather than counts. Maximum number of responses were obtained from 41 to 60 age group as per mentioned in figure 3.

Gender of Responded

		Frequency	Percent
Gender	Male	98	67.1
	Female	48	32.9
	Total	146	100.0

Age group of respondents

		Frequency	Percent
Age Group	0-20	9	6.2
	21-40	56	38.4
	41-60	62	42.5
	61 and above	19	13.0
	Total	146	100.0

Occupation of Individual

		Frequency	Percent
Respondent	Student	8	5.5
	Business	64	43.8
	Farmer	10	6.8
	Government Worker	1	.7
	Teacher	3	2.1
	Construction Related	10	6.8
	Driver	1	.7
	Other	9	6.2
	Unemployed/undisclosed	40	27.4
	Total	146	100.0

Figure 3: Demographic Information of Respondent

4.2 Data Findings

The obtained perception of community people are analysed using SPSS tool as sub-categorize.

4.2.1 Aanbukhaireni-Pokhara road section

In the overall section, 83.2% of community members cited project delays as the main contributor to negative community health effects. Only 2.1% believed dust control measures were adequate. A significant 47.2% felt that contractors did not effectively address runoff/surface water problems, while 33.8% thought pothole maintenance was lacking. Additionally,

37.1% believed contractors struggled with public utility relocation, and 48.6% faced issues with water supply. Noise pollution severely affected 19.9% of respondents. Most respondents (82.1%) believed construction work should not be carried out at night. Only 2.9% thought contractors have effectively implemented landslide prevention measures. Around 42.9% believed solid waste management was satisfactory, but 9.4% felt construction activities negatively impacted uncompensated farmland. Similarly, 15.4% considered the contractor's traffic management ineffective as shown in figure 4.

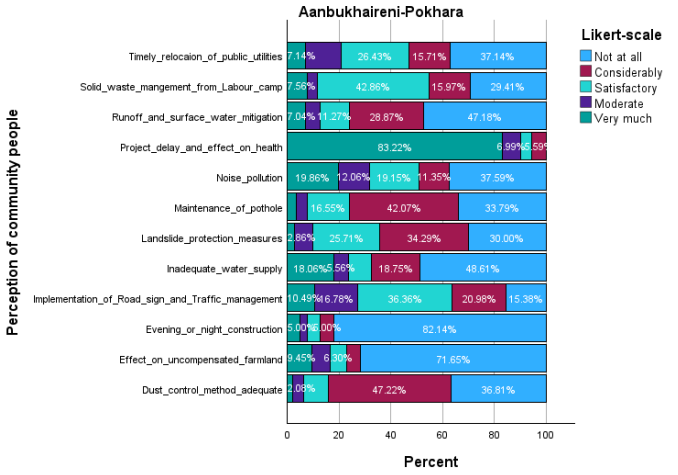

Figure 4: Aanbukhareni-Pokhara: Perception of community people regarding construction mangement in Likert-scale

Similarly, the overall section, a mere 4.2% of individuals noticed vehicles or equipment being washed or refueled near streams, while just 4.9% thought that contractors have disposed excavated spoils and waste into water sources. Likewise, only 4.2% of respondents reported witnessing open burning of solid waste from construction activities. This indicates that contractors have managed waste in these three aspects (Figure 5). Furthermore, 40.3% witnessed construction-related landslide/soil erosion, and a substantial 94.4% noted that the construction company didn't conduct hygiene, sanitation, and communicable disease awareness programs.

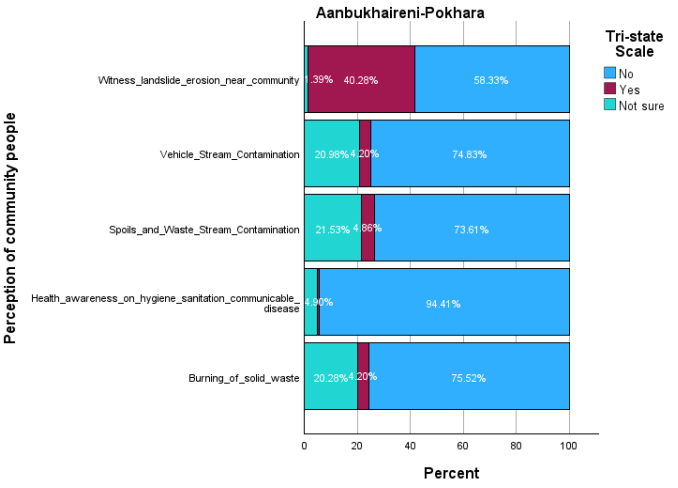

Figure 5: Aanbukhareni-Pokhara: Perception of community people regarding construction mangement in Tri-state Input

According to the bar graph (Figure 6), the majority of the community, specifically 74.3%, dealt with coughing. Other prevalent symptoms included headaches (38%), nasal irritation (40.6%), throat infections (33.7%), eye irritation (25.6%), and skin infections (19.8%). Additionally, around 8.6% of individuals experienced fever.

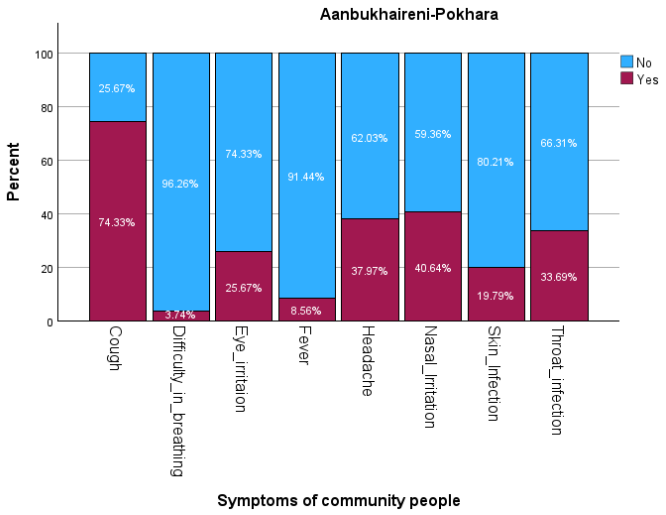

Figure 6: Aanbukhareni-Pokhara: Health Effect on Community People

4.2.2 Cluster Analysis: Perception of Community People

In clusters 1 (Figure 7), 2 (Figure 8), 3 (Figure 9), and 4 (Figure 10), with 40, 47, 29, and 30 respondents respectively, the primary concern across all clusters was project delays and their health impacts. Dust control measures were inadequately implemented. Key areas requiring attention in ongoing road construction include landslide prevention, surface water runoff management, pothole maintenance, effective traffic control, and the installation of road signs. The analysis of stacked bar charts for all sections highlighted deficiencies in effective construction management practices. Timely relocation of public utilities, like water supply pipelines and electric poles, was lacking, resulting in insufficient water supply. Noise pollution was a common issue

Figure 7: Pokhara-Jamune: Perception of community people regarding construction management in Likert-scale

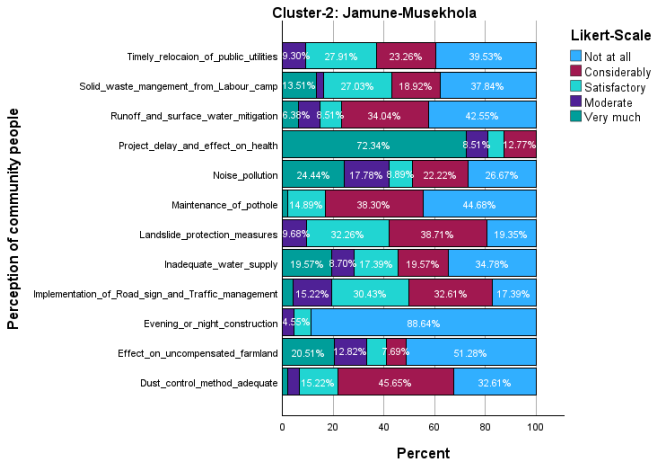

Figure 8: Jamune-Musekhola: Perception of community people regarding construction mangement in Likert-scale

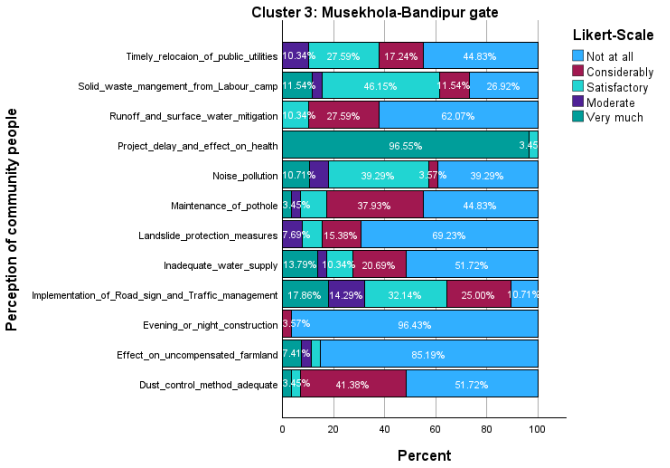

Figure 9: Musekhola-Bandipur Gate: Perception of community people regarding construction mangement in Likert-scale

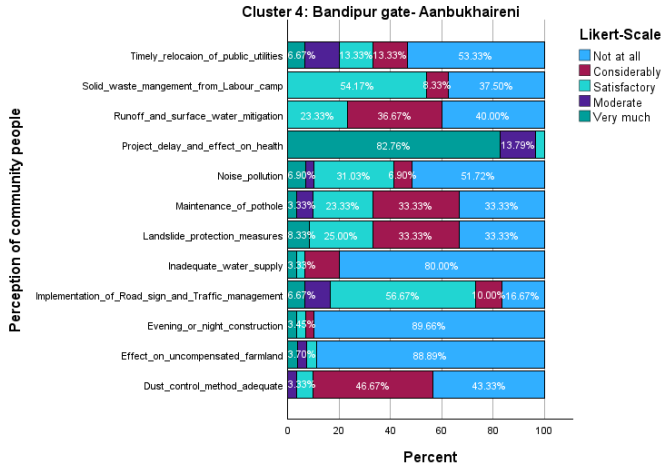

Figure 10: Bandipur Gate-Aanbukhaireni: Perception of community people regarding construction mangement in Likert-scale

in all clusters except for evening or night construction, which was problematic only in cluster 1. Solid waste management in labor camps received a satisfactory rating. However, adverse effects on uncompensated farmland were noted, impacting the community's socioeconomic well-being.

The Tri-state input on perception of community people regarding construction mangement are per listed figures 11,12,13 and 14.

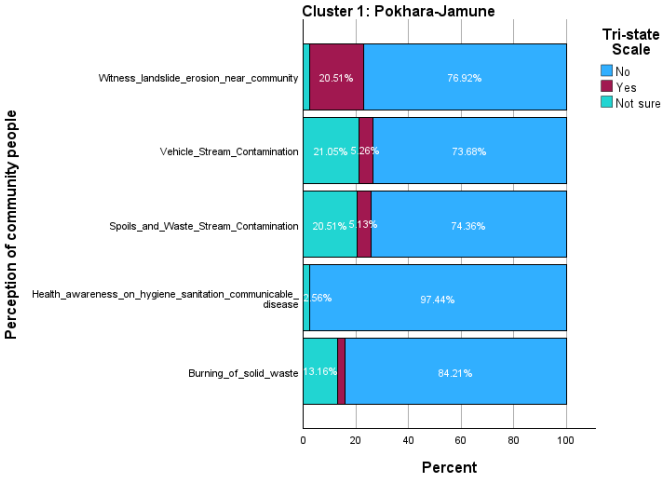

Figure 11: Pokhara-Jamune: Perception of community people regarding construction mangement in Tri-state Input

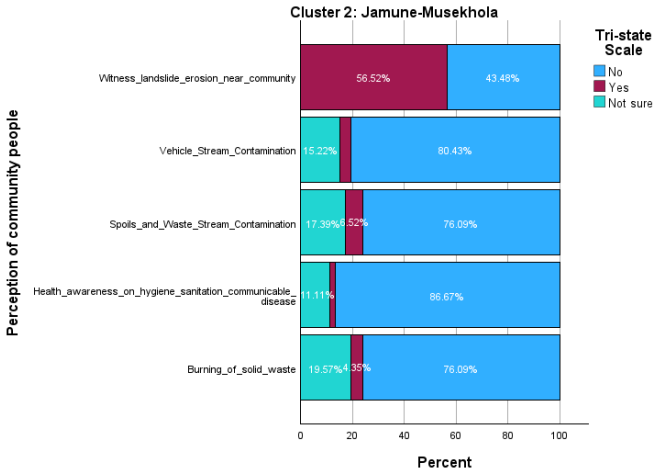

Figure 12: Jamune-Musekhola: Perception of community people regarding construction mangement in Tri-state Input

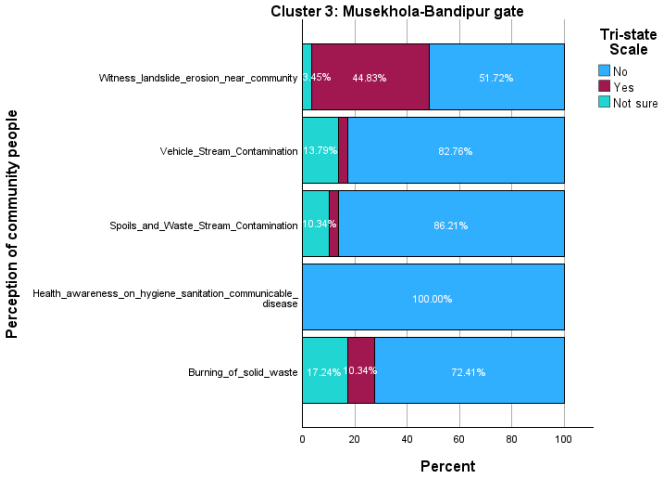

Figure 13: Musekhola-Bandipur Gate: Perception of community people regarding construction mangement in Tri-state Input

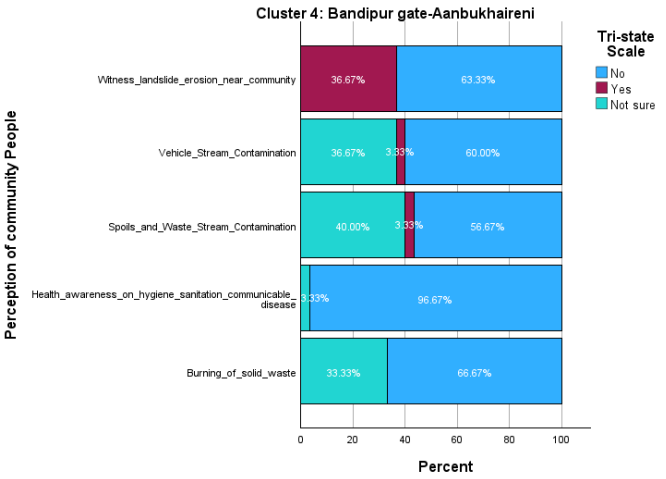

Figure 14: Bandipur Gate-Aanbukhareni Perception of community people regarding construction management in Tri-state Input

4.2.3 Buffer Zone: Symptoms on Community People

In buffer zones 1, 2, 3, and 4, there were 70, 47, 9, and 20 respondents, respectively. The buffer zone bar-chart illustrates the impact of road construction activities across these different buffer zones. Cough emerges as a prevalent health concern in all buffer zones, primarily attributed to dust and pollution. Buffer zones 1 and 2 exhibit a wide range of identified health effects. However, in buffer zone 3, conditions like fever, breathing difficulties, and skin infections were not reported, likely due to the limited number of survey participants. Similarly, in buffer zone 4, all health effects were observed except for breathing difficulties as shown in Figure 15, 16, 17 and 18 with percentage indication for respective symptoms.

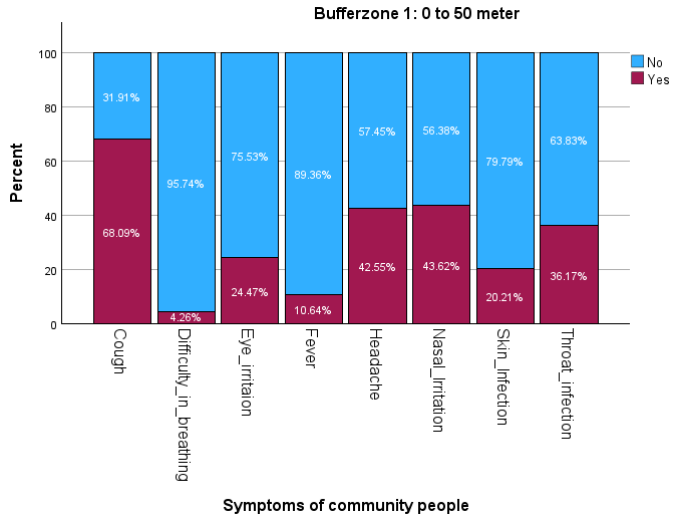

Figure 15: Buffer Zone 1: Symptoms on Community People

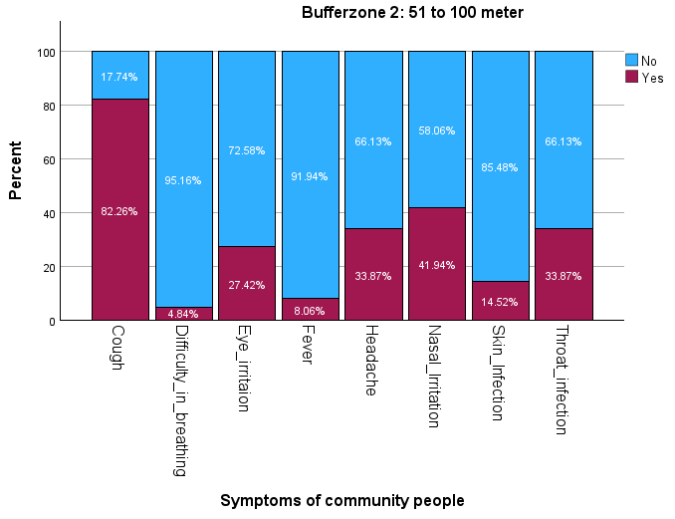

Figure 16: Buffer Zone 2: Symptoms on Community People

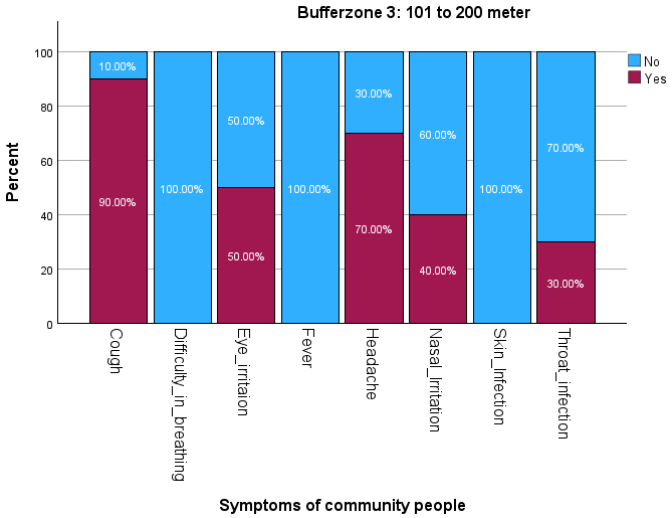

Figure 17: Buffer Zone 3: Symptoms on Community People

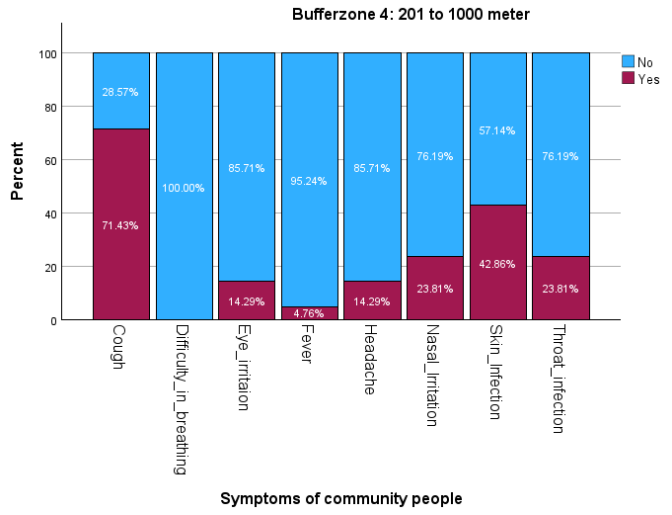

Figure 18: Buffer Zone 4: Symptoms on Community People

4.3 Community status and suggestions

Community respondents disclosed their health-related expenditures for themselves and their families, along with the possible causes of their health problems. They also provided necessary suggestion for management of construction activities as shown in tabulated figure 19. Among the 146 respondents, 53 recommended expediting work progress, 44 advised regular water sprinkling, 11 proposed periodic maintenance, 14 suggested better planning, monitoring, and execution, and 12 emphasized the management of road

Remarks and Suggestion

	Adequate Sprinkling of water	Peroidic Maintainance	Rapid Work Progress	Proper planning, monitoring and execution	Surface water management or drainage
No. of respondant	44	11	53	14	12
Total no. of respondant	146				

Potential Cause for health issues

		Air Pollution	Contaminated Drinking water
N	Yes	164	15
	No	23	172

Respondent with health expenses due to road expansion causes only

	Frequency	Percent
Yes	127	67.9
No	60	32.1
Total	187	100.0

Figure 19: Community Status and Suggestion

surface water or drainage. Respondents were also requested to complete Family Muster Roll, aiming to pinpoint potential causes for health issues and assess any health-related expenses within their family resulting from the ongoing road expansion. Consequently, 187 individuals reported spending money on health issues due to road construction, indicating their potential causes as illustrated in Figure 19.

4.4 Validation of health effect

Construction on this segment commenced in the middle of 2021. Based on the chart, the analysis will focus on the number of patients who experienced respiratory illnesses both before and after construction in mid-2021. During the Covid-19 pandemic, certain hospitals remained operational while others had to close their doors. Therefore, the data for the year 2020 is contingent upon the availability of hospital services.

4.4.1 Damauli hospital

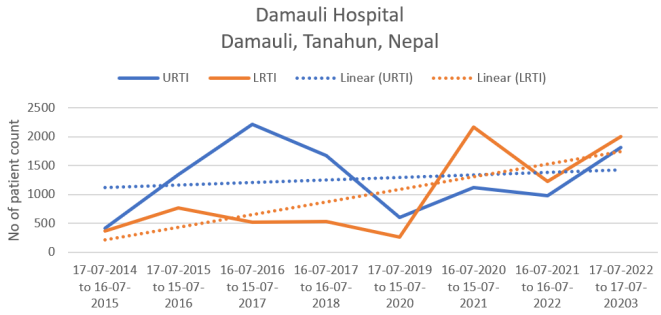

Figure 20: Trend Chart of Respiratory Related of Damauli Hospital

From figure 20 of Damauli hospital, we can observe Upper Respiratory Tract Infection (URTI) and Lower Respiraory Tract Infection (LRTI) cases declines after 2017, and suddenly rises from 2020.According to them, data of 2018 and 2019 is merged due to less number of patient count in 2019.The rise is due to COVID-19 pandemic Despite the decrease in COVID cases starting from 2021, there has been a rise in respiratory cases since 2022.

4.4.2 National Apollo Hospital

Figure 21 indicates, URTI and LRTI cases at National Apollo Hospital decline after 2019. Subsequently, there is a gradual

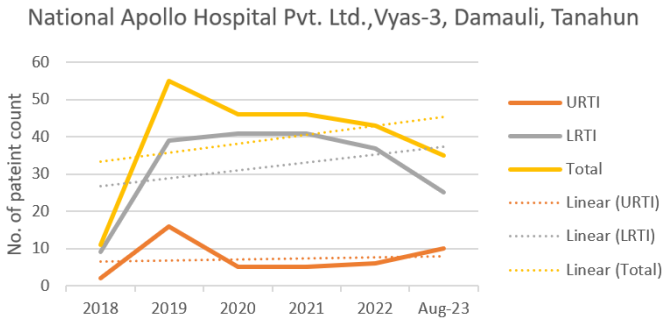

Figure 21: Trend Chart of URTI and LRTI Cases of National Apollo Hospital

increase in URTI cases from 2020 to 2022, with a further rise noted from 2022 onward.

4.4.3 Tanahun Sewa Hospital

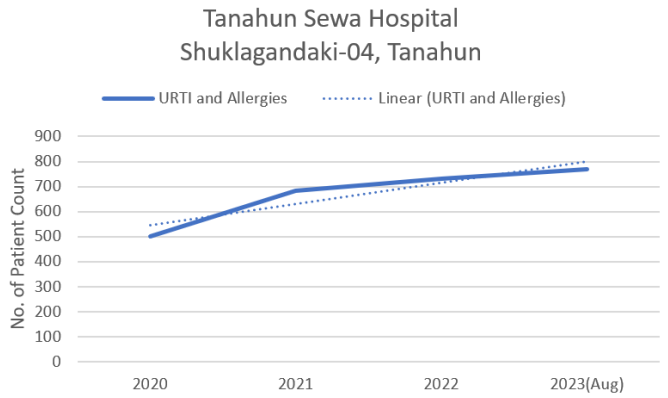

Figure 22: Trend Chart of URTI cases of Tanahun Sewa Hospital

As indicated in the figure 22, there is an increase in the instances of URTI from 2020 to 2021, primarily attributed to the impact of COVID-19. Even after the decline in COVID-19 cases, there is a gradual uptick in URTI cases. Medical professionals at this hospital have associated URTI and allergies with the effects of road construction activities, and gave data accordingly.

5. Conclusion

Certainly, expanding roads enhances mobility, but construction management professionals should prioritize addressing health concerns as their primary focus. Preparing Environmental Impact Assessment (EIA) or Initial Environmental Examination (IEE) reports alone is insufficient to adequately mitigate the adverse effects of construction activities on the environment and human health. Each adverse health impact should be taken seriously during the implementation phase, and if the measures are unable to completely eliminate the respective issues, alternative solutions should be made during the planning or implementation stages.

In the selected study site, there is a haphazard excavation and construction activity along the section which negatively

affects the entire community's health situation. When comparing the community's perceptions with the hospital-reported data, it becomes evident that cases of Upper Respiratory Tract Infections (URTI) are on the rise. The project has only advanced by 20% from mid-2021 to August 2023, but there's a concerning trend of increasing cases of URTI (Upper Respiratory Tract Infections). To further mitigate the health effects, it is imperative to implement proper construction management. A phase-by-phase construction process should be adopted dividing the sections into smaller segments to limit the construction's impact on a smaller area or segment of the community at a time.

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