



Impact Assessment of Utility Relocation on Road Construction Projects: A Case Study Analysis

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ABSTRACT

Road construction projects often involve the relocation of utility services to accommodate the growing needs of society. However, the impact of these relocations on project performance has not been comprehensively studied. This research aims to assess the challenges and impacts of utility relocation on road construction projects. Data on the impact of utility relocations was gathered from case studies of seven road projects in various phases, including construction and completion. A total of 90 questionnaires were distributed, with a response rate of 77.78%, representing contractors, consultancy firms, and clients. Data analysis included mean and standard deviation calculations, as well as correlation tests between the number of utility-related change orders, time slippage, and cost overruns. The findings indicate that, on average, utility relocation leads to a 555.78% increase in the utility budget and an average time slippage of 13.79%. The primary challenges in managing utility relocations in road projects include delays in commencing utility identification and relocation work, insufficient utilization of technological tools and software for utility visualization and management, delays in acquiring rights of way for utilities, and the need for rework or change orders. The most impactful utility issues in road construction projects include the failure to identify and characterize utility conflicts, infrequent updates of utility relocation estimates during project development, and changes in utility plans caused by late project design modifications. The study reveals a strong correlation between the number of utility-related change orders and time and cost overruns in road construction projects. Addressing these challenges and proactively managing utility relocations is crucial for enhancing the efficiency and cost-effectiveness of road construction projects.

Keywords: Utility relocation, road construction, impact assessment, challenges, change orders, time slippage, cost overruns, questionnaire survey, case study analysis.

I. INTRODUCTION

1.1 Background

"Managing Roads for National Integration and Socio-Economic Development" stands as the guiding vision for the development of road infrastructure in Nepal. The overarching objective is to facilitate sustainable socio-economic advancement by ensuring the provision of affordable, secure, and efficient public road services through the establishment of a cost-effective and dependable road network system. With a primary aim of directly contributing to the reduction of poverty in Nepal, the central goal of road development is to create, expand, and reinforce the road network in a sustainable manner, thereby enhancing overall socio-economic development and fostering national integration. Special attention is given to addressing the needs of remote areas and underserved communities to ensure balanced regional development. To achieve the road sector's mission, it strives to offer leadership and create a conducive environment for the development and maintenance of the road transportation system through effective policy formulation, market regulation, asset management, and service provision. [1]

The importance of road infrastructure cannot be overstated in the context of a nation's socio-economic development, making it a focal point for every government. Road construction plays a pivotal role in a country's economy due to its capital-intensive nature, publicly funded

structure, and the multitude of stakeholders involved. Therefore, it is imperative that roads are constructed within specified timelines and budgets to safeguard the benefits for the community and provide value for the taxpayer's money. Nonetheless, the timely and efficient execution of road projects is frequently hindered by unforeseen and unbudgeted events, with the presence of utilities on public right-of-ways being a notable factor impacting road projects.

The right-of-way is a shared public resource used by both public road agencies and utility service providers to deliver services to the general public. Within the boundaries of these highway projects lies a intricate network of utility lines, encompassing electric, telephone, cable TV, telecommunications, fiber optics, natural gas, water, sanitary, and storm sewers. [2]

Studies conducted by Sturgill et al. [3] emphasize that "utilities located within and near right-of-ways present challenges to road agencies in terms of coordinating the reconfiguration of those facilities to accommodate highway system improvements. As part of the transportation infrastructure improvements, utilities may be forced to relocate horizontally, vertically, or both. Construction and maintenance operations that enhance road infrastructure, in turn, impact and necessitate the relocation or protection of utility infrastructure sharing space with transportation facilities." When highway improvements and utility

relocations are not effectively coordinated, it results in delays and additional expenses for the public, utilities, and highway contractors. The situation has become so challenging that there are no national-level construction projects that have been completed on time and within the specified budget [4]. Studies by Mishra, A. K., and Magar, B. R. (2017)[5] further highlight this

Utility Management Practices

Sterling et al. (2009)[7] observed close connection between the development process and operations of transport systems and utility systems. To foster speedy utility relocation, closer coordination and collaborations between owners/managers of the two systems is necessary. The report stressed that in order to minimize time slippage and cost overruns, unintended destruction to service systems, and destruction to roadways arising from uncoordinated engineering, an improved stakeholder engagement mechanism in project development is required. Many authors shared the essence of effective stakeholder engagement and this was also emphasized in a survey report by the American Public Works Association (APWA) and ASCE (1974), cited in Quiroga et al. (2015)[8]. The report noted that cooperation, coordination, compromise, and compulsion (i.e., four Cs) was one way to deal with the utility conflict problem on the right of ways. Cooperation among all stakeholders (road agencies, utility owners and other regulatory and

issue, municipal transport plan and a deep review by Mishra, A. K., and Singh, N. K. (2018) [6] shows the global situation of delays.

1.2 Objective

The overarching objective of this research is to comprehensively assess the impact of utility service relocation on road construction.

II LITERATURE REVIEW

governmental agencies) and the willingness at times to Compromise were found to be key in ensuring effective Coordination. Left on their own, in the most cases, the needed communication, cooperation and coordination expected of stakeholders to make sure effective project development is missing. Hence, in order to protect the public interest, governmental Compulsion through laws and regulations was deemed essential in strengthening the efforts of stakeholder cooperation, comprise and coordination. Anjay Kumar Mishra, & Aithal, P. S. (2020) [9] stated some administrative and institutional challenges that sometime hamper the effective management of delays within road projects as follows:

- Limited project resources: Limited resources may force transport agencies to prioritize the actual pavement works over utility issues and cut down on investment in utility issues;
- Uncertainty of transportation project: Due to uncertainty until later stages of design, utility owners often show little interest in utility coordination at the early stages of

project development; and

- Availability and quality of existing utility facility data: Inadequate documentation and information about the characteristics and location of conflicting existing utility infrastructure.

In managing utility issues within projects, various State transport agencies have made strides in spite of many challenges. The subject area has been studied by many researchers and diverse reports have been presented on what constitute best practices in utility management. For instance, US Domestic Scan program (2006) among three states; Florida, Texas and Minnesota aimed at classifying, recording and publishing state-of the-art and cost-effective right-of-way acquisition and utility relocation practices, shared the following as common traits among the three States studied:

- Dedication to establishment of supportive organizational milieu;
- Emphasis on procedure;
- Use of technical tools; and
- Openness to new ideas and techniques.

Supportive organizational milieu

Mishra, A.K., Sudarsan, J.S. & Nithiyantham, S. (2021)[9] ; Bista, D. B., and Mishra, A. K. (2019)[10]; Ghimire, S., and Mishra, A. K. (2019)[11] observed that a supportive organizational environment played a vital role in the success story of the agencies reviewed. According to this report, such a supportive institutional environment bore the following

characteristics across all states and **Agencies visited:**

- A team approach – the Scan team noticed that a team approach to utility management encourages joint ownership of the project and promotes all parties involved to navigate around problems;
- Upper management support – In all three states, it was observed that upper management did not only delegate authority to lower ranks, but backed it with the required financial resources to complete the assigned tasks. This act also served as a motivator to the staff by creating a “can-do” attitude among team members in the pursuit of the project goals;
- Disposition to innovate and accept risks – the freedom for staffs of right of way and utilities to try new techniques and to innovate was found to have contributed considerably to success;
- Provision of enough logistics – Every state prioritized utility issue by providing logistics like competent staff, cutting-edge technical tools, and monetary resources, needed for the functions of ROW acquisition and utility relocation; and
- Commitment to monitor and improve performance – it was also observed that these states reviewed had developed tools and procedures (with identifiable performance indicators) that enable them to track, monitor

and evaluate performance with regard to utilities.

Emphasis on Procedure

To tackle the issue of utilities on rights-of-way (US Domestic Scan program, 2006), the essence of a precise, distinct, but flexible procedure was seen as crucial. According to the authors of the abovementioned study such a process was found to be characterized by the following:

- Cross-disciplinary approach – the research findings also showed that the States understudied took clear steps to involve people with diverse expertise in the project development process from the early stages which included staffs from design, right of way, utilities, environmental, and construction departments. This approach did two things:
 - i) it enabled early identification and addressing of critical issues during design hence eliminating delays and increased expenses
 - ii) it created an invigorating work environment where staffs felt responsible for ensuring project success;
- Early involvement of stakeholders – As early as practicable, all the States endeavored to engage external stakeholders. These stakeholders included: community members, utility owners, affected private property and business owners, and resource agencies. This process created trust and enabled the implementation of projects with

less negative impacts;

- Explicit, written procedures – State DOTs were also observed to have written and explicit procedures about stakeholder coordination process. Written procedures also helped capture institutional knowledge as well as provide opportunity for process auditing;
- Incentives to maintain staff continuity – States also instituted incentive packages to maintain staffs on projects, especially for complex and high-visibility projects;
- Delegated decision-making authority – States eliminated hierarchical decision-making delays by delegating certain decision-making functions to the lowest level possible. This helped to keep right of way acquisition and utility relocation within the time scheduled;
- Conflict resolution – disputes among stakeholders can cause costly delays on projects. These three States avoided conflicts by using conflict management techniques such as “escalation ladder” and “white paper” methods for disputants to elevate disagreements and disharmony to management. These techniques aided speedy conflict resolution without the involvement of top management;
- Co-location of major participants – delays were minimized and communication aided by co-locating transport agency staffs,

design build consultant, staff of ROW, and FHWA representatives;

- Focus on schedule adherence – State DOTs operated a system that did not tolerate delays at any level for any reason. Other team members were made to work up to compensate for any delays that occurred at any level; and
- Design-build – the scan team suggested the use of design-build method of contracting, where permissible by state law, to accelerate project development.

Technical Tools

Findings by US Domestic Scan program (2006) showed that each state invested in state-of-the art tools that facilitated effective project administration, property and services management, and stakeholder education. Some examples of these tools according to US Domestic Scan program (2006)[12] include:

- Tools for managing property – these comprised GIS-based tools that are designed in a way that allows the tracking of the status of individual properties during acquisition, implementation as well as the operations stage;
- Data management – the Scan findings also showed that the states invested in staffs, data filing structures, tools, automated monitoring, as well as staff development;
- Electronic field data entry – another vital system that was seen to be helpful was the

electronic data management systems where original data once entered was passed on to the State's electronic data system;

- Visualization and animation technology – these tools have proven to be helpful especially in educating utility owners and the public. They are able to model road design proposals relative to existing structures and utility services thus facilitating impact assessment and alternative design solutions;
- Web sites – these served to inform stakeholders thus facilitating enhanced stakeholder coordination and engagement as well as aid the processing of documents; and
- Ecological considerations – environmental issues are a component of right-of-way development, and require collaboration with other design staff to ensure speedy process. Technical tools that consolidate environmental data was found to be helpful.

Other Techniques

Other techniques cited in US Domestic Scan program (2006)[12] that were used to improve the utility conflict resolution process include:

- Incentive acquisition and relocation payments to the property owner;
- Advance acquisition payments to assist local governments in making property advanced purchases of ROW parcels;
- Appraisal waiver and appraisal review;
- Utility reimbursements;

- Employment of subsurface utility; and
- Design mitigation strategies and value engineering.

Mishra et al. [13-16] have suggested the following as innovative practices in managing performance issues:

- Site clearance considerations should form part of project planning and scheduling [17];
- As much as possible, decision-making powers concerning the road development should be given to staffs directly involved in project execution rather than retained at top management levels;
- Encourage an all-inclusive environment in which decisions affecting any functional units receive the active participation by such units;
- Create an environment that promotes staff development in other disciplines beyond their traditional core job competencies;
- Give advance notices to service providers concerning all project development in the ROW and create a forum to engage and educate service providers on these developments;
- Notify service providers early and give them enough time ahead of project development to relocate their systems;
- Form local teams to coordinate all utility issues on the ROW;
- Institute utility destruction prevention measures by establishing one-call centers to collate notifications of proposed excavations on the ROW;
- Promote joint use of facilities and consider establishing utility corridors to accommodate ducts of buried utilities;
- Disseminate road development proposals and schedules to all relevant stakeholders;
- Meet with and engage service providers regularly on future project development and construction activities;
- Inform service providers of road developments ahead of the design stage;
- Pass schematic road design details to service providers for comment in the course of the project design;
- Perform an impact assessment of road development proposals on services and other structures on the right of way;
- Engage with service providers prior to the commencement of every key stage of a highway project, including planning, design, and construction;
- Determine and resolve utility conflicts prior to implementation;
- Allocate a focal person at the agency to work with service providers on a project from inception to completion;
- Publicize on the annual basis, maps of city, province, state highway agency, and utility

projects;

- Publicize details of construction programs as well as details of project managers and other key implementation staff of road projects;
- Planning for utility services should be done in conjunction with other public planning efforts;
- Utility companies should furnish to transport agencies plans showing updates of their utility systems every 2 to 5 years;
- Endeavour to reduce the effect of utility facilities on routes with high traffic volumes, few alternative routes, or limited right of way;
- Early design involvement;
- Fiscal incentives/disincentives for expedient relocation;
- Incorporation of utility corridors;
- Increased utilization of Subsurface Utility Engineering to promote utility avoidance; • The use of utility relocation management software;
- Offering utility relocation design and construction services via state-wide contracts;
- Establishing term utility agreements;
- Clearing right-of-way prior to utility relocations
- Providing a loan program to help finance utility relocations;

- Exploring the four C's (communication, cooperation, collaboration, coordination);
- Adopting trenchless technologies to expedite utility relocations;
- Use of advanced sensing technologies to improve the accuracy of locating existing utility lines;
- Development of utility conflict matrices; and
- Use of Civil Information Models for improved visualization of utility conflicts in 3D CAD models.

Moreover, according to Lees and Scott (2002), the need for relocations could be avoided by acquisition of a separate ROW for utilities. Specific locations nearby the ROW line may be assigned for each utility, when ROW is acquired for utilities. However, to balance the many interests that compete for limited horizontal or vertical space, good road design must discover ways. The common practices that make the most of the use of available land and eliminate road openings are utility corridors and undergrounding. Utility Corridors are longitudinal strips of road right of way exclusively for the location of utility facilities; where buried facilities share a joint trench or utilize pipe or box culvert structures (Clarke, 2008)[18]. Undergrounding is an expensive process of converting existing overhead utility facilities to underground for accommodation, aesthetic or safety reasons. Nevertheless, according to the study made on utility owners in

Auburn, United States, underground lines are much costly; and customers would be paying more if a utility has to bear this cost and pass it through to its customers (Stokes, 2011). With the ever-increasing expense and time required for relocation; leaving utilities in place and designing the road to avoid utility conflicts would avoid the need to relocate many utility facilities. Even when utilities are relocated on or before a scheduled time and there are no unexpected delays, the work is often very costly and time consuming. It is for that reason in the best interest of all stakeholders, if there is no need to relocate at least major utilities in the first place. Utility owners and design consultants can considerably impact project delivery by seriously taking into consideration utilities during the design of highway projects. In this case, some countries try through design measures to avoid the need to relocate utilities

III.METHODOLOGY

The methodology employed in this research involved a multi-pronged approach to comprehensively analyze the impact of utility service relocation on road construction projects.

Selection of Respondents:

Several national level research is going on shows importance of the issue. Respondents for the questionnaire survey were chosen based on their experience in road construction projects, including consultants, contractors, and clients.

A total of 90 questionnaires were distributed, with 70 of them being completed and returned,

during highway construction. Major delay during construction to identify, remove, or seal the facility is eliminated by identifying abandoned or out-of-Service utilities and removing early in the design stage. This would benefit utility relocation efforts by avoiding misinformation concerning utilities in highway plans, and clearing space for highway project features or utilities. As many personnel are not sufficiently knowledgeable of the utility relocation process especially on utility coordination process, and technical issues, providing training to designers, managers and consultants is helpful practice. Training eliminates utility decision-making positions of inexperienced personnel devoid of proper knowledge. For successful utility management, preparing adequate standard guidelines, and ensuring that they do not conflict with each other is also mandatory.

resulting in a response rate of 77.78%.

The distribution included 26 responses from consultants, 23 from contractors, and 21 from clients. Selection of Road Projects: Road projects that involved utility relocation during construction were chosen for the desk study. The selected projects were: Leguwahat Bojpur Road (LB), Bhairahawa Lumbini Taulihawa (BLT), Lumbini Buddhist Circuit Road (LBC), Biratchowk Ghinaghat Road (Km0+000 to Km 10+000) (BG1), Biratchowk Ghinaghat Road (Km 10+000 to Km 20+000) (BG2) Sitalpokhari-Khopichaur-Rukumkot Road (SKR) Nibel-Naya Sanghu-Palungtar Road (NNP)

Data Collection:

Six Key Informant Interviews (KII) were conducted to gain a deeper understanding of utility relocation-related issues and to validate the findings from the questionnaire survey.

Data regarding variation orders and extensions of time for the selected projects were obtained from various contractors and consultants.

Data Analysis:

IV. RESULTS

Backgrounds of Respondents

The study gathered responses from various stakeholders closely associated with road construction, including the Department of Roads (Client), consultants, and contractors. The questionnaire included questions aimed at categorizing the activities and areas of expertise of the respondents, facilitating the tracking of specific viewpoints within each stakeholder group. This inclusive approach aimed to ensure a balanced and representative perspective on the subject matter, with 30 questionnaires distributed to each of the three stakeholder categories.

Out of the 90 questionnaires distributed, a total of 70 were completed and returned, consisting of 26 responses from consultants, 23 from contractors, and 21 from clients. This impressive response rate of 77.78% reflects the engagement

Respondents' Experience Level with Utility Relocations

Respondents were to specify the number of years they had been involved in road projects. This

The research separately documented the cost and time slippage due to utility services for each selected project. These values were compared with utility-related change orders to calculate the correlation coefficient.

Integration of Data:

Data collected from the questionnaires provided insights into the views of clients, consultants, and contractors regarding the challenges and impacts of utility issues in road construction.

and commitment of these stakeholders in contributing their

insights to the research. The distribution and return rates for questionnaires to clients, consultants, and contractors are summarized in the table below:

Questionnaires Distributed:

Clients: 30

Consultants: 30

Contractors: 30

Questionnaires Returned:

Clients: 21

Consultants: 26

Contractors: 23

These figures illustrate the extent of stakeholder participation and contribute to the comprehensiveness of the study.

will invariably affect how well-informed respondents are with utility relocation issues and ultimately determine the quality of responses they give to the questions. From the survey,

45.71% of the respondents (32) have had a road experience level of 0-5 years, 27.14% of them (19) had an experience level of 6-10 years, 8.57% of them (6) had 11-15 years of experience level, while 18.57% of them (13) had experience level of above 15 years. The responses indicate that majority of the respondents have fairly experienced utility relocations, as majority of them have experienced 6 or more years in road projects and hence can contribute meaningfully to the study objective.

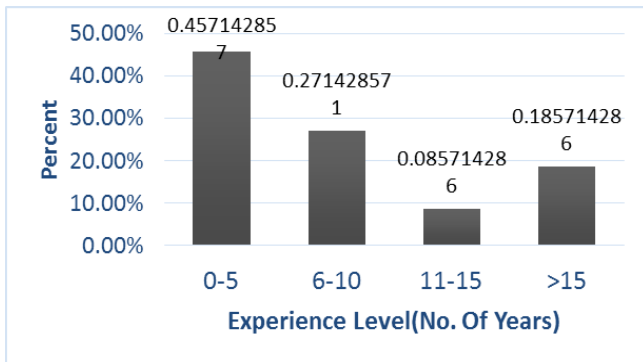


Figure 1: Respondent’s Road experience level over the years

Desk Study of Selected Road Projects

The desk study has revealed that the number of approved change orders issued directly as a result of utility relocations in the right-of-way was four. The findings indicate that average cost increment on utility budget due to utility relocation was 555.78%, while time slippage level averaged 13.79 %. In case of Bhairahawa Lumbini Taulihawa road, although there has been significant increase in the original estimate of utility relocation, the contractor has been

denied for any chance of time extension for utility relocation as they have been already provided EoT for other causes of concurrent delay and they have been compelled for schedule compression through project crashing thereby adding more resources to accelerate the project timeline.

Inadequate utility relocation cost estimates due to failure to identify and characterize utility conflicts is what happened exactly in case of Lumbini Buddhist circuit road where underburied water pipelines has gone unnoticed during design stage, thereby causing cost overrun in the project. Similarly, changes in utility relocation plans due to late project design changes is the reason for the increased in time and cost in the Biratchowk Ghinaghat Road section.

From the result, 0.73 value of correlation coefficient between utility change orders and time growth value indicates that the utility issues, when they occur, mostly delay projects and a coefficient of 0.80 a coefficient of 0.80 which shows that there is a very strong relationship between the number of utility issues and cost growth in road projects which shows that there is a very strong relationship between them. Similar to previous research [19 &20].

Table-3: Analysis of impact of utility issues on cost and time performance of selected roads

No	Road Project	Scope (Length-km)		Cost		Time (months)		PS	UCO	Utility relocation impacts				Utility contr. To cost/ time growth	
		Plan	Accom	Original	Final	Orig	Acc			Add Time req	BoQ utility budget	Utility cost to date	Utility contr to extra	%cost growth	% time growth
1	LB	65.5	65.5	994M	1,097M	30	57	Com	0	none	2M	0.2M	1.7M)	-88.58	0
2	BLT	41.13	41.13	1,930M	2,088M	30	42	DLP	1	none	10M	57M	47M	471.45	0
3	LBC	42.6	42.6	529M	624M	24	57.83	Com	1	8.17	1M	12M	11M	1100.0	34.03
4	BG1	10.00	6.00	686M	725M	24	30	OG	1	9	2M	20M	17M	649.06	37.50
5	BG2	10.00	9.00	690M	732M	24	30	OG	1	6	1M	20M	19M	1804.7	25.00
6	SKR	19.01	16.7	903M	935M	36	44	OG	0	none	2M	1.67M	.32M)	-16.25	0.00
7	NNP	15.7	0	550M	550M	24	15	OG	0	none	3M	2M	0.9M)	-30.00	0.00
													Avg.	555.78	13.79

*M=Million, PS=Project Status, DLP=Defect Liability Period, Com=Completed, OG=Ongoing, UCO= Utility issue related change order

IV. CONCLUSION

This research has shed light on the significant impact of utility relocation on road construction projects in Nepal. The findings of this study underscore the critical importance of addressing the challenges associated with utility relocations to mitigate time delays and cost overruns in road development.

To ensure smoother project execution and timely delivery, it is imperative to establish Coordinating Teams comprising representatives from road agencies, utilities, municipal assemblies, and all relevant stakeholders. These teams should work collaboratively to consolidate planning and development schemes into comprehensive master plans. Such a cooperative approach is vital for the success of every project, emphasizing the necessity of resilient institutions.

Furthermore, there is a pressing need for legislation to govern, oversee, and enforce the

proper use of public right-of-way by all stakeholders. The establishment of a one-call center, as suggested by this research, could play a pivotal role in coordinating right-of-way usage. Many countries already have state laws that provide a framework for utility accommodation within the right-of-way.

The study highlights the challenges associated with the identification of utilities. To address this issue, both road agencies and utilities should invest in modern technological tools for locating and characterizing underground utilities. Additionally, the adoption of modern right-of-way management software is essential for efficient information storage, retrieval, sharing, publication, and management.

In the procurement of public works, transitioning from the design-bid-build contract system to the design-build method should be considered. This shift can help eliminate many of the delays

associated with right-of-way planning and management, ultimately contributing to more efficient road construction projects.

In essence, this research emphasizes the importance of a collaborative, technologically advanced, and legislative approach to mitigate the challenges posed by utility relocations in

road construction. By adopting these recommendations, Nepal can enhance its road infrastructure development, ensuring timely and cost-effective project delivery while positively impacting socio-economic development and national integration.

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