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Utility relocation management in highway projects

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Abstract

Purpose – Utility relocation issues are unfortunately frequent and recurring problems in several countries' highway projects. Very few studies have addressed the utility relocation issues in highway projects. The purpose of this paper is two-fold. First, this paper explores how the utility relocation issues are managed in highway projects. Second, this paper systematically identifies the prioritized technical and coordination strategies to be adopted to avoid delays in utility relocation.

Design/methodology/approach – Multiple case-based research methodology was used to explore how the utility relocation issues are managed in highway projects. Empirical evidences from 11 road and bridge projects in India were used to develop the descriptive storyline for each of the project. The strategies used to manage the utility relocation issues were identified from three sources namely literature review, case studies and nominal group technique (NGT). The strategies were then evaluated quantitatively using NGT.

Findings – The analysis of the case studies showed that the delays in utility relocation were in the range of 5-52 months. It was found that the duration of relocation of utilities is impacted more significantly by the complexity of underground utilities rather than the size of the projects. Strategies that are used to manage utility relocation were identified across two groups namely; technical and coordination strategies.

Practical implications – Recommendations are provided for the practical use and policy changes.

Originality/value – The prioritized technical and coordination strategies can be used systematically to avoid delays in utility relocation.

Keywords Case study, Project delays, Nominal group technique, Highway projects, Utility conflict management, Utility relocation

Paper type Research paper

1. Introduction and background of the infrastructure development in India

The infrastructure sector is a key driver for the Indian economy (IBEF, 2016). The transport infrastructure sector in India grows at a compounded annual growth rate (CAGR) of 5.9 percent through the year 2021, thereby becoming the fastest-expanding component of the country's infrastructure sector. India has the second largest road network across the world at 5.4 million km and it is expected to cover another 50,000 km by 2019. An outlay of Rs 6.92 trillion (US$ 107.64 billion) has been invested in October 2017 to build a road network of 83,677 km over the next five years (IBEF, 2017). The growth potential is also immense in other sectors such as power, railways, metro rail, ports, irrigation, and pipelines.

Various media reports show incidents of extended delays and extensive cost overruns in Indian infrastructure projects (*The Times of India*, 2011; *The Hindu*, 2012; *The Hindu*, 2013; *Infrastructure Today*, 2013; *The Hindu*, 2014 etc.). Delays in utility relocation are the most common causes for delays which highly impacts the road projects (World Bank Report, 2008; *The Times of India*, 2012). The analysis conducted on 21 ongoing and completed National Highway Authority of India projects, showed that these projects were extensively delayed due to delay in the relocation of utilities. Among the relocation processes, the relocation of electrical utilities took an average of 33 months, the relocation of telephone utilities took an average of 31 months and water utilities about 29 months on average, against the planned target of about 18 months (World Bank Report, 2008).

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Understanding and eliminating the delays caused due to utility relocation is very important in buffering the projects against negative outcomes on the overall project performance (Chou *et al.*, 2009).

There are a number of problems associated with the relocation of utilities. Coordination of the parties involved in the process is also complex. Effective strategies should be implemented to mitigate these problems. Although there are few studies that identify the problems in utility relocation, limited research has been done to look at strategies for mitigating utility relocation problems. The purpose of this paper is to explore how utility relocation issues occur in projects and to develop strategies for avoiding utility relocation delays.

The paper is organized as follows: first, the literature on utility relocations is reviewed followed by the discussion on the methodologies used such as multiple case-based research methodology and the nominal group technique (NGT). After the methodology, the case study analysis and the findings of the case study analysis are discussed. This is followed by the identification and evaluation of the strategies. Finally, attention is drawn to the recommendations and conclusions.

2. Literature review

Worldwide, transportation agencies follow various practices for utility relocations. American Association of State Highway and Transportation Officials' conducted an international level study to identify the utility relocation best practices followed in different countries (FHWA, 2002). It was found that developed countries such as USA, Australia, England, Norway, Netherlands, and Germany adopt best practices such as: Subsurface utility Engineering; MoU and agreements, Utility councils, and committees for utility coordination; separate agencies for storing and retrieving underground utility information such as dial before you dig; one call centers and cable tube information centers. In developing countries such as India, the process of relocation gets unduly delayed due to poor coordination between the highway department and the various utility departments (World Bank Report, 2008).

Studies in the developed countries present bodies of knowledge that identify the problems in utility relocation and best practices for utility relocation (GAO, 1999; Marti *et al.*, 2002; Ellis, 2003; Utility Relocation Task Force, 2004; Osman and El-Diraby, 2007; Caldas *et al.*, 2008; Goodrum *et al.*, 2008; Jung, 2009; Ellis *et al.*, 2009; Chou *et al.*, 2009; Quiroga *et al.*, 2012; Sturgill *et al.*, 2014; Monri, 2015) and there is a need for similar studies on utility relocation best practices in developing countries.

In Indian context, Vilventhan and Kalidindi (2016) have identified the factors influencing delays in utility relocation and mapped the interrelationships between factors using cognitive mapping technique. This study provides only the interaction between the delay factors and does not provide any insight on how the various utility relocation issues are managed in different projects. Hence, in order to further understand the various practices, and to explore how the utility-related issues are managed during relocation, this paper presents the case level analysis of the road and bridge projects.

Utility relocation issues commonly occur worldwide and there is a need to effectively manage these issues through adopting appropriate strategies. Ralph (2003) has developed strategies to avoid utility relocation delays in highway projects. But these strategies are generic and do not identify the specific technical and coordination strategies used to avoid utility relocation delays. This paper systematically identifies the important technical and coordination strategies to avoid delays in utility relocation and right of way acquisition. This paper contributes to the growing literature on the utility conflict management in transportation infrastructure projects.

3. Research methodology

This study adopts mixed research methods. Multiple case-based research methodology is used for identifying the utility relocation issues and strategies adopted to overcome these issues. NGT is used to evaluate the strategies quantitatively.

3.1 Methodology 1: multiple case-based research methodology

The case study is an appropriate strategy when the research study aims to explore in depth a program, an activity or a process (Stake, 1995). It enables the researcher to explore differences within and between cases. Case studies were used to explore the rich issues in the process of relocation of utilities.

3.2 Case study design

Case studies can be exploratory, explanatory or descriptive (Yin, 2009). The nature of this study is exploratory. It intends to answer questions such as:

RQ1. How do utility relocation issues occur in projects?

RQ2. What are the strategies adopted to overcome utility relocation issues in projects?

The first question seeks to shed light on the various utility relocation issues. The second question aims to address the different strategies used to manage these issues in road and bridge projects. The unit of analysis for these case studies is the utility relocation issues and the relocation strategies.

3.3 Selection of cases

The cases were selected through screening the possible road and bridge projects that have the following characteristics (Table I). Projects that seem to be most affected by delays due to utility relocation. Projects with both conventional and combined relocation strategy were chosen. In conventional strategy, utility agencies themselves relocate the utilities whereas in the combined strategy the relocation is carried out by the construction contractor under the supervision of the utility agencies (Vilventhan and Kalidindi, 2016). To compare the impact of utility relocation issues based on location, projects from both urban metropolitan and rural areas were selected. To compare the projects based on size, small, medium and large-sized projects were considered. Both ongoing and completed projects were chosen. These criteria for selection captured the variation and the similarities in the issues on various types of project.

The evidence for case studies originates primarily from six sources (Yin, 2009). In this context, the descriptive storyline for each case was developed from data collected through interviews with project participants, archival records, project document, site visits, and other secondary data sources such as newspaper reports and informal dialogues. Project document includes minutes of site meetings, letters, work program, progress reports, highway manual and contract documents.

Semi-structured interviews were conducted with various stakeholders associated with each project such as officials from the highway department, utility agencies, and contractor. The officials held positions such as project director, deputy chief engineer, divisional engineers, superintendent engineers, assistant executive engineers, project managers and project engineers. For this study, the interviews were open-ended and focused (semi-structured). Interview guide and case study protocol were prepared in order to capture the information required from all interviews. The number of interviews conducted and data sources for each of the case are shown in Table I. The data from interviews were coded and analyzed using the computer-aided qualitative analysis software (NVIVO 10).

Table I.
Characteristics of the case studies

S. No	Project	State	Contract price – INR Millions	Year (Sstart)	No. of interviews conducted	Data sources	Status during the period of study (June 2012-May 2014)
1	ROB1	Tamil Nadu	188.2	2005	6	Interviews, archival records	Completed
2	ROB2	Tamil Nadu	113	2000	5	Interviews, archival records	Completed
3	FL1	Maharashtra	1,474	2008	12	Interviews, archival records	Completed
4	FL2	Tamil Nadu	635.6	2005	8	Interviews, site visits, project document, newspaper reports and informal dialogues	Ongoing
5	RD1	Andhra Pradesh	1,134	2009	8	Interviews, archival records	Completed
6	RD2	Andhra Pradesh	940	2012	7	Interviews, site visits project document, and informal dialogues	Ongoing
7	RD3	Andhra Pradesh	781	2012	8	Interviews, site visits, Project document, and informal dialogues	Ongoing
8	FOB1	Tamil Nadu	60.2	2012	12	Interviews, site visits, project document, newspaper reports and informal dialogues	Ongoing
9	FOB2	Tamil Nadu	60.2	2012	7	Interviews, site visits, newspaper reports and informal dialogues	Ongoing
10	FOB3	Tamil Nadu	60.2	2012	8	Interviews, site visits, newspaper reports and informal dialogues	Ongoing
11	FOB4	Tamil Nadu	60.2	2012	6	Interviews, site visits, newspaper reports and informal dialogues	Ongoing

3.4 Methodology 2: NGT for the evaluation of the strategies for mitigating utility relocation delays

The NGT is used to generate information and solutions to a problem that can then be ranked through group discussion (Potter *et al.*, 2004). NGT must be conducted with a small group of 5-9 participants, while some researchers have also tried with larger groups consisting of 22-24 individuals (Parthasarathy and Sharma, 2014). NGT has more advantages than other group processes such as Delphi (Delbecq *et al.*, 1975), focus groups and brainstorming (Stewart and Shamdasani, 1990). The steps involved in the NGT are shown in Figure 1. Purposive sampling was adopted to ensure a good mix of officials from contractor, utility

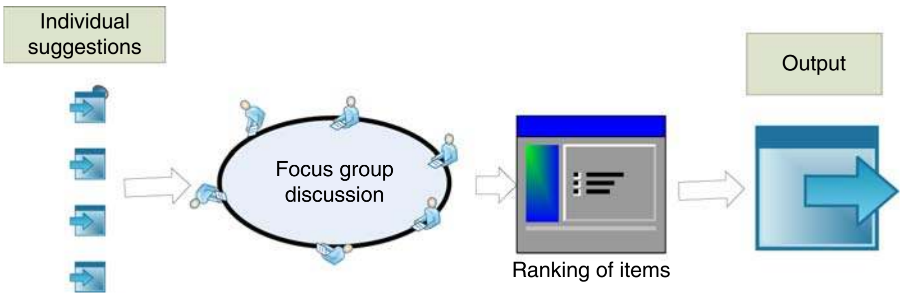

Figure 1.
Nominal group technique

agencies and highway department, and particularly majority (75 percent) of the selected officials with experience greater than 20 years as shown in Table II.

A focus group discussion was conducted as part of the NGT according to a predetermined schedule and new ideas were brought up. All participants were encouraged to share their thoughts collectively and brainstorm on specific issues such as problems faced in utility relocations and the strategies for mitigating utility relocation delays. The group discussion guide was prepared to aid the moderator. The group discussion came to an end when there were no further comments. To ensure the reliability and validity of the study, the audio recording was done (Leung and Chan, 2012). The participants ranked the strategies on the level of importance in a questionnaire. Thirty minutes were given to answer the questionnaire. A five-point scale from "very low" to "very high" was used for rating the importance of these strategies. The relative importance index (RII) was evaluated for each strategy. The RII is calculated as follows (Kumaraswamy and Chan, 1998):

$$\mathrm{RII} = \frac{\Sigma w}{A \times N}$$

where w, is the weight assigned by each participant in a range from 1 to 5, where 1 implies "very low" and 5 implies "very high"; A the highest weight (5); N the total number in the sample.

4. Case level analysis

The case level analysis involved the development of descriptive storyline for all the 11 case studies. The descriptive storyline for each of the cases was developed based on the data collected and the memos developed during coding (Strauss and Corbin, 1998). The following section presents the descriptive storyline of only two cases due to space constraints.

4.1 Analysis of case FL1

Mumbai's longest flyover (FL1) which is 2.448 km long and running over nine signals was developed in the year 2007 and the construction started in 2008. Right from appointing the consultants to awarding the contract, the process was completed in a record time of six months (Sharma, 2011). The relocation of utilities started in the year 2008, during the construction phase. A combined strategy (both contractor and utility agency jointly responsible) was followed for the relocation of utilities.

There were many challenges in the relocation of the utilities in the project due to various reasons. The unplanned old city has a variety of underground utilities with most of them being uncharted. These include sewerage, storm water drains, gas lines, power lines, water supply, and even abandoned tram rails. When the excavation was done manually for three to four meters' depth most of the utilities were encountered. Utilities were mapped and the drawings were used for designing of piles. Also, the concerned department was contacted for diversion of utility lines where possible. In some cases, the relocation could not be done as planned necessitating redesigning of piles.

Category	No. of participants Working experience (> 20 years)	(10-20 years)	(5-10 years)	Total number (%)
Highway department	9 (82%)	1 (9%)	1 (9%)	11 (55%)
Utility agencies	5 (100%)	–	–	5 (25%)
Contractors and consultants	3 (75%)	–	1 (25%)	4 (20%)
Total number (%)	17 (85%)	1 (5%)	2 (10%)	20 (100%)

Table II. Details of the participants in the NGT

As the geometry of utilities at every location was unique, each foundation had to be separately redesigned. Smaller utilities, wherever possible, were accommodated in the foundation structure itself. Sometimes, pile cap shape was redesigned to permit the utility close to it. In case it was not feasible, the utility was diverted away from the foundation. Diversion routes were chalked out in consultation with the concerned department.

Conflict with underground water pipelines. The diversion was not possible in case of large diameter water pipelines that were under pile caps. Hence, the pipeline was permanently protected by Reinforced Cement Concrete (RCC) encasement for the portion below the pile cap and 2 m on either side. Water mains were ruptured a couple of times as the piling rig punctured them and there was a delay in restoring the water pipelines.

Conflict with Dhapa drains. One more challenge in the project FL1 was in the relocation of Dhapa drains. Dhapa drains are egg-shaped masonry drains carrying storm water to the sea. They are too big to be diverted. The structure on such drain required special design so that the load was transferred to RCC arch that rested on the firm ground beside the drain.

The various issues faced in the relocation of utilities in FL1 were a delay in starting the relocation work, uncertainty over the location of underground utilities, design changes, and challenges in handling a number of utilities. As a result of such various challenges, the duration of the relocation of utilities took two years as compared to the initial planned duration of 1.5 years. This process formed a major portion of the entire construction phase which was planned to be completed in three years.

4.2 Analysis of case FL2

A flyover 475 meters long and 17.2 meters' wide was developed in the year 2005 in Chennai. Delay in the development phase was due to the delay in land acquisition. The relocation started only in the construction phase (2010). The conventional strategy was adopted for the relocation of utilities where the utility agencies had to shift their respective utilities.

Conflict with underground water pipeline. The construction work on the four-lane flyover began in March 2010 but had to be put on hold after completion of just 10 percent of the construction. The water supply and sewerage agency had to shift 3100 meters of water pipes from the center to the side of the road. The flyover was initially designed to have two columns with two-lane carriageway on either side. It was later made to a single column facility with a four-lane carriageway to limit the disruption to the drinking water pipeline along the stretch. The plan was revised, but still, the water supply department had to shift three pipelines of varying diameters. Experiencing difficulty in locating a suitable contractor to handle the work, the water supply and sewerage agency handed back the funds received from the highways department for implementation of this task. Work had stopped in 2011 on the flyover after the highways department had laid the foundation for a majority of the columns that were to support the flyover to allow metro water to shift a major pipeline from the middle of the road to its shoulder.

The planned duration of the construction of the flyover was 18 months and it was expected to be completed by August 2011. Only 50 percent of the project work was completed as on February 2015, due to the delay in the relocation of water pipeline. According to various informants of the case, the primary reason for the delay was the lack of coordination among the utility agencies. The water supply and sewerage agency were unable to get permission from the corporation to excavate the road and move the lines, and hence the chosen contractor refused to continue with the work due to an escalation in costs. Most contractors refused to bid as they felt that the road was too congested for unloading of construction materials. Subsequently, the highways department agreed to shift the water pipeline themselves.

The issues in the relocation of water pipelines were resolved after a delay of two years, after which work resumed on the project. Increase in costs of building materials required a fresh estimate for the project, which could now cost around 50 percent more than the originally estimated cost. This delay had a spiraling effect on the whole duration of the project leading to congestion and traffic jams in the area.

5. Findings from case analysis

The case study analysis revealed that the utility relocation delays normally occur in all projects due to various issues. The impact of issues influencing delays in utility relocations were compared across three different characteristics such as strategy for relocation, size and location of the project as shown in Table III. The interpretations were given with respect to the degree in which the issues influenced the delays in utility relocation as shown in Table III (Edelenbos and Klijn, 2006). Comparing the size of the project, it was evident that small projects such as FOB1, FOB2, FOB3 and FOB4 in India were delayed largely due to the delays in utility relocations. These projects encountered complex underground utilities. In the flyover project (FL1), a large-sized project, the impact of utility relocation issues on the project was medium, whereas in FL2, a medium sized project, the impact of utility relocation issues was high. This clearly shows that, "The duration of the utilities relocation has been adversely impacted more by the complexity of the underground utilities than the size of the projects." Based on the location of the project, it was evident from Table III, that "The impact of issues influencing utility relocation delays are high in urban areas than rural areas." The urban areas have a complex web of underground utilities, both private and public than in the rural areas.

The analysis of the case studies showed that the delays in utility relocation are the major cause of delays in Indian road and bridge projects. The planned duration of the FOB projects (FOB1, FOB2, FOB3 and FOB4) was eight months. But the delays in utility relocation were in the range of 8 to 18 months. The delays in utility relocation of the projects were equal to or much higher than the planned duration of the project. Likewise, in project FL2, the planned duration of the project is 14 months, but the delay in utility relocation is 54 months. It is clearly evident that these projects have extensively delayed only due to the delays in utility relocation.

6. Identification and evaluation of strategies

In this study, the strategies were identified from sources such as literature review, case studies and NGT. The identified strategies were then classified into:

(1) technical strategies; and

(2) coordination strategies.

S. No	Project	Strategy	Size of project	Location	Impact of issues influencing delays in utility relocation
1	FL1	Combined	Large	Urban	2
2	FL2	Conventional	Medium	Urban	4
3	RD1	Combined	Large	Rural	2
4	RD2	Combined	Medium	Rural	2
5	RD3	Combined	Medium	Rural	2
6	ROB1	Conventional	Medium	Suburban	3
7	ROB2	Conventional	Medium	Suburban	4
8	FOB1	Conventional	Small	Urban	3
9	FOB2	Conventional	Small	Urban	3
10	FOB2	Conventional	Small	Urban	3
11	FOB3	Conventional	Small	Urban	3

Notes: 0, very low; 1, low; 2, Medium; 3, High; 4, Very high

Table III. Comparison of projects across the different characteristics

Technical strategies are the methods/plan to achieve solutions for technical problems that arise during the process of utility relocations. Coordination strategies are the methods/plan to achieve coordination all through the process of utility relocations. The technical and coordination strategies identified from literature, case study and NGT are summarized in Table IV and Table V. The results of analysis of the importance of strategies with the RII and the ranks for each strategy under various categories are given in Tables IV and V.

6.1 Technical strategies for mitigating delays in utility relocation work

The importance of technical strategies for mitigating delays in utility relocation work is given in Table IV. The participants ranked early identification and removal of abandoned/out of service/defunct utilities (RII 0.80, Rank1) as the important technical strategy to mitigate delays in utility relocation work. From the interviews, it was noted that removal of abandoned utilities is very important in the early stages of the project as it may cause confusions and delays during relocations. It was also clear from the case studies that lot of time was wasted in confirming whether the utility facility is functioning or out of service. The participants ranked avoiding utility relocation through change in geometry/alignment, change in structure/footing, and adjusting the location of utility lines (RII 0.69, Rank2), and Use of available technologies such as SUE, CADD systems, vacuum extraction, GIS/GPS systems (RII 0.78, Rank 3) as important technical strategy to mitigate delays in utility relocation work.

From the case studies, it was clear that avoiding utility relocations through design changes in the structure during the construction stage reduced higher cost of relocations. Highway designers can design around the utilities with certain alternatives and avoid unnecessary utility relocations. This may increase the design time and cost but save time and cost later in the construction stage. To design around the utilities the exact location of the utilities must be known and hence the use of SUE is recommended for this purpose. If there is an uncharted utility that is not taken into account in the design, it takes time to solve the problems and redesign the project. Implementing SUE permits the designer to identify the exact locations of utilities so that unnecessary utility relocation and unexpected utility conflicts are avoided at the design stage (Jung, 2012).

Table IV. Importance of technical strategies for mitigating delays in utility relocation work

S. No	Technical strategies	Source	Code	NGT participants RII	NGT participants Rank
1	Avoiding utility relocation (change in geometry/alignment, change in structure/footing, and adjusting the location of utility lines)	FHWA (2002), case studies, NGT	TS1	0.79	2
2	Use of available technologies such as SUE, CADD systems, vacuum extraction, GIS/GPS systems	GAO (1999), Ellis (2003), Leuderalbert (1999), case studies	TS2	0.78	3
3	Adopting context sensitive design	Sturgill *et al.* (2014)	TS3	0.65	8
4	Early identification and removal of abandoned/out of service/defunct utilities	Case studies, FHWA (2002), NGT	TS4	0.80	1
5	Adopting manual excavation to a certain depth (3 to 4 m)	Case studies	TS5	0.68	7
6	Adopting Trenchless Technology	FHWA (2002), Ralph (2003), Leuderalbert (1999), Utilities Manual (2009)	TS6	0.72	5
7	Adopting joint trenching/utility corridors/utility tunnel	FHWA (2002), Leuderalbert (1999)	TS7	0.73	4
8	Use of subways for dry lines	FHWA (2002), Leuderalbert (1999), Utilities Manual (2009)	TS8	0.69	6

S. No	Coordination strategies	Source	Code	NGT participants RII	Rank
1	Electronic document delivery	Utility relocation task force report (2004)	CS1	0.80	5
2	Training	Case studies, GAO (1999)	CS2	0.68	16
3	Incentives and penalties	Ellis *et al.* (2009), Goodrum *et al.* (2008)	CS3	0.72	13
4	Designated utility coordinator	Case studies, NGT	CS4	0.81	4
5	Project-level monitoring committee	Case studies, NGT	CS5	0.86	3
6	Conducting monthly, quarterly or other periodic planning/coordination meetings	FHWA (2002), Quiroga *et al.* (2012), NGT	CS6	0.90	1
7	Utility agreements	Utility relocation task force report (2004)	CS7	0.69	15
8	Utility coordinating councils	Sturgill *et al.* (2014), WSDOT Utilities Manual (2008)	CS8	0.79	7
9	One-call notification	Ralph (2003)	CS9	0.70	14
10	Cost sharing	FHWA (2002), NGT	CS10	0.72	12
11	Joint project agreements	FHWA (2002), Leuderalbert (1999)	CS11	0.66	17
12	Use of special contracting methods like partnering	GAO (1999)	CS12	0.62	18
13	Early planning and coordination	GAO (1999), case study, NGT	CS13	0.87	2
14	Adopting design-build contracts	GAO (1999), case study	CS14	0.79	6
15	Government level review meetings	NGT	CS15	0.74	11
16	Expediting decision making	NGT	CS16	0.75	10
17	Risk sharing	NGT	CS17	0.78	8
18	Providing advance funding for utility relocations	Case studies, NGT	CS18	0.77	9

Table V. Importance of Coordination strategies for mitigating delays in utility relocation work

6.2 Coordination Strategies for mitigating delays in utility relocation work

The importance of strategies for mitigating delays during utility relocation work is given in Table V. The participants ranked conducting monthly, quarterly or other periodic planning/coordination meetings (RII 0.90, Rank1) as the most important coordination strategy to mitigate delays in utility relocation work. From the interviews, it was noted that if highway department, contractor, and utility agencies involved in the coordination meeting weekly or monthly to discuss all issues and resolve problems, then it will help improve communications and reduce delays.

The participants ranked early planning and coordination (RII 0.87, Rank2) as the important coordination strategy to mitigate delays in utility relocation. Early planning and coordination promote efficient highway design, economical utility relocation, and reduced construction costs (GAO, 1999). The participants ranked project-level monitoring committee (RII 0.86, Rank 3) as the most important coordination strategy to mitigate delays during utility relocation work. The case studies brought out the fact that the utility relocation was considerably coordinated and delays were low in projects that had project-level monitoring committee. The participants ranked designated utility coordinator (RII 0.81, Rank 4) as the important coordination strategy to mitigate delays during utility relocation work. A utility coordinator serves as a resource person in coordinating and communicating with multiple agencies in all activities from identification of the utilities to the relocation of the utilities.

7. Recommendations

Delays in the relocation of utilities are a major hindrance to the development of highway projects in India. Hence, there is a need for the government at the central level and the state level to take action and bring policy level changes to improve utility coordination and overcome delays. Based on the strategies identified, we suggest the following recommendations and actions that should be taken by the government, highway department, utility agencies, consultant and contractor involved in utility relocations:

- Legislations and regulations have to be established for guidance on utility relocation timings, and for streamlining the permits process.
- Lack of inter-organizational coordination is a major roadblock for the successful utility relocation. Changes in policy for appointing coordination wing for inter-organizational coordination are required. The government should allocate sufficient fund in the budget for utility relocation works for all the planned projects.
- The response from utility agencies can be expedited through assigning a separate person for one-point contact to manage the requests from the coordination wing, highway department or the contractor regarding the information on utilities, its jurisdiction control and estimates for relocation.
- Wherever possible, utility agencies should consider using joint trenching/utility corridors and other combined facilities in project right-of-way. This may help prevent conflicts between contractors and utility agencies, thereby reducing time lost and other problems.
- The government should invest in Subsurface Utility Engineering and map all the underground utilities. Use of available sensing technologies to locate the underground utilities should be encouraged.

8. Conclusion

Any new construction, renewal or widening of road and bridge projects involve the relocation of utilities requiring coordination between the highways department, utility agencies, designers, and contractors. Issues in the relocation of utilities impacting the overall duration of the project are a great concern. This paper explored how the various utility relocation issues impact the duration of the project through the case analysis of 11 road and bridge projects in India. The analysis of the case studies showed that the duration of the relocation of utilities is impacted more significantly by the complexity of underground utilities rather than the size of the projects.

Strategies were identified from three sources, namely, literature review, case studies and NGT. The important technical strategies identified to manage utility-related issues are: Early identification and removal of abandoned/out of service/defunct utilities; avoiding utility relocation through change in geometry/alignment; change in structure/footing, and adjusting the location of utility lines, and Use of available technologies such as SUE, CADD systems, vacuum extraction, GIS/GPS systems. The important coordination strategies identified to manage utility-related issues are conducting monthly, quarterly or other periodic planning/coordination meetings; early planning and coordination; and project-level monitoring committee. When the strategies are implemented systematically, these strategies will resolve many utility-related issues and thereby reduce utility-related delays in projects.

There are few limitations in this study. First, the study of the utility relocation was limited only to road and bridge projects in India. Similar studies could be performed in other transportation infrastructure projects. Second, the descriptive storylines for only two cases are presented in this paper. However, the findings reflect the analysis of the 11 cases. The projects selected for this study are from the Indian context. Further research is needed with data from projects of other national contexts to explore the utility relocation issues and compare the findings.

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