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Evolutional Attitude Based on Option Prioritization for Conflict Analysis of Urban Transport Planning in Pakistan

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Abstract. This paper constructs a dynamic conflict model that considers Decision Makers' (DMs) evolutional attitude using the option prioritization. The proposed evolutional attitude approach is based on the framework of the Graph Model for Conflict Resolution (GMCR). Compared with the existing state-based preference, the option prioritization is a more convenient and efficient approach to analyze larger models with consideration of the evolutional attitude, which exists broadly in the evolutional conflicts in real-life. This study reveals how the evolutional attitude of a DM succeeds in the overall evolution of conflict. The analysis unfolds that DMs change their attitude(s) consequent upon the changes in DMs and options available to them as conflict evolves from one level to the next. The changes in attitude of DMs during dynamic conflict situation have substantial effects on the equilibrium outcomes of a conflict. The proposed evaluation attitude-based approach is employed to analyze the conflict between the Punjab Government (G) and Heritage Campaigner and the Public (P) in Pakistan that appeared due to the inappropriate design, planning, and construction of an urban transport system project in Lahore, Pakistan. The present study demonstrates the modeling procedure of a two-level evolutional attitude-based conflict analysis. The results of the stability analysis reveal that improper (*negative*) attitude may result in undesirable and unexpected consequences, such as project temporalities and delays. This research provides a foundation for future research in urban project planning that employs strategic ways to avoid disputes caused by DMs' attitudes.

Keywords: Urban planning, infrastructure management, heritage protection, decision making, evolutional attitudes, conflict management, evolutional GMCR

1. Introduction

Developing a sustainable urban transport system in large cities is challenging, especially in developing countries. Large cities are exposed to various issues, such as population outburst, urbanization, road traffic congestion due to heavy traffic jams, road accident injuries and pollution, which have led the governments to develop rapid and integrated transit systems for sustainable urban mobility (Mohan 2008). Well-managed transport systems are indispensable for the growth and prosperity of the cities that are centers for commerce, business, trade, industry, tourism and other services (UNDESA 2011). A comprehensive collaborative urban transport planning is indispensable to resolve the dominant contemporary transport related issues. But the urban planning itself is a very complex and complicated process. The process of strategy development may vary from city to city, but all requires the consensus of the government and major stakeholders on vision for the city, agreement on strategic framework to realize the vision, and technical capacity to convert the development strategy into actions (Chiao et al. 2007, Mohan 2008, James et al. 2013, Aas et al. 2005).

Close interactions between the political DMs and project planners are the prerequisite for a suitable urban planning and project execution. The attitude of the focal decision-

maker in planning may have serious implications on the execution of the development strategy. Consequently, the strategic conflict between the government and the relevant stakeholders may be serious and complicated. This negative attitude-driven behavior of the focal DM may change the overall structure of the conflict. In this case, an evolutional attitude-based conflict resolution strategy can give a profound insight into the course of a complex and dynamic conflict.

Numerous studies have reported the issues regarding urban planning, such as Balling et al. (1999), Gobster (2001), Silva et al. (2017a), Silva et al. (2017b) and Tam et al. (2009), to name a few. Balling et al. (1999) proposed a genetic algorithm to deal with multiple conflicting objectives of the DMs and planners. Gobster (2001), assessed participatory planning and design process in urban park restoration in Chicago. Tam et al. (2009) employed conflict analysis techniques to study the urban planning in Hong Kong. Two recent studies, Silva et al. (2017a) and Silva et al. (2017b) also analyzed urban planning conflicts. Silva et al. (2017b) suggested a multiple criteria method to rank the preferences over feasible states. The involvement of relevant stakeholders in planning process is important (Chiao et al. 2007, Davies et al. 2012, Kovacs 2016, Ploger 2004, Silva et al. 2017a) to ensure a wide acceptance of the development plan (Burby 2003).

A comprehensive and integrated approach to urban planning is indispensable to develop a sustainable urban transport system. It requires a decision-making strategy aiming to develop an affordable, economically feasible, people-oriented and eco-friendly mass-transit system (UNDESA 2011) without compromising historical and cultural landscape of a city. When it comes to the planning and development of a metro train project, the selection of route, design and vertical alignment of a metro line need to be decided with the consultation of the stakeholders including planners equipped with technical expertise and knowledge, political DMs and those likely to be influenced by the projects (Mohan 2008, UNDESA 2011).

The rapid mass-transit projects like metro train are popular UNDESA (2011) as these projects are easily identifiable (Javed 2016) in developing countries, like Pakistan, and perceived as a significant achievement of the government. Institutions in these countries are weak and not so autonomous in their functioning. The government may bypass standard operation procedures to complete these projects. Environmental quality and protected heritage may be compromised to save the time and cost for the completion of the project. A similar incident took place in Lahore, the capital city of Pakistan's most populous province. The government decided to build a metro line in Lahore, however, the design and vertical alignment specifications of the metro line exposed that the route trespasses protected cultural, religious and historical monuments and alter their structure and visibility. It is also the violation of the national and international laws, and conventions regarding social and religious basic human rights. Thus, the execution of metro project in Lahore was intercepted following the protests and lawsuits filed against the project. An efficient negotiation strategy based on a comprehensive conflict analysis is indispensable to examine the nature, evolution, and course of urban planning conflicts.

The scientific literature offers various methods for conflict analysis. Among others, GMCR (Xu et al. 2018, Fang et al. 1993) is considered as an efficient and valuable tool for modeling and analyzing strategic conflicts (Ali et al. 2018 2019, Fang et al. 1993, Xu et al. 2018, Walker et al. 2012, Kilgour and Hipel 2005). A graph model for a strategic conflict comprises a finite set of DMs, a set of feasible states for each DM, a preference relation on states and a directed graph (Fang et al. 1993, Kassab et al.

Table 1 Comparison of Existing Attitude-Based Studies in the Graph Model

Study	Title	Attitude Preference	Evolutional Analysis
Inohara et al. (2007)	Conflict analysis approaches for investigating attitudes and misperceptions in the War of 1812	Based on States	No
Walker et al. (2012)	Dominating attitudes in the graph model for conflict resolution	Based on states	No
Xu P et al. (2017)	Evolutional Analysis for the South China Sea Dispute Based on the Two-Stage Attitude of Philippines	Based on option prioritization	Change in attitude
Xu et al. (2017)	Attitude Analysis in Process Conflict for C1919 Aircraft Manufacturing	Based on option prioritization	No
Xu et al. (2018)	Integrating an Option-Oriented Attitude Analysis into Investigating the Degree of Stabilities in Conflict Resolution.	Based on option prioritization	No
This study	Evolutional Attitude Based on Option Prioritization for Conflict Analysis of Urban Transport Planning in Pakistan.	Evolutional attitude-based option prioritization	Overall evolutional structure of the conflict

2006, Xu et al. 2018). Compared with the game theory, the GMCR needs less information than that required for relative preferences in utility function approach (Fang et al. 1993, Xu et al. 2018). This convenient and efficient nature of GMCR increases its practical uses and applications to resolve wide range of strategic conflicts in practice. Preference plays an important role in the GMCR framework. GMCR approach also considers the attitude of DM(s) into consideration. A prioritization of the set of states for each DM expresses preferences. The DMs' attitude also influences their preferences (Ali et al. 2018, Inohara et al. 2007, Xu et al. 2018, Walker et al. 2012, Yousefi et al. 2010, Xu et al. 2017). Table 1 represents the summary of comparisons of the previous attitude-based studies in the graph model.

Recently, DMs' attitude is incorporated into GMCR to analyze the nature and outcomes of the conflict (Inohara et al. 2007, Walker et al. 2012, Xu P et al. 2017, Xu et al. 2017). In fact, DMs' attitude directly affects their preference in GMCR. Inohara et al. (2007) and Walker et al. (2012) used an attitude based on the state preferences of DMs. But it becomes difficult to generate the preferences when the number of feasible states is larger than the number of options available to the DMs. In a large complex conflict, if there are k options, the number of states would be as large as $m = 2^k$ (Xu et al. 2017, Xu P et al. 2017). Therefore, Xu et al. (2017) proposed a preference generation method based on option prioritization.

The attitude preference based on options makes it convenient to generate preference ranking by prioritizing the options with respect to DMs' attitude. Moreover, preference ranking based on options is flexible. It also makes state prioritization convenient when analyzing the evolutional conflicts due to changes in the attitude(s) of the DM(s). This character-

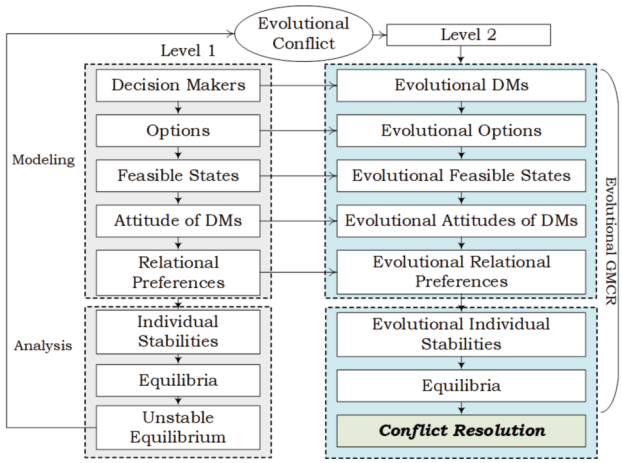

Figure 1 Evolutional Attitude in Evolutional GMCR

istic of the evolutional flexibility of the attitude-based options makes the conflict analysis more reflective and efficient in finding the equilibrium solutions of a conflict.

The evolutional conflict analysis approach in Xu P et al. (2017) focuses only on changes in the attitude of the DMs. However, the real-world conflicts are more dynamic and evolutional rather than static (Ali et al. 2019). Keeping in view the nature of the real-life conflicts, the present study proposes an evolutional attitude-based conflict analysis approach into the GMCR framework (Figure 1). In a conflict, the DMs may vary if the conflict evolves from one level to another. The evolution in a conflict may be due to the improper (*negative*) attitude of a DM on first level a conflict. Changes in DMs, due to the evolution, may result in changes in options available to them, and thereby changes in their preferences. This may affect the outcomes of a conflict (Ali et al. 2019). In a recent study, Ali et al. (2019) examined the evolutional conflict without considering the evolutional attitude. However, having the evolutional nature of a conflict, attitude of DM(s) towards other DM(s) in a conflict may change. Evolutional analysis of conflict provides better understating of a conflict as it unfolds the causes of conflict and helps to trace out the best possible and favorable solution(s).

The present study develops an evolutional conflict management strategy by incorporating evolutional attitude in the framework of GMCR and represents extremely important advancement in the GMCR theory. The structure and procedure of the evolutional attitude-based conflict analysis strategy is applied to the real-world evolutional conflict. This evolutional attitude-based on option prioritization is a seminal study to assess evolutional urban planning conflicts especially the construction of mass transit system in megacities. The proposed approach is applied to evolutional conflict appeared during the construction of the Orange Line Metro Train (OLMT) (GoP 2016) in the historical city of Lahore, Pakistan. Following the evolutional nature of the OLMT conflict, the study analyzes the OLMT conflict at two levels which provide a deeper understanding of the conflict.

The study describes how the evolutional attitude of a DM ensued change in the overall structure of the conflict. *Firstly*, it unfolds how the exclusion of the relevant stakeholder, such as archaeological experts and the public from the planning process resulted in a serious conflict. *Secondly*, how the inappropriate (*negative*) attitude of the government towards those stakeholders worsened the conflicting situation. *Thirdly*, how the negative attitude of the government caused the conflict to persist, and

how the heritage campaigners, archaeologist, and the public were compelled to opt a legal process against the OLMT project then a new DM Judicial Authorities (J) appeared as a new decision maker at the second level of the conflict. *Fourthly*, it shows how the choices of the government to implement the OLMT plan reduced as conflict evolved to the second level. Moreover, the analysis unveils how the negative attitude of the government caused the evolution of the conflict from the first level to the second, and how the preferences of the DMs changed following the changes in the options and attitude of the focal DM.

The rest of the article is structured as follows. Section 2 presents the background of the GMCR and incorporation of the attitude of the DMs in conflict analysis. Section 3 comprises the evolutional GMCR and evolutional attitude. This section also discusses the evolution in the DMs, changes in options and attitude of DMs. Section 4 presents the conflict analysis of the OLMT conflict by incorporating the evolutional attitude in the GMCR. Section 5 and 6 contain the evolutional conflict analysis at level 1 and 2 respectively. The subsections 6.5 and 6.6 represent the discussion on the results of the evolutional attitude-based analyses and research implications, respectively. The conclusion of the study is provided in section 7.

2. Attitude-Based Conflict Analysis Under GMCR

2.1 Graph Model for Conflict Resolution (GMCR)

The GMCR (Fang et al. 1993, Xu et al. 2018) is a very popular technique amongst the DMs and conflict analysts to analyze the stability and equilibrium solutions. The GMCR is a 4-tuple $(K, S, (A_i)_{i\in K}, (\succ_i, \sim_i)_{i\in K})$, where K and S are the set of all DMs ($|K| \geq 2$) and the set of all states in the conflict ($|S| \geq 2$), respectively. (S, A_i) is DM i's graph, where S: the set of all vertices, $A_i \subset S \times S$ is set of all arcs such that $(s, s) \notin A_i$ for all $s \notin S$ and $i \in K$. $(\succ_i, \sim_i)$ is the preferences of S for DM i. Whereas, $s \succ_i m$, for $(s, m) \in S$, implies that s is preferable to state m for DM i. The DM i's preference $\succ_i$ is symmetric if $s \succ_i m$ for all $(s, m) \in S$. So, $s \succ_i m$ and $m \succ_i s$ would not hold simultaneously. The preferences $\sim_i$ is reflexive for any $s \in S$ and it is also symmetric $s \sim_i m$ or $m \sim_i s$ for all $(s, m) \in S$. Moreover, $(\succ_i, \sim_i)$ is complete for all $(s, m) \in S$ as one of preferences $s \succ_i m$, $m \succ_i s$ or $m \sim_i s$ holds (Fang et al. 1993, Xu et al. 2018).

2.2 Attitude of the DMs and Attitude-Based Preference

The attitude of the DMs towards other DM(s) plays a pivotal role in determining their preferences, moves, and counter-moves from one state to another (Ali et al. 2019, Inohara et al. 2007, Walker et al. 2012, Xu et al. 2017, Xu P et al. 2017). The attitude is a stable psychological tendency of an individual to a person, event, idea, or emotion. It contains a subjective evaluation of the individual and preferences of DM(s) in a conflict that can be generated by subjective evaluation of DM(s) (Xu P et al. 2017). In the general preference prioritization, the focal DM considers only his or her own options while prioritizing the states. However, in attitude-based conflict analysis, attitudes of DMs play a pivotal role in generating preferences of DMs over the states, as shown in Figure 2.

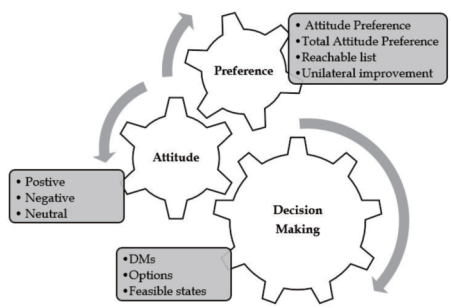

Figure 2 Attitude in Conflict Analysis

In the attitude-based preferences, the focal

DM also considers his or her opponent's option prioritization. Having a positive attitude, DM i's option statement would be same as DM j's option statement. But, if DM i have a negative attitude towards DM j ($i.e. e_{ij} = -$), his or her option statement would be opposite of DM's option statement(s). That would not be beneficial for DM j. However, if DM i has a neutral attitude towards her opponent, he/she does not care about the options statement of the opponent. It means that DM i would be indifferent (I) of the options statements of his/her opponent DM.

3. Evolutional Attitude-Based Conflict Analysis Using Option Prioritization in GMCR

3.1 Evolutional GMCR

Conflicts are more complex than they seem theoretically. This characteristic of real-life conflicts calls for dynamic analysis. It becomes imperious to trace out the evolutional course of a conflict (Ali et al. 2019). An evolutional analysis of a conflict can be helpful to provide DMs and decision analysts with a deeper insight into the conflict and appropriate to trace out a reasonable and acceptable solution. Owing to the dynamic and changing conditions of real-world complex conflicts, there may be changes in the DMs and their options consequently changing the preference of DMs in that conflict. The number of DMs may change as a conflict evolves from one level to another.

3.2 Decision Makers in Evolutional GMCR

Let the set of DMs at level 1 of a conflict be $D^1 = \{i, j\}$. Where superscript 1 shows the level of a conflict. The set of DMs D^1 may be a union set of two subsets such as $D^1 = D^{\neg 2} \cup D^{+2}$. Where set $D^{\neg 2}$ is the et of DMs that belong to set D^1 but do not belong to set of DMs at level 2, D^2. And D^{+2} is set of DM(s) belonging to D^1 also belonging to D^2 . Whereas, $D^{+2} \subset D^1$, $D^{+2} \subset D^2$, and $D^{+2} = D^1 \cap D^2$. For the sake of simplicity, $D^1 = \{i, j\}$. As conflict evolves to level 2, $D^{\neg 2} = \{j\}$ and $D^{+2} = \{i\}$. If DM k is a new DM at level 2, then the set of new DMs at level 2: $D^{2^*} = \{k\}$. So, $D^2 = \{i, k\}$ would be the set of DMs at level 2 (Ali et al. 2019).

3.3 Options of DMs in Evolutional GMCR

Evolutional changes in DMs in a conflict may also lead to changes in options of the DMs (Ali et al. 2019). A DM i having the set of options O_i^1 would have a set of options O_i^2 at level 2. However, for DM i, $n(O_i^2) \gtreqless n(O_i^1)$. DM i may rest with the limited options as at second level due to its preferred opted strategy at first level. So, $n(O_i^2) < n(O_i^1)$. The DM i may have a new set of options in addition to previous level options then $n(O_i^2) > n(O_i^1)$. The DM i may have same options at level 2 or a combination of previous level options and new options depending on the changing situation in a conflict. There may be some new DM k at the next level of a conflict having the set of options O_k^2. Hence, the set of total options at level 2 of an evolutional conflict would be $O^2 = O_i^2 \cup O_k^2$.

3.4 Prioritization Based on Options

The option prioritization approach is a generalization of the preference tree method initially proposed in (Fraser and Hipel 1988). While prioritizing options, the researcher provides an ordered set of preference statements of each DM, which comprises of options and connectives. Each preference statement, at a specific state, takes a truth value either True (T) or False (F). The position of preference statement reflects its relative importance. A state occupying a higher place is considered important in determining a DM's preference (Hou et al. 2015).

Preference between any two states is established using the statements $\omega_1, \omega_2, \ldots, \omega_q$ in order of priority. The state $s \in S$ is preferred to state $m \in S$ $(s \neq m)$ for a DM if and only if there exists q, $1 \leq r \leq q$, such that:

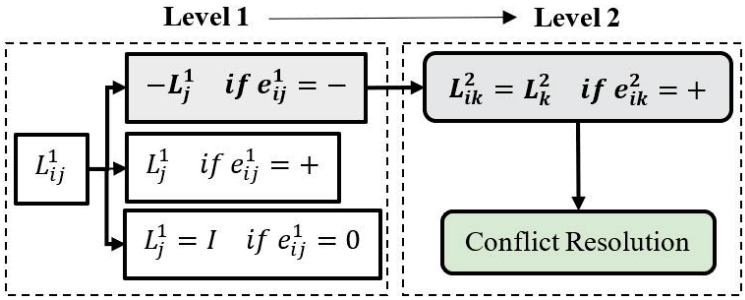

Figure 3 Evolutional Attitude of DMs

$$\begin{cases} \omega_1(s) = \omega_1(m) \\ \omega_2(s) = \omega_2(m) \\ \vdots \\ \omega_{r-1}(s) = \omega_{r-1}(m) \\ \omega_r(s) = T\ and\ \omega_m(m) = F \end{cases} \quad (1)$$

The preference statement, in GMCR II, is expressed using options and logical connectives as given in Table 2. Here " – ", "&" and "|" represent nonconditional logical relations "not", "and" and "or", respectively. The conditional relations between two nonconditional statements are shown as "IF" and "IFF" (Rubin 1990).

Table 2 True-Value for Simple Preference Connectives (Hou et al. 2015)

A	B	-A	A & B	A | B	B IF A	B IFF A
T	T	F	T	T	T	T
T	F	F	F	T	F	F
F	T	T	F	T	T	F
F	F	T	F	F	T	T

A "score" $\psi(s)$ is assigned to each state s according to its truth values while employing the statements. Assuming the total number of statements q that have been provided and $\psi_r(s)$ is defined by:

$$\Psi_r(s) = \begin{cases} 2^{q-r}, & \text{if } \omega_r(s) = T \\ 0, & \text{otherwise} \end{cases} \quad (2)$$

$$\text{and } \Psi(s) = \sum_{r=1}^{q} \Psi_r(s)$$

3.5 Evolutional Attitude Based on Option Prioritization

At first level of a conflict, the options preferences and opted strategy of a DM having a negative attitude towards other DM(s) may result in an equilibrium situation that may be a conflict itself. Consequently, this may reduce the options for the former DM as conflict evolves to the next level. The conflict analysis could come up with an acceptable solution if the DM(s) have a proper (positive) attitude as shown in Figure 3.

3.6 Attitudinal Preference Based on Option Prioritization

This study uses attitude based on options in the GMCR analysis. Option prioritization is the most effective approach to model the preferences in a complex conflict situation (Hou et al. 2015, Xu P et al. 2017). For DMs $(i, j) \in K$, in a conflict, the DM i may have positive ($e_{ij} = +$), negative ($e_{ij} = -$) or neutral ($e_{ij} = 0$) attitude for DM j. Each DM has some option(s) in a K-DMs conflict (Hipel et al. 1997). The DM i's option statement and and preference are denoted as $L_i(i = 1, 2, ..., k)$ and $P_i(i = 1, 2, ..., k)$, respectively. There may be three attitude-based option option statements as per DMs attitude toward its opponent.

Definition 1 ***Positive attitude option statement****: If DM i has a positive attitude for DM j ($e_{ij} = +$), it would have a devoting preference for DM j (Inohara et al. 2007), and DM i's option statement is favorable for DM j, i.e. $L_i(e_{ij} = +) = L_j$.*

Definition 2 ***Negative attitude option statement****: If DM i has a negative attitude for DM j* ($e_{ij} = -$)*, it would have a aggressive preference for DM j (Inohara et al. 2007), and DM i's option statement is not favorable to DM j, i.e.* $L_i(e_{ij} = -) = -L_j$.

Definition 3 ***Neutral attitude option statement****: If DM i has a neutral attitude for DM j* ($e_{ij} = 0$)*, it would have an indifferent preference for DM j (Inohara et al. 2007), and DM i's option statement would be* $L_i(e_{ij} = 0) = I$*, where 'I' stands for indifferent.*

Definition 4 ***Attitude Preference****: After having* L_{ij}*, one can get the preference of DM i symbolized as* T_{ij}*, for* $(s, m) \in S$, $i \in K$*, if* $m \succ_i s$ *is satisfied,* T_{ij} *symbolized as* $m \in T_{ij}(s)$ *(Xu et al. 2017, Xu P et al. 2017).*

Definition 5 ***Total Attitude Preference****: For* $(s, m) \in S$, $i \in K$*, if* $m \in T_{ij}(s)$ *for all* $j \in K$*, then the total attitude preference is described as* $m \in T_i^+(s)$*. Total attitude preference satisfies all the attitude preferences for DM i (Xu et al. 2017,* **?***).*

The attitude-based preferences reveal that the attitude of DM(s) toward itself and/ or for the opponent(s) have significant impact on their preferences on the states (Ali et al. 2018, Inohara et al. 2007, Walker et al. 2012, Yousefi et al. 2010, Xu et al. 2017, Xu P et al. 2017). The attitude-based preferences of the DM i, (T_{ij}), given the attitude-based statement of the DM (L_{ij}), can be obtained. For $i \in K$ and $(s, m) \in S$, T_{ij} is $m \in T_{ij}(s)$ if $m \succ_i s$. The total attitude preference of DM i for $i \in K$ and $(s, m) \in S$ is $m \in T_{ij}(s)$ if $m \in T_{ij}(s)$ for all $j \in K$. Furthermore, the set of less preferred states at total attitude for DM i would be $m \in T_i^{-=}(s)$, for all $(s, m) \in S$, if $m \notin T_i^+(s)$. By definition, $T_i^{-=}(s)$ is the supplementary set of $T_i^+(s)$. After having feasible states in the conflict, the conflict analysis proceeds further to identify reachable list and unilateral improvement lists for the DMs in the conflict. The reachable list is the record of all the states that a DM could move to from a specific state in one step or more. The reachable list, $(R_i(s) \subset S)$ for DM i for $i \in K$, and $s \in S$, is the set $\{m \in S | (s, m) \in A_i\}$ (Fang et al. 1993, Xu et al. 2018). The attitude-based unilaterla improvement list for DM i is $m \in T_i^*(s)$ for $i \in K$ and $(s, m) \in S$, if $m \in R_i(s)$ and $m \in T_i^+(s)$.

3.7 Attitude-Based Stability Definitions Used in the GMCR

After distinguishing the option statement(s) of the DMs, next step is the stability analysis. It is a systematic evaluation of possible moves and counter-moves of the DMs as they long for the preferred positions in the conflict negotiations (Hipel et al. 2007). Certain stability definition(s) need to be considered. Since the attitude-based options would be used for the stability analysis so attitude-based (relational) stability definitions (Inohara et al. 2007, Walker et al. 2012, Xu P et al. 2017, Xu et al. 2018) are summarized as follows:

Definition 6 ***Relational Nash Stability (RNash)****: For any* $i \in K$*, state* $s \in S$ *is RNash,* $(s \in S_i^{RNash(e)})$*, at attitude e for DM i if and only if (IFF)* $T_i^*(s) = \phi$*. Where* $T_i^*(s)$ *is reachable and preferable for DM i from stat 's'.*

In this situation, at an attitude '*e*', DM i has no benefit to move from a state to other states. It implies that the state '*e*' is RNash for DM i *IFF* DM i has no unilateral improvement at an attitude from '*s*'. Either DM i does not want to move or he or she cannot reach the state(s) preferred to state *s*.

Definition 7 ***Relational General Metarationality (RGMR)****: For any* $i \in K$*, state* $s \in S$ *is RGMR,* $(s \in S_i^{RGMR(e)})$*, at attitude e for DM i, if for all* $m \in T_i^*(s)$ *and* $R_j \cap T_i^{-=}(s) \neq \phi$.

A state is RGMR, at an attitude, if any movement to a more preferred state for DM i can be sanctioned by other DM(s). It implies that DM i, at an attitude, would not like to unilat-

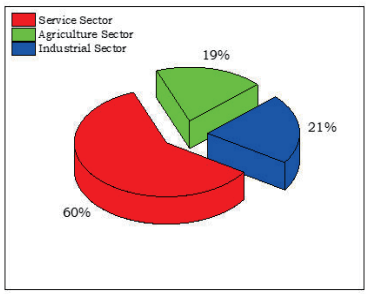

Figure 4 Sectoral Share in GDP

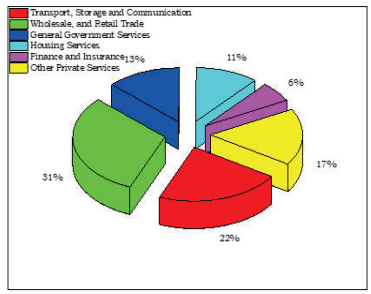

Figure 5 GDP Share of Subsectors in Service Sector

erally improve to preferred state if he or she perceives that the opponent DM j could make a countermove to sanction DM i's unilateral move regardless of his or her own benefit.

Definition 8 ***Relational Symmetric Metarationality (RSMR)****: For any $i \in K$, state $s \in S$ is RSMR, $(s \in S_i^{RSMR(e)})$, at attitude e for DM i, if for all $m \in T_i^*(s)$ there exist $z \in R_j(m) \cap T_i^{-=}(s)$ and $t \in T_i^{-=}$ for all $t \in R_i(z)$.*

The movement of a focal DM to a preferred state may trigger a counter-move by the opponent DM even this counter-reaction is harmful to opponent DM herself. But the focal DM has no chance to counter-react. In this situation, DM i would prefer to stay at the initial state 's'. Since RSMR DM not only considers the counter-move by his or her opponent but also his or her own counter-response so the RSMR has one more step ahead than the RGMR DM.

Definition 9 ***Relational Sequential Stability (RSEQ)****: For any $i \in K$, state $s \in S$ is RSEQ, $(s \in S_i^{RSEQ(e)})$, at attitue e for DM i, if for all $m \in T_i^*(s)$ and $T_j^*(s) \cap T_i^{-=}(s) \neq \phi$.*

In this case, DM i's unilateral improvement, at an attitude, could be sanctioned by DM j's unilateral improvement at an attitude. In RSEQ, DM i considers benefits of his own at the time of sanction. It makes RSEQ the same as RGMR except that DM i considers his or her own benefit at the time of possible sanction by the opponent.

4. Case Study-Analysis of the OLMT Project Conflict

4.1 Overview of Urbanization and Transport Systems in Pakistan

Pakistan is the world's 36th largest country by area with the 6th largest population in the world with a huge population of 207.77 million. Basically, Pakistan economy has been agrarian. Over the years, the economy has also developed industrial and service sectors. The contribution of agriculture, industrial and service sectors to national GDP is 19 percent, 21 percent and 60 percent, respectively (MoF 2018) (see Figure 4). The transport sector is a major contributer in the service sector with an about 22 percent contribution (Figure 5).

The trend in urbanization in Pakistan are not different from the rest of the world. The share of urban population is increasing due to higher population growth, rural to urban migration, and refugees' migration. The statistics of urban, rural, and total population of Pakistan are given in Figure 6. The population in big cities in Pakistan has also increased enormously (MoF 2018) (Figure 7). Urbanization has caused unprecedented economic, spatial, social, environmental, and infrastructural challenges (MoF 2017 2018). This increasing in urbanization is expected to continue. It is forecasted that half of the population of Pakistan will be living in urban areas by 2030. The governments in Pakistan from national to provincial to local levels are well-aware of the issues

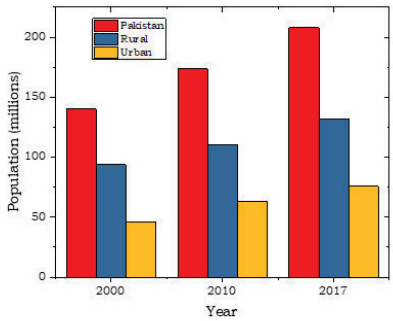

Figure 6 Population of Pakistan

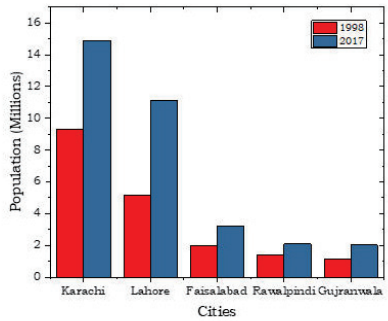

Figure 7 Population in Big Cities in Pakistan

related to population growth and rampant urbanization. The government is putting efforts to improve the quality of life in urban cities through planned urbanization (MoF 2018). Moreover, steps are also being taken to improve the urban infrastructure, especially the transportation facilities.

4.2 Mass Transit System Conflict in Lahore

Lahore, known as the "cultural heart" of Pakistan (Rana and Bhatti 2018), is the second largest metropolis of the country with a population of 11.12 million (MoF 2018) (see Figure 7), which has increased enormously during the last two decades. Motor bus services, taxis, vans, and rickshaws are the major transportation modes in the city. A Rapid Bus Transit System (RBTS) has been developed on the green line of the Lahore Rapid Mass Transit System (LRMTS) plan. The increased number of motor vehicles in the city has also led to traffic congestions. Moreover, the growing pollution has caused extreme weather events both in summers and winters. For example, the average day-time temperature during the summer is between 40-48 C, while the temperature in winter (December and January) can be as low as 0C (Rana and Bhatti 2018). There are about 5 million registered motor vehicles in Lahore, which include motor cars, jeeps, station wagons, motorbikes, scooters, pick-ups, delivery vans, minibusses, buses, luxury coaches, taxis, and auto rickshaws (PBS-GoP 2017).

The government realized the indispensability of public transport to deal with the problems of extreme congestion, severe traffic jams, long commuting times, deadly traffic accidents and increasing air and noise pollutions in Lahore. The provincial government acclaimed the need for mass-transit system in the city and commissioned MVA Asia Ltd. to undertake a feasibility study of Rapid Mass Transit System (RMTS) for Lahore (GoPP 2017). The study proposed a RMTS with four lines - Green, Orange, Blue and Purple (SYSTRA 2007). In more details, the 27km green line (*Gajju Matta* to *Shahdra*) was given the highest priority, and the metro bus system was accomplished on it in 2012-13.

The second priority was given to the 27.1 km orange line (*Ali Town* to *Dera Gujjran*), which was planned to be divided into three sections (GoPP 2017, SYSTRA 2007): a) the south-west section of 12 km as elevated section viaduct; b) the 7km-long middle section (*Chouburji* to *Sultanpura*) underground; and c) the north-east section of 8 km (*Sultanpura* to *Dera Gujran*) also as elevated viaduct. After 7 years of the original feasibility study, Government of the Punjab Province (GoPP) employed the National Engineering Services Pakistan (NESPAK) to revise the plan. NESPAK, in a revised study, proposed two alternatives: a) completing 27.1 km length of the orange line to be elevated; and b) a 25.4km metro line to be

elevated but cut & cover for 1.7 km (NESPAK 2015).

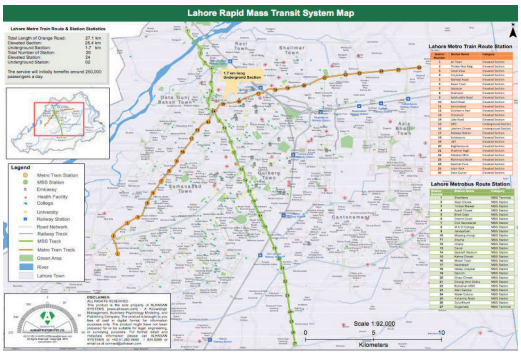

Figure 8 LRMTS Map

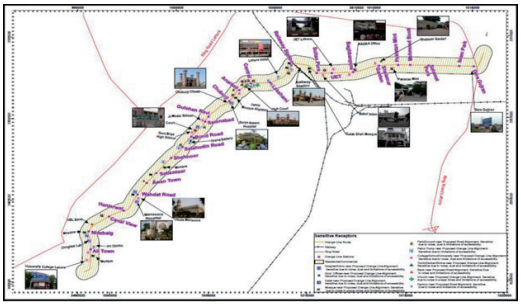

Figure 9 Sensitive Receptors along the Alignments of OLMT (PMA 2015)

The government decided to construct the orange line and complete project as an Early Harvest Project (EHP) in China-Pakistan Economic Corridor (CPEC) plan (GoP 2016) signed between China and Pakistan (BOI 2015). The OLMT project attracted criticism on its design since the inception. Way the project was planned and being implemented has led this project to a serious conflict. The construction has been believed to have several negative impacts. Firstly, the metro project may adversely affect 26 historical buildings (LMA 2016, Zahid 2015) and sites on its route (Summarized in Appendix I), as shown in Figure 5. In addition to fully or partially demolishing 6 of historical building and sites, the vibrations during construction and post-construction may also damage the structure of the monuments. Moreover, heritage sites may have a permanent visual impairment. This heritage loss may be irreplaceable and cannot be mitigated with current alignment and technology. Secondly, a large-scale concrete construction in the center of the city would also create the Urban Heat Island (UHI) effect and may cause climate change (LMA 2016, Sajjad et al. 2009). There has been an annual mean temperature increase of 10 C in Lahore due to rapid urbanization (Ghous et al. 2015).

Lahore's civil society, including environmental, archaeological and cultural activists, started a campaign to preserve the historical and cultural cityscape and appealed to the government for reconsidering the project design (Ashfaq 2016). The heritage campaigners and the public demanded a redesigning of the OLMT and certain changes in its alignment with the consultation of archaeologists, architects, and civil engineers.

The government showed a negative attitude and decided unilaterally to build OLMT (Javed 2016) as suggested in the revised study. Heritage campaigners chose the court system and challenged the construction of the metro-line within 200 ft radius of the historical monuments. Once the heritage campaigners chose litigation, the government has limited options but rests with the Judicial Authorities (J) to decide the fate of the project.

5. Level 1: Analysis of the OLMT Conflict Based on Negative Attitude Preferences

5.1 The Decision Makers at Level 1

Since the project was initiated by the Punjab Government (G) (GoP 2016), it makes this government a major DM in the OLMT conflict. The archaeological experts and LCS, heritage campaigners, environmentalists, the civil society, environmentalists and UNESCO had shown serious reservations on the OLMT project because of its adverse impacts on historical monuments in the city. So, the heritage campaigners and the public (P) become another DM in the conflict. After identifying the DMs, the

Table 3 The Decision Makers at Level 1

States	Attitude	Attitude Preference
G	1. NESPAK	Construct the OLMT as per revised design suggested in (NESPAK 2015)
	2. Original Design (OrD)	Build the metro line as was proposed in the initial study (SYSTRA 2007) with 7 km tunnel underground for Chauburji Chauburji to Sultanpura.
	3. Minor revision (MinR)	Pursue the independent review of the design of the metro line suggested in PC-I in (NESPAK 2015) with the consultation of archaeological, environmental, and other relevant experts for the minor revision in the metro design especially in the 200 ft circumference of the historical monuments.
	4. Major revision (MajR)	Conduct an independent review study for the overall design of the OLMT with the consultation of civil engineers, archaeological experts, and other relevant experts.
	5. RBTS	Develop an RBTS on the orange line as was developed on the green line of the RMTS project in Lahore.
P	6. Appeal	Appeal to the government for constructing the metro line without causing any damage to the historical buildings on the route of the proposed project.
	7. Petition	File the legal petition and pursue it in the High Court and the Supreme Court of Pakistan (SCP) against the OLMT project.

Table 4 Feasible States at Level 1

States	Label	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	S_{12}	S_{13}	S_{14}	S_{15}	S_{16}	S_{17}	S_{18}	S_{19}	S_{20}	S_{21}	S_{22}
G	1 NESPAK	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	2 OrD	N	N	N	N	N	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	N	N	N
	3 MinR	N	N	N	N	N	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	Y	Y	Y	Y
	4 MajR	N	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	5 RBTS	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N	N	N	N	N	Y	Y	N	N	Y	Y
P	6 Appeal	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	N	Y	Y	N	Y	N	Y	N	Y
	7 Petition	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N	N	N

next step is to identify the options of the DMs summarized in Table 3.

5.2 Options of the DMs and Feasible States at Level 1

There are two DMs: G and P with 5 and 2 options respectively. Mathematically, there would be 128 possible states at level-I of the conflict. Most of these states are infeasible due to mutually exclusive nature of the options available to DMs. Furthermore, the states such as "NNNNN - -" are also infeasible as there is no conflict if DM G had no plan to construct a mass-transit system on the orange line. After deleting infeasible states there are 22 feasible states (Table 4). The feasible states, for the sake of convenience, are named as $S_1, S_2, \ldots, S_{22}$.

5.3 Option Statements, Attitude Preferences, and Total Attitude Preferences at Level 1

After obtaining the 22 feasible states, the next step is to determine the preference ranking of the states. For this purpose, the option statements of each DMs (given in Table 5) are described and put into the NUAAGMCR software.

The attitude preferences of DMs are given in Table 6. Since the DM G, at level 1, has a postive attitude for itself ($e_{G,G} = +$) but neg-

Table 5 Evolutioal Attitude Option Statements at Level 1 (Negative Attitude)

DMs	Attitude Option Statements	
	$L^1_{G,G} = L^1_G(e^1_{G,G} = +)$	$L^1_{G,P} = L^1_{G,P}(e^1_{G,P} = -)$
G	1	1
	-3IFF1	-7IFF1
	-7	-4
	-6	-2
	-5	-5
	-4	-3IFF1
	-2	-6
	$L^1_{P,G} = I(e^1_{P,G} = 0)$	$L^1_{P,P} = L^1_{P,P}(e^1_{P,P} = +)$
P	Don't care	-1
		7IFF1
		4
		2
		5
		3IFF1
		6

Table 6 Evolutional Negative Attitude-based Preferences at Level 1

States	Attitude		Attitude Preference
G	$e^1_{G,G} = +$	$T^1_{G,G}$	$S_{13} \succ S_{17} \succ S_{15} \succ S_{18} \succ S_{14} \succ S_{16} \succ S_{19} \succ S_{21} \succ S_{20} \succ S_{22} \succ S_7 \succ S_9 \succ S_8 \succ S_{10} \succ S_{11} \succ S_3 \succ S_1 \succ S_5 \succ S_{12} \succ S_4 \succ S_2 \succ S_6$
	$e^1_{G,P} = -$	$T^1_{G,P}$	$S_{13} \succ S_{15} \succ S_{19} \succ S_{20} \succ S_{17} \succ S_{18} \succ S_{21} \succ S_{22}, S_{14} \succ S_{16} \succ S_7 \succ S_8 \succ S_9 \succ S_{10} \succ S_1 \succ S_2 \succ S_{11} \succ S_{12} \succ S_3 \succ S_4 \succ S_5 \succ S_6$
P	$e^1_{P,G} = 0$	$T^1_{P,G}$	don't care
	$e^1_{P,P} = +$	$T^1_{P,P}$	$S_6 \succ S_5 \succ S_4 \succ S_3 \succ S_{12} \succ S_{11} \succ S_2 \succ S_1 \succ S_{10} \succ S_9 \succ S_8 \succ S_7 \succ S_{16} \succ S_{14} \succ S_{22} \succ S_{21} \succ S_{18} \succ S_{17} \succ S_{20} \succ S_{19} \succ S_{15} \succ S_{13}$

ative attitude for DM P ($e_{G,P} = -$), so $T^1_{G,P}$ would be the inverse of $T^1_{P,P}$ for DM G, *i.e.* $L^1_G(e^1_{G,P} = -) = -L^1_P$. Whereas, DM P is supposed to have neutral attitude for the DM G ($e^1_{P,G} = 0$) but positive attitude for itself ($e^1_{P,P} = +$), so the attitude preference of the DM P would be $T^1_{P,P}$.

Once the attitude preference of DMs is available, the total attitude preference set for each DM can be computed considering this DM's attitude toward the other one, and hence the preference ranking of the states based on options can be obtained. Considering the attitude-based option statements of the DMs, attitude preferences (T_{ij}) are calculated under Definition 5 as shown in Table 5. For instance, if DM G have a negative attitude towards DM P, it considers inverse of ranking of DM P's.

As can be seen in the second row of Table 6 that the DM G having the negative attitude towards DM P is opposite of its opponent's preference ranking. The DM G have positive attitude for itself. The list of attitude preference of DM G from the state S_1 with positive attitude for itself is $(S_3, S_7, S_8, S_9, S_{10}, S_{11}, S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}) \in T^+_{G,G}(S_1)^{(e^1_{G,G}=+)}$ and the list of attitude preference of DM G with the negative attitude for the opponent DM P is $(S_7, S_8, S_9, S_{10}, S_{13}, S_{14}, S_{15}, S_{16}S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}) \in T^+_{G,P}(S_1)^{(e^1_{G,P}=-)}$. So the total attitude preference from state S_1 for DM G can be obtained by the intersection of these two lists as $T^{1,+}_G(S_1) = T^+_{G,G}(S_1)^{(e^1_{G,G}=+)} \cap T^+_{G,P}(S_1)^{(e^1_{G,P}=-)} =$

Table 7 The Total Attitude Preference at Level 1 (Negative Attitude)

States	$T^{+}_{G,G}(s)^{(e_{G,G}=+)} \cap T^{+}_{G,P}(s)^{(e_{G,P}=-)}$	$T^{+}_{P,G}(s)^{(e_{P,G}=0)} \cap T^{+}_{P,P}(s)^{(e_{P,P}=+)}$
S_1	$S_7, S_8, S_9, S_{10}, S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}$	$S_2, S_3, S_4, S_5, S_6, S_{11}, S_{12}$
S_2	$S_1, S_7, S_8, S_9, S_{10}, S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}$	$S_3, S_4, S_5, S_6, S_{11}, S_{12}$
S_3	$S_7, S_8, S_9, S_{10}, S_{11}, S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}$	S_4, S_5, S_6
S_4	$S_1, S_3, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}$	S_5, S_6
S_5	$S_1, S_3, S_7, S_8, S_9, S_{10}, S_{11}, S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}$	S_6
S_6	$S_1, S_2, S_3, S_4, S_5, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}$	$Null$
S_7	$S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}$	$S_1, S_2, S_3, S_4, S_5, S_6$ $S_8, S_9, S_{10}, S_{11}, S_{12}$
S_8	$S_7, S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}$	$S_1, S_2, S_3, S_4, S_5, S_6, S_9, S_{10}, S_{11}, S_{12}$
S_9	$S_7, S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}$	$S_1, S_2, S_3, S_4, S_5, S_6, S_{10}, S_{11}, S_{12}$
S_{10}	$S_7, S_8, S_9, S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}$	$S_1, S_2, S_3, S_4, S_5, S_6, S_{11}, S_{12}$
S_{11}	$S_7, S_8, S_9, S_{10}, S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}$	$S_3, S_4, S_5, S_6, S_{12}$
S_{12}	$S_1, S_7, S_8, S_9, S_{10}, S_{11}, S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}$	S_3, S_4, S_5, S_6
S_{13}	$Null$	$S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}$
S_{14}	$S_{13}, S_{15}, S_{17}, S_{18}$	$S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8$ $, S_9, S_{10}, S_{11}, S_{12}, S_{16}$
S_{15}	S_{13}	$S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{14}, S_{16}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}, S_{22}$
S_{16}	$S_{13}, S_{14}, S_{15}, S_{17}, S_{18}$	$S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11}, S_{12},$
S_{17}	S_{13}	$S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{14}, S_{16}, S_{18}, S_{21}, S_{22}$
S_{18}	S_{13}, S_{15}, S_{17}	$S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{14}, S_{16}, S_{21}, S_{22}$
S_{19}	S_{13}, S_{15}	$S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{14}, S_{16}, S_{17}, S_{18}, S_{20}, S_{21}, S_{22}$
S_{20}	S_{13}, S_{15}, S_{19}	$S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{14}, S_{16}, S_{17}, S_{18}, S_{21}, S_{22}$
S_{21}	$S_{13}, S_{15}, S_{17}, S_{18}, S_{19}$	$S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{14}, S_{16}, S_{22}$
S_{22}	$S_{13}, S_{15}, S_{17}, S_{18}, S_{19}, S_{20}, S_{21}$	$S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{14}, S_{16}$

Table 8 Stability Analysis with Evolutional Negative Attitude at Level 1

States	RNash			RGMR			RSMR			RSEQ		
	G	P	E	G	P	E	G	P	E	G	P	E
S_1					♣			♣			♣	
S_2		♣			♣			♣			♣	
S_3					♣			♣			♣	
S_4		♣			♣			♣			♣	
S_5					♣			♣			♣	
S_6		♣			♣			♣			♣	
S_7					♣			♣			♣	
S_8		♣			♣			♣			♣	
S_9					♣			♣			♣	
S_{10}		♣			♣			♣			♣	
S_{11}					♣			♣			♣	
S_{12}		♣			♣			♣			♣	
S_{13}	♣			♣			♣			♣		
S_{14}	♣			♣			♣			♣		
S_{15}	♣			♣			♣			♣		
S_{16}	♣	♣	*	♣	♣	*	♣	♣	*	♣	♣	*
S_{17}				♣	♣	*	♣	♣	*	♣	♣	*
S_{18}		♣		♣	♣	*	♣	♣	*	♣	♣	*
S_{19}				♣	♣	*	♣			♣	♣	*
S_{20}		♣		♣	♣	*	♣	♣	*	♣	♣	*
S_{21}					♣			♣			♣	
S_{22}		♣			♣			♣			♣	

$(S_7, S_8, S_9, S_{10}, S_{13}, S_{14}, S_{15}, S_{16}S_{17}, S_{18}, S_{19}, S_{20})$ (see Table 7). Where the "1" in the supercript shows the level 1 of the conflict.

The list of total attitude preference from all the states for DM G can be obtained in a similar fashion. Specifically, the attitude preference from state S_1 for DM P with neutral attitude for the opponent, DM G, is $\phi \in T^+_{P,G}(S_1)^{(e^1_{P,G}=0)}$ becasue if the DM P has neutral attitude it does not considers the option statement and attitude preference of DM G. The attitude preference of DM P from the state S_1 with a positive attitude for itself is $(S_2, S_3, S_4, S_5, S_6, S_{11}, S_{12}) \in T^+_{P,P}(S_1)^{(e^1_{P,P}=+)}$. So the total attitude preferences from the state S_1 with the attitudes $e^1_{P,G} = 0$ and $e^1_{P,P} = +$ is $T^{1,+}_P(S_1) = T^+_{P,G}(S_1)^{(e^+_{P,G}=0)} \cap T^+_{P,P}(S_1)^{(e^1_{P,P}=+)} = (S_2, S_3, S_4, S_5, S_6, S_{11}, S_{12})$ (see Table 7). The total attitude preferences from Table 7 can be input into NUAAGMCR to test stability of each state for each DM.

5.4 Stability Analysis Based on Evolutional Negative Attitude at Level 1

Given the set of DMs: $D^1 = \{G, P\}$, the set of feasible states: $S^1 = \{S^1_1, S^1_2, ..., S^1_{22}\}$, and the total attitude preference of DMs, the next step is stability analysis conducted by the solution concepts from Definitions 6-9. The results of the stability analysis are given in Table 8, where the symbol ♣ and $*$ indicate the stability of the state under respective stability definition(s) and equilibrium(s), respectively. The state S^1_{16} is RNash as $R^{1+}_G(S^1_{16}) = \phi$ having $R^1_G(S^1_{16}) = \phi$. Since, $R^1_P(S^1_{16}) = \{S^1_{13}, S^1_{14}, S^1_{15}\}$ and $S^1_{16} \succ_P (S^1_{13}, S^1_{14}, S^1_{15})$, so $R^{1+}_P(S^1_{16}) = \phi$. Moreover, state S^1_{16} is also RGMR, RSMR, and RSEQ for DMs. The stability analysis reveals $S_{16}(YNNNNYY)$ to be an equilibrium of the conflict with negative attitude of DM G towards DM P. This implies that if DM G chose

Table 9 The Decision Makers and Options at Level 2

DMs	Options	Description
G	1. NESPAK	The government decides to construct the OLMT as suggested in (NESPAK 2015) aiming to complete the project as an EHP in the CPEC project.
	2. MinR	Revise and modify the design of the OLMT within 200 ft radius of the historical monuments with the consultation of archaeological experts and independent civil engineers.
J	3. Suspend	Suspend the construction of the orange line within the 200 ft radius of the historical buildings until the revision and modification in its design.
	4. Allow	Allow the project as being constructed.
	5. Reject	Reject the construction of the project affecting the cultural heritage of the historical city of Lahore.

to construct the OLMT as per design in (NESPAK 2015), the DM P would not only appeal the government and international heritage organizations such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), but also file a legal petition against the project.

When DM G has the negative attitudes towards DM P, the stability analysis furnishes a more hostile solution of the conflict, S_{16}^1. Though some archaeologists, architects, and planners could succumb comprehensive redesigns which could help the government to construct metro line without affecting the historical monuments, the government "retained a facade of inclusion and discussion" Javed (2016) and took the decision unilaterally to construct the orange line as per NESPAK's feasibility. DM P kept on appealing to the government to consider the hisotrical monuments into consideration. But the government allowed the construction on the porject. DM P used their right to file a legal petition in the LHC against the construction of the OLMT project to protect the historical, cultural, and religious monuments in the Punjab province.

6. Level 2: Analysis of the OLMT Conflict Based on Evolutional Attitude Preferences

6.1 The Decision Makers at Level 2

DM G chose to construct the OLMT as proposed in NESPAK (2015) at Level 1, and therefore the construction of the OLMT was started. DM P kept on appealing to save the historical and cultural monuments and filed a petition in LHC to stop the construction work on the OLMT line within the 200 ft radius of the monuments under the protection laws. The judicial authorities are believed to verdict the petition as per the existing laws and regulations. So, at the second level of the OLMT conflict, the DM G and the judicial authorities (J) are the vital DMs.

6.2 Options of the DMs and Feasible States at Level 2

When it comes to the options available to these DMs (summarized in Table 9), DM G has only two options at the second level. The negative attitude of the government reduced the available options to two. The construction of the OLMT project has been started so the NESPAK option is an irreversible move of DM G. The second option available to DM G is to revise design of the metro line within the 200 ft radius of the historical buildings (a minor revision) and build the rest of the metro line per revised feasibility. However, DM J has three options: suspending the construction within

Table 10 The Feasible States at Level 2

DMs	Options	Feasible States							
G	1. NESPAK	N	N	N	Y	Y	Y	Y	Y
	2. MinR	Y	Y	Y	N	N	N	Y	Y
J	3. Suspend	N	N	Y	N	N	Y	N	Y
	4. Allow	N	Y	N	N	Y	N	Y	N
	5. Reject	Y	N	N	Y	N	N	N	N
	Label	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8

Table 11 Evolutional Positive Attitude-based Option Statements at Level 2

DMs	Attitude Option Statements	
	$L^2_{G,G} = L^2_G(e^2_{G,G} = +)$	$L^2_{G,J} = L^2_J(e^2_{G,J} = +)$
G	1	-1
	4	5IFF1
	-5	3IFF1&2
	-3	-4
	-2	
	$L^2_{J,G} = I(e^2_{J,G} = 0)$	$L^2_{J,J} = L^2_{J,J}(e^2_{J,J} = +)$
J	Don't care	-1
		5IFF1
		3IFF1&2
		-4

the 200 ft radius of the monuments until the necessary modifications in the metro line are made, allowing DM G to construct the orange line with the current design, or rejecting the construction and abandon the project.

There are 32 possible states, mathematically. Most of the states are infeasible because options 3, 4 and 5 are mutually exclusive. After deleting the infeasible states, the authors are left with 8 feasible states (Table 10).

6.3 Option Statements, Attitude Preferences, and Total Attitude Preferences at Level 2

Referring to option statements given in Table 11, the most preferred option for the government at the second level is also to complete the OLMT as it did choose to construct at the first level. When DM P opted legal action against the project, the government preferred the judicial authority to verdict in favor of the government to construct and complete the project as per schedule. However, the option of a minor revision in the NESPAK design is also available to though it is not as favorable for the government. On the other hand, the judicial authorities are likely to favor the constitutional and legal regulations to protect the heritage. So, DM J would not support the construction of if the project affects the protected monuments, but in favor of the development of the mass-transit system in the city. The preference of DM J is clear as the constitution of the Pakistan as well as protection acts and laws provide the protection. Note that this situation is different from the Recife conflict analyzed in Silva et al. (2017a). Silva et al. (2017a) presumed that judicial authorities as a new DM in the conflict cannot have a preference in the strict sense of the word and all states are equality preferred for the new DM.

In contrast to the Recife conflict, after the launch of a legal bid to block work on the OLMT project, LHC suspended the construc-

Table 12 Attitude Preference at Second Level 2 (Positive Attitude)

States	Attitude	T_{ij}	Attitude Preference
G	$e^2_{G,G} = +$	$T^2_{G,G}$	$S_5 \succ S_7 \succ S_6 \succ S_8 \succ S_4 \succ S_2 \succ S_3 \succ S_1$
	$e^2_{G,J} = +$	$T^2_{G,J}$	$S_2 \succ S_3 \succ S_1 \succ S_4 \succ S_8 \succ S_5 \succ S_6 \succ S_7$
J	$e^2_{J,G} = 0$	$T^2_{J,G}$	Don't care
	$e^2_{J,J} = +$	$T^2_{J,J}$	$S_2 \succ S_3 \succ S_1 \succ S_4 \succ S_8 \succ S_5 \succ S_6 \succ S_7$

Table 13 Total Attitude Preference at Level 2 (Positive Attitude)

States	$T^+_{G,G}(s)^{(e_{G,J}=+)} \cap T^+_{G,J}(s)^{(e_{G,J}=+)}$	$T^+_{J,G}(s)^{(e_{J,G}=0)} \cap T^+_{J,J}(s)^{(e_{J,J}=+)}$
S_1	S_2, S_3	S_2, S_3
S_2	$Null$	$Null$
S_3	S_2	S_2
S_4	$Null$	S_1, S_2, S_3
S_5	$Null$	S_1, S_2, S_3, S_4, S_8
S_6	S_5	$S_1, S_2, S_3, S_4, S_5, S_8$
S_7	S_5	$S_1, S_2, S_3, S_4, S_5, S_6, S_8$
S_8	$Null$	S_1, S_2, S_3, S_4

tion work until the final decision on the case (Boone 2016). Later, the court decided to allow but after minor revisions in the design and alignment of the metro line within the protected area around the monuments. So, the preference of DM J is the construction of the project with ensurance of the protection of the historical monuments.

As the conflict evolves to level 2, the government is considered to have a positive attitude towards the judicial authorities. Conflict analysis was done by considering the DM G's positive attitude towards the DM J ($e^2_{G,J} = +$). The attitude preferences of DMs with the attitude ($e^2_{G,G} = +$), ($e^2_{G,J} = +$), ($e^2_{J,G} = 0$), and ($e^2_{J,J} = +$) are given in Table 12. Since, DM G, now, have a positive attitude for herself ($e^2_{G,G} = +$) but also for the DM J ($e^2_{G,J} = +$), so $T^2_{G,J}$ would be the same as $T^2_{J,J}$ for DM G, *i.e.* $L^2_{G,J}(e^2_{G,J} = +) = L^2_J$. whereas, DM J is supposed to have positive attitude for herself but neutral attitude for DM G.

After obtaining the attitude preference, total attitude preferences of DMs G and J are $T^{2,+}_G(s) = T^+_{G,G}(s)^{(e^2_{G,G}=+)} \cap T^+_{G,J}(s)^{(e^2_{G,J}=+)}$ and $T^{2,+}_J(s) = T^+_{J,G}(s)^{(e^2_{J,G}=+)} \cap T^+_{J,J}(s)^{(e^2_{J,J}=+)}$, respectively. The "2" in the superscript indicates teh leve 2 of the conflict. Total attitude preference list of teh DMs is summarized in Table 13.

6.4 Stability Analysis with Evolutional Positive Attitude at Level 2

The stability analysis with the evolutional positive attitude of the DM(s) not only for herself but also for the other DM is given in Table 14. In contrast to the stability analysis with the negative attitude at level 1, the stability analysis with positive attitude provides with multiple equilibria, (S_2, S_4, S_8), opening the avenues for more considerable equilibrium(s) of the conflict.

6.5 Discussion

This subsection stands for the discussion on the results of the stability analyses of two-level evolutional conflict. The evolutional stability analysis based on the evolutional attitude-driven preference of the DMs helps to understand the decision-making behavior of the DMs. Therefore, the aim of the study is to unfold a better view of the real-life complex and dynamic conflict on the planning and development of the urban mass-transit system in a

Table 14 Stability Analysis with Evolutional Postive Attitude at Level 2

States	RNash			RGMR			RSMR			RSEQ		
	G	J	E	G	J	E	G	J	E	G	J	E
S_1	♣			♣	♣	*	♣	♣	*	♣		
S_2	♣	♣	*	♣	♣	*	♣	♣	*	♣	♣	*
S_3	♣			♣	♣	*	♣	♣	*	♣		
S_4	♣	♣	*	♣	♣	*	♣	♣	*	♣	♣	*
S_5	♣			♣			♣			♣		
S_6	♣			♣			♣			♣		
S_7				♣			♣			♣		
S_8	♣	♣	*	♣	♣	*	♣	♣	*	♣	♣	*

historical city of Lahore.

Since the OLMT conflict is of dynamic and evolutional nature, the conflict is analyzed at two levels. At the first level, negative attitude-driven preference of the government played a critical role. The government has multiple options to develop a mass-transit system on the orange line of the LRMTS. The stability results at the first level of the conflict unveil that, given the negative attitude of DM G towards the historical campaigners and the public, state S_{16} as an equilibrium state. Due to the negative attitude, the government paid no heed to the heritage campaigners and the public consider the modifications in the metro design. DM P decided to file a legal petition against the project for the protection of the heritage monuments and sites. At the second level, DM G left with only two options as it already started construction work on the project as suggested in NESPAK (2015). However, the new DM judicial authorities emerged as DM P filed a legal petition. Now the court has to decide the fate of the project according to the constitution of Pakistan, the Punjab Special Premises (Preservation) Ordinance (1985), and UNESCO convention regarding the world protected heritage.

The preference of the new judicial authorities regarding options is not clear at first. As in the Recife conflict, Silva et al. (2017a) asserted. But, it was learned from the proceeding and the hearings in the LHC, the DM J were not against the OLMT project. However, DM J showed concerns about the negative impacts of the project on heritage monuments and sights. So, the minor revision was likely to be the more preferred option if the government has already allowed the construction work on the project. The neutral attitude of the DM J was considered because the court would decide according to the constitution of the state and protection rules and regulations. The government was supposed to have a positive attitude as it is not likely to go against the court verdict or orders.

The evolutional stability analysis at second level confirmed three states (S_2, S_4, S_8) as equilibrium. However, preference ranking of the DMs plays a critical role in the conclusion of the common equilibrium states. State S_8 is likely to be a suitable equilibrium state for all the DMs in the conflict. The judicial authorities reached a verdict to suspend the construction of the OLMT. The LHC issued the stay order (Boone 2016) against the construction of the OLMT project within the 200 ft radius of the historical monuments until the final decision of the legal petition filed by DM P in February 2015. Hereafter, the LHC suspended the construction of the OLMT as per NESPAK feasibility. Furthermore, the LHC ordered the Director General (DG) Archaeology Department Punjab to carry out a fresh and independent study, in consultation with the independent specialists including international experts, regarding protected historical monuments. However, DM G has

used its right of appeal in the SCP. The case is in the court now. The SCP also maintained the LHC verdict to suspend the construction on the OLMT within the 200 ft of the buildings until the final decision is made. As the government wants to complete the project so the best outcome of the conflict at level 2 could be state $S_8(YYYNN)$. The best solution for the conflict is that the government change the OLMT design within the protected area around the historical buildings and sites, and the judicial authorities suspend until these changes are completed to ensure the protection of the heritage.

The conflict analysis concludes: though the government has been unequivocally in favor of mass-transit projects in the city, yet it does not need conferring the government an endless hall-pass for the metropolitan. Makeshift in infrastructure development policies, perpetual violation of laws and standard procedures in urban planning, issuance of NOCs from the archaeology and environmental department raised questions of transparency in the political and economic strategy of the government. This attitude of the government to pursue "concrete development" led to severe conflict resulting in delays and escalation in project costs.

A comprehensive study on the decision of route, redesign and vertical alignment of the metro line with the consultation of independent and reputed archaeological experts, architects, and civil engineers could avoid the conflict and the project could complete in time. The results and conclusion of the evolutional conflict analysis of the OLMT conflict is in agreement with the arguments in previous studies (Balling et al. 1999, Chiao et al. 2007, Davies et al. 2012, Ploger 2004, Silva et al. 2017a, Tam et al. 2009), where a close interface between the political decision makers (DMs), planners, public and other stakeholders is a prerequisite for suitable and doable urban planning and strategy for its implementation. The urban planning is a complex procedure not only in developing world, but also in the developed countries, while the dynamic nature may be different. However, strong public sector institution plays a pivotal role in development.

In developed economies, institutions are strong and decentralized to the local and municipal level. Local governments are strong enough to defend their interests, more concerned about security and safety, have modern local public administration systems. The coordination between the socioeconomic institutions in the developed world is effective and efficient. There is an effective public participation in decision making. However, in developing economies institutions are not so decentralized. These countries are characterized by low capacity, deficiency of resources, lower technical expertise. Local governments and municipal intuition are not independent and autonomous in decision-making. But political decision making is also very important in initiating a project for development. In human behavioral decision-making, attitude is a pivotal factor. When it comes to decision-making, the results of the study can be generalized that attitude of the DM(s) is important and it may change depending on the conditions and nature of the human activities in every sphere in the real-life.

6.6 Research Implications

Present evolutional attitude-based conflict analysis implies that: a) the attitude of the focal DM, the government, is important in decision-making about the urban planning in Pakistan; b) the decentralization of the intuitions to local and municipal levels would help to increase the institutional functioning. There is a need to increase the institutional strength and capacity. The capacity building and modernization of local public administration would be effective and efficient in planning and executing the project plans; c) independent and autonomous functioning of the institutions is necessary for

the efficient sustainable development; d) there is dire need to adopt collaborative and effective public participatory planning to achieve the objectives of the project(s).

The implications of the evolutional attitude-based negotiation strategy are not only limited to urban planning. The present negotiation strategy may be helpful in resolving conflicts from different spheres of real-world. Such a strategy could be suitable in resolving strategic conflicts on natural resources and water sharing disputes in neighboring countries such as Pakistan and India. Moreover, conflicts in global environmental governance are more likely to be of evolutional nature. For instance, in the Paris Agreement to climate change, the behavior of the US's leadership in Washington has changed the overall scenario of the global environmental governance regime.

2. Conclusion

The present study extends the GMCR theory by incorporating the evolutional attitude in developing a conflict management strategy. This study also illustrates the applicability of the proposed evolutional attitude-based approach to resolve an urban planning conflict. The current study shows that evolutional attitude-based approach in GMCR is an efficient and flexible method to analyze urban mass-transit planning conflicts. The study analyzes the OLMT project conflict in the City of Lahore. Evidently, urban planning is a very complex process. Especially, the planning and implementation of mass-transit development projects in historically rich cities is a challenging task. The behavior of the focal DM in decision making regarding the urban planning project is pivotal. The study reaffirms that the inappropriate (*negative*) attitude of focal DM, the government, caused the conflict to persist and evolve it to the second level. The government could avoid the conflict if it considered the aspirations of the heritage campaigners and the public at the first level. But the government stick with its plan and allowed the construction of the project according to the controversial plan. As the conflict entered into the second level, the government rest with the limited options and a new DM appeared consequent upon the public's decision to file a petition to the court. The court's preferences played an important role in the case. The LHC was in favor of the project to resolve the traffic problem in the city. However, it showed concerns about the protection of the historical monuments and sights. The stability analysis at the second level provided a feasible and acceptable solution of the evolutional conflict. The equilibrium state S_8 deemed to be the acceptable solution, which implies that the government should ensure the modification (minor revisions) in the design of the metro line within the 200 ft radius of the historical sights and monuments.

In the short run, due to the court decision, the government not only faced a set back on its political motive but also delays in project implementation, which affected its ability and credibility to execute international development projects. The government should consider this case without prejudice for the policy development of infrastructure projects in the future. In the long run, all such projects should be properly consulted without preconception through independent consultants and all relevant stakeholders should be taken on board in project planning. A proper standard inclusive planning process may avoid the conflict. Moreover, such development project's details should be made available to the public domain, so that concerns could be taken into consideration before the execution. Furthermore, the institutional capacity to perform their functions independently is indispensable to gain public confidence in their ability to comply with the national interest. Therefore, a systematic

and scientific approach should be adopted rather than the subjective and idiosyncratic behavior. The government attitude plays a vital role in the success of such projects, so the government should show a flexible attitude by involving the public in decision making, but not skeptical of their political motive. This study not only gives policy guideline for the government in the construction of the orange line, but also for the future mass-transit systems to be developed in the major cities of Pakistan.

Appendix A Table A: Impacts of OLMT on Historical Buildings and Sites in Lahore

Name	Distance from OLMT	Technology Used	Impacts of OLMT
1. Shalamr Garden	7′ from pile foundation viaduct elevated track height 56′	Elevated Viaduct	- Structure damage due to vibrations - Obstructed view - Reduced access - Compromised environment
2. Gulabi Bagh	58′ from the foundation of bridge pile, track height at sight approx. 50′	Elevated Viaduct	- Structure damage due to vibrations during and post construction - Obstructed view - Reduced access
3. Buddu ka Awa	Less than 30′ from the track. track height approx. 50′	Elevated Viaduct	- Structure damage due to vibrations during and post construction - Obstructed view - Reduced access
4. Chauburji	50′ from the pile foundation track height approx. 36′	Elevated Viaduct	- Endangered by the project during and post construction - Possible structure damage - Vibrations and noise stresses - Obstructed view - Restricted access
5. Zaibunnisa's Tomb	100′ from the track height 36′	Elevated	- Obstructed view - Compromised vistas - Obstructed view
6. Mauj Darya Mosque	5′ from the track	Cut & Cover	-Demolished
7. Mauj Darya Shrine		Cut & Cover	-Demolished
8. Shah Chiragh	track height 36′	Cut & cover	-Damage due to vibration - Complete loss of Shah Chirag Garden
9. Mominpura Graveyard	with in 200′ from the track. Track height 36′	Elevated	-Loss of area and graves -Visual imprint -Noise and vibration -Compromised security and privacy

Name	Distance from OLMT	Technology Used	Impacts of OLMT
10. Mahabat Khan Garden	with in 200′ from the track. Track height 36′	Elevated	-Obstructed view - Reduced access -Noise - Compromised vistas
11. Old EFU House	36′ form Central station	Cut & cover	Damage due to vibration -Possible structural damage
12. The LHC Building			-Loss of front parking lot
13. General Post Office	station	Cut & cover	-Demolition of porch and front lawn -Half of the veranda of GPO is cut -Structural damage
14. Lakhshmi Mansion	36′ from track foundation, Track height 36′	Elevated viaduct	-Possible structural damage -Obstructed view -Structural damage from vibration -Collapse of front facade
15. Jain Mandir		Cut & cover	-Largely demolished - Possible structural damage
16. Andrews Presb. Church			- Demolished due to NESPAK plan
17. Aiwan e Auqaf	With in 30′	Cut & cover	*Uncertain*
18. Aiwan e Augaf Bagh		Cut & cover	-demolished for central station
19. Supreme Court Reg		Cut & cover	*Uncertain*
20. Naulakha Pres. Church	Track height 36′	Elevated Vdt.	-Loss of front wall - Compromised viability security
21. Central Cath. Church	Track height 36′	Elevated viaduct	- Loss of front wall - Compromised viability security
22. Delhi Milestone			-Demolished by constructino crew
23. PIA Planetarium		Elevated	-Being demolished
24. Heritage Corr. Nic. Rd.	With in 36′ of track Track height 56′	Elevated Viaduct	- Demolition -Visual imprint - Environmental damage -loss of historic vegetation
25. Heritage Corr. Mcld. Rd.	With in 36′ of track Track height 56′	Elevated Viaduct	-Demolition -Visual imprint - Environmental damage - loss of historic vegetation
26. Anarkali			

Source: LMA (2016)

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