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ORIGINAL ARTICLE

Pathways to project delivery success and failure in Indian road public–private partnership projects

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ABSTRACT

This study examines conditions that impact public–private partnership (PPP) delivery success or failure in the roadways sector in India using qualitative comparative analysis (QCA). QCA is well suited for problems where multiple factors combine to create pathways leading to an outcome. Past investigations have compared PPP and non-PPP project delivery performance, but this study examines performance within PPPs by uncovering a set of conditions that combine to influence the success or failure road PPP project delivery in India. Based on data from 21 cases, pathways explaining project delivery success or failure were identified. Specifically, PPPs with high concessionaire equity investment and low regional industrial activity led to project delivery success. Projects with lower concessionaire equity investment and low reliance on toll revenue and with either (a) high project technical complexity or (b) high regional industrial activity led to project delivery failure. The pathways identified did not have coverage values that they were extremely strong. Coverage strength was hindered by lack of access to information on additional conditions that could be configurationally important. Further, certain characteristics of the Indian market limit generalization. Identification of the combinations of conditions leading to PPP project delivery success or failure improves knowledge of the impacts of structure and characteristics of these complex arrangements. This study is one of the first studies to use fuzzy QCA to understand project delivery success/failure in road PPP projects. Moreover, this study takes into account factors specific to a sector and delivery mode to explain project delivery performance.

Keywords: *public–private partnership; evaluation of public–private partnership; qualitative comparative analysis; project delivery performance*

1. Introduction

Projects procured through public–private partnerships (PPPs) are perceived to fare better in terms of project delivery performance compared to traditionally procured projects (Yescombe 2007). Several international studies contrasting PPP and conventional projects indicate that PPP projects have higher degrees of cost and time certainty. For

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instance, Hampton *et al*. (2012) in their perception-based study of construction stakeholders found that traditionally procured projects had greater potential for delays compared to PPPs. Chasey *et al*. (2012) analyzed North American PPP and design-build (DB) and DB-build projects to conclude that PPP projects performed better in both cost and schedule overruns. Contrary to these findings, Rajan *et al*. (2013), in their analysis of the incidences of overruns in PPP and non-PPP national road projects in India, found that PPP projects had higher cost overruns than traditionally procured projects. More recently, Liyanage and Villalba-Romero (2015) examined four PPP toll road projects in Europe to develop an overall measure of success from three perspectives: Project management, stakeholder, and contract management. Since PPPs are generally viewed as a strategy to improve infrastructure development, the recent attention to their "success" is not surprising. This study further examines this issue by assessing project delivery performance in roadway PPPs in India to better understand factors contributing to delivery success or failure.

2. Background

Time and cost performance are typically viewed as the critical parameters when judging the success of a construction project (Freeman and Beale 1992). These two metrics have their merits since they are quantifiable and objective compared to other measures; project management sources such as Clough *et al*., (2000), recognize the centrality of these two parameters when accounting for project success. Although assessing project success is argued to involve far more than quantifying cost and time performance (Shenhar *et al*., 2002), the challenges of quantifying other measures often limit studies of project delivery performance, so they typically employ a set of quantifiable and observable measures, such as cost and time.

Time and cost performance often have a clear connection. For instance, Arditi *et al*. (1985) showed that the prospect of simultaneous cost and schedule overrun was fairly high since drivers of these overruns were not different. A few of the general causes of project delivery failures include the inability to estimate the cost and schedule correctly due to a lack of data and poor estimation techniques (Arvan and Leite, 1990). Moreover, Dey *et al*. (1996) stated that uncertainties in the project environment were the major cause for project delivery failures.

However, existing literature outside India is insufficient to understand the features of project delivery success or failure in India. For instance, Morris and Pandey (2003), in their study of public sector projects in India, reasoned that constraints on available funds were no longer a major contributing factor in project overruns due to a shift to a more rational limitation on the number of government-sponsored projects in the 1990s. Singh (2010) found that large-scale projects in India tend to experience higher cost overruns compared to smaller ones.

Existing Indian literature on this subject has several shortcomings, which strengthens the need for an India-based study to explain delivery performance of road PPP projects: (a) Existing empirical studies are limited and somewhat dated; (b) very few studies have taken into account the sector-specific factors that play an important role in explaining causes of project delivery success and failure; and (c) no studies focused on a specific delivery mode (such as PPPs) have examined project delivery issues and performance.

3. Objective

While a few investigations comparing PPP and non-PPP project delivery performance exist, a very limited set has focused on a specific delivery mode (such as PPP). Hence, the objective of this study is to fill this void by identifying conditions that combine to influence the success or failure of project delivery of Indian road PPP projects.

4. Methodology

4.1. Qualitative comparative analysis (qca)

To identify the parameters that are conditions for project delivery success or failure of road PPP projects in India, this investigation takes an alternative approach from previous studies that have either used statistical or a case-based methods. The reasons for adopting this approach are several.

First and foremost, the research objective is viewed as a configurational problem. In the complex environment of construction or PPP projects, success or failure is generally derived from causal factors combining with each other to affect a project's outcome. PPP projects are complex arrangements with a significant number of stakeholders as well as formal and informal relationships. Second, the data available on road PPP projects have complexities and limitations, which make the use of quantitative analysis techniques challenging. PPPs are large-scale projects, which generally limit the number of existing projects available for evaluation. The number of completed road PPP projects in India, for which critical data are available, lies in the intermediate range (10–40 cases), which is not sufficient for typical quantitative methods. Further, the complexity of causal factors makes quantitative approaches difficult since retention of case-based knowledge is impractical in large-N quantitative analysis (Runyan, 1982).

Therefore, to investigate the complex causality of success or failure of project delivery of PPP road projects in India, QCA is an attractive approach. It is ideal for infrastructure or construction research studies where (a) the research question is interrogating combinations of causal factors and multiple pathways that lead to an outcome; (b) the number of cases is in the intermediate range; and (c) causal factors are qualitative or quantitative in nature (Jordan *et al*., 2011). QCA aims "to allow systematic cross-case comparisons, while at the same time giving justice to within-case complexity, particularly in small- and intermediate-N research designs" (Rihoux and Ragin, 2009). QCA incorporates good characteristics of both qualitative and quantitative research. Like a case-based approach, it sustains the circumstantial and interactive behavior of variables while quantitative methods treat them in isolation. Yet, the systematic research process of QCA provides transparency and replicability, which can be challenging in qualitative methods.

Fuzzy set QCA was chosen since finer gradations of the data for causal factors and outcomes of PPP projects in India enhanced the investigation. Fuzzy set QCA allows variables to take a value along a continuous range which best represents the membership score in that fuzzy set.

4.2. Data collection and description

The PPP India Database web source created by the Ministry of Finance provided the key information on operational road PPP projects (Ministry of Finance, 2013). Alternative official sources include quarterly status reports (from January 2004 to June 2009) of the Ministry of Statistics and Program Implementation (MOSPI, 2013), information from the website of the National Highway Administration of India (NHAI) such as concession agreements (NHAI, 2013a), and compendiums of PPP projects (Planning Commission, 2013; and Ministry of Finance, 2010). Other than these official sources, reliable sources such as project reports/information from newspapers/magazines and websites of relevant private players/investors were used to gather information on road PPP projects in India.

5. Application of fuzzy set QCA

Implementing QCA involves several steps: (a) Identifying outcome(s) of interest; (b) selection of cases; (c) developing causal conditions; (d) calibration of fuzzy sets of outcomes and conditions; (e) analysis of necessary conditions; (f) construction of a truth table; (g) analysis of sufficient conditions; and (h) interpretation of results. The following sections describe each of these steps; other studies discuss the concepts and underpinnings of the methodology (Jordan *et al.*, 2011; Rihoux and Ragin, 2009; Gross and Garvin, 2011; Ragin, 2008).

5.1. Identifying outcomes of interest

The outcomes of interest were project delivery success and failure of road PPP projects denoted by "Project Success"[1] or "Project Overrun," respectively. Cost and schedule performance were the two project variables used to define and quantify the outcomes of interest. Specifically, Project Success is achieved when no cost or schedule overrun occurs while Project Overrun is a case where either a cost or schedule overrun occurs.

Cost overrun was the difference between the actual project cost[2] and estimated project cost at financial close:

$$\text{Cost overrun} = \text{Actual project cost} - \text{Estimated project cost at financial close} \tag{1}$$

$$\text{Cost overrun}\left(\text{percentage}\right) = \frac{\text{Cost overrum}}{\text{Estimated project cost at financial close}} \times 100 \tag{2}$$

Schedule overrun was the difference between actual project completion date and the project agreement's completion date:

$$\text{Schedule overrun (months)} = \text{Actual completion date} - \text{Agreement completion date} \tag{3}$$

5.2. Selection of cases

Cases were selected on the basis of availability and veracity of critical data (e.g., project cost at financial close and project completion date) while also maximizing heterogeneity of condition and outcome values, which is an important element of QCA. The focus was on large PPP projects (national or state highways of comparable size and characteristics), so small PPP projects were excluded from the research. A total of 21 projects were chosen where data availability and reliability were high. These projects had a reasonable amount of heterogeneity in condition and outcome values as well as location. Table 1 depicts the selected projects.

5.3. Selection of causal conditions

Conditions were selected in a deductive and inductive manner incorporating relevant current literature and available case knowledge. After evaluating a preliminary list of causal factors posited to affect project delivery success and failure of Indian road PPPs, the conditions selected were as follows:

- Complexity: It represents the technical complexity in road development. A high degree of

1 Names of defined outcomes and conditions are conventionally denoted by capitalizing each word.

2 "Project cost" means the total capital cost of the project up to the commercial operation date as approved by senior lenders. This definition is consistent throughout this study wherever this term is used.

Table 1. Overview of project cases

Project name (year of completion)	Case ID	Project Cost[3] (₹ Crore)	State	PPP type	Scope
Nellore - Tada Road (2003)	NT03	613	AP	Toll[4]	2-lane to 4-lane
Dharmavaram – Rajahmundry (2005)	DR05	250	AP	Annuity[5]	2-lane to 4-lane
Nellore Bypass (2004)	NBP04	147	AP	Annuity	4-lane (Greenfield)
Anakapalli - Tuni (2004)	AT04	295	AP	Annuity	2-lane to 4-lane
Raipur Durg Expressway (2006)	RDE06	114	CG	Toll	2-lane to 4-lane
Durg Bypass (2001)	DBP01	70	CG	Toll	2-lane (Greenfield)
Delhi - Gurgaon Highway (2008)	DGH08	1175	DH	Toll	4-lane to 8-lane
Vadodara - Halol Toll Road (2000)	VHTR00	160	GJ	Toll	2-lane to 4-lane
Maharashtra Bdr - Belgaum Rd. (2004)	MBR04	544	KA	Annuity	2-lane to 4-lane
Tumkur - Neelmangala (2003)	TN03	193	KA	Toll	2-lane to 4-lane
Mumbai - Pune Expressway (2006)	MPE06	1630	MA	Toll	6-lane (Greenfield)
Ambala - Zirakpur (2008)	AZ08	364	PB	Toll	4-lane (Greenfield)
Mahapura - Kishangarh Road (2005)	MK05	632	RJ	Toll	2-lane to 6-lane
Madurai - Arupukot - Tuticorin (2011)	MAT11	982	TN	Toll	4-lane (Greenfield)
Tindivanam - Ulunderpret (2009)	TU09	887	TN	Toll	2-lane to 4-lane
Tambaram - Tindivanam (2004)	TT04	377	TN	Annuity	2-lane to 4-lane
Thanjavur - Trichy (2010)	TT10	456	TN	Toll	2-lane to 4-lane
Krishnagiri - Thopurghat (2009)	KT09	525	TN	Toll	2-lane to 4-lane
IT Expressway (2008)	ITE08	290	TN	Toll	6-lane (Greenfield)
Agra - Bharatpur (2009)	AB09	192	UP	Toll	2-lane to 4-lane
Panagarh - Palsit (2005)	PP05	592	WB	Annuity	4-lane (Greenfield)

complexity indicates circumstances such as difficult terrain or greater numbers of bridges. Such projects often require higher levels of coordination, utility relocations, and government clearances. While such challenges are arguably knowable ex-ante, Indian PPPs are characteristically contractually weak (compared to those in developed nations), which heightens the significance of this condition. Thus, complexity in road projects should adversely affect a project's budget and schedule (Hinze *et al*., 1992). The quantitative proxy for complexity is as follows:

$$\text{Complexity} = \frac{\text{Total project cost (indexed to 2013-2014 prices)}}{\text{Number of lanes added} \times \text{Legenth of project}} \quad (4)$$

- Leverage: It denotes the distribution of debt and equity used to finance a project. In general, initiatives like PPPs using project financing are highly leveraged. Leverage is defined by equity portion of the debt to equity ratio. In a highly leveraged project, equity invested by project sponsors is relatively low, so the sponsors have less at stake. However, in a low leveraged project, multiple equity providers are typically involved (since more investment is required), which could add management or control issues. In this case, low leverage could negatively affect project delivery performance. Therefore, leverage could behave either way with respect to project delivery performance.
- Toll Reliance: It represents the nature and source of revenue for a project. High Toll Reliance

indicates a greater dependency on toll revenues. 'Negative grant'[6] toll projects are highly dependent on toll revenues since they are auctioned on account of expected high returns or commercial viability. Annuity projects are the other extreme of toll reliance since there is absolutely zero dependence on toll revenues. Subsidy-driven toll projects fall in the intermediate region. Therefore, the degree of Toll Reliance of PPP projects and consequently with project performance is:

"Negative grant" toll>>"Subsidy-driven" tool>>Annuity (5)

- Industrial Output: It denotes the health of regional secondary economic sectors. Adjusted state domestic product (SDP) is taken as a proxy for industrial output. Here, adjusted SDP is a 5-year average (2007–2012) of per capita net SDP of secondary economic sectors (e.g., manufacturing and construction). The expectation is a better economic/industrial setting will positively impact road development efforts. Thus, better project performance is expected in states with stronger industrial growth.

Other causal factors such as institutional complexity (to represent the challenge of coordinating with various governmental entities) and level of competition were not included in the final causal factors due primarily to the lack of consistent data.

5.4. Calibrating fuzzy sets of outcomes and conditions

The assignment of the fuzzy membership score or calibration for conditions and outcomes is a very important aspect of Fuzzy set QCA as it requires both qualitative and quantitative information. Calibration in Fuzzy set QCA follows multiple approaches including the direct method of calibration (Ragin 2008). Direct calibration involves defining three qualitative anchors to structure calibration - full membership (0.95), no membership (0.05) and crossover[7] (0.50) and then utilizing these anchors to convert raw data into a degree of membership ranging between 0 and 1 for each case. A unique approach was used to calibrate the outcomes (Project Success and Project Overrun). First, Ragin's (2008) direct method of calibration was applied to calibrate the fuzzy sets of cost overrun and schedule overrun. Next, two new fuzzy sets, Project Success and Project Overrun, representing the outcomes of interest, were calibrated using fuzzy set operations (union of fuzzy sets and negation) on cost overrun and schedule overrun as illustrated in Equations 6 and 7. The first fuzzy set outcome Project Overrun was defined as the union of fuzzy sets (Logical OR) of Cost overrun and schedule overrun. The second fuzzy set outcome Project Success was defined as the negation of Project Overrun.

Project Overrun = MAX (Cost Overrun, Schedule Overrun) (6)

Project Success = 1 – Project Overrun (7)

For calibration of the conditions, Leverage and Toll Reliance, a six-value and a four-value fuzzy

3 Here, Project Cost represents the actual costs incurred for completing the project. 1 Crore INR ~ US$160,000.

4 In BOT (Toll), investment by private sector is recovered through tolls from users during the concession period. Thus revenue risk in this arrangement is borne by the private sector. To make some projects financially viable, grants are provided by NHAI/government.

5 In BOT (Annuity), the concessionaire recovers investment out of the annuities payable by the client (NHAI/government) on an annual or semi-annual basis. No grant is provided in this case. Revenue risk is borne by the client (NHAI/government).

6 "Negative grant" denotes the amount paid by the private sector to the government at the bidding stage on the account of future earnings after completion from expected high returns.

7 Crossover point is the data value where there is maximum ambiguity whether it is in or out of the target set.

Table 2. Summary of calibration approach by fuzzy set

Fuzzy set	Calibration method	Fuzzy set membership determination
Cost overrun	Direct	Qualitative anchors: • Full membership (0.95)=30% Overrun • Non membership (0.05)=−10% Overrun • Crossover (0.5)=5% Overrun
Schedule overrun	Direct	Qualitative anchors: • Full membership (0.95)=12 months • Non membership (0.05)=−3 months • Crossover (0.5)=3 months
Complexity	Direct	Qualitative anchors: • Full membership (0.95)=₹10 Crores/lane-km • Non membership (0.05)=₹2 Crores/lane-km • Crossover (0.5)=₹5 Crores/lane-km
High industrial output	Direct	Qualitative anchors: • Full membership (0.95)=22000/person/year • Non membership (0.05)=2000/person/year • Crossover (0.5)=12000/person/year
High leverage	6-value fuzzy set	Degree of membership (equity share of debt equity ratio) • 1.0=0–5 • 0.9=5–14 • 0.6=15–23 • 0.4=24–33 • 0.1=34–44 • 0.0=45 and above
Toll reliance	4-value fuzzy set	Degree of membership (data groups) • 1.0=Toll projects with high “negative grant” (>5%) • 0.66=Toll projects with low subsidy (<10%) or subordinate debt or low “negative grant” (<5%) • 0.33=Toll projects with high subsidy (>10%) • 0.0=Annuity projects

set coding scheme was adopted, respectively. This technique was used since these conditions can be sorted into a discrete number of options. Table 2 summarizes the calibration methods utilized. Table 3 presents the calibration summary of all conditions and outcomes for each project case. The mean membership score for individual conditions and outcomes is close to 0.5, which indicates that coding of these conditions and outcomes captures relevant variation.

6. Results and interpretation

Analyses of sufficient and necessary conditions were performed separately for Project Overrun and Project Success using fsQCA software. Analyses of necessary conditions for both the outcomes yielded no single condition as necessary; none had a consistency level >0.90, which is the threshold recommended by Legewie (2013). For the same reason, there was no need to check for the necessity for combinations of conditions. The absence of necessary conditions indicates that no single dominant cause exists for the occurrence of project delivery failure or success. The methodology of the analysis of sufficient conditions follows Ragin (2008) where a crisp truth table is constructed from the fuzzy membership table without lessening the gradations in set membership which is central to constituting fuzzy sets. Considering the small number of cases, the frequency cutoff was taken as 1 for both analyses. Similarly, the consistency cutoff was 0.75 (threshold recommended by Ragin

Table 3. Calibration summary of conditions and outcomes

Case ID	Conditions				Outcomes of interest	
	Complexity	High leverage	Toll reliance	High industrial output	Project overrun	Project success
NT03	0.60	0.00	0.33	0.38	0.18	0.82
DR05	0.40	0.60	0.00	0.38	0.87	0.13
NBP04	0.23	0.40	0.00	0.38	0.12	0.88
AT04	0.51	0.60	0.00	0.38	0.27	0.73
RDE06	0.23	0.40	0.66	0.28	0.92	0.08
DBP01	0.35	0.40	0.66	0.28	0.27	0.73
DGH08	1.00	0.40	0.66	0.89	1.00	0.00
VHTR00	0.62	0.10	0.66	0.94	0.23	0.77
MBR04	0.76	0.60	0.00	0.53	0.31	0.69
TN03	0.65	0.10	0.33	0.53	0.12	0.88
MPE06	0.53	1.00	0.33	0.93	0.92	0.08
AZ08	0.29	0.40	1.00	0.77	0.18	0.82
MK05	0.17	0.40	0.33	0.25	0.03	0.97
MAT11	0.08	0.60	0.33	0.77	1.00	0.00
TU09	0.96	0.40	1.00	0.77	0.70	0.30
TT04	0.27	0.60	0.00	0.77	0.12	0.88
TT10	0.66	0.60	0.33	0.77	0.95	0.05
KT09	0.75	0.40	1.00	0.77	0.27	0.73
ITE08	0.25	0.40	0.33	0.77	1.00	0.00
AB09	0.17	0.40	0.66	0.1	0.18	0.82
PP05	0.33	0.60	0.00	0.15	0.72	0.28

2008) for both the analyses. Next, Boolean minimization[8] was used to reduce the configurations of conditions sufficient for the outcome to causal pathways.

6.1. Pathways to project overrun

Analysis of sufficient conditions yielded two pathways for Project Overrun as presented in Figure 1a. Consistency is >0.75. Overall solution coverage is 0.49, which indicates that almost half of the cases can explain one of the two pathways to the outcome.

The relationship shows that projects having less equity investment, with low toll reliance and with either (a) high technical complexity or (b) high regional industrial activity, lead to Project Overrun. The presence of all four conditions in at least one of the pathways illustrates the relevance of the selected conditions. Individual behavior of three of the four conditions, based on both the solutions collectively, strengthens some of the initial perspectives: (a) Complexity of the project adversely affects the cost and schedule of the project; (b) a highly leveraged project has less oversight by project sponsors, which results in cost and schedule overrun; and (c) projects with less dependency on "revenue from tolls" tend to produce project overruns. The behavior of the condition "industrial output" is contrary to initial expectations that affirms with better industrial settings should provide a better environment for road development, leading to fewer project overruns.

8 The default algorithm for minimization used by fsQCA software is the Quine-McCluskey algorithm.

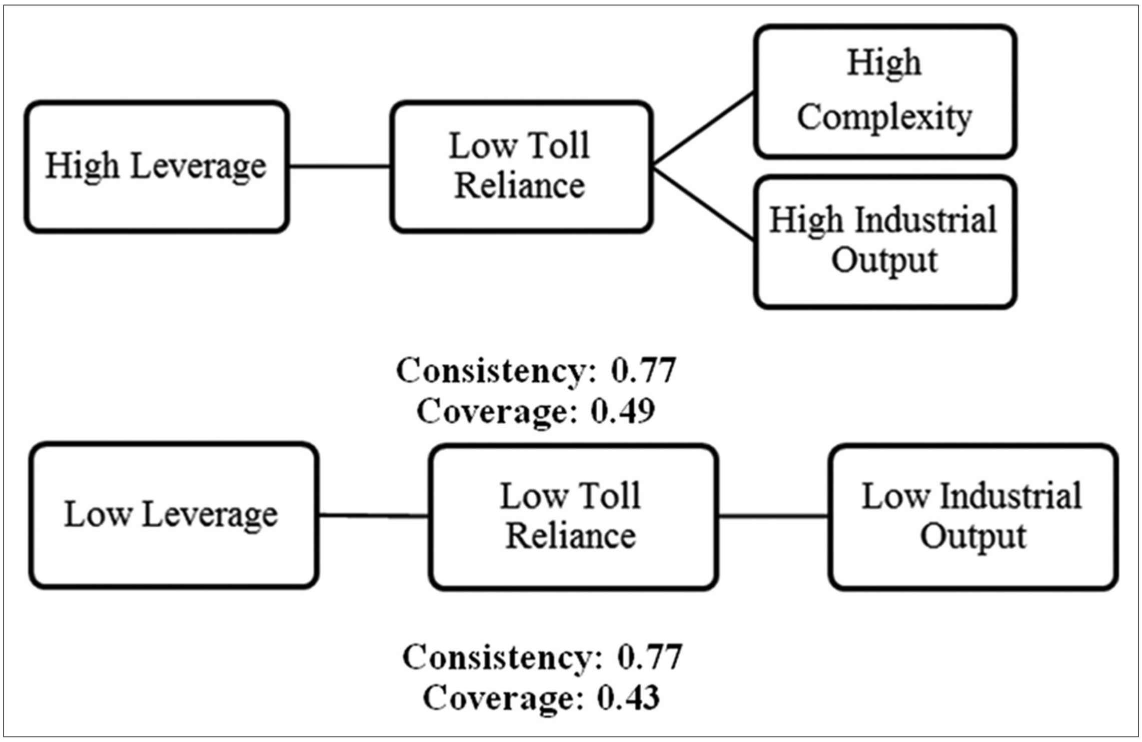

Figure 1. Pathways for Project Overruns and Project Success. (a) Pathways to project overruns (b) Pathway to project success.

6.1.1. Relation between industrial output and institutional complexity

The behavior of the industrial output condition is investigated further. Figure 2 compares the values of adjusted SDP (the selected metric for Industrial Output) with Property Rights Index (PRI) (Debroy *et al.*, 2011) for the year 2005,[9] (considered as a proxy for Institutional Complexity), for 20 states.[10] Figure 2 suggests that adjusted SDP is directly proportional to PRI. This proportionality is even greater if the states where project cases occurred are considered. For instance: (a) Tamil Nadu - TN (6 cases) has both high adjusted SDP and high PRI; (b) Andhra Pradesh - AP (4 cases), Karnataka - KA (2 cases), Chhattisgarh - CG (2 cases), and Rajasthan - RJ (1 case) have both adjusted SDP and PRI in the intermediate range; and (c) Uttar Pradesh - UP (1 case) and West Bengal - WB (1 case) have both adjusted SDP and PRI in the low range. Only major exceptions are seen in the states of Maharashtra - MH and Gujarat - GJ which have one project case each. Hence, states having increased industrial activity are conceivably also the ones which have better individual property protections, which could make land acquisition more difficult in those states; this likely could lead to project delays. Thus, the condition "Industrial Output" is behaving like a substitute for "institutional complexity" whose increment is perhaps adversely affecting the project and leading to project overruns.

6.1.2. Interaction between leverage and toll reliance

The presence of the conditions, high leverage and low toll reliance, in both the pathways illustrates the configurational behavior of the conditions and clarifies their interaction. Equity invested by project sponsors is dependent on expected returns, which is related to the source of those returns and how early those returns accrue; hence, the Toll Reliance condition is capturing this interaction. Interactive

9 As most of the project cases spanned much close to 2005, so this year values were taken for comparison
10 Property Rights Index was available for only 20 states

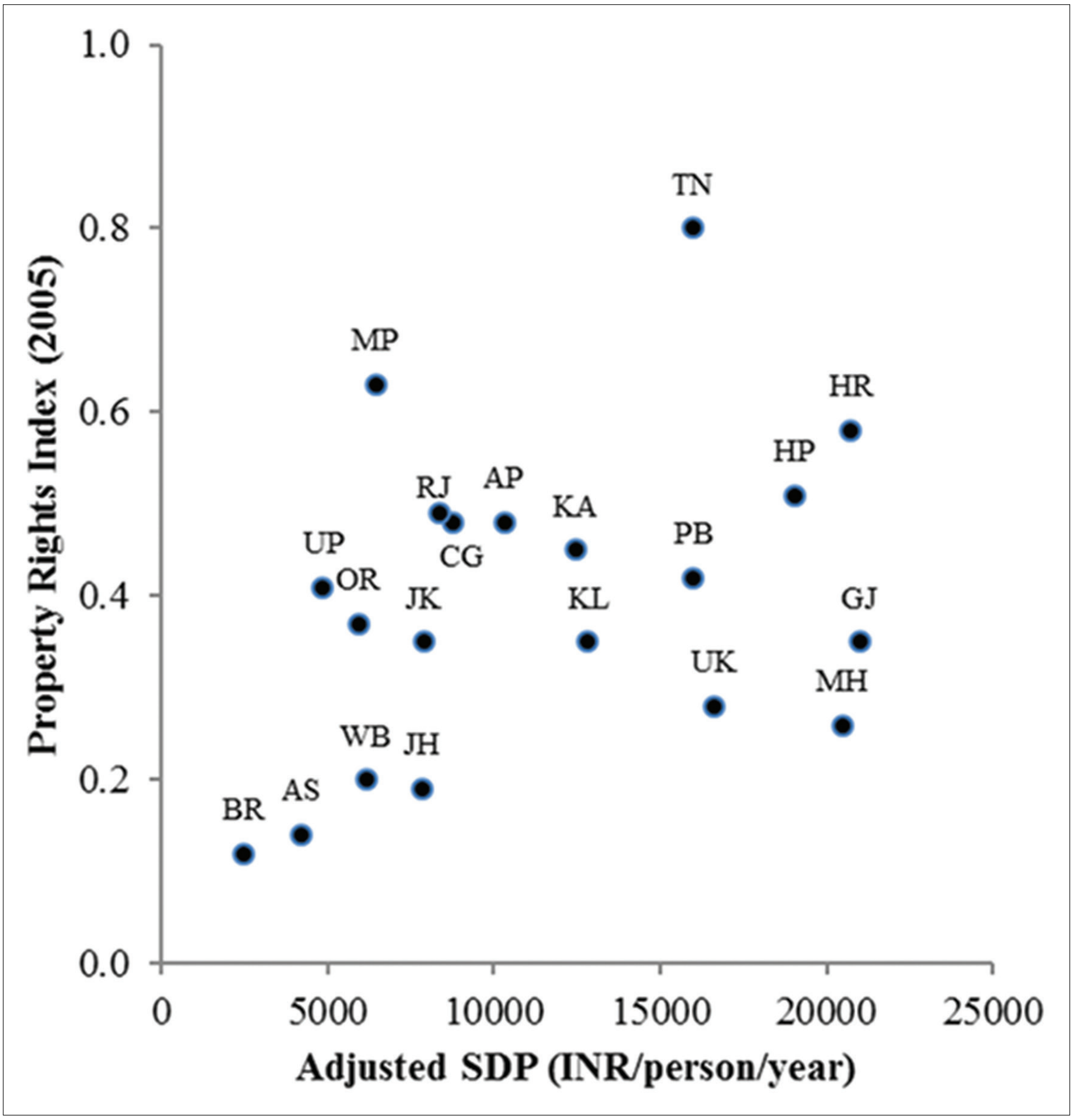

Figure 2. Comparison of property rights index and adjusted state domestic product.

behavior of this sort strengthens the basis of using a set theoretic or configurational approach to investigate project delivery performance of PPPs.

Plots are developed between memberships in each pathway with membership in the fuzzy set of Project Overrun to assess consistency and coverage of the solution. As seen from Figure 3a for Pathway 1, two cases in the lower triangle (AT04 and MBR04) impact this configuration and lower the consistency to 0.81. In AT04, the developer could receive a bonus payment for earlier completion and also could incur a penalty for delays (Ministry of Finance, 2010). This explains the inconsistent nature of this case. Similarly, from Figure 3b for Pathway 2, TT04 was considerably inconsistent. Closer examination of the case revealed that of 93 km of project length, only 53 km was widened from the 2-lane to 4-lane carriageway, while 39 km was improving the existing 4-lanes (ICRA Limited, 2012).

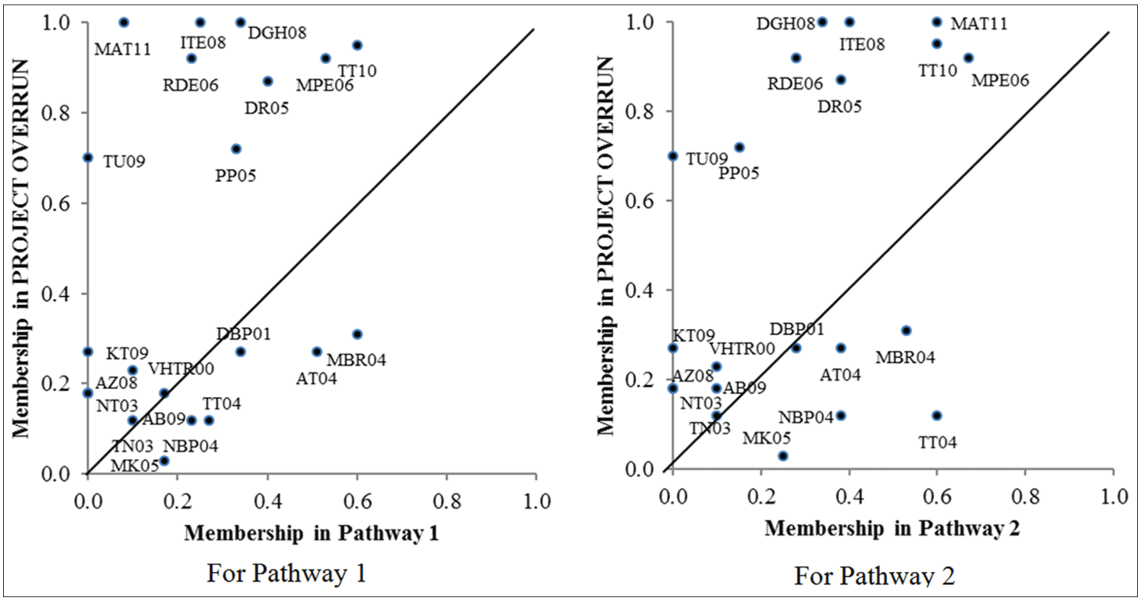

Figure 3. Project overrun versus membership plots. (a) For Pathway 1. (b) For Pathway 2.

6.2. Pathways to project success

Analysis yielded one pathway for Project Success as shown in Figure 1b. Consistency level is >0.75, and overall solution coverage is 0.43.

Three of the four conditions are found in the pathway. Two conditions behave diametrically with their behavior in the Project Overrun pathways; this is anticipated since Project Success is essentially a reverse of Project Overrun: (a) A low leveraged project generally has more oversight by the project sponsors which tends to produce project delivery success in those cases; and (b) a low industrial output is indicative of low institutional complexity (as explained in previously) which promotes successful project delivery. The appearance of low Toll Reliance in the pathway, however, contradicts the notion that less dependency on "revenue from tolls" will tend to generate project overruns. Consequently, the consistency and coverage levels of a proposed pathway that removed low Toll Reliance from the solution, Low Leverage *Low Industrial Output against Project Success were determined as 0.78 and 0.55, respectively, which is higher than the consistency level (0.77) and coverage level (0.43) of the obtained solution. These observations were further scrutinized to understand the driving force behind these results. To illustrate this, two XY plots were developed - (a) obtained pathway (low leverage × low toll reliance × low industrial output): Redesignated as OLD pathway versus Project Success (Figure 4a) and (b) proposed pathway (low leverage × low industrial output): Designated as New pathway versus project success (Figure 4b).

Six of 21 cases (labeled with Case ID) alter the consistency level when low Toll Reliance, which is the driving force in those cases, is eliminated in the New pathway. Based on the consistency computation methodology (Ragin, 2008), only one case RDE06, which lies in the inconsistent region in both pathways, is decreasing the consistency level while the other five are increasing it in the New pathway. In addition, RDE06 and DBP01 (Table 3) have equal degrees of membership in all three conditions but have a considerably different degree of membership in the Project Success outcome. Thus, RDE06 is a contradictory case that impacts the consistency of the results in the New pathway. Hence, if RDE06 is removed, then the consistency level in New pathway will be

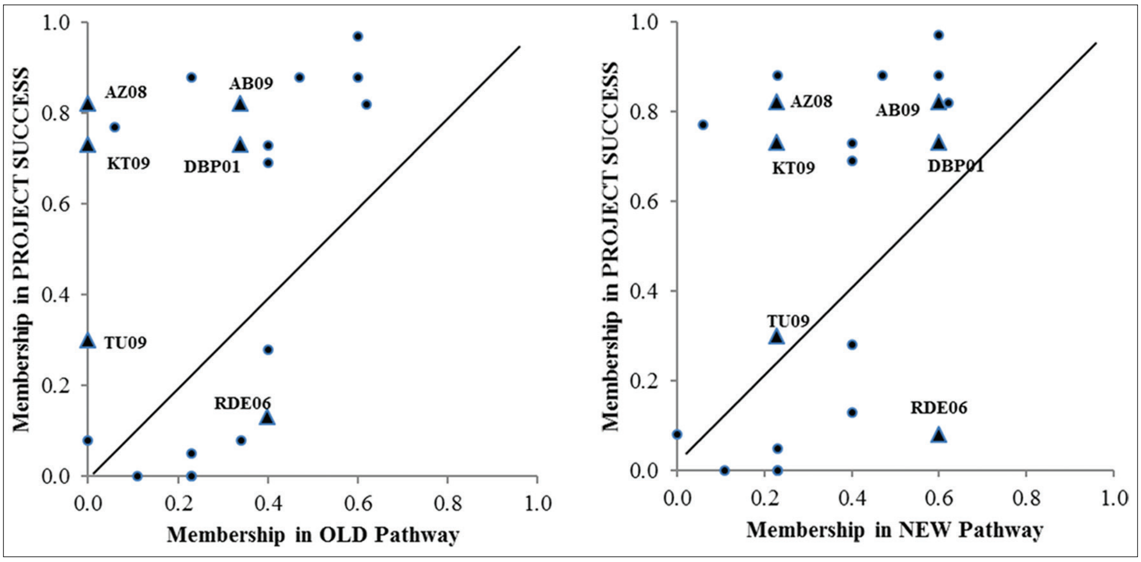

Figure 4. Project Success comparisons. (a) Project success versus OLD pathway. (b) Project success versus new pathway.

considerably higher than OLD pathway. Based on these observations and the argument that the configurational behavior of solutions suggests that conditions combine to reduce inconsistency, an argument could be made to drop low Toll Reliance from the solution pathway.

The behavior of this condition challenges the conceived theoretical relationship of Project Success with Toll Reliance. Annuity projects that have no Toll Reliance were argued to have limited added incentives to manage cost and time effectively unlike toll projects where accelerated schedules provide revenues sooner and opportunities for refinancing increase considerably once revenue stabilizes. Nonetheless, annuity projects can have other incentives, such as milestone payments made at different points in the construction phase to encourage project delivery success that could affect the outcome Project Success. In addition, conceptualizing the behavior of subsidy-driven toll projects, which typically experience low expected revenues, with Project Success was not straightforward. The calibration methodology assumes that it is more out than in the set of Toll Reliance (membership - 0.33). This is arguable since the applied calibration methodology places such projects in the same place as annuity projects (membership - 0); however, quantifying the gap of these two types of projects (annuity and subsidy-driven toll) in terms of Toll Reliance with Project Success was clearly challenging. Aspects of the complicated behavior of this condition were also seen in the solution of Project Overrun where low Toll Reliance was not present in the parsimonious solution, which opens the possibility of counterfactuals behaving in a manner (if they existed) that could nullify the presence of low Toll Reliance in the solution of Project Overrun.

7. Conclusion

To identify parameters that are conditions for project delivery performance in road PPPs in India, fuzzy set QCA was introduced which combines good practices of qualitative and quantitative research and uses a set-theoretic approach to investigate factors influencing cost and schedule performance of PPP projects. Using publicly available information on 21 operational road PPP projects in India, pathways were identified to explain the occurrence of project delivery success or failure of road PPP projects in India; however, the coverage values indicate that they are not extremely strong. The strength of the findings is hindered by the lack of access to information on additional parameters that could be used to develop conditions that are configurationally as important as the ones that are presently used. For instance, if the information on a number of bidders was available for a greater number of cases, then this condition could be included in the analysis. Similarly, a specific parameter that could depict the institutional setting of the project was not readily identifiable, which is likely an important parameter considering that land acquisition and environmental clearances are major factors identified in qualitative research on this subject. Thus, future work could search for additional data on relevant conditions which could further differentiate the cases from one another and/or enhance our substantive knowledge of the cases. However, the addition of conditions usually requires a greater number of cases for analysis to avoid the generation of complex solutions that are difficult to interpret. Regardless, the investigation presented has indicated combinations of conditions that lead to PPP project delivery success or failure, which further enhances knowledge regarding the performance of these increasingly utilized but quite complex arrangements for the provision of infrastructure assets and services.

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