

EVALUATION OF PERFORMANCE IN PPP/PUBLIC ROAD PROJECTS

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ABSTRACT. PPP has become the preferred way for execution of Infrastructure projects. The main reasons for partnerships between public and private are the risk sharing and higher capacity to finance and lower costs of operation of construction projects and time than the government projects. However, some of the public-private partnership (PPP) projects has been lacking the targeted performance level. This problems can lead to termination of the agreement causing unexpected costs. For this reason, number of research papers has been studied and various performance measurement indices have been studied. The need for successful completion of public-private partnership (PPP) projects the performance management has become more important. There is requirement for further more competent and effective public-private partnership (PPP) projects creates performance management of increasing importance. Performance of existing PPP road project evaluated using various performance indices. The performance indices represent competency in terms of time, billing, cost, profitability, effectiveness of planning, business efficiency, quality and revenue growth. The case study I show that the total performance of the project is so very poor, in spite of delivering outstanding performance for quality. The case study II show the overall performance poor as the revenue collection has been started from last 5 months hence, there are chances to improve the performance of project. The results of proposed study can be useful in framing the performance model.

Keywords: PPP (public private partnership), Performance, revenue collection.

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INTRODUCTION

Public-private partnerships (PPPs) are attaining the popularity in developing countries. Major challenge is financial crisis for implementing of PPPs [1]. However, with respect to their value of money PPPs are a desirable option for public projects. In performance measurement the Key Performance Indicators (KPIs) are the most important elements, viewed as efficient way to help PPPs deliver monetary value [2].

Performance measurement is an essential part of management and thus may have been practiced since many years. Industrial performance measurement in construction has normally depends on efficiency, returns, and profitability [3], in terms of progress i.e. work completion within time[4].The performance indices are used as a tool to measure PPP project performance for identifying the strengths and weaknesses of PPP construction projects. Evaluating the performance of PPP projects using various indices is not so easy because a PPP projects are completed as a result of a lots of combinations as events and interactions over its entire life cycle [5].

The performance of PPP projects can be affected by no. of factors and their effects during various projects phases [6].As projects become more complex and project management is difficult, performance measurement must extend from project-control measures as cost and schedule to other major aspects of project such as quality, cash flow, client satisfaction, safety, project team satisfaction, and profitability [7].Performance measurement are useful to define the type of performance to improve the efficiency and the mathematical model evaluates cross-impact analysis and coincidental inference to capture the uncertainties [8]. There has been increasing interest of policy builders and researchers for directing competency bottlenecks at urban PPP projects. However, there is a lack of study on the availability of competencies[9].The performance measurement systems is divided into three main phases are: (1) performance measures design (2) the implementation (3) the use performance measures[10].

METHODOLOGY

A useful framework for construction project performance measurement is required to guide the practitioners to evaluate the performance of all types of PPP construction projects. The index is depends on the measurement of project objectives, quality, profitability, safety, project team satisfaction, cost, schedule, billing or cash flow and client satisfaction, effectiveness of planning, business efficiency, revenue growth. A methodology that evaluate performance of the all competencies of a project in order to evaluate the overall performance that quantifies separately the performance of all project in order to measure the overall performance[11].

The existing study integrates the all project performance indices into one equation by assigning a priority or weight to each criteria. The study has been conducted for PPP road projects.

PROJECT PERFORMANCE INDICES

Generally cost, Time, quality are the main objectives considered as the most critical to the successful completion of construction projects. The proposed study explains eight

performance indices to measure the PPP construction performance index. The use of the eight indices to analyse the success of projects derived from the literature review. The performance indices represent efficiency in terms of quality, cost, time, billing or cash flow, profitability, effectiveness of planning, business efficiency and revenue growth [11]

Cost Performance Index (CPI)

The Cost Performance Index (CPI) measures the cost efficiency of the project. The CPI is determined using earned value and actual costs incurred. Any value of $CPI < 1$ indicates that costs are overrun.

$$CPI = BCWP/ACWP$$

Where,

BCWP = Budgeted Cost of Work Performed. It is the budgeted amount of cost for work-completed to-date or the cost allowed (based on budget) to be spent for the actual work done.

ACWP = Actual Cost of Work Performed. It is the cost incurred to complete the accomplished work to-date.

Table 1 Cost Performance Index Rating [11]

| CONDITION | RATING | INDEX RANGE |
|-----------|-------------------------|----------------------|
| A | Outstanding performance | $I > 1.15$ |
| B | Exceeds Target | $1.05 < I \leq 1.15$ |
| C | Within Target | $0.95 < I \leq 1.05$ |
| D | Below Target | $0.85 < I \leq 0.95$ |
| E | Poor Performance | $I \leq 0.85$ |

Schedule Performance Index (SPI)

The Schedule Performance Index (SPI) measures the schedule efficiency of the project, the SPI is determined by dividing the earned value by the scheduled value. Any value of $SPI < 1$ indicates that we are running behind schedule.

$$SPI = BCWP/BCWS$$

Where,

BCWP = Budgeted Cost of Work Performed. It is the budgeted amount of cost for work completed to date.

BCWS = Budgeted Cost of Work Scheduled. It is the budgeted amount of cost for work scheduled to date.

Table 2 Schedule Performance Index Rating [11]

| CONDITION | RATING | INDEX RANGE |
|-----------|-------------------------|----------------------|
| A | Outstanding performance | $I > 1.15$ |
| B | Exceeds Target | $1.05 < I \leq 1.15$ |
| C | Within Target | $0.95 < I \leq 1.05$ |
| D | Below Target | $0.85 < I \leq 0.95$ |
| E | Poor Performance | $I \leq 0.85$ |

Billing Performance Index (BPI)

Billing Performance Index (BPI) measures the efficiency of invoicing the Client for the earned work.

A BPI value of 1.0 is desired because it means that the amount billed by the contractor covers all the work earned and the project is therefore efficient in billing the client.

$$BPI = BRWP/ERWP$$

Where,

BRWP = Billed Revenue of Work Performed, or the cumulative amount of invoices.

ERWP = Earned Revenue of Work Performed, or the revenue earned for the actual work accomplished to date.

Table 3 Billing Performance Index Rating [11]

| CONDITION | RATING | INDEX RANGE | BPI RANGE |
|-----------|-------------------------|----------------------|------------------------|
| A | Outstanding performance | $I > 1.15$ | $BPI > 0.98$ |
| B | Exceeds Target | $1.05 < I \leq 1.15$ | $0.95 < BPI \leq 0.98$ |
| C | Within Target | $0.95 < I \leq 1.05$ | $0.90 < BPI \leq 0.95$ |
| D | Below Target | $0.85 < I \leq 0.95$ | $0.85 < BPI \leq 0.90$ |
| E | Poor Performance | $I \leq 0.85$ | $BPI \leq 0.85$ |

Profitability Performance Index (PPI)

The Profitability Performance Index (PPI) is to measure the profitable on date. A PPI value greater than 1.0 is desired because it means that the revenue earned for the amount of work completed to date is greater than the cost incurred for that same work and the project is therefore profitable.

$$PPI = ERWP/ACWP$$

Where, ERWP = Earned Revenue of Work Performed, or the revenue earned for the actual work accomplished.
 ACWP = Actual Cost of Work Performed. It is the cost incurred to complete the accomplished work.

Table 4 Profitability performance Index Rating [11]

| CONDITION | RATING | INDEX RANGE | PPI RANGE |
|-----------|-------------------------|----------------------|------------------------|
| A | Outstanding performance | $I > 1.15$ | $PPI > 1.3$ |
| B | Exceeds Target | $1.05 < I \leq 1.15$ | $1.2 < PPI \leq 1.3$ |
| C | Within Target | $0.95 < I \leq 1.05$ | $1.05 < PPI \leq 1.2$ |
| D | Below Target | $0.85 < I \leq 0.95$ | $0.90 < PPI \leq 1.05$ |
| E | Poor Performance | $I \leq 0.85$ | $PPI \leq 0.90$ |

Quality Performance Index (QPI)

The Quality Performance Index (QPI) is to check the Project Standards and Procedures as well as acquiesce of the delivered product with the project specifications.

$$QPI = CFRI = \text{Construction Field Rework Index}$$

$CFRI = \text{Total direct and indirect cost of rework performed in the field} \div \text{Total field construction phase cost}$

Table 5 Quality performance Index Rating [11]

| CONDITION | RATING | INDEX RANGE | PPI RANGE |
|-----------|-------------------------|----------------------|---------------------|
| A | Outstanding performance | $I > 1.15$ | $CFRI \leq 0.5$ |
| B | Exceeds Target | $1.05 < I \leq 1.15$ | $0.5 < CFRI \leq 1$ |
| C | Within Target | $0.95 < I \leq 1.05$ | $1 < CFRI \leq 2$ |
| D | Below Target | $0.85 < I \leq 0.95$ | $2 < CFRI \leq 4$ |
| E | Poor Performance | $I \leq 0.85$ | $CFRI > 4$ |

Effectiveness of planning index

The effectiveness of planning index is a measure of consistency in planning and managing the project. It also shows how effective is the planning for project.

$$\text{Index} = (\text{Actual cost} - \text{Anticipated cost}) \div \text{Anticipated cost}$$

Table 6 Effectiveness of Planning Performance Index Rating [11]

| CONDITION | RATING | INDEX RANGE |
|-----------|-------------------------|----------------------|
| A | Outstanding performance | $I > 1.15$ |
| B | Exceeds Target | $1.05 < I \leq 1.15$ |
| C | Within Target | $0.95 < I \leq 1.05$ |
| D | Below Target | $0.85 < I \leq 0.95$ |
| E | Poor Performance | $I \leq 0.85$ |

Business efficiency index

Business efficiency index measures the efficiency of business and of any construction project. It shows how efficient project is, and extent to which a project can deliver the profit.

$$\begin{aligned} \text{Efficiency ratio} &= \text{expenses/revenue} \\ \text{OR} \\ \text{Efficiency} &= (\text{output} \div \text{input}) \times 100 \end{aligned}$$

Growth rate index

The growth rate index gives the revenue growth of the project. It is also a measure of consistency in revenue generation for the particular project.

$$\begin{aligned} \text{Growth rate} &= \text{revenue growth} \\ \text{OR} \\ \text{Growth rate} &= \text{volume of works growth rate} \end{aligned}$$

DATA COLLECTION

Case Study 1

A case study is selected for performing evaluation of performance in PPP/Public road projects. Project selected is 4/6 laning in Pimpalgaon – Nashik – Gonde section of NH-3 in the state of Maharashtra. Data were collected from the National Highways Authority of India (Nashik division).

Project details

Name of project: 4/6 -Laning from km 380.00 to km 440.00 in Pimpalgaon-Nashik-Gonde section of NH-3 in the state of Maharashtra implemented by NHAI under NHDP-III on DBFOT basis. The subject project was awarded to L&T and Ashoka buildcon.

Table 7 Details of case study-I

| PARTICULARS | DETAILS |
|---|---|
| Project length | 60 km |
| Client | National highways authority of India, New Delhi. |
| BOT concessionaires | PNG tollway ltd., Chennai (Terminated w.e.f. 29.03.2016) |
| Date of signing of concession agreement | 8th July 2009 |
| Commencement date | 4th Jan 2010 |
| Scheduled date of completion | 2nd July 2012 |
| Likely date of completion | April, 2019 |
| Toll collection started | 2nd Oct 2012 |
| Concession period | 20 years |
| Construction period | 30 months |
| Total budgeted cost of project | 940 crores |
| Actual cost of project | 1691 crores |
| Total completed length | 57.321 km |

Data collected

Table 8 Financial details of case study-I

| PARTICULARS | AMOUNT (Rs.) |
|--|---------------|
| Budgeted cost of work performed | 873,75,00,000 |
| Budgeted cost of work scheduled | 940,00,00,000 |
| Total direct and indirect cost of rework performed | 404,93,77,413 |
| Expected toll collection (for 42 months) | 379,24,36,893 |
| Actual toll collected at the end of 42 months | 235,19,54,442 |
| Billed revenue (for 42 months) | 144,04,82,451 |
| Earned revenue (for 42 months) | 235,19,54,442 |
| Total revenue collected (for year 2014) | 72,36,63,255 |
| Total revenue collected (for year 2015) | 92,16,60,712 |

Case study 2

A case study is selected for performing evaluation of performance in PPP/Public road projects. Project selected is Sinnar to Nashik section of NH-50 from km 177 to km 201 to 4 – lane on ppp following DBFOT in the state of Maharashtra. Data is to collected from the Public Works Department (Nashik division).

Data collected

Table 9 Financial details of case study-II

| PARTICULARS | AMOUNT (Rs.) |
|--|----------------|
| Budgeted cost of work performed | 352,00,00,000 |
| Budgeted cost of work scheduled | 355,00,00,000 |
| Actual cost of work performed | 339,00,00,000 |
| Total direct and indirect cost of rework performed | 34,62,15,000 |
| Expected toll collection (for 5 months) | 9,03,93,518.52 |
| Actual toll collected at the end of 5 months | 8,94,04,464 |
| Billed revenue (for 5 months) | 8,74,00,000 |
| Earned revenue (for 5 months) | 8,94,04,464 |
| Total revenue collected (for year 2017) | 3,42,79,909 |
| Total revenue collected (for year 2018) | 5,51,24,555 |
| Actual time for work performed | 37 months |
| Anticipated time for work performed | 24 months |

Questionnaire survey

A systematic approach has been taken to analyze the weightage for the performance indices. A questionnaire is prepared with 5 point likert scale for all 8 performance indicators. The respondents were asked to rank these performance indicators.

DATA ANALYSIS

The data collected were used to find performance index. The values were added into the formula for each index. By using the analytical hierarchy process the weightage for each index is calculated. The quantified value of each index is multiplied with its weightage and by adding all normalized values the overall performance index of project is obtained.

Analysis for case study I

1. Cost performance index

$$\begin{aligned} \text{CPI} &= \text{BCWP}/\text{ACWP} \\ \text{CPI} &= 873,75,00,000/1691,00,00,000 \\ &= 0.516 < 1 \dots\dots\dots (\text{Cost overruns}) \end{aligned}$$

2. Schedule performance index

$$\begin{aligned} \text{SPI} &= \text{BCWP}/\text{BCWS} \\ &= 873,75,00,000/940,00,00,000 \\ \text{SPI} &= 0.929 < 1 \dots\dots\dots (\text{Running behind the schedule}) \end{aligned}$$

3. Billing performance index

$$\begin{aligned} \text{BPI} &= \text{BRWP}/\text{ERWP} \\ \text{BPI} &= 144,04,82,451/235,19,54,442 \end{aligned}$$

$$= 0.612$$

4. Profitability performance index

$$PPI = ERWP/ACWP$$

$$PPI = 235,19,54,442/1691,00,00,000$$

$$= 0.139$$

5. Quality performance index

$$QPI = \text{Construction field rework index (CFRI)}$$

CFRI = Total direct and indirect cost of rework performed in the field ÷ Total field construction phase cost

$$QPI = 404,93,77,413/1691,00,00,000$$

$$= 0.239 < 0.5$$

6. Effectiveness of planning index

$$\text{Index} = (\text{Actual cost} - \text{Anticipated cost}) \div \text{Anticipated cost}$$

$$= (1691,00,00,000 - 940,00,00,000) \div 940,00,00,000$$

$$= 0.798$$

7. Business efficiency index

$$\text{Efficiency} = (\text{output} \div \text{input}) \times 100$$

$$= (1691,00,00,000 \div 235,19,54,442) \times 100$$

$$= 13.90 \%$$

$$= 0.139$$

8. Growth rate index

Growth rate = revenue growth

$$\text{Index} = 19,79,97,457/72,36,63,255$$

$$= 0.27$$

Total revenue growth of 27.36% from last year

Table 10 Calculations of weightage factor

| PERFORMANCE INDICATORS | RATING | | | | | TOTAL | WEIGHTAGE FACTOR |
|---------------------------|--------|---|---|---|---|-------|------------------|
| | 1 | 2 | 3 | 4 | 5 | | |
| Cost | | | | 1 | 4 | 24 | 0.138 |
| Schedule | | | | 2 | 3 | 23 | 0.132 |
| Billing | | | | 3 | 2 | 22 | 0.126 |
| Profitability | | | 3 | | 2 | 19 | 0.109 |
| Quality | | | | 1 | 4 | 24 | 0.138 |
| Effectiveness of planning | | | | 3 | 2 | 22 | 0.126 |
| Business efficiency | | | 2 | 3 | | 18 | 0.103 |
| Revenue growth | | | | 3 | 2 | 22 | 0.126 |
| Total | | | | | | 174 | |

Overall performance index

$$\begin{aligned}\text{Performance index} &= 0.516 \times 0.138 + 0.929 \times 0.132 + 0.612 \times 0.126 + 0.139 \times 0.109 + \\ &0.239 \times 0.138 + 0.798 \times 0.126 + 0.139 \times 0.103 + 0.27 \times 0.126 \\ &= \mathbf{0.467}\end{aligned}$$

Analysis for case study II

1. Cost performance index

$$\begin{aligned}\text{CPI} &= \text{BCWP}/\text{ACWP} \\ \text{CPI} &= 352,00,00,000/339,00,00,000 \\ &= \mathbf{1.04} > \mathbf{1} \dots\dots\dots (\text{Within target})\end{aligned}$$

2. Schedule performance index

$$\begin{aligned}\text{SPI} &= \text{BCWP}/\text{BCWS} \\ &= 352,00,00,000/355,00,00,000 \\ \text{SPI} &= \mathbf{0.99} < \mathbf{1.05} \dots\dots\dots (\text{Within target})\end{aligned}$$

3. Billing performance index

$$\begin{aligned}\text{BPI} &= \text{BRWP}/\text{ERWP} \\ \text{BPI} &= 8,74,00,000/8,94,04,464 \\ &= \mathbf{0.977}\end{aligned}$$

4. Profitability performance index

$$\begin{aligned}\text{PPI} &= \text{ERWP}/\text{ACWP} \\ \text{PPI} &= 8,94,04,464/339,00,00,000 \\ &= \mathbf{0.026} < \mathbf{0.90} \dots\dots\dots (\text{poor performance})\end{aligned}$$

5. Quality performance index

$$\begin{aligned}\text{QPI} &= \text{Construction field rework index (CFRI)} \\ \text{CFRI} &= \text{Total direct and indirect cost of rework performed in the field} \div \text{Total field construction phase cost} \\ \text{QPI} &= 34,62,15,000/339,00,00,000 \\ &= \mathbf{0.102} < \mathbf{0.5} \dots\dots\dots (\text{outstanding performance})\end{aligned}$$

6. Effectiveness of planning index

$$\begin{aligned}\text{Index} &= (\text{Actual time} - \text{Anticipated time}) \div \text{Anticipated time (in months)} \\ &= (37 - 24) \div 24 \\ &= \mathbf{0.54} < \mathbf{0.85} \dots\dots\dots (\text{poor performance})\end{aligned}$$

7. Business efficiency index

$$\begin{aligned}\text{Efficiency} &= (\text{output} \div \text{input}) \times 100 \\ &= (8,94,04,464 \div 339,00,00,000) \times 100\end{aligned}$$

$$\begin{aligned} &= 2.60 \% \\ &= \mathbf{0.026} \end{aligned}$$

8. Growth rate index

$$\begin{aligned} \text{Growth rate} &= \text{revenue growth} \\ \text{Index} &= 2,08,44,646/3,42,79,909 \\ &= \mathbf{0.608} \end{aligned}$$

Total revenue growth of 60.8% from last year

Overall performance index

$$\begin{aligned} \text{Performance index} &= 1.04 \times 0.138 + 0.99 \times 0.132 + 0.977 \times 0.126 + 0.026 \times 0.109 + 0.102 \times 0.138 \\ &\quad + 0.54 \times 0.126 + 0.026 \times 0.103 + 0.608 \times 0.126 \\ &= \mathbf{0.565} \end{aligned}$$

RESULTS AND DISCUSSION

The cost, schedule, billing, profitability, effectiveness of planning, business efficiency, growth rate, quality performance index are quantified with the help of respective formulae as mentioned in above section. And by using these all performance index the overall performance of project is obtained. The normalization of all index can be done by using the index range which is mentioned in the section of methodology.

Results for case study I

- The value of CPI is **0.516** which is less than 1 shows that cost overruns, according to index range it satisfies the condition F which shows **poor performance**.
- The value of SPI is **0.929** which is less than 1 shows that project running behind the schedule, according to index range it satisfies the condition D which shows project schedule is **below target**.
- The value of BPI is **0.612** which is desired to be 1, according to index range it satisfies the condition F which shows **poor performance**.
- The value of PPI is **0.139** which is desired to be greater than 1 as the value is much lesser than 1 which indicates very bad profitability performance, according to index range it satisfies the condition F which shows **poor performance**.
- The value of QPI is **0.239** which is less than 0.5 shows that minimum rework is performed at field, according to index range it satisfies the condition A which shows **outstanding performance**.
- The value of effectiveness of planning index is **0.798**, according to index range it satisfies the condition F which shows **poor performance**.
- The value of business efficiency index is **0.139**, according to index range it satisfies the condition F which shows **poor performance**.
- The value of growth rate index is **0.27**, according to index range it satisfies the condition F which shows **poor performance**.

- The value of overall performance index is **0.467**, according to index range it satisfies the condition F which shows **poor performance**. It indicates that the total performance of the PNG tollway is poor.

Results for case study II

- The value of CPI is **1.04** which is greater than 1 shows that cost is within target, according to index range it satisfies the condition C which shows **Good performance**.
- The value of SPI is **0.99** which shows that project is running as per the schedule, according to index range it satisfies the condition C which shows project schedule is **Within target**.
- The value of BPI is **0.97** which is desired to be 1, according to index range it satisfies the condition B which shows **that the project exceeds target**.
- The value of PPI is **0.026** which is desired to be greater than 1 as the value is much lesser than 1 which indicates very bad profitability performance, according to index range it satisfies the condition F which shows **poor performance**.
- The value of QPI is **0.102** which is less than 0.5 shows that minimum rework is performed at field, according to index range it satisfies the condition A which shows **outstanding performance**.
- The value of effectiveness of planning index is **0.54**, according to index range it satisfies the condition F which shows **poor performance**.
- The value of business efficiency index is **0.026**, according to index range it satisfies the condition F which shows **poor performance**.
- The value of growth rate index is **0.608**, according to index range it satisfies the condition F which shows **poor performance**.
- The value of overall performance index is **0.565**, according to index range it satisfies the condition F which shows **poor performance**. It indicates that the total performance of the Nashik-Sinnar tollway is poor.

CONCLUSION

The Indian government has taken various initiatives to improve the condition of the National Highways as consented PPP for the development of road networks. The Public Private Partnerships (PPPs) have come out as a very feasible, viable, and growing mode for development of infrastructure for our country. However several problems and challenges have been incorporated in PPP model development. Henceforth to create more efficient and effective public-private partnership (PPP) projects makes performance evaluation most important.

The major objective of this study was to evaluate the performance of the PPP/Public project by measuring the key performance index. The **case study I** shows that the total performance of the project is very poor, in spite of delivering outstanding performance for quality. The **case study II** shows the overall performance poor as the revenue collection has been started

from last 5 months hence, there are chances to improve the performance of project. The results of proposed study can be useful in framing the performance model.

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