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Smart Maintenance and Management of Roads through Implementation of Outpurt and Performance-Based Road Contract (OPRC) System: A Caset Study of Gujarat Region

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***Abstract*—Reduced maintenance cost and timely improvement of road transportation is the need for road infrastructure preservation as improper road networks can lead the road towards the stage of expensive rehabilitation and reconstruction. The focus should be diverted from creating assets to maintaining the existing assets to reduce vehicle operating costs, fatal accident rates, and illiteracy in rural communities. Most of the traditional contracting methods are lacking in providing benefits for stakeholders, including employer, concessionaire, and road user. 'Output and Performance-Based Road Contract' (OPRC) is one of the new methods for the management of existing as well as new roads which can provide cost-effectively; significant and innovative maintenance service and help maintain roads as assets. The software is developed with the inclusion of a checklist and compliance criteria with World Bank document consideration to assess the overall road condition of the project road. This is first of its kind of pilot project taking place in Gujarat state, India. The service level criteria are bifurcated and defined based on technical and field data collected for contract and contract area. Based on the assessment of road, the overall road condition can be assessed in categories with the rating scales of very Poor (0-2) to very good (8-10). To make easy and convenient rating of road conditions; the ratings of the given scale is converted to adopted scale with the opinions of experts. The inspection authority must mark the checklist according to the road conditions observed. The average of the total score obtained through the assessment is calculated, and according to the score of rating value; the overall road condition can be determined with the help of an adopted scale and their prescribed category. If any noncompliance is found in existence, then the respective contractor must repair the defect in permitted response time. In failing to do so, he can be penalized according to the time of several days of noncompliance exceeding the response time. Road User Service- Comfort Performance Measurement and Road Durability Performance Measures (RDPM) are focused on developing this software which is be measured every six months. This paper presents the importance to adopt OPRC for maintaining roads as assets.**

***Keywords*— Performance Based Management, Road maintenance, Pavement, Deterioration, Criteria**

I. Introduction

Infrastructure for any nation is the complete system of power, telecom, ports, air terminals, streets, common flight, railroads, and transportation in a nation. As an irrefutable actuality, Infrastructure can be considered as the help of the economy of a nation and Its significance in the improvement of a nation can't be disregarded.

The need of maintenance is generally remembered, it is still not completing enough. Numerous countries spend extremely less of what they ought to spend on maintenance of roads. Also, this phenomenon is generally portrayed in developing countries who are concentrating on developing new infrastructure instead of keeping up the current ones [1]. Indian Road Congress (IRC) characterizes road maintenance as the normal assignment performed to safeguard the road pavement, shoulders and all the necessary facilities in their conditions they were built[2].

There is the need to consider the significance of road maintenance as a part of road asset managements. Asset Management is the way toward limiting the existence cycle cost of disintegrating road facilities by keeping up better assistance level criteria of roads to every one of the stakeholders and overseeing road condition as an asset.

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'Output and Performance-based Road Contracts' is another contracting technique for completing maintenance of existing just as new roads, and it fundamentally contrasts from other strategy based agreements that have been utilized to maintain the roads[3]. It has its primary spotlight on the performance reflected by the individual contractors [4].

II. Output and Performance-Based Road Contract (OPRC) System

A. Introduction to Method

In conventional method-based contracts, the road agency as a customer regularly indicates methods, innovations, materials, and amounts of materials to be utilized, together with the timespan during which the maintenance works ought to be executed. The installment to the contractor depends on the quantity of information sources (e.g., cubic meters of asphalt concrete, number of working hours)[5]. The fundamental contrast is that under OPRC a large portion of the installment to be made to the contractor depend on estimated "Output" mirroring the objective state of the roads under contractual agreements communicated through service levels. Another significant contrast is that the contractor is completely answerable for the design of works important to arrive at the necessary levels[1].

For example, the contractor isn't paid for the quantity of potholes he has fixed, however for the performance of his work: no pothole staying open (or 100% fixed). Inability to agree to the performance indicators or to promptly rectify revealed deficiencies unfavorably influences the contractor's installment through a progression of plainly characterized punishments. If there should arise an occurrence of consistence, the installment is routinely made, for the most part in equivalent regularly scheduled payments[6].

Table 1: Comparison of Methods

Conventional Approach	OPRC Approach
Fixing bad roads	Network Management
Landing projects	Sector project financing
Engineering Road View	Service level view
Payment based unit pricing	Payment based on performance reflected
Timeline: (1) Completion of work, (2) Payment, (3) End of project	Service level provision over long period of time

OPRC structure can be of following kinds: Simple or Pure OPRC, Hybrid OPRC [1]. Here, Hybrid OPRC joins the highlights of both technique and Performance based contracts, a few services are paid on a unit rate premise while others are connected to meeting (Service Level Criteria) Performance Indicators [7]. OPRC may cover either only individual assets i.e. traffic signs, bridges etc., or all road assets within the road corridor. Its complexity can be from simple to comprehensive [7].

B. Level of Service: Significance

Under these road contracts, the existing road would be maintained on the basis of customer based Performance Indicators (Service Level Criteria), which allocates higher risks to contract agreements, but at the same time opens up the opportunities to increase his margin where improved efficiency and effectiveness of design, process, technology or management are able to reduce the cost of achieving the Specific Performance Standards [8].

'Service level' define the desired road performance standards mainly from road users' perspective. They are the operational conditions of roads. Whereas, 'Performance Criteria' should cover all aspects of contract [4]. Service level criteria should be defined on the basis of affordability and economically justifications [1]. The performance indicators must ideally cover all aspects of contracts, they should be clearly defined and measurable [7]

C. Allocation and Mitigation of Risk

The risk is defined as the uncertainty of outcome, whether positive- It's an opportunity, If negative- It represents an impact [1]. It is essential to quantify all the risks involved. Risk allocation is the process of apportioning individual risks related to project and service delivery to the party best placed to manage the risk where; project-related risks to the private sector and non-project related risks to the public sector [9].

D. Study Area and Data Collection

To assess the overall road condition of the proposed road stretch, the collection of data is one of the most important parts. With the help of all the technical data, it becomes easy to formulate the exact methodology require to be adopted for defining the service level criteria and its bifurcation and developing the checklist as well as a framework. Hence, with these objectives the technical data regarding the proposed OPRC road stretch is collected from Roads and Building Department, Government of Gujarat and LEA Associates South Asia Pvt Ltd (LASA). And based on that, the further research methodology is carried out.

This contract is for Output and Performance-based Road Contract (OPRC) for Improvement, Rehabilitation, Resurfacing & Network Performance (Routine Maintenance including maintenance management works) of the following corridors:
a) Dhandhuka - Dholera: 27+000 Km (Km 0+000 to Km 27+000), b) Dhandhuka – Paliyad: 46+246 Km (Km 104+772 to Km 151+018), c) Limbdi – Dhandhuka: 29+967 Km (Km 65+814 to Km 95+781).

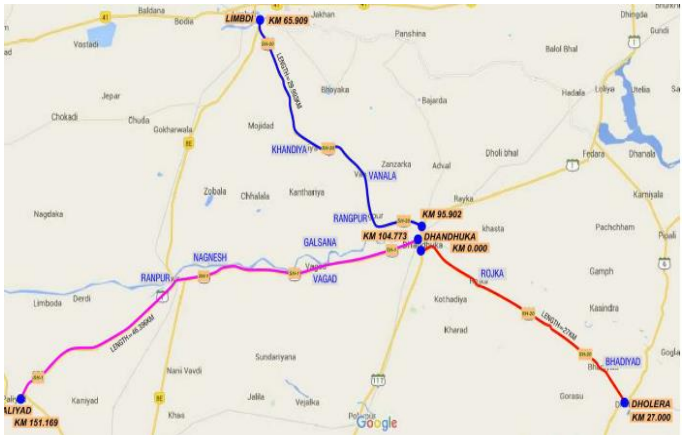

Fig. 1: Project Area

The area under contract falls in the jurisdiction of the Ahmedabad, Botad and Surendranagar districts of the State of Gujarat (India).

E. Analysis and Interpretation of Data

The data regarding Contract, Contract Area, Design Chainage to Existing Chainage, Traffic Volume Count, Junction Details, Design Speed, Bus Shelter, Roadside Drainage, Crash Barriers, Cattle Crossing Zones, Utility Duct and Solar Powered Blinkers are collected from Roads and Building Department and LEA Associates South Asia Pvt Ltd (LASA).

Along with all these technical data, the design data including Overall Site Information, Pavement Condition of Project Area, Typical Cross-Sections are also obtained. With collected data, the observational information from site visits and after reviewing Standard Procurement Document (World Bank Document), the service level criteria are bifurcated and defined.

These Service Level Criteria are defined on the basis of three main categories which are as follows:

- Usability of Road
- Serviceability and Comfortability for Road Service and;
- Road Durability

Output and Performance Based Road Contracts (OPRC) mainly focus over the performance reflected by the contractor at the end of given time interval. And this performance is measured at the time interval mentioned in the contracting document. Normally, this measurement of performance is done by the employer personnel or person hired by the Employer authority. As there may be the case that the inspection to be carried out by the third party. It is not necessary that the person who is going to inspect the work carried out by the contractor is technically sound, So, the need of preparing such kind of checklist is required which can provide easy and convenient to the person carrying out the inspection.

To resolve this issue, one checklist has been prepared in Excel through which the overall assessment of project road can be carried out easily. The performance will be measured by government officials at the defined time interval and if any non-compliance is found in existence then the respective contractor should repair the defect in permitted response time. If the contractor fails to comply with such requirement in given time, he will be penalized according to the time of a number of days of noncompliance exceeding the response time. Based on the assessment of road, the overall road condition will be assessed in categories with the rating scales of Very Poor (0-2), Poor (2-4), Average (4-6), Good (6-8) and Very Good (8-10). Here, to make the rating of road conditions easy and convenient for the inspection authority; the rating of the given scale is converted to Adopted Scale (Midpoint of given slab) with the views and opinions of experts. The inspection authority just has to mark the checklist according to the observation of road condition. With the i.e., for Very Poor Condition: Scale 0-2 will be marked as 1 (Mid-Point of Slab 0-2) by the road inspection authority.

Following table shows the Rating Scale, Adopted Scale and Defined Service Level Criteria for road condition assessment to be carried out by inspection authority.

Table 2 : Developed Software Ratings

Category	Rating Scale	Adopted Scale
Very Poor	0.0-2.0	1
Poor	2.1-4.0	3
Average	4.1-6.0	5
Good	6.1-8.0	7
Very Good	8.1-10.0	9

Once the inspection authority is commanded to visit and assess the particular stretch of Output and Performance Based Road Contract (OPRC), the overall assessment of the road condition can be easily evaluated. To calculate the overall road condition, the average of the total score obtained through the assessment is calculated. And according to the score of rating value, the overall road condition can be determined with the help of an adopted scale and their prescribed category. i.e., If the overall value obtained after the average calculation of total rating is 6.5, then that overall condition of that particular stretch is Good. The various color code given to the categorical rating scales are narrated in Table 3.

Table 3: Color Codes according to Road Category

Category	Rating Scale
Very Poor	Dark Red
Poor	Gold
Average	Bright Yellow
Good	Lime
Very Good	Green

III. Conclusion

Another objective of this research was to formulate and develop a strategic framework model for Output and Performance Based Road Contract (OPRC). The developed model is for Road User Service and Comfort Performance Measurement and Road

Durability Performance Measures (RDPM) which is be measured every six months. This model is developed with the help of Excel with certain formulas and it incorporates elements like Target compliance for project road, Actual compliance from the work performed by contractor, Non-compliant length, Weightage for various service level criteria according to their importance, Payment reduction length (in km), Permitted response time provided by the employer authority, Days taken by contractor to complete the non-compliant work, Number of days of non-compliance exceeding beyond the response time, Non-compliant length due to continuance of noncompliance beyond response time and, Non-compliant length for payment reduction (km).

The checklist prepared will not only provide the employer authority the information about overall road condition but it is prepared in such a way that if the inspection is to be carried out by a person having non-technical engineering background, it will not affect the efficiency and ease of the overall assessment. The rating value and adopted scale are formulated such a way that it will be easy to understand for all the stakeholders i.e., Employer, Concessionaire, and Road User. 'Output and Performance Based Road Contract (OPRC)' is an innovative approach dealing with asset management of roads and through this the roads can be managed and maintained with better insights of asset management unlike other traditional contracting methods.

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