



**OUTPUT AND PERFORMANCE  
BASED ROAD MAINTENANCE  
CONTRACTS  
IN  
HIMACHAL PRADESH**

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**An Evaluation Study**

**Planning Department  
Yojana Bhawan, H.P. Secretariat, Shimla  
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# PREFACE

Roadways are the life lines of any country and to conserve them maintenance is essential. Maintenance encompasses all the activities necessary to ensure the performance of the required function of an asset, including all the supporting activities like technical, administrative and managerial actions. The maintenance activities aimed at preventing failure from happening and delay can lead the road in the stage of expensive restoration. This can be done performing maintenance at planned interval, or by carrying out check-ups and determining how close the asset's condition is to failure.

In Himachal Pradesh, Public Works Department is responsible for the maintenance of roads. The maintenance work of roads in state is specifically based on traditional departmental labour, item rate based short term maintenance contracts, and outsourcing of long-term maintenance of physical works. The long-term contracts differ substantially from other methods where most of the maintenance payments made to the contractor based on measured outputs reflecting the service levels of the roads under contract.

In the present study, an attempt has been made to collect, analyse and to draw systematic conclusions about the relative effectiveness of Performance Based Road Maintenance Contracts vs. regular periodic maintenance in Himachal Pradesh. The study assesses performance and maintenance practices on the basis of the framework of cost efficiency, service effectiveness, quality of service and user satisfaction.

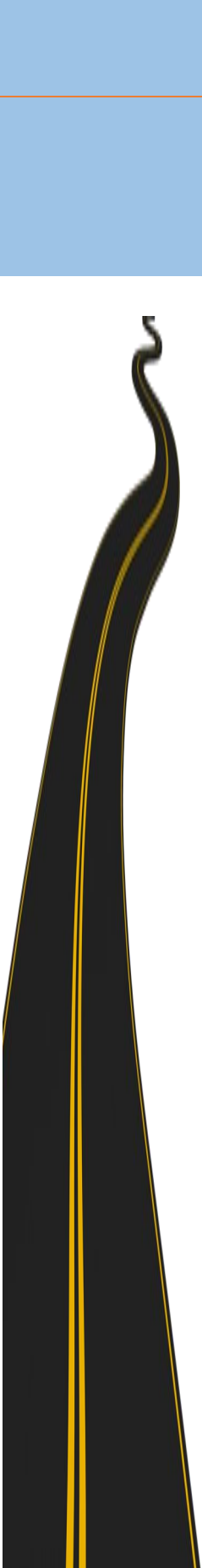
The Planning Department has got all secondary information from Public Works Department. On the basis of analysis of data, discussions have been drawn and these discussions are based on the findings of the study.

**(Prabodh Saxena, IAS)**  
Additional Chief Secretary (Planning)

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# TEAM

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**Dr. Basu Sood**  
Adviser,  
Planning

Conception of Study, Critical revision of the draft report, Finalization of the report

**Anuj Kumar**  
Deputy Director,  
Planning

Design of the study, Data collection, Data analysis & interpretation, Drafting the report

**Mohan Singh**  
Asst. Research Officer,  
Planning

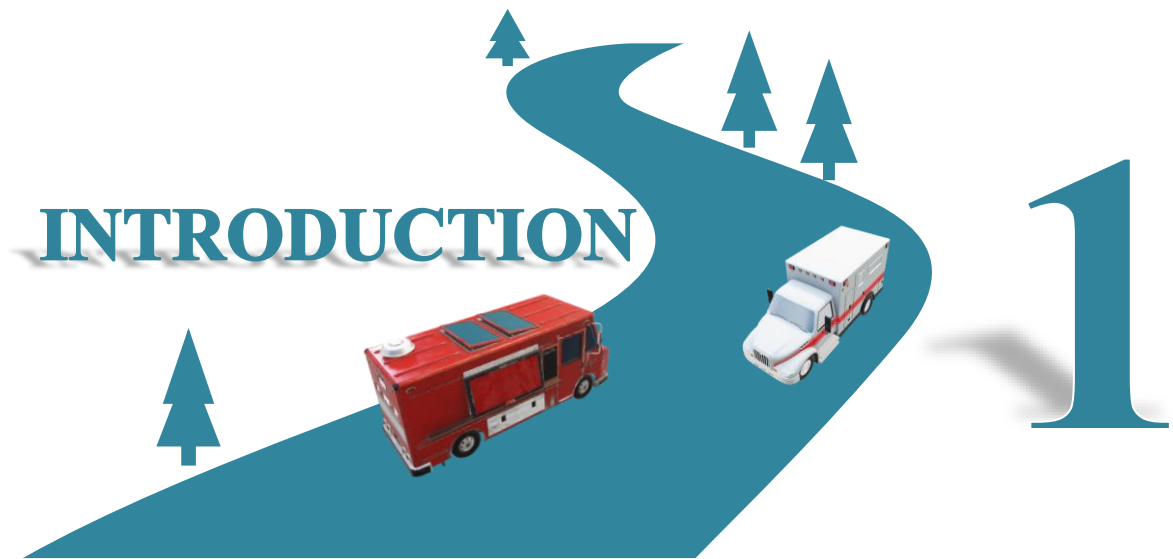
Field visit, Acquisition of data

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Road maintenance has traditionally been the realm of public road organizations. Many countries in the Central Asia Regional Economic Cooperation (CAREC) region are still performing road maintenance in-house, especially routine road maintenance. However, there is now a global trend for such works to be contracted out to the private sector. The main reason for shifting to such contracts is to improve efficiency <sup>[1]</sup>.

The Output and Performance Based Road Maintenance Contracts (OPBMC) started in the late 1980's and early 1990's. Firstly, British Columbia in Canada contracted out its road maintenance in 1988, shortly afterwards, Argentina, Uruguay in mid-1990's, Australia in 1995, United States of America in 1996, New Zealand in 1998 started using the new contract scheme to their road networks applying a mixture of performance specifications and unit prices. Since 2000, Performance Contracts were adopted in and spread to Europe, Asia and Africa. The World Bank, the Asian Development Bank as well as EBRD (European Bank for Reconstruction and Development) are actively propagating the new contracting scheme- PBMC <sup>[2]</sup>.

PBMC is aimed at by the road agency to increase the efficiency and effectiveness of road asset management and maintenance for a road or group of roads and entrusts the responsibility to a contractor for the maintenance of the road(s) to a pre-defined service level/ performance criteria on a continuous basis for the entire duration of the contract. The contractor is expected to not only maintain the road as per the defined performance criteria but also to protect and maintain all road assets along the contracted road as well as respond to complaints/requests of the road users.



Contractor is, in turn, paid strictly for ensuring compliance of the desired service level/ performance criteria and not for his inputs in maintaining these conditions. This type of contract significantly expands the role of the private sector, from the simple execution of works to the management and conservation of road assets.

Road agencies that have adopted PBMC approach have achieved cost savings of between 10% to 40% compared to traditional method-based contracts in other countries<sup>[3]</sup> (Table 1). Thus, some countries have turned to contractors to deliver road maintenance.

Country	Cost Savings, %
Norway	About 20-40%
Sweden	About 30%
Finland	About 30-35%; about 50% less cost/km
Holland	About 30-40%
Estonia	20-40%
England	10% minimum
Australia	10-40%
New Zealand	About 20-30%
USA	10-15%
Ontario, Canada	About 10%
Alberta, Canada	About 20%
British Columbia, Canada	Some, but might be in the order of 10%

## 1.1 The Context

OPBMCs are a further development of the earlier “Performance based Management & Maintenance of Roads (PMMR)” contracts (2002) <sup>[4]</sup> where contractor must not necessarily and in all cases be traditional works contractor but can be any type of firm or business venture having the necessary technical, managerial and financial capacity to fulfil the contract. As an important focus of the Output and Performance Based Maintenance Contract (OPBMC), the contractor has to maintain the road at a certain contract specified service level for a period of 5 years. This type of Contract generally constitutes of following 5 schedules <sup>[5]</sup>:





- i. Routine/ Ordinary Maintenance (Lump sum) total for 60 months to be carried out in order to bring the Roads up to pre-defined standards.
- ii. Initial Rehabilitation/ Rectification (Repair) work (Lump sum) - Initial works to bring the road to below the intervention level (to be executed within 8 months of 1<sup>st</sup> year) consisting of works beyond Maintenance Services but not included in Periodic Maintenance or Improvement Works.
- iii. Periodic Maintenance (Lump sum) - total for 4 years consists of predictable and more costly measures consisting of specific types of works of a less frequent nature designed to avoid road degradation.
- iv. Minor Improvement Works, Unit Rates (Reconstruction and Structural Overlay, widening of narrow minor bridges, widening of culverts, etc.) aiming at adding new features in response to the need, safety or other considerations.
- v. Emergency Works/Day Works (Provisional Sum) comprising activities needed to reinstate the Roads after each emergency on case-by-case basis, etc.

To avoid ambiguity, all contracts must be clearly defined ranging from simple to comprehensive depending on the (i) traffic volume and composition, (ii) urban or rural roads (iii) flat, hilly or mountainous terrain, (iv) subgrade quality and type, (v) quality of available construction materials, (vi) capacity of available contractors, (vii) any environmental constraints, such as protected areas, parks, forest reserves, etc. This helps to ensure that variation orders are minimised and that the contractor is generally paid in equal monthly instalments throughout the contract period. The risk of cost overruns is transferred to the contractor.

The service level can be afforded and economically justified for the road in question by aligning contractor payment with needs of the road user. This also ensures stable financing for the maintenance program over a longer term covering a period of several years.

The model of OPBMC is also suitable for procuring works and services under long term- design, build, operate and maintenance contracts for roads as compared to traditional road governance practices <sup>[6]</sup>.





The chapter attempts to define the activities to be undertaken during the study, the ways to proceed, tools to measure progress and what measures constitute success.

## **2.1 Framework for assessment of road maintenance practice in Himachal Pradesh**

World Bank on trial basis in February 2002 introduced the first bidding document for Procurement of Performance- based Management and Maintenance of Roads (PMMR) in Himachal Pradesh. Thereafter, in November 2009 a revised Sample Bidding Document was introduced for Works and Services under Output and Performance Based Road Contracts (OPRC) to provide its clients with an alternative to the traditional methods of procuring road reconstruction, rehabilitation and maintenance.

Somewhere, during the period 2006-2008 Public Works Department of Himachal Pradesh, through the consultant SMEC International Pvt. Ltd., Australia, worked on the Draft Sample Bid Document of OPBMC for Central, North and South zones as per the topography of the State as well as to cover a large area of the State. This Draft Sample Bid Document- Output Performance-based Maintenance Contract (OPBC) was aimed at routine road maintenance pilot project financed by World Bank with incorporation of specifications of MoRTH (Ministry of Road Transport and Highways). After the finalization of Draft Sample Bid Document- Output Performance-

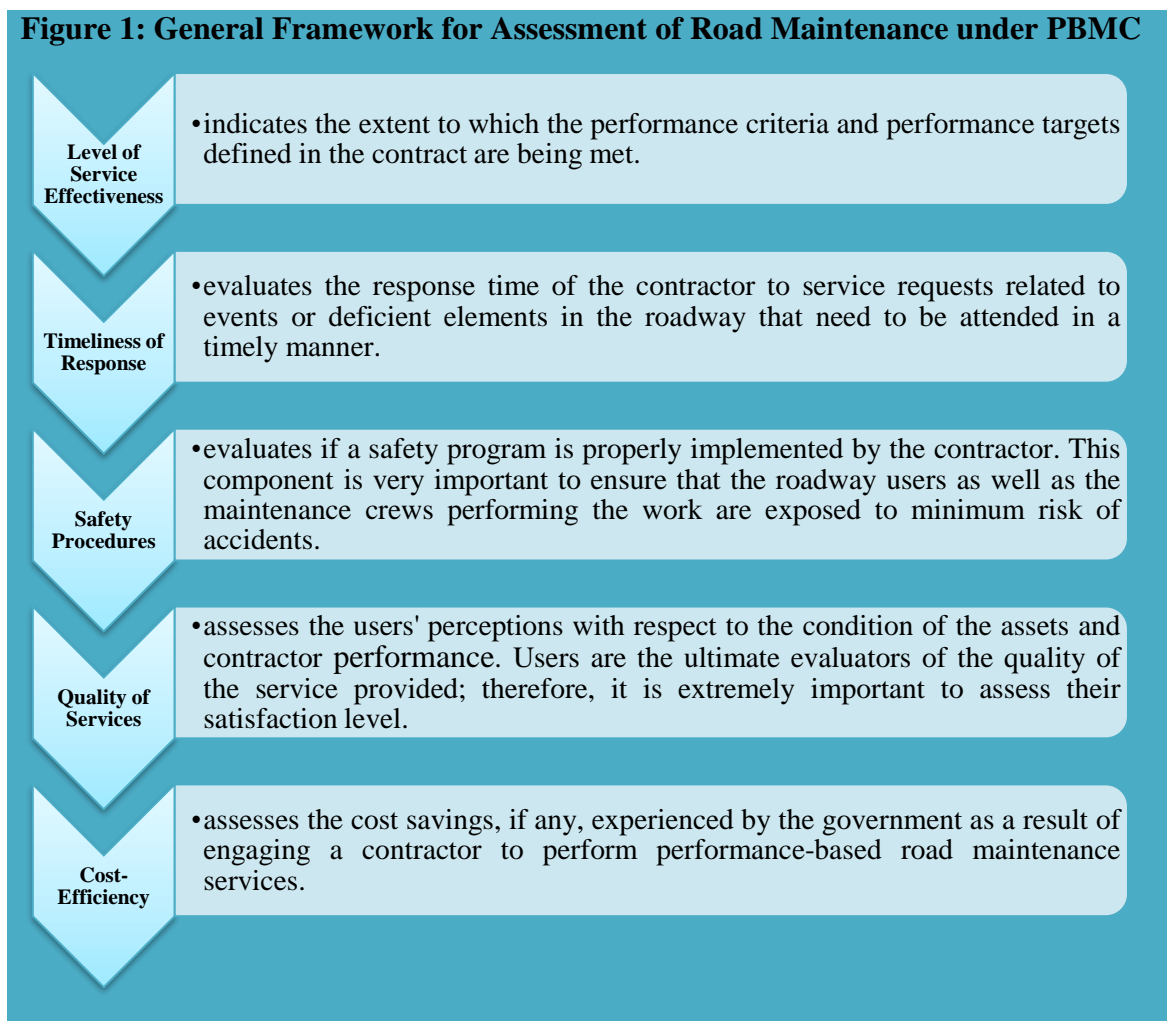


based Maintenance Contract (OPBC), three numbers of contract packages for four zones were shortlisted as under:

1. Central Zone- 126.500 Km
2. North Zone- 129.300 Km
3. South Zone- 185.285 Km.

However, thereafter the road lengths earlier proposed were revised by the concerned Zonal Chief Engineers due to various reasons such as declaration of earlier proposed roads into National Highways, tough geographical condition and harsh climate for contractors to carry out OPBMC etc.

A review of the roads contracted on pilot basis was conducted as a part of this study which led to the identification of five key components that define the framework to monitor PBMC [7]. A brief description of each component as follows (Figure 1):



## 2.2 Selection of roads for evaluation purpose of the performance based maintenance contract practices in Himachal Pradesh

Under the Core Road Maintenance and Management Component of Himachal Pradesh State Roads Project (HPSRP)- I, about 347 KM length of core roads (SHs & MDRs) were executed under Pilot Output and Performance Based Maintenance Contract under State Roads Project in Himachal Pradesh.

Finally, eight road lengths were shortlisted in each of four zones of Himachal Pradesh with the assumption that maximum compliances would be in place due to strong monitoring by the World Bank. The following roads were selected in each of four Zones (Table 2):

Sr. No.	Zone (HPPWD)	Circle	Name of Road	Road No.	Lane	Length (in KMs)	Contract Cost (In Crores)
1	Hamirpur Zone-01	Hamirpur	Sujanpur- Sandhol- Marhi Road	MDR-38	Single	23.000	13.66
			Hamirpur-Bhoranj- Jahu Road	MDR-35	Single	30.055	
<b>Total of Hamirpur Zone</b>						<b>53.055</b>	
2	Mandi Zone-02	Mandi	Shimla-Tattapani- Mandi Road. (From Tattapani to Dadaur)	MDR-76	Single	133.350	38.33
<b>Total of Mandi Zone</b>						<b>133.350</b>	
3	Shimla Zone-04	Shimla	Shimla-Tattapani- Mandi Road. (From Dhalli to Tattapani)	MDR-76	Single	34.050	9.01
<b>Total of Shimla Zone</b>						<b>34.050</b>	
4	Kangra Zone-03	Palampur	Hamirpur Sujanpur Thural Maranda road (portion) Alampur to Thakudawara Km. 24/135 to 59/775	MDR-86	Double	126.093	26.11
			Bhawarna Jhungadevi road Km. 0/0 to 26/280	Rural / Village Road (VR003)	Single		
			Ranital to 32 Mile (Kotla road Km 0/0 to 39/173	MDR-88	Double		
			Gaggal Tiara Lunj road km. 0/0 to 25/0	Rural / Village Road	Single		
<b>Total of Kangra Zone</b>						<b>126.093</b>	
<b>Grand Total of Five Roads</b>						<b>346.548</b>	<b>87.11</b>



The other attributes of PBMC selected roads (Table 3):

Table 3: Other Aspects of Selected Roads for Study of PBMC in H.P.							
Sr. No.	Funding Agency	Location /Name of Road	Duration of Contract (Years)	Date of award	Completion date of contract as per agreement	Status of contract (completed or not)	Contract Number
1	World Bank	Shimla Tattapani Mandi road (From Tattapani to Dadaur)	5 Years	17/11/2014	12-05-2019	Completed	OPBRC - 02
2	World Bank	i) Hamirpur Sujjanpur Thural Maranda road (portion) Alampur to Thakudawar a Km. 24/135 to 59/775	5 years	18/03/2016	17/03/2021	Completed	OPBRC - 04
		ii) Bhawarna Jhungadevi road Km. 0/0 to 26/280					
		iii) Ranital to 32 Mile (Kotla road Km 0/0 to 39/173					
		iv) Gaggal Tiara Lunj road km. 0/0 to 25/0					
3	World Bank	Shimla Tattapani Mandi Road (From Dhally to Tattapani) Km. 6/00 to 33/300 & 45/550 to 52/300	5 Years	17/04/2015	31/05/2020	Completed	OPRC -04
4	World Bank	Sujanpur Sandhol Marhi road Km. 0/0 to 23/0	5 Years	26/03/2015	29/02/2020	Completed	OPRC -01
5	World Bank	Hamirpur Bhoranj Jahu road Km. 2/690 to 32/745	5 Years	26/03/2016	29/02/2021	Completed	OPRC -01

### 2.3 Indicators selected for analysis of the performance based maintenance contract practices in Himachal Pradesh

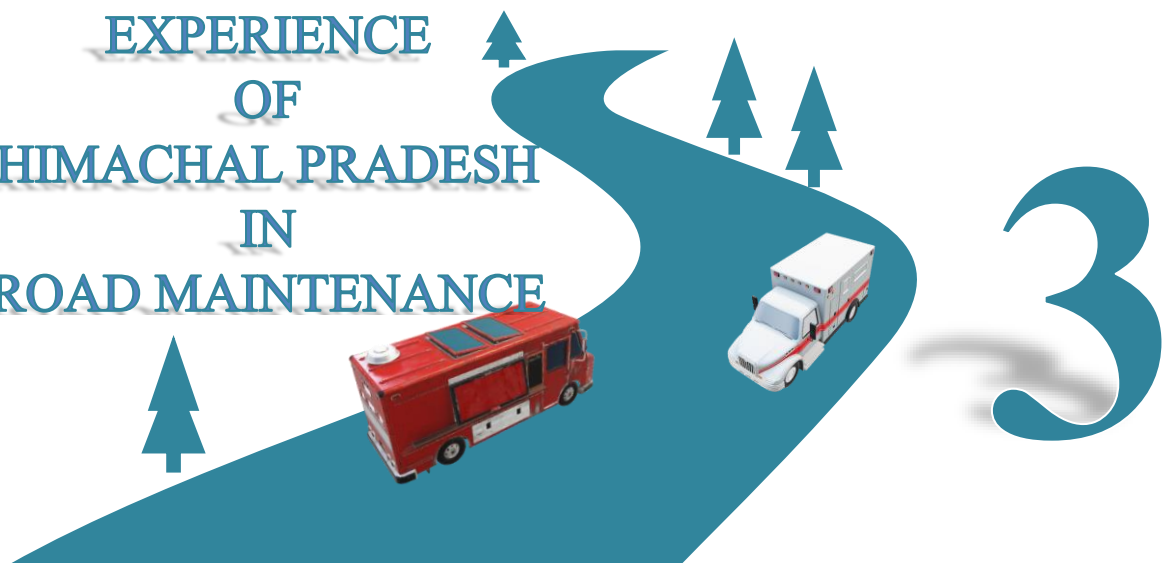
Four indicators have been selected for the analysis of the PBMC in Himachal Pradesh and are as follows:



- i) **Cost Efficiency:** Cost comparison of PBM roads with the cost of the same roads with the maintenance based on the traditional / input-based practices. The analysis is primarily based on the secondary data.
- ii) **Level of Service Effectiveness:** This is related with the service delivery of contractor. Hence, this part is generally based on the survey questionnaire administered to the PWD. In this section, six components have been considered as indicators for analysis of the service delivery of contractor. These indicators are i) Performance of Self Control and Mobile Maintenance Unit, ii) Weekly Safety Inspection, iii) Monthly Service Quality Inspection, iv) Surface Distress Index (SDI) and Road Roughness Survey, v) Axle Load Station or Weighbridge Installation, vi) Maintenance of Traffic Data.
- iii) **Quality of Service:** Comparison of quality of services of PBM Roads with maintenance practice based on the traditional input-based maintenance contracts.
- iv) **User Satisfaction:** Under this qualitative survey, in-depth interviews were conducted with the key user groups/ stakeholders on all selected eight road segments to capture opinion regarding their perceptions post OPBMC on improvement of road conditions, travel time & fuel economy and safety aspects.



# EXPERIENCE OF HIMACHAL PRADESH IN ROAD MAINTENANCE



Road is the dominant mode of transport in the State of Himachal Pradesh (HP). The state has a total available road network of 40,020 KMs of motorable roads as on April, 2022<sup>[8]</sup>. In terms of typologies, majority (over 75%, including both non- black topped (BT) and black topped (BT) was contributed by Rural Roads, followed by Major District Roads (MDRs) and National Highways (NHs). Nineteen National Highways (NHs) pass through the state with a total length of 2,592 kms. In addition to this, there were 110 Major District Roads with a length 4,703 km <sup>[9]</sup>.

As the apex body, Himachal Pradesh Public Works Department (HPPWD) is responsible for development, maintenance and management of most of the roads, bridges and other road infrastructure in the State.

The worldwide growth, expansion and implementation of an OPRC approach on the basis of cost saving, expenditure certainty, reduction of the in-house workforce, improved conditions of contracted road assets & reduction of roads in poor condition, greater road user satisfaction, multi-year financing, increased transparency, etc. opened the track for Public Work Department of the State Government too, in following the same approach. The same has been recognized as an effective tool in practice in Himachal Pradesh for roads since year 2006-07<sup>[10]</sup>.

At present, out of three main modes of maintenance as explained below, the Road Maintenance activities are primarily based on Item Rate and Performance based Maintenance practice in H.P.<sup>[11]</sup>.



### **3.1 Modality of Maintenance under Departmental Labour**

In departmental labour maintenance, the labour on the rolls of the Department is assigned various tasks to be carried out for the maintenance of the road section under the supervision of a mate or a supervisor. The mate/supervisor has to assign the tasks on a day to day basis, daily monitor the progress of the labour and arrange proper tools and implements to carry out the allotted activities and also requisite quantities of various materials for these repairs and maintenance works. All responsibility and risks involved in delivering the results rest with the Public Works Department and its field personnel.

### **3.2 Modality of Contract Implementation of Maintenance under Item Rate**

Under this conventional method, PWD Engineers are directly involved from procurement to the implementation and entrusting the maintenance of road to a contractor based on item rate. This method is based on the amount of work actually executed and then is measured and paid for on agreed rates against various items of work. The road agency specifies techniques by way of quantities of materials, their quality and the technology to be adopted and the time period during which various activities are to be executed and payment is made to the contractor based on his inputs. There is no consultant outsourced for the supervision of the construction work under maintenance contract. Contractor is selected on the basis of the lowest competitive bid.

### **3.3 Modality of Contract Implementation of Maintenance under Performance Based Maintenance Contract**

Under this newly emerging system of maintenance, the HP PWD, by adopting PBMC (Performance Based Maintenance Contract) model for a road or group of roads, entrusts the responsibility to private firms and it does not stipulate any method or material requirements. No separate measurements are required and paid for in respect of various tasks executed by the contractor. Payments are made on how well the contractor has managed to comply with the pre-defined performance matrix.

The private sector or contractor is expected to not only maintain the road as per the defined performance criteria but also to protect and maintain all road assets along the contracted road as well as respond to complaints/requests of the road users. The firm or contractor is, in turn, paid strictly for ensuring compliance of the desired service

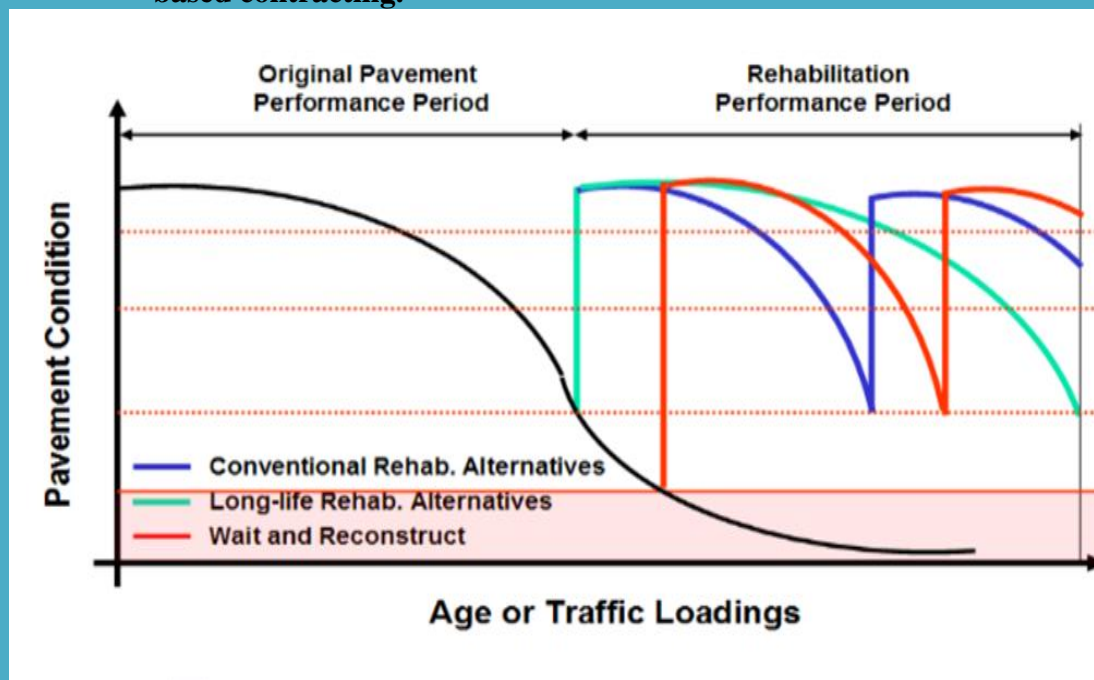




level/ performance criteria and not for inputs required by him in maintaining these roads. These service levels are defined in the contract.

In the traditional and conventional method based maintenance contracts the wait and reconstruction process/ cycle tends to fluctuate with wide variations over a particular base line. While the performance based contracting or long-life rehabilitation ensures the road asset condition consistent by being maintained over the long period of time as is reflected by a trend line consistently above a base line <sup>[12]</sup> (Figure 2).

**Figure 2: Asset condition under the traditional, conventional and performance-based contracting.**



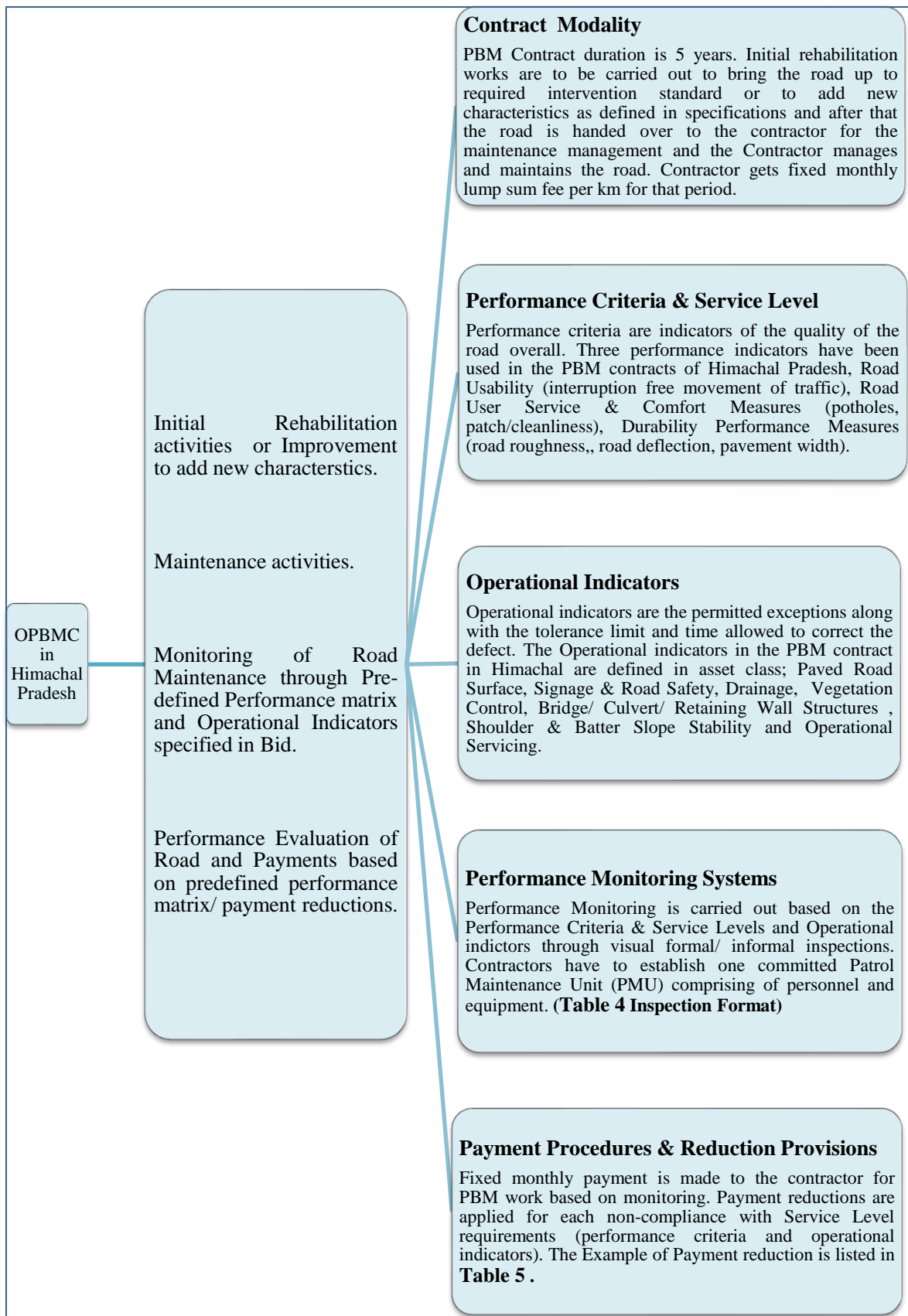
Source: Asset Management Program Enhancement Plan <sup>[13]</sup>

### 3.4 Performance Based Maintenance Contract Modality in Himachal Pradesh

In Himachal Pradesh, the first pilot based OPBMC was insisted upon by World Bank as an alternative maintenance approach and was started in 2008 with the greater role of the contractor which comprised of General works, Maintenance works, Rehabilitation works, Improvement works and Emergency/ Day works. The Performance Based Maintenance Contract modality, in Himachal Pradesh, and its characteristics are shown in Figure 3.



**Figure-3: Performance Based Maintenance Contract in Himachal Pradesh**



**Table 4: Performance monitoring/ Service quality evaluation for 1 KM section of the road based on operational indicators**

Aspects	1 (0+ 200)	2 (0+ 400)	3 (0+ 600)	4 (0+ 800)	5 (0+ 1000)	Number of non-complying segments
Insert 'No' if a segment does not comply and mark 'Yes' on compliance segment						
1.	2.	3.	4.	5.	6.	7.
<b>(A) Pavement/ shoulder/roadside</b>						
Patch work (Y/N)						
Cracks/rutting/ravelling (Y/N)						
Pavement edge break (Y/N)						
Cleanliness (Y/N)						
Shoulder (Y/N)						
Embankment slopes (Y/N)						
Vegetation control (Y/N)						
Obstruction on road (Y/N)						
<b>Sub Total (A)</b>						
<b>(B) Bridges and structures</b>						
Bridge Maintenance (Y/N)						
Retaining and protection wall (Y/N)						
Waterway maintenance (Y/N)						
<b>Sub Total (B)</b>						
<b>(C) Drainage System</b>						
Longitudinal drains (Y/N)						
Culverts and cause ways (Y/N)						
<b>Sub Total (C)</b>						
<b>(D) Signalling and road safety</b>						
Sign maintenance (Y/N)						
Kilometre/delineators/ guideposts/ confidence blocks (Y/N)						
Road marking(Y/N)						
Crash Barrier or Parafits (Y/N)						
<b>Sub Total (D)</b>						
<b>(E) Provision of maintenance services (Y/N) (to be confirmed from concerned JE)</b>						
<b>Sub Total (E)</b>						
<b>Total A+B+C+D+E</b>						

Source: Bidding Document, OPBRC Maintenance of Package-4- Roads in Kangra District of H.P.



<b>Table 5: Payment Reduction Provisions</b>	
<b>1. Road Usability- Interruption of Motorized traffic</b>	20% of Monthly lump sum for the entire road or affected roads for each day of non-compliance.
<b>2. Road User Comfort- Potholes/ Crack in pavement/ Multiple cracks/ Rut Depth/ Pavement &amp; Shoulder (Cleanliness)/ Depression/ Vegetation/ Traffic Signage &amp; Safety Devices</b>	10 to 30% of the monthly lump sum for one KM applied to each one KM section which does not comply
<b>3. Road Durability- Roughness/ Useable road surface width/ Drainage cleanliness/ Slope stabilization/ Structure/ Stream Maintenance</b>	<ul style="list-style-type: none"> <li>• Liquidated damages shall be applied at the rate of Rs 100 per 100-meter travel lane for each day of non-compliance over the time</li> <li>• 10% of the monthly lump sum for one km applied to each one-km section which does not comply.</li> </ul>
<b>4. Management Performance Measure-</b>	
<b>i.</b> Failure to provide minimum Patrol Maintenance Unit (PMU)	Full day - Rs 25,000/- or Rs 500/- per hour for part of day
<b>ii.</b> Failure to conduct and submit the relevant Surveys/ Inspections report	Full day delay – Rs 2000/-
<b>iii.</b> Failure to submit the Program of Performance (Contract Plan)	Weekly penalty of Rs 30,000 shall apply until the Plan is presented
<b>iv.</b> Failure to comply with Contract requirements (Quality, Environmental, Social, Traffic Management, Emergency Response)	Initial penalty of Rs 3,000 shall apply, to be doubled every month until non-compliance is corrected.
<b>v.</b> Failure to secure necessary approvals/ authorizations for Legislative requirements	Penalty of Rs 25,000 (applicable per approval per month of delay after commencement of related activity)

Source: Bidding Document, OPBRC Maintenance of Package-4- Roads in Kangra District of H.P.





The notional and calculated direct and indirect cost savings<sup>[14]</sup> in the performance-based maintenance contract has not only influenced the funding agencies but is also forcing the road agencies to accept the new pattern worldwide. Cost comparison of the performance based maintained roads with the maintenance based on traditional/ conventional process of the same roads is analysed in this section.

#### 4.1 Cost Distribution Analysis

As mentioned in the preceding text, the PBM contract in Himachal Pradesh generally comprises of Ordinary Maintenance works, Initial Rectification (Repair) works, Periodic Maintenance, Minor Improvement works, and Emergency works. The cost distribution pattern of the selected roads contracted for maintenance based on PBM is presented in Table 6 and Figure 4:

The actual expenditure pattern shows that Periodic Maintenance work component varies from the minimum of 32.31% of total expenditure amount in Project-E to the maximum of 66.33% of total contract amount in Project-B. Only the Minor Improvement Works cost expenditure pattern showed the least expenditure variation from minimum of 8.72% to maximum of 12.98% in Project-A and Project-C, respectively. The cost expenditure data shows that in Project-C, Emergency Work contains a significant percentage of 30.44% whereas, other projects have this component constituting not more than 14.04 % of the total maintenance contract. The component related to emergency works is contingent upon the eventuality in which such



works are required to be done and can vary largely from one contract to other depending on the nature and gravity of emergency.

This component can not be used strictly for comparing the costs of two modes and not even inter-work comparison within the same maintenance contract is possible with reference to the costs incidental on emergency works.

**Table 6: Cost Distribution Patterns of Selected Roads for Study of PBMC in H.P. (Rs. in Crore)**

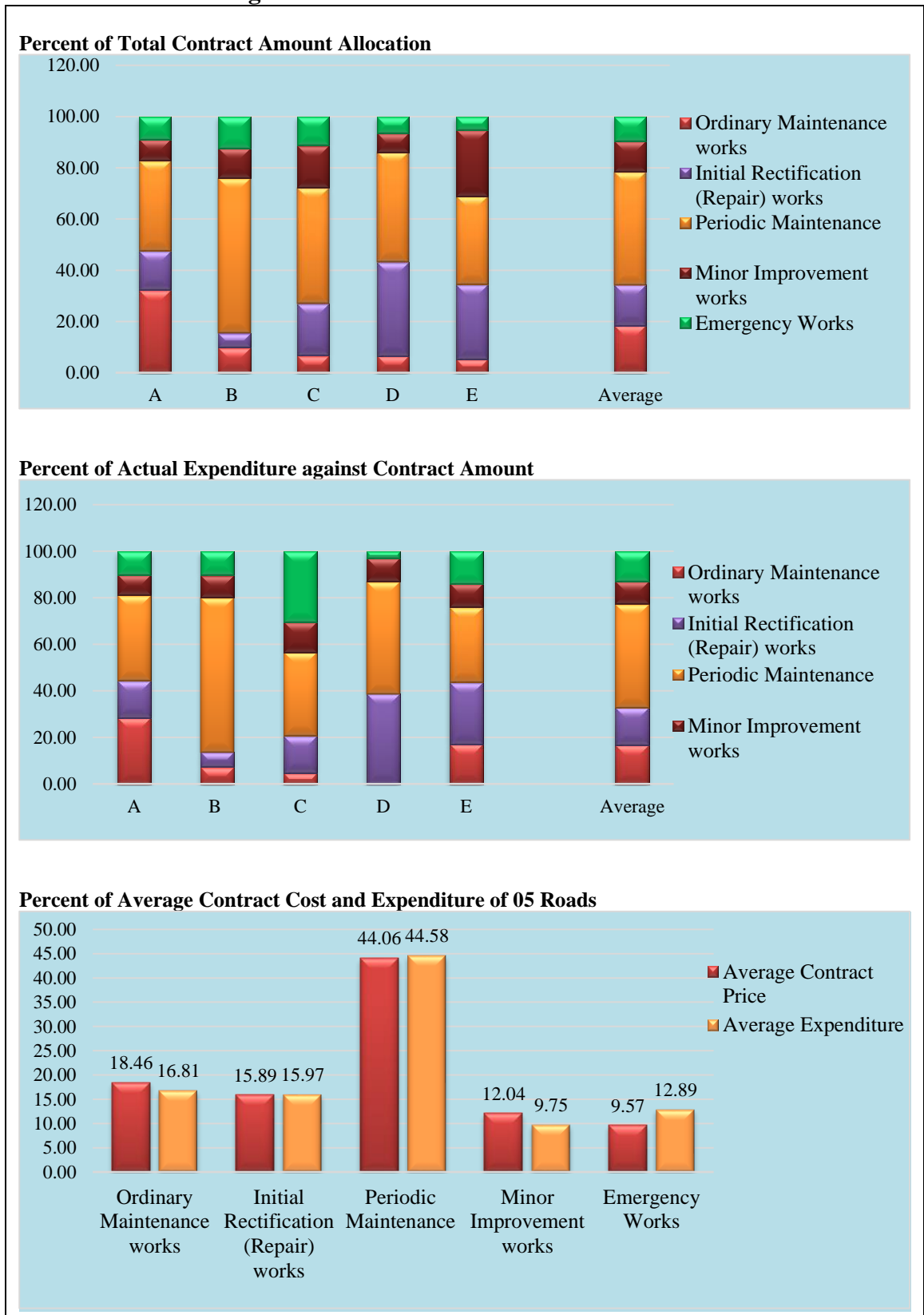
Name of Project (^)	Ordinary Maintenance works		Initial Rectification (Repair) works		Periodic Maintenance		Minor Improvement works		Emergency Works		Total		
	Cost as per contract	Actual Expenditure	Cost as per Contract	Actual Expenditure	Cost as per Contract	Actual Expenditure	Cost as per Contract	Actual Expenditure	Cost as per Contract	Actual Expenditure	Cost as per Contract	Actual Expenditure	Per Km Expenditure
(A)	12.36	10.70	5.86	6.04	13.52	13.85	3.20	3.29	3.39	3.84	38.33	37.72	0.28
% of total contract amount (A)	32.25	28.37	15.29	16.01	35.27	36.72	8.35	8.72	8.84	10.18	100	100	
(B)	2.58	1.65	1.46	1.46	15.76	15.05	3.08	2.20	3.23	2.33	26.11	22.69	0.18
% of total contract amount (B)	9.88	7.27	5.59	6.43	60.36	66.33	11.80	9.70	12.37	10.27	100	100	
(C)	0.60	0.53	1.83	1.83	4.09	4.09	1.48	1.48	1.02	3.47	9.02	11.40	0.33
% of total contract amount (C)	6.65	4.65	20.29	16.05	45.34	35.88	16.41	12.98	11.31	30.44	100	100	
(D)	0.39	0.00	2.17	1.92	2.54	2.40	0.44	0.50	0.38	0.15	5.92	4.97	0.22
% of total contract amount (D)	6.59	0.00	36.66	38.63	42.91	48.29	7.43	10.06	6.42	3.02	100	100	
(E)	0.51	1.62	2.83	2.52	3.33	3.06	2.52	0.94	0.50	1.33	9.69	9.47	0.32
% of total contract amount (E)	5.26	17.11	29.21	26.61	34.37	32.31	26.01	9.93	5.16	14.04	100	100	
<b>Total</b>	16.44	14.50	14.15	13.77	39.24	38.45	10.72	8.41	8.52	11.12	89.07	86.25	0.25
% of average contract cost/ Expenditure of 05 roads	18.46	16.81	15.89	15.97	44.06	44.58	12.04	9.75	9.57	12.89	100	100	

Name of Projects (^)		Road Length (in KM)
Project-A	Tattapani to Dadaur	133.350
Project-B	Alampur to Thakurdawara	126.093
	Bhawarna Jhungadevi	
	Ranital to 32 Mile	
	Gaggal Tiara Lunj	
Project-C	Dhally to Tattapani	34.050
Project-D	Sujanpur Sandhol Marhi	23.000
Project-E	Hamirpur Bhoranj Jahu	30.055
<b>Total</b>		<b>346.548</b>

Source: Based on the information collected from the Department of Public Works (Himachal Pradesh)



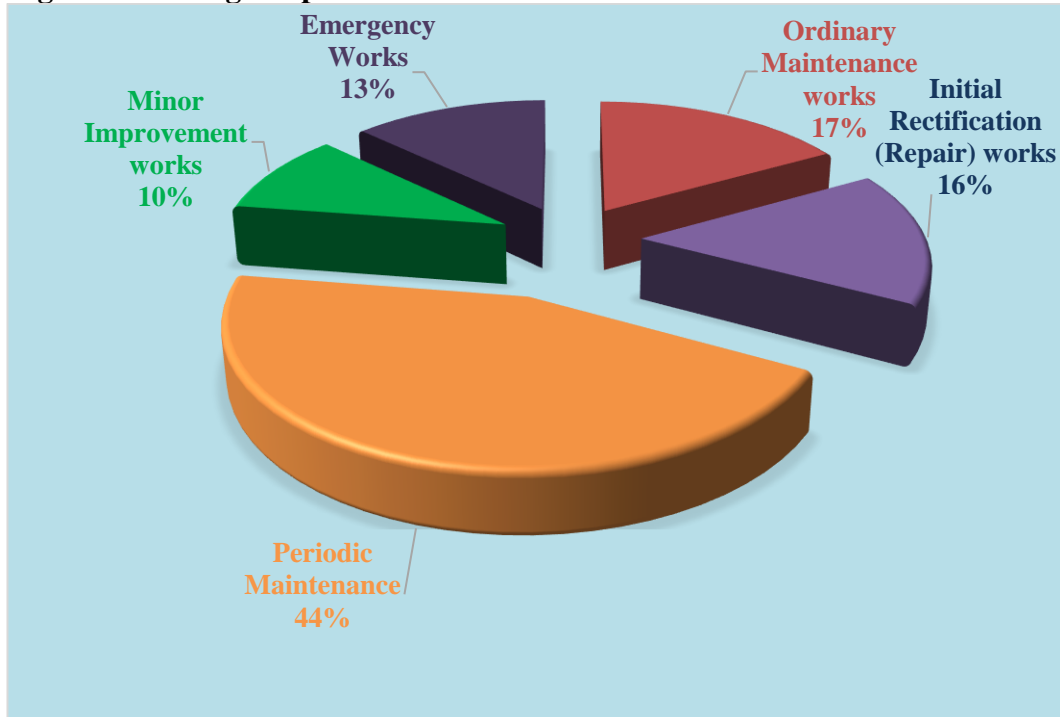
**Figure 4: Cost distribution pattern of % of contract cost, actual expenditure and their averages**



## 4.2 Discussion

- The reason behind the cost distribution pattern analysis is to look into the bidding behaviour of the department and pattern of incurred expenditure on different selected roads of the State.

**Figure 5: Average Expenditure Distribution Pattern**



- Periodic maintenance work generally consists of the predictable and more costly measures of a less frequent nature designed to avoid road degradation (such as grading, drainage work, resurfacing, asphaltic concrete overlays, etc.) in all of the contracts. Periodic Maintenance was for four-year, first year sections were already identified, for next three-years, contractor had to identify the sections/locations based upon road condition data collected in the month of November/December every year. Payments were made in accordance with the progress in the execution of measured outputs. Overall, 44.58% of the contract amount has to be spent in four years of the five-year contract. This shows the front-loading behaviour of the Contract. High bidding with regard to the Periodic Maintenance phase of the PBM projects meant that there is consistently high incentive for the contractor to retain an interest in this component of the project the cost of which ranges from 32.31% to 66.33% of the contract amount.





- Bidding with regard to the Ordinary Maintenance, Initial Rectification, Minor Improvement and Emergency works in PBM projects do not appear to be motivating a contractor to have interest in the contract as the average percentage of total contract amount spent on these components ranges from 0% to 38.63% of the contract amount.
- It may also be observed that the amount for which the budget allocation was made across various components (periodic maintenance, ordinary maintenance, preliminary improvements, minor improvements and emergency works) were contracted and the actual amount spent on them had only variation. Hence, the purpose with which the performance-based maintenance project was formulated appears to have been succeeded in fulfilling its objective in respect of all the components.
- Minimum or maximum threshold amount or contract values for Ordinary Maintenance, Initial Rectification and Emergency works is not easy to ascertain for monthly/quarterly/ yearly payments for the required maintenance period as the same has been found to be varying from the minimum of 0% to maximum of 38.63%.
- Minimum threshold amount or contract value for Minor Improvement which varies from 8.72% to 12.98% can be included for the monthly/ quarterly/ yearly payments for the required maintenance period.

### 4.3 Cost Efficiency

Comparison of the maintenance cost based on the traditional/conventional (In house Practice/Unit Cost Based) practice and PBMC needs to be interpreted with a little caution keeping in mind two facts. First, all these five roads were rural or intermediate roads and were upgraded before their maintenance was contracted following OPBMC. A nominal increase in the total maintenance cost is natural due to upgradation. Secondly, the maintenance requirement during pre-OPBMC maintenance was met by allocating budget on actual requirement and no fixed amount for maintenance of a particular road was allocated in advance as is done in case of OPBMC. Another major difference between pre-OPBMC and OPBMC scenario is that the components A & B selected for this study were rural roads during the pre-OPBMC period and were



upgraded as Major District Roads during OPBMC period. Hence, increased contracted OPBMC amount has to be discounted for upgradation cost for comparing costs during pre-OPBMC & OPBMC contracts. These differences in the said practices/ components may not help in the calculation of direct cost efficiency and even actual expenditure doesn't make the results strictly comparable as presented in Table 7. However, OPBMC assures a certain level of maintenance of a road with a fixed periodicity and that obviously results in higher maintenance cost.

However, an attempt has been made to make comparison between two modes of road maintenance by deflating the cost prices to the level of 2011-12 i.e. the first year of pre-OPBMC contracts which has been selected for present study. The prices have been deflated against the Wholesale Price Index (WPI) as per the prevailing practice in respect of the costs for construction sector. The benefit of deflating costs spread over various years to the prices of the base year is that the costs are discounted for inflationary push responsible for pushing up the cost during subsequent years and the real costs at the prices of a base year (which is 2010-11 in the current study) became comparable and computable easily.

Since the validity period of an OPBMC is five years, it was assumed that an equal amount was paid to the contractor each year. Similarly, the total maintenance cost was also equally spread over a period of five years during pre-OPBMC period. All those costs/ payments to the contractors were then deflated to the prices in 2011-12. Table 7 exhibits the real costs every year that was borne by the Public Works Department or was paid to the contractor for period maintenance of the roads selected for present study during pre-OPBMC and OPBMC modes of maintenance contracts. The table clearly indicates that the maintenance cost actually incurred during OPBMC contract was less than that of pre-OPBMC period in real terms in respect of project components C, D and E. It was considerably higher in case of components A & B for the OPBMC in comparison to pre-OPBMC contracts. However, as discussed earlier, the OPBMC also included upgradation cost of these two components, which were not available readily with the Public Works Department. The upgradation costs, are also if discounted for, will bring down the OPBMC costs lower than pre-OPBMC period in real terms.



<b>Table 7: Cost Efficiency</b>							
<b>Pre-OPBMC deflated contract costs on WPI Basis</b>							
<b>^ (Name of Project)</b>	<b>Total Cost</b>	<b>2011-12</b>	<b>2012-13</b>	<b>2013-14</b>	<b>2014-15</b>	<b>2015-16</b>	<b>Total</b>
<b>A</b>	16,54,00,000	3,30,80,000	3,09,44,808	2,94,04,444	2,90,43,020	3,01,54,968	15,26,27,241
<b>B</b>	73,00,000	14,60,000	13,65,762	12,97,778	12,81,826	13,30,902	67,36,269
<b>C</b>	11,64,00,000	2,32,80,000	2,17,77,362	2,06,93,333	2,04,38,982	2,12,21,513	10,74,11,190
<b>D</b>	5,92,00,000	1,18,40,000	1,10,75,772	1,05,24,444	1,03,95,083	1,07,93,072	5,46,28,372
<b>E</b>	9,69,00,000	1,93,80,000	1,81,29,093	1,72,26,667	1,70,14,925	1,76,66,363	8,94,17,047
<b>OPBMC deflated contract costs on WPI Basis</b>							
<b>^ (Name of Project)</b>	<b>Total Cost</b>	<b>2016-17</b>	<b>2017-18</b>	<b>2018-19</b>	<b>2019-20</b>	<b>2020-21</b>	<b>Total</b>
<b>A</b>	42,97,00,000	7,70,07,168	7,47,95,474	7,17,36,227	7,05,58,292	6,96,43,436	36,37,40,598
<b>B</b>	25,01,00,000	4,48,20,789	4,35,33,507	4,17,52,922	4,10,67,323	4,05,34,846	21,17,09,387
<b>C</b>	11,40,00,000	2,04,30,108	1,98,43,342	1,90,31,720	1,87,19,212	1,84,76,499	9,65,00,880
<b>D</b>	4,97,00,000	89,06,810	86,51,001	82,97,162	81,60,920	80,55,105	4,20,70,998
<b>E</b>	9,47,00,000	1,69,71,326	1,64,83,899	1,58,09,683	1,55,50,082	1,53,48,460	8,01,63,450

<b>Name of Projects (^)</b>		<b>Road Length (in KM)</b>
<b>Project-A</b>	Tattapani to Dadaur	133.350
<b>Project-B</b>	Alampur to Thakurdawara	126.093
	Bhawarna Jhungadevi	
	Ranital to 32 Mile	
	Gaggal Tiara Lunj	
<b>Project-C</b>	Dhally to Tattapani	34.050
<b>Project-D</b>	Sujanpur Sandhol Marhi	23.000
<b>Project-E</b>	Hamirpur Bhoranj Jahu	30.055
<b>Total</b>		<b>346.548</b>



## 4.4 Discussion

- The comparison between conventional unit cost based maintenance method and OPBMC is not restricted to direct costs only. Indirect benefits are many which are discussed briefly in the following text.
- The real cost comparisons between the OPBMC and traditional unit cost based maintenance, if discounted for inflation and other extra components which were not a part of this traditional unit cost based method, would indicate the direct costs to the government are lower in case of OPBMC.
- The cost efficiency needs to be explored keeping in view the overhead costs accruing each year in terms of procurement costs which must be made in case of In-house Practice/Unit Cost Based practices and not in the PBMC. There are other overhead costs like tendering process, assessment time, payment lag, etc. which need to be considered while making comparison.
- The indirect potential financial benefits of implementation of PBMC are savings of cost for road maintenance works, risk sharing and assurance of quality by the contractor, introduction of innovation, enhancing the efficiency of road authority & contractors, reducing the administrative burden, higher user satisfaction, a sustainable road management system, increased flexibility, increased transparency and reduced chances of corruption.
- The principal advantage of regular OPBMC is its potential for reducing necessary rehabilitation or reconstruction works later or after five years and removal of maintenance backlog in a phased manner.
- Risks allocated to the private contractor includes cost variations due to latent road conditions, traffic volumes, axle loadings, selection of treatments, and the cost of any re-work required to meet agreed standards.
- OPBMC addresses damage immediately before the road requires more expensive and extensive work to correct.
- Persistent potholes and recurring ruts wreak havoc with commuters and impose financial burdens on account of frequent automobile repairs and potentially inflict accidents. OPBMC can easily take care of these concerns of the users.





In this section six component mentioned at 2.3 (II) have been considered as the indicators for analysing the quality of service delivery by the contractor. The performance of the contractor on mutually agreed upon components and as assessed by the officials of the Public Works Department has been taken as an indicator of the success of the PBMC project. This assessment is based on the feedback of the departmental officers who were actually overseeing the execution of OPBMC related to specific roads as shortlisted for the present survey. Tables 8 and 9 shows the nature of service delivery of contractor.

The tabulated feedback shows that out of the five completed projects, in all the five projects, contractor had set up the mobile maintenance unit and they were all well performing. Mobile maintenance unit was not established in one of the running project. Likewise, in other completed projects, three contractors carried out safety inspection of the road regularly while two contractors carried out safety inspections only occasionally and that too on the direction of PWD authority. Similarly, in two completed projects out of five, contractor carried out the Monthly Service Quality Inspection only occasionally on direction of PWD authority. In three of the projects, the contractor had carried out the inspection regularly on his own.

In all projects, contractor had carried out the Road roughness survey but it was not carried out regularly. Likewise, in none of the projects, contractor had installed the Weighbridge. Similarly, in all five completed project, the contractor had not maintained traffic data.



**Table 8: Service delivery of Contractor- Maintenance Unit, Safety Inspection and Service Quality Inspection.**

Sr. No.	Name of Road	Performance of Mobile Maintenance Unit		Weekly Safety Inspection by the Contractor (Mark <input checked="" type="checkbox"/> in relevant Colm.)			Monthly Service Quality Inspection by the Contractor and Monthly Working Programme of Contractor (Mark <input checked="" type="checkbox"/> in relevant Colm.)		
		Not Established (Mark <input checked="" type="checkbox"/> )	Well Performed (Yes/No)	Carried Regularly	Occasion-ally	Not Carried yet	Carried Regularly	Occasion-ally	Not Carried yet
1	2	3	4	5	6	7	8	9	10
1	Shimla Tattapani Mandi road (From Tattapani to Dadaur)		Yes	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		
2	Hamirpur Sujanpur Thural Maranda road (portion) Alampur to Thakudawara Km. 24/135 to 59/775		Yes	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>	
	Bhawarna Jhungadevi road Km. 0/0 to 26/280								
	Ranital to 32 Mile (Kotla road Km 0/0 to 39/173								
	Gaggal Tiara Lunj road km. 0/0 to 25/0								
3	Shimla Tattapani Mandi Road (From Dhally to Tattapani) Km. 6/00 to 33/300 & 45/550 to 52/300 ,		Yes	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		
4	Sujanpur Sandhol Marhi road Km. 0/0 to 23/0		Yes		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	
5	Hamirpur Bhoranj Jahu road Km. 2/690 to 32/745		Yes		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	
<b>Total No.</b>		<b>0</b>	<b>5</b>	<b>3</b>	<b>2</b>	<b>0</b>	<b>3</b>	<b>2</b>	<b>0</b>

The data shows that the contractors had not complied with all the conditions related to five components for analysing level of service effectiveness.



**Table 9: Service delivery of Contractor- Road Roughness & SDI Survey, Weigh Bridge Installation and Traffic Data**

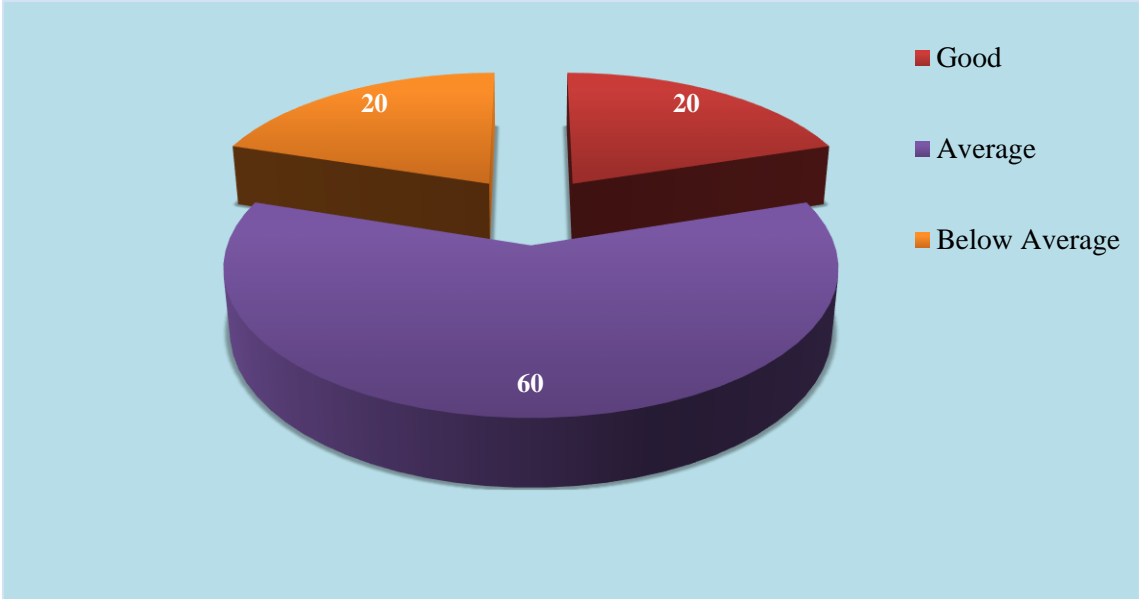
Sr. No.	Contract name and Road	Road Roughness and SDI Survey (Mark <input checked="" type="checkbox"/> in relevant Colm.)			Weigh Bridge Installation and axle Load Control (Mark <input checked="" type="checkbox"/> in relevant column)			Maintaining Traffic Data	
		Carried out as per specification (conducted mechanically or manually)	Not at all	Carried not regularly	Installed	Not Installed	In Process of Installation	Yes	No
1	2	3	4	5	6	7	8	9	10
1	Shimla Tattapani Mandi road (From Tattapani to Dadaur)	Mechanically		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
2	Hamirpur Sujapur Thural Maranda road (portion) Alampur to Thakudawara Km. 24/135 to 59/775	Mechanically		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
	Bhawarna Jhungadevi road Km. 0/0 to 26/280								
	Ranital to 32 Mile (Kotla road Km 0/0 to 39/173								
	Gaggal Tiara Lunj road km. 0/0 to 25/0								
3	Shimla Tattapani Mandi Road (From Dhally to Tattapani) Km. 6/00 to 33/300 & 45/550 to 52/300 ,	Mechanically		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
4	Sujanpur sandhol Marhi road Km. 0/0 to 23/0	Mechanically		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
5	Hamirpur Bhoranj Jahu road Km. 2/690 to 32/745	Mechanically		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
	<b>Total No.</b>	Mech. -5 Manually-0	0	5	0	5	0	0	5

A detailed discussion based on the pre-decided questions was held with the engineers at different levels of hierarchy posted in the Divisions in which the selected roads fell. Only those engineers were contacted who were actually involved in implementation of PBMC of the selected roads even if they had been transferred to some other division by tracing their present place of postings. All the questions put to them were direct and no indirect questions were asked. All the questions put were open ended and were related to the quality of service rendered by the contractor in their perception on the PBMC shown in Figure 6. 20% of the respondents opined that performance of contractor was good. 60% believed that performance of the contractor was average and could have been better. 20% believed that performance was below

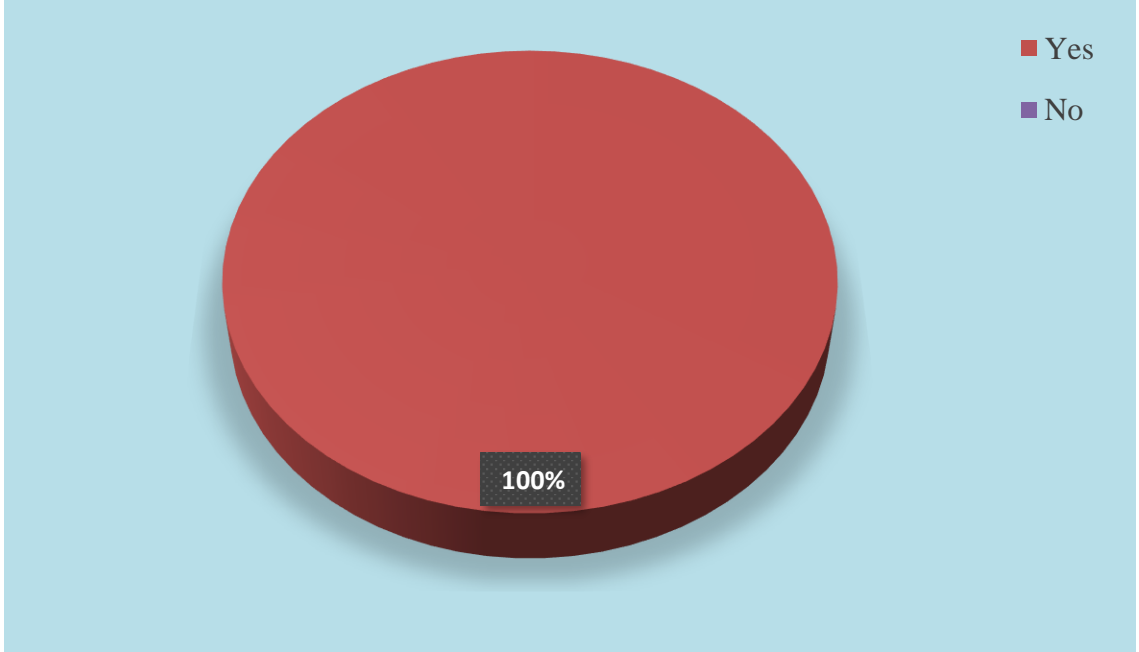


average and they agreed that contractors' focus was on earning the profit out of the improvement component of the PBM contract. The Contractor tried to escape the liability and risk linked with the performance based maintenance during the later part of the contract. They never employed labour and machinery as per requirement on their own and waited for the call from PWD authorities to take action related to those components.

**Figure 6: Performance of the Contractor in Implementation of PBMC**

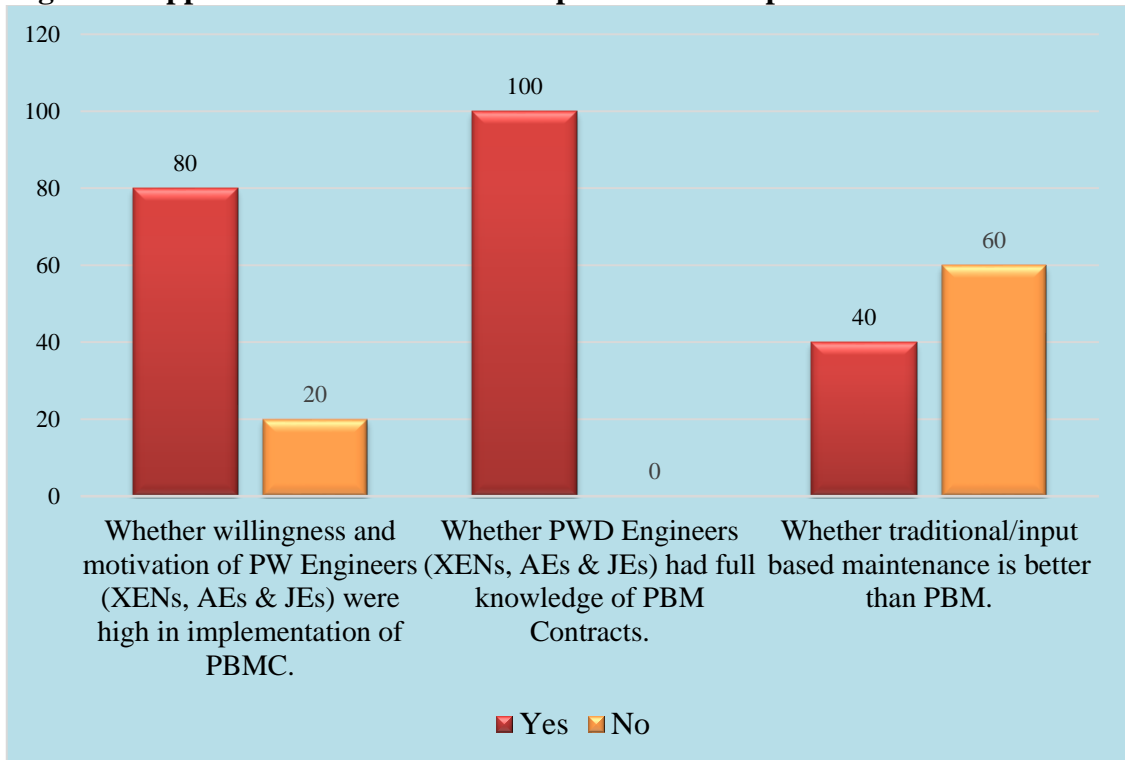


**Figure 7: Full and Effective Enforcement of the PBMC by Public Works Department**





**Figure 8: Approach of Public Works Department in Implementation of PBMC**



An interesting fact that emerged from the discussion with the engineers responsible for enforcement of PBMC is that they had claimed to have thorough knowledge about the strengths of OPBMC and yet 60% of them still believed that the traditional unit cost based maintenance model was better than the PBMC maintenance. All the engineers also claimed that the PWD had effectively enforced the PBMC on maintenance of selected five roads. 40% of the engineers also believed that the performance of the contractors in complying with the agreed upon contractual clause was not up to the mark. Only 20% engineers held the view that the engineers of the PWD were not adequately motivated and willing to follow the PBMC based maintenance.

Different opinions given by the engineers of the PWD indicate to a possibility that due to it being a relatively new practice, the departmental officials are not very comfortable with the concept as change from the convention always meets a resistance initially. Considering relatively high impact and effectiveness of the PBMC based maintenance of roads, it would be worth considering a recommendation of the study that departmental engineers and other officials are given orientation to the benefits and



various components of the PBMC based maintenance through special and dedicated training programmes.

The tendency of the contractor to avoid or skip compliance during the later period of the contract requires strict enforcement by the engineers. The practice of compliance by the contractor only after intervention of the departmental engineers needs to be curbed by designing and incorporating certain additional penal clauses into the contract. Timeliness of all the compliances also needs to be monitored very closely. 60 percent of the interviewed engineers reporting performance of the contractor as below average, in itself, as an indication of poor enforcement and monitoring by the departmental officers.

A minimum fixed tenure of the engineers without frequent transfers/ changes also needs to be ensured to see that contractors render all the compliances within agreed upon timeliness.





In this part, analysis of quality of PBM roads with the help of road roughness index and other operational indicators has been analysed to further explore the effectiveness of PBM contracts in the improvement of condition of selected roads.

### **6.1 Quality of Service based on Road Roughness Index**

Performance indicators such as Road Roughness Index provide the basis for comparison of service level of PBM roads with similar roads with maintenance based on unit cost. The data collected from the Public Works Department before and after PBMC forms the basis of this analysis. Table 10 lists the time series data of road roughness index of the projects implemented under the Performance Based Maintenance Contract. From the year 2010 to 2014, the maintenance data was not available with the department as data or riding quality test report was never collected mechanically with the help of Bump Integrator. From the year 2015 to 2020, PBMC has been implemented on the selected roads and roughness is worked out and documented in mm/Km as per MoRTH specifications.

In the absence of road roughness data pertaining to pre- PBMC period it is difficult to draw any inference as to what extent the road conditions have improved after the implementation of OPBMC. Yet the road roughness index for the year 2015 has been assumed to be a benchmark that existed at the end of the conventional unit cost based maintenance method to compare the changes in the road roughness index during



execution period of the OPBMC. Figure 9 shows that along the roads (A, G & H) during the traditional maintenance contract process there existed extremely high degree of unevenness as reflected by the road roughness index, as all in-carriage roads were not in proper pavement condition.

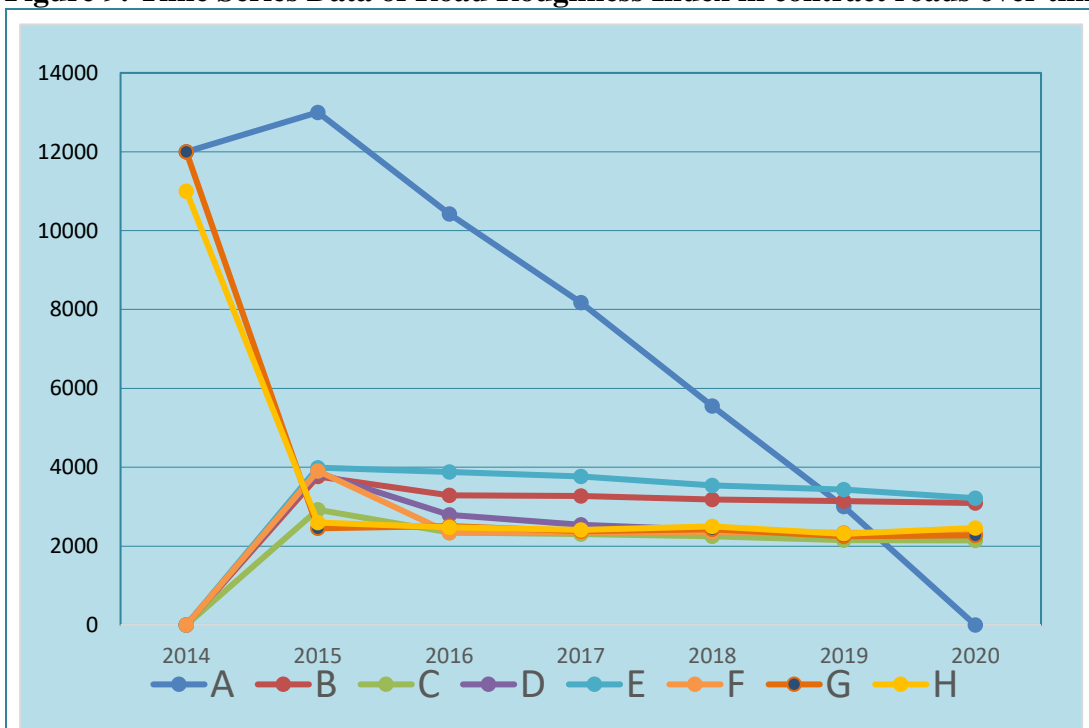
Table 10: Time Series Data of Road Roughness Index												
Project Name	Road name	During (Year wise) Traditional Maintenance Contract					During PBMC					
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	2	3	4	5	6	7	8	9	10	11	12	13
<b>A</b>	Shimla Tattapani Mandi road (From tattapani to Dadaur)	---	---	---	≥11000	≥12000	13000	10424	8174	5549	3000	....
<b>B</b>	Hamirpur Sujapur Thural Maranda road (portion) Alampur to Thakudawara	---	---	---	---	---	3765	3290	3270	3180	3138	3090
<b>C</b>	Bhawarna Jhungadevi road	---	---	---	---	---	2922	2343	2301	2249	2148	2142
<b>D</b>	Ranital to 32 Mile (Kotla road)	---	---	---	---	---	3852	2788	2542	2412	2312	2301
<b>E</b>	Gaggal Tiara Lunj road	---	---	---	---	---	3989	3878	3765	3542	3435	3217
<b>F</b>	Shimla Tattapani Mandi Road (From Dhally to Tattapani)	---	---	---	---	---	3908	2337	2350	2365	2340	2335
<b>G</b>	Sujanpur sandhol Marhi road	---	---	---	---	≥12000	2450	2510	2375	2430	2250	2275
<b>H</b>	Hamirpur Bhoranj Jahu road	---	---	---	---	≥11000	2600	2475	2410	2500	2310	2460

In contrast, a minimum performance standard of calibrated roughness in mm/Km is expected during the performance based maintenance period. Road- A (Tattapani to Dadour) had a gradual decrease in road roughness from 12000mm/Km to 3000mm/Km between 2015 and 2019; which can mainly be attributed to the implementation of ordinary maintenance, rectification, and other minor improvement works. The roughness of all other roads were within the permissible good to average limit of 2250 – 3989 mm/Km once performance-based maintenance contracts were



introduced in 2015. The physical manual inspection conducted by the staff of Planning Department in the month of September, 2021 revealed that the roughness was visibly greater on roads A, F, G & H (Table 10) after one year of the expiry of PBM contract in 2019-20. The PWD engineers also had the same view that the road roughness was gradually increasing against the expected performance standard. Therefore, we may conclude that riding quality level of the roads during the implementation of PBMC was maintained with in the permissible limits and started deteriorating after expiry of the contract. This was a clear indication that any road during OPBMC period is maintained in good condition by the contractor provided contract enforcement is closely monitored by the departmental officers.

**Figure 9: Time Series Data of Road Roughness Index in contract roads over time**



Name of Projects	
<b>Project-A</b>	Shimla Tattapani Mandi road (From tattapani to Dadaur)
<b>Project-B</b>	Hamirpur Sujampur Thural Maranda road (portion) Alampur to Thakudawara Km. 24/135 to 59/775
<b>Project-C</b>	Bhawarna Jhungadevi road Km. 0/0 to 26/280
<b>Project-D</b>	Ranital to 32 Mile (Kotla road Km 0/0 to 39/173
<b>Project-E</b>	Gaggal Tiara Lunj road km. 0/0 to 25/0
<b>Project-F</b>	Shimla Tattapani Mandi Road (From Dhally to Tattapani) Km. 6/00 to 33/300 & 45/550 to 52/300 ,
<b>Project-G</b>	Sujanpur Sandhol Marhi road Km. 0/0 to 23/0
<b>Project-H</b>	Hamirpur Bhoranj Jahu road Km. 2/690 to 32/745



Formats for service quality inspection was devised to collect data on Performance Indicators set by the PWD engineers in the bid document to ascertain the service level of the contractor and payment deductions for incomplete job activities. The result has been summarized in Table 11. Full payment was made to the contractor for performance-based maintenance only against 100% compliance with the service quality level of various aspects after visual inspection as part of the formal and informal inspection by PWD officials.

Payment reductions for non-compliance of 28 service levels fixed by the PWD engineers pertaining to road user service comfort measures and durability (other than roughness) have been incorporated in the bid document. The deductions in the contractor’s payment certificate were determined and added for the non-compliance of service quality for all aspects. The calculations for the Payment deductions for each kilometre of road each month was calculated based on formula shown in Figure 10.

**Figure 10: Calculation of payment deductions for non-compliance of 28 Service Levels**

**Example:**  
 Pothole Patching-The length of the network less excluded sections is 100Km. 20km of pothole patching is identified in the monthly Program for repair within the month, based on the Contractor's and Engineer's inspections. However, at the end of the month after assessment it was found that if 15km of the total 20km had been repaired by the Contractor. 5 km had not been completed within the required Response Time.  
*Accordingly, the assessed deduction for non-compliance is:*

Operation & Management (OM) Lump Sum Bid (Schedule 1 Item 1)  $\times$  1/60 (per month)  $\times$  18% (percentage applicable for Potholes)  $\times$  5KM/100KM (portion of road not compliant to the Service Level for this activity)

Deductions for all Standard Job activities are calculated similarly and totalled.  
 Payment reduction also to be made in respect to road usability (interruption of motorized traffic) and non-provision of management requirements, for example, failure to provide the following: the Patrol Maintenance Unit, and program reports.  
 Deductions for all items to be added to determine the total penalty to be applied against the Lump Sum.

*Source: Bidding Document, OPBRC Maintenance of Package-4- Roads in Kangra District of H.P.*

The formal discussions with the PWD officials revealed that no payment reduction was made in any of the PBMC road and yet all officials backed the penalty



and payment reduction provision provided in the PBM contract. They also suggested that the provisions of penalty deductions made in the contract are not compatible and need modification because contractors pay little attention on the off-carriage activities.

## 6.2 Quality of Service based on Operational Indicators

In order to pay for maintenance services monthly, the contractor must ensure that the road quality under the contract is complied with the level of service quality specified in the bidding document. The Public Works Department determines how to deduct payments for incomplete activities of 28 specified works under road user service & comfort measures, road usability and project measurement requirement.

Service quality evaluation for 1 Km section of road by the survey team showed that most of the works such as signage boards on road bifurcations, road guard stones, guard rails, parafits, distance stones, danger signs, narrow road signs, left right side white road markings, cat eyes, speed limit boards etc. were never paid attention to nor installed as was required under the PBM contract.

The data collected and shown in Table 11 substantiates that 10% weightage has been given by the department to Signalling and Road Safety aspect. 50% weightage has been given to in-carriage maintenance aspect and remaining 40% to the off-carriage aspects/activities of the road by the PWD engineers. Other works like road signage, side white road marking, cat's eye which are important dimensions especially, during night which carry a small weightage, are either never or rarely complied with. The maximum non-compliance on signalling and safety aspects was recorded at 36%, 22%, 18% and 12% with the quality of service level as assessed based on the assessment. The rest of the maintenance aspects with compliance were within the permissible standards.

It is clear from the Table 11 that the Public Works Department was successful in getting the paved roads (in-carriage) maintained, but the other important aspects of roads, mainly works related to off-carriage part of the roads could not be properly done by the contractor or was done on the call of PWD. This is probably due to low weightage assigned to compliances related to these aspects for payment deduction. This aspect needs a special attention by the PWD by either rethinking about the weight assigned to this aspect or by including more stringent clauses in the contract as off-carriage aspects of any road are as important as in-carriage aspects are.



**Table 11: Service quality evaluation for 1 Km section of road <sup>[5]</sup>**

Aspects	Weight factor/ value (%)	Project (^)							
		A	B	C	D	E	F	G	H
<b>(A) Pavement/ shoulder/ roadside</b>									
Patch work	15	0	0	0	0	0	0	0	0
Cracks/ rutting/ ravelling	9	0	0	0	0	0	0	0	0
Pavement edge break	16	0	0	0	0	0	0	0	0
Cleanliness	2	0	0	0	0	0	0	0	0
Shoulder	11	0	0	0	0	0	0	0	0
Embankment slopes	3	0	0	0	0	0	0	0	0
Vegetation control	4	0	0	0	0	0	0	0	0
Obstruction on road	10	0	0	0	0	0	0	0	0
<b>Sub Total (A)</b>	<b>70</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>(B) Bridges and structures</b>									
Bridge Maintenance	3	0	0	0	0	0	0	0	0
Retaining and protection wall	3	0	0	0	0	0	9	0	0
Waterway maintenance	3	0	0	0	0	3	0	0	0
<b>Sub Total (B)</b>	<b>9</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>9</b>	<b>0</b>	<b>0</b>
<b>(C) Drainage System</b>									
Longitudinal drains	5	0	0	0	0	0	5	10	5
Culverts and cause ways	6	0	0	6	0	0	0	0	0
<b>Sub Total (C)</b>	<b>11</b>	<b>0</b>	<b>0</b>	<b>6</b>	<b>0</b>	<b>0</b>	<b>5</b>	<b>10</b>	<b>5</b>
<b>(D) Signalling and road safety</b>									
Sign maintenance	2	6	4	4	0	2	6	0	4
Kilometer/ delineators/ guideposts/ confidence blocks	2	6	0	0	0	2	0	0	2
Road marking	4	16	4	0	0	16	8	8	0
Crash Barrier or Parafits	2	8	0	0	0	2	4	4	2
<b>Sub Total (D)</b>	<b>10</b>	<b>36</b>	<b>8</b>	<b>4</b>	<b>0</b>	<b>22</b>	<b>18</b>	<b>12</b>	<b>8</b>
<b>(E) Provision of maintenance services (to be confirmed from concerned JE)</b>									
<b>Sub Total (E)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Total A+B+C+D+E</b>	<b>100</b>	<b>36</b>	<b>8</b>	<b>10</b>	<b>0</b>	<b>25</b>	<b>32</b>	<b>22</b>	<b>13</b>

Name of Projects (^)	
<b>Project-A</b>	Shimla Tattapani Mandi road (From tattapani to Dadaur)
<b>Project-B</b>	Hamirpur Sujampur Thural Maranda road (portion) Alampur to Thakudawara Km. 24/135 to 59/775
<b>Project-C</b>	Bhawarna Jhungadevi road Km. 0/0 to 26/280
<b>Project-D</b>	Ranital to 32 Mile (Kotla road Km 0/0 to 39/173
<b>Project-E</b>	Gaggal Tiara Lunj road km. 0/0 to 25/0
<b>Project-F</b>	Shimla Tattapani Mandi Road (From Dhally to Tattapani) Km. 6/00 to 33/300 & 45/550 to 52/300 ,
<b>Project-G</b>	Sujanpur Sandhol Marhi road Km. 0/0 to 23/0
<b>Project-H</b>	Hamirpur Bhoranj Jahu Road





### 6.3 Discussion

- The time series data during the PBMC process from Year 2015 to 2020 shows that PBMC process was well implemented on all the road sections as the road condition was good during the contract period as indicated by the road roughness index and other compliances.
- The performance standard based on International Roughness Index (IRI) in the initial road condition survey expects the road to be in good condition (<4500mm/Km) during the performance based maintenance period. In most of these roads the ordinary maintenance works, initial rectification works, minor improvement works under Performance Based Maintenance Contract only started and completed after year 2015. The gradual reduction in road roughness values has shown the backlog in the maintenance work.
- The contract modality of performance Based Maintenance Contract is based on the input based bill of quantities, and an approximate 42% of the total contract amount was spent on the ordinary maintenance works, initial rectification works, minor improvement works which directly confirms that backlog has resulted an increase in the performance based maintenance contract amount and the condition of the road was not fair before the implementation of PBMC. The modalities of the contract under Performance Based Maintenance Contract were fully indicative of that risk.
- The contractor was able to maintain the performance standard based on IRI and which has clearly resulted in increased traffic volume on these roads in the later part of the PBMC. However, there is no record of traffic data with the PWD engineers or with the contractor. This inference is based on the feedback received from the users and vendors along the road.
- The reason for faster deterioration of roads pavement is the overloaded traffic and increasing traffic volume in the later part of the contract. The contract had no provision of axle load control through installation of weigh bridge.
- The contract modality is not totally output based as the bill of quantities on all contracted roads contain the item of works and the contractor quote the rate for each item to compete for the bid. Therefore, it is difficult to ascertain what the



contracted road contains under performance level and what on rate for each item during the PBM contract.

- There is a suggestion for the modification of the service quality inspection format compatible with the geography of the State.
- Overall, the PWD and contractors were able to maintain the 100% performance standard on the paved roads but the performance was dismal on the off-carriage activities. However, there was no record of inspection formats with the PWD engineers or with the contractor that was shared with the survey team.





Apart from receiving feedback from the officers of the Public Works Department on the OPBMC, users on the road were also interviewed to assess the level of their satisfaction with the quality of road they used which was under the OPBMC contract. 240 users were interviewed in all using all the 8 selected road segments. These users were categorized into two distinct categories viz. commuters and others. Persons driving taxis, commercial vehicles and heavy vehicles; own vehicles including two wheelers on the day of survey were included in the category of commuters. All other users like pedestrians using the road, residents and shopkeepers along the selected road segment, porters and labourers found working on the selected road segment on the day of survey were included in the second category of respondents. The questionnaire administered constituted of two parts- the first part sought general information related to the respondents and the second part tried to capture their level of satisfaction with the quality and other attributes of road on a five point scale.

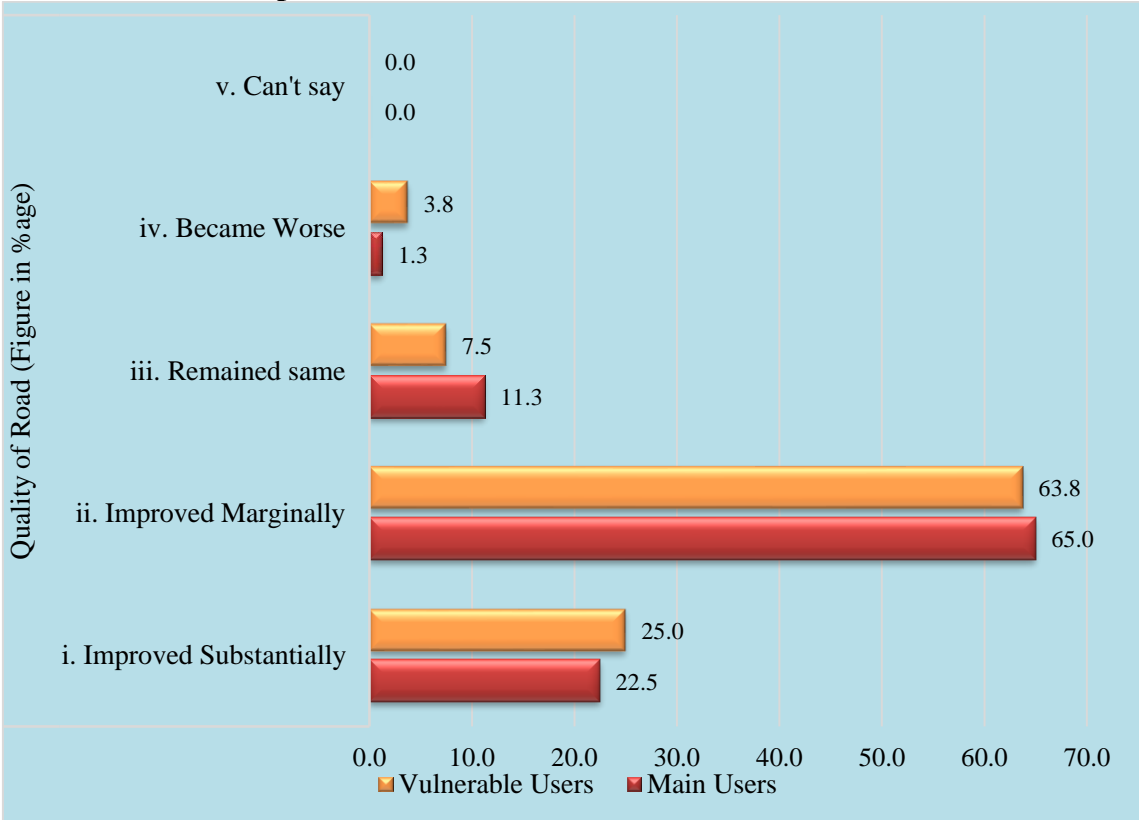
## 7.1 Road Condition

The commuters were asked to indicate the level of their satisfaction with the quality and condition of road during the OPBMC which has been captured in the Figure 11. Majority of the commuters indicated to marginal improvement in the condition of the road during the OPBMC period. The percentage of such responses was 65 percent. Only about 23 percent of the commuters were of the opinion that the quality of the road had improved substantially during the OPBMC period. Around 11 percent commuters



opined that the quality of the road has not changed and only 1.3 percent of the respondents responded by saying that the road quality had deteriorated post OPBMC. Almost similar pattern of satisfaction level was exhibited by the other category of respondents with minor variations. The inference that can be drawn certainly from the feedback received from the users is that the road condition had actually improved post OPBMC.

**Figure 11: Satisfaction level of main & vulnerable users in percentage regarding their experience with road condition**



Source: Interviewed Main users- 160 and Vulnerable users- 80

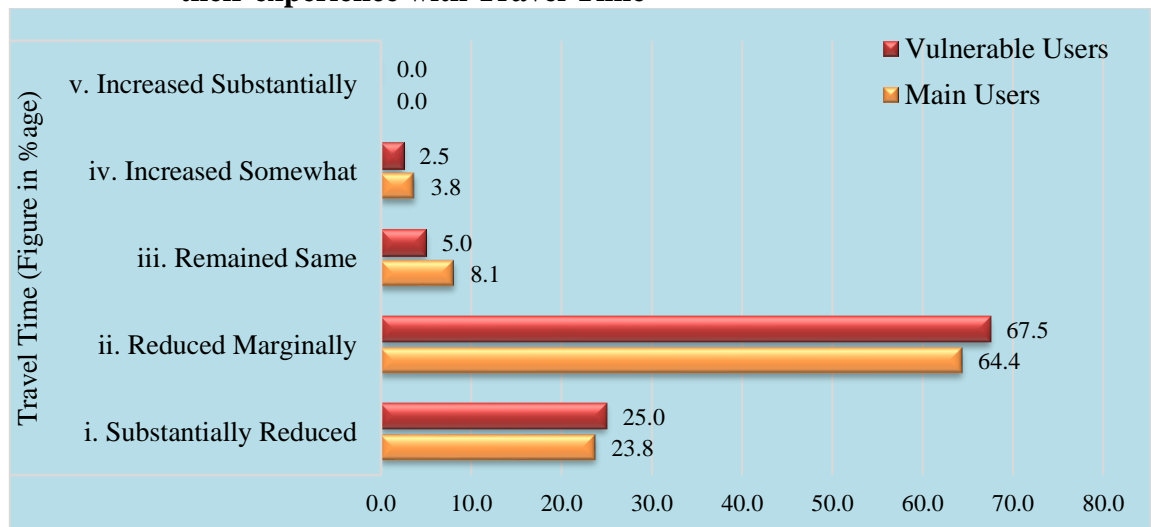
### 7.2 Travel Time and Fuel Economy

About 65 percent of the commuters responded by saying that the time taken to travel along the same road was marginally less than what it used to be taken during the conventional unit cost based maintenance contract. About one fourth of the commuters actually reported to have experienced considerable reduction in time taken to travel along the road post OPBMC. It can be concluded safely that improved road condition during the OPBMC was responsible for reducing the travel time along the road segment. The second category of the users also confirmed the same as 25 percent of



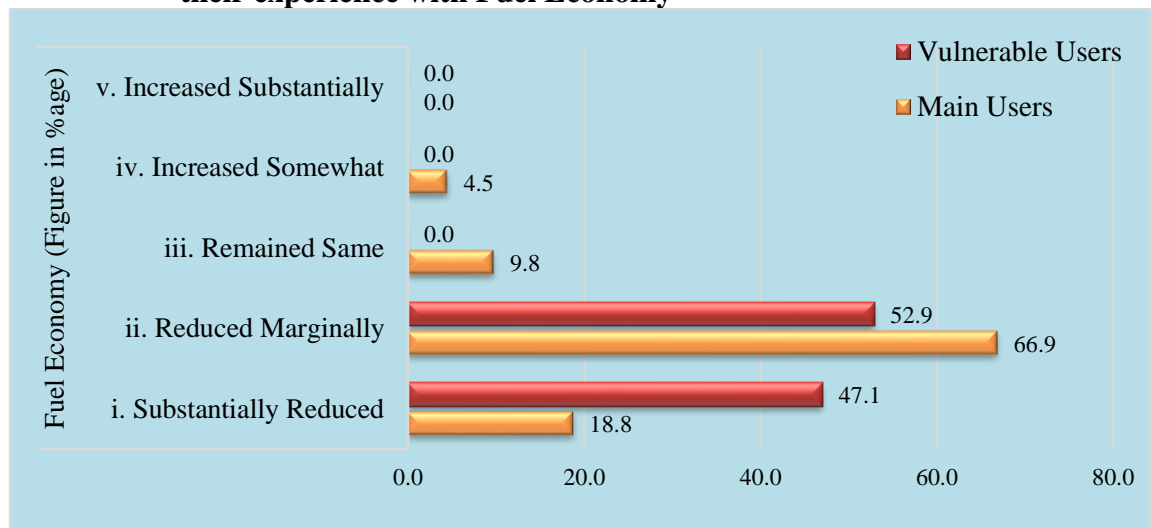
them indicated to substantial reduction in travel time whereas about 68 percent users were satisfied with marginal reduction time taken to cover the distance along the selected road segment. The users who exhibited little or no satisfaction with the improved road quality post OPBMC were not probed further exploring the reasons for their dissatisfaction/ low satisfaction. However, the apparent reasons that seemed to have influenced the level of their satisfaction were narrow road width, sharp bends without banking on roads, no or little presence of off-carriage components etc.

**Figure 12: Satisfaction level of main & vulnerable users in percentage regarding their experience with Travel Time**



Source: Interviewed Main users- 160 and Vulnerable users- 80

**Figure 13: Satisfaction level of main & vulnerable users in percentage regarding their experience with Fuel Economy**



Source: Interviewed Main users- 133 and Vulnerable users- 17



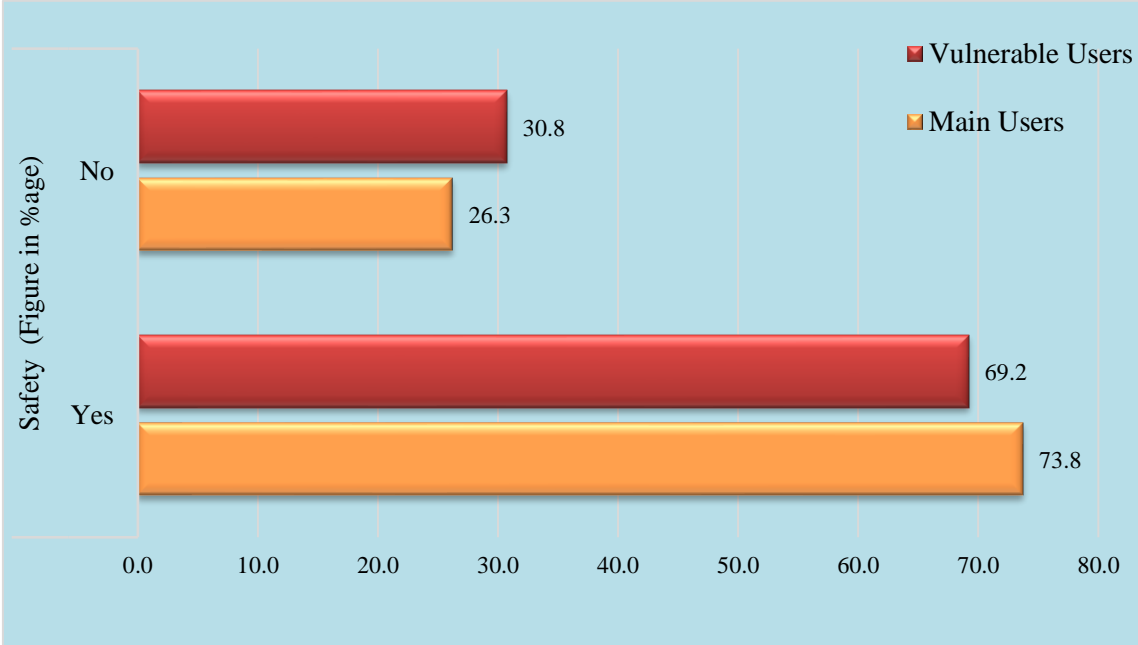
About 86% of the main users affirmed that the fuel consumption has reduced while travelling on the selected road segment post OPBMC, out of which only about 19 percent of the users reported to have experienced substantial reduction in fuel consumption. The findings are supportive of the fact that improved road conditions not only reduce fuel consumption but also helped in reducing the travel time along the improved road segment.

### 7.3 Safety

Both the categories of the users interviewed had almost similar opinion when they were asked about the safety aspect post OPBMC. Around three fourth of the users were affirmative in responding that the improved road quality post OPBMC has improved the safety of the commuter while travelling along the road segment maintained through OPBMC. However, the safety concerns of the remaining one fourth of the users still remain a point of attention for the executing department.

It is clear from the responses (shown in Figure 14) received from the users that OPBMC based maintenance of roads has not only improved the road conditions but has also contributed to enhanced safety of the commuters.

**Figure 14: Satisfaction level of main & vulnerable users in percentage regarding their experience with Safety**



Source: Interviewed Main users- 160 and Vulnerable users-78



# CONCLUSION AND SUGGESTIONS



1. Component wise cost distribution and expenditure percentage clearly indicate to the fact that periodic maintenance occupies the largest proportion of the total amount of the contract (OPBMC). The minor improvement works constitute the least percentage of total contract amount. This pattern explains front loading behaviour of the contractor and contractor's least priority for other minor improvement works including ordinary maintenance, initial rectification works etc.
2. It has also been observed that the contractors have not delivered the full service as per the contract agreement related to all the five components of the contract identified for present survey. This only indicates to poor service delivery but also points to weak contract (OPBMC) enforcement by the Public Works Department.
3. With the road maintenance through OPBMC, the Road Roughness Index (RRI) showed an improvement with the passage of contract period and was maintained within the limits agreed upon as permissible under the contract.
4. All the selected road segments for the survey were maintained in reasonably good condition through OPBMC based mode of maintenance which has resulted in accident risk reduction, reduction in travel time and enhanced fuel efficiency.
5. The OPBMC contains clauses indicating to monthly expenditure well in advance leading to certainty in the expenditure required to be incurred for maintaining a



particular road. This would certainly enable the Public Works Department to plan the maintenance of roads for longer period in advance.

6. The comparison between the traditional unit cost based maintenance method and the OPBMC based maintenance mode, in terms of the total cost incidental on the road agency, clearly indicates that the OPBMC turns out to be a cost effective mode of road maintenance. Other implied costs including over head expenditure, if is also considered, will lead to inferring that a considerable cost reduction can be witnessed by the road agency by following OPBMC mode of road maintenance.
7. The contractors have failed to honour their off-carriage commitments like display of signboards, collection and management of asset inventory data, emergency call logs, records of response to public requests etc. as they were not well defined in the contract.

Finally, based on the findings of the survey, following recommendations are made for make Performance Based Maintenance Road Contracts (PBMC) more effective and efficient in the State:

1. The contract despite having defined in-carriage responsibilities of the contractors must also contain clear and explicit mention of the off-carriage responsibilities of the contractor along with the clauses enabling risks transfer to the contractor.
2. The standard format for monitoring the quality indicators and inspection formats designed by the road agency may not necessarily be applicable for the roads located in entirely different location with different topography and terrain. The department needs to customize all the formats catering to the requirements of various topographical features in consultation with the domain experts. This will help in better monitoring and feedback.
3. It would be a good idea to include comments made by the consultants in every DPR for execution of OPBMC. This will help in evaluating the success of the contract against the comments made by the consultants and making them a standard, if required.
4. Effective supervision and monitoring during execution of the OPBMC is an imperative for efficient enforcement of the contract. The concerned officers,





contractors and other stakeholders may be educated about various clauses of the contract and the need and importance for including each of them into the contract. Departmental capacity needs to be up-scaled with the help of well designed modules and their timely administration.

5. A detailed inventory of the road network within the State with well defined parameters and attributes is required to be established and its periodic updation is required for ensuring evidence and information based detailed maintenance plan for a period covering at least four to five years. This information will also help in better implementation of the OPBMCs.



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