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ROLE OF HDM-4 IN FUTURE MAINTENANCE BY SELECTING THE BEST ALTERNATIVE OF THE MMU INSTITUTIONAL ROAD NETWORK

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ABSTRACT

A study has been carried out on Maharishi Markandeshwar University Institutional road network to provide a powerful system for the analysis of pavement management. The Highway Development and Management-4 (HDM-4) software has been used for Project analysis of the Institutional road network. The HDM-4 tool provides the deterministic approach in data input and processing also utilizes data on existing road condition, traffic volume and composition to predict road deterioration. A network economic evaluation is the most challenging use of the model, but the effort is well justified due to the potential savings on transportation costs achieved by comparing various alternatives and performing a budget constraint optimization. This paper presents guidelines of HDM-4 analysis, reviews the applied methodology, input requirements and also shows future directions in order to choose the best alternative through Internal Rate of Return values being generated through HDM-4 software.

Keywords: HDM-4, Highway , Institutional Road, Internal Rate Of Return, Pavement Maintenance Management System

I. INTRODUCTION

HDM-4 is computer software for Highway. Development and Maintenance Management System. It is a decision making tool for checking the Engineering viability of the investment in road projects. The World Bank for the global use has developed it. The Highway Development and Management-4 (HDM-4) software is a decision making tool for checking the engineering and economic viability of the investments in road projects. The HDM-4 system assists in effective investment choice at all management levels (IRC, 1997). Generally the factors associated with both economic and equity consideration in road project investment decisions are also said to be difficult to isolate, measure in their respective units and predict over a long term. The HDM-4 develops and implements pavement maintenance management system to make consistent decisions on maintenance, rehabilitation or reconstruction of road pavements. The HDM-4 model can be used both for strategic planning and programming of road works requiring different levels of input data. For planning purposes, an evaluation of road classes is typically conducted characterizing representative road classes with aggregate data of traffic and road condition.

1.1 OBJECTIVE- The objectives of the study is to develop a Pavement Management Maintenance System (PMMS) for MMU institutional road network. The scope of work Include comprehensively the following:

- To predict pavement maintenance and rehabilitation standards.
- To find out the best alternative for road network.
- To calibrate the pavement deterioration models of HDM-4 using the collected data from the institutional road.
- To develop the PMMS methodology.

II. METHODOLOGY

2.1Identification of Maharishi Markarndeshwar University Institutional Road Network- The prime step in developing the pavement management system is to identify the road network. Fig. 1 shows the layout plan for the selected road network.

Figure 1. Layout Plan of Selected Institutional Road Network

2.2 Data Collection and Database Management-It is necessary to ensure that the minimum data collected provides information regarding riding quality, surface distress, road inventory, traffic characteristics and pavement strength. The important aspect in data collection is to collect as little as possible that will provide the necessary management information .In the software system, the data collection is classified under following four categories:

- Road Network Data
- Inventory Data
- Vehicle Fleet Data
- Maintenance and Rehabilitation Works Data
- Cost Data

2.3 Road Network data- The road network data includes the locational data that describes the position and geometry of the pavement section, and the attribute data, which describes the road characteristics or inventory associated with it. The data regarding type of pavement, traffic density, Date of last surfacing and maintenance record (if any) were provided by these departments (Aggarwal, S.et al, 2003)

2.3.1 Road Network element

- Traffic flow pattern: The traffic flow pattern in case of each pavement section is defined as of the type 'Inter Urban'.
- Speed flow type: The speed flow type on different pavement segments varies from "Intermediate Road" depending upon the capacity and the width of carriageway.
- Climate Zone: As the area in concern is of small extent, only one kind of climate namely "Sub Humid" have been used for Ambala.

2.3.2 Functional Evaluation-Functional evaluation of pavements involves the collection of road data relevant to surface distress (crack area, raveled area, pothole area), rut depth, surface roughness etc. The extent and type of distress developed in quantitative terms were visually inspected and measured,in addition to the visual recording of the pavement surface condition (Kerali, H.R.et al, 2000). The information on type of shoulder, width, and condition, and drainage etc. was also recorded.

- Measurement of crack area -The affected area was marked in the form of rectangular figures .Incase of single longitudinal and transverse cracks, the crack length was measured and the effective width of the crack was taken as 6 mm. Thus crack area was expressed as percentage of total pavement area. It was observed that in majority of cases the percentage of wide crack area was found to be approximately one-fourth of the total crack area (Odoki, J.B. and Kerali, H.R.,2000)
- Measurement of raveled area-Ravelling is the loss of material from wearing surface. This distress type is associated with thin surfacing, such as, surface dressing, seal coat and premix carpet. The affected area was measured by taking into account area enclosed in regular geometric shapes such as, rectangle, triangle etc. and then it was expressed as percentage of total pavement area (Martin, T.C. et al, 2004)
- Measurement of pothole area–The pot holes were measured in square meters and then it was converted into volumes of standard pot holes for HDM-4 software.

2.4 Inventory Data- Inventory data contains the following details about the selected pavement segments: Name of road, category of road, carriage way and shoulder width, drainage conditions ,surface type and thickness, pavement layer details etc.

2.5 Vehicle Fleet-Vehicle fleet comprises of 2 Axle Trucks, Tractor/ Trolley, Car/Jeep, Buses, Motorcycle, Auto Rickshaw. Survey was conducted in calculating the total vehicle coming in and going out of the road. It is found that coming in vehicle is almost equal to going out. Through the survey conducted and calculations done. Motorized and non motorized AADT found to be 3400 and 420.Depending upon the frequency of vehicular movement, 24 hour day has been divided into 7:30 am-12:30 noon , 12:30 noon -5:30 pm , 5:30pm -10:30pm , and 10:30 pm -7:30 am.

2.6 Cost Data-The road user cost (RUC) data is one of the most important in the life-cycle cost analysis of pavements. The road user cost is composed of three main components. Vehicle Operating Cost (VOC) is defined as the price the user has to spend to move the vehicle per unit distance. Time cost involves monetary value of the time of passengers spent on travelling and the time taken by cargo in transit. The accident cost involves costs of human life and property, which is very difficult to quantify in monetary terms (Kerali, H.R.et al, 1998)

2.7 Input data-The input data for this study is included in the 'Road Network' and' Vehicle Fleet' data bases as defined earlier. An optimum analysis period of 25 years is selected considering the fact that almost all pavement segments will become candidates for reconstruction in the next twenty five years in the absence of any other maintenance or rehabilitation measure.

2.8 Specify alternatives- Since the purpose of this study is to determine the time period before reconstruction of the pavement is due, only one Maintenance & Rehabilitation (M&R)alternative is defined for each of the selected pavement section. Different type of work standards was provided. Table1 shows the various alternatives chosen for the selected institutional road network.

Table1. Various Alternatives Taken for the Road Network

Alternative	**Description**	**Intervention Criteria**
Routine Maintenance	Pot holing and Crack sealing	Pot holing is applied when the pot holes exceeds by 2 per km and Crack sealing is applied when the cracks exceeds by 10%.
Alternative-I	The thickness of surfacing is 25mm SDBC and the surface material is asphaltic concrete.	Total damaged area is increased by or equal to 15%.
Alternative-II	The thickness of surfacing is 40 mm BC and the surface material is asphaltic concrete	Total damaged area is increased by or equal to 15%.
Alternative-III	The thickness of surfacing is 50 mm DBM and the surface material is asphaltic concrete.	Total damaged area is increased by or equal to 15%.
Alternative-IV	Alternative-IV the thickness of surfacing is 12 mm and it is described as micro surfacing and the surface material is asphaltic concrete.	Total damaged area is increased by or equal to 15%.

2.9 Analysis of Project- The best alternative for the selected institutional road network sections was selected on the basis of Internal Rate of Return method. IRR values of the various alternatives have been taken from the generated reports of the HDM-4 software. Internal Rate of Return is the discount rate which makes the discounted future benefits equal to the initial outlay. Basically it is the discount rate which makes the stream of cash flows to zero. The internal rate of return is a rate of return used in capital budgeting to measure and compare the profitability of investment. IRR is a rate quantity, it is an indicator of the efficiency, quality or yield of an investment. IRR is also useful for corporation in evaluating stock buyback programs.

III. RESULTS AND DISCUSSION

Selection of the best alternative from the selected alternatives was done on the basis of Internal Rate of Return which was generated by HDM-4 software. Table2 shows the values for IRR for the various alternatives calculated on the basis of the input data in the software. Currency of IRR value is Million Rupees.

Table2. Values of Internal Rate of Return

Alternative	Increase in Agency Costs (C)	Decrease in User Costs (B)	Net Present Value (NPV=B-C)	NPV/Cost Ratio (NPV/C)	Internal Rate of Return (IRR)
Base Alternative	0.000	0.000	0.000	0.000	0.000
Alt 1	4.018	78.550	74.531	18.548	**137.8**
Alt 2	7.956	92.102	84.146	10.577	95.0
Alt 3	8.381	100.316	91.935	10.969	99.7
Alt 4	7.317	64.972	57.654	7.879	74.8

From the analysis it can be concluded that Alternative 1 i.e. 25mm SDBCis the best alternative having the highest value as 137.8 million rupees.

IV. CONCLUSION

The above study has shown that the alternative having highest IRR value is the one with composition having layer of 25mm Semi Dense Bound Macadam (SDBC). This alternative proves to be the most economical for the vehicle fleet and present road network conditions. Also it can be stated that HDM4 software is a highly effective tool for the future maintenance and management of road networks existing.

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