Discrete Event Simulation Model for Project Selection Level Pavement Maintenance Policy Analysis

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Abstract

A pavement investment and management process has a dynamic structure with cause and effect. Better investment decisions for maintenance will increase the condition of the flexible pavement and will end up with a better level of service. Therefore, better investments decisions on pavement maintenance will increase the economic growth and global competition for the area. However, improper allocation of money and resources would end up with further deteriorations of the facilities. So asset management encourages highway maintenance managers to spend their scarce budget for the maintenance that is really needed. A well-developed pavement management simulation model will allow highway maintenance managers to consider the impact of choosing one maintenance policy alternative versus another through what-if analysis and having informed decisions.

Discrete event simulation (DES) is an alternative method of analysis that offers numerous benefits in pavement management. Unlike the models currently in use, a decision support model created by utilizing the DES technique would allow fractionalizing the pavement in smaller proportions and simulating the policies on these smaller segments. Thus, users would see how their decisions would affect these specific segments in the highway network over a period of time. Furthermore, DES technique would better model the multiple resource requirements and dynamic complexity of pavement maintenance processes.

The purpose for this research is to create a decision support tool utilizing discrete event simulation technique where the highway maintenance managers can foresee the outcomes of their what-if scenarios on the specific segments and whole of the highway network evaluated. Thus, can be used for both project and network level decision support. The simulation can also be used as a guiding tool on when, where and why resources are needed on needs basis.

This research relies on the budget allocation results from the linear optimization model (LOM). This model is a tool that creates the optimized budget allocation scheme for a network fitting to a determined scenario. Thus by integrating the LOM and the DES model, the
maintenance managers can acquire an optimized budget allocation for their district and evaluate the results in both network and project selection level. Maintenance managers can obtain the best budget allocation plan without performing the repetitive trial and error approach like the previous decision support tools.

There is a vast amount of data in many varieties gathered as results from the simulation model. This fact alone demonstrates how powerful the discrete event simulation model is. By the nature of this simulation technique, the resources (highway segments, annual budget) can be traced throughout the simulation and this trait allows the design of the project selection level decision support system. By examining these reports, the maintenance managers can better observe how the scenarios evolve. Thus this tool helps the maintenance managers to have better decisions on the project selection level. The discrete event simulation model established in this research carries the project selection level pavement management from a position where maintenance managers should solely depend on their engineering judgment and experience to a position where maintenance managers can have more effective and justified plans since they can foresee the results of these decisions on the segments that are forming the network.

This simulation engine is created with the discrete event simulation language called STROBOSCOPE. The model consists of two parts which work like a lock and key mechanism. The first part of the model is the data feeding mechanism where information from any network is loaded. The second part is the generic engine which can evaluate any road network data it is fed. The purpose of segregating these two components of the model is to allow the user to evaluate any network regardless of length, number of segments or the location.