Incorporating socio-political criteria into the maintenance prioritization of Chilean urban pavement networks

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A B S T R A C T

Managing urban pavement networks presents additional challenges when compared to the management of interurban pavements. In particular, the prioritization of maintenance activities – which is critical when resources are limited – requires special considerations. Within these considerations, there are socio-political criteria that are not formally considered in current UPMS (Urban Pavement Management Systems). In practice, decision makers consider these socio-political factors but without a formal procedure and proper information, leading to decisions based on subjective information, which lack traceability and reliability.

The objective of this study is the identification and formal definition – including the quantification method – of socio-political criteria relevant for the sustainable management of urban pavement networks. The research method included the application of interviews and a survey of experts and practitioners in various agencies involved in the pavement maintenance decision-making process in Chile. As a result of the study, five primary socio-political criteria were identified: neighbors' perception, proximity to critical infrastructure, benefited population, presence of alternative routes, and strategic selection based on public policy. These criteria were formalized – including how they should be quantified – through an expert panel. A regression analysis applied to various scenarios considered in the survey resulted in the quantification of the relative importance of the formalized socio-political factors to be considered in the decision process, complementing technical and economic criteria. Future research will explore the use of Geographic Information Systems (GIS) to quantify the recommended socio-political factors and implement them in an UPMS.

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1. Introduction

Urban pavement management is a difficult task for the institutions responsible for maintaining and preserving this type of infrastructure due to a number of factors, namely: heterogeneity of pavement structures, hierarchical differences throughout the road network, difficulty in determining vehicle flows, among others. Given the limited financial resources available to maintain public infrastructure, it is necessary to optimize and prioritize the most cost-effective alternatives to maintain the urban pavement network. A common practice worldwide, especially in developing countries, is to make maintenance

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decisions based on subjective criteria, historical investments, and, to some extent, technical and economic criteria. Technical criteria commonly include serviceability, traffic and street hierarchy, while economic criteria usually focus on maintenance costs on a short-term basis.

This practice is not consistent with the sustainable provision of pavement management proposed by the Southern African Development Community (Southern African Development Community, 2003), which considers seven aspects for the sustainable management of road networks: technical, economic, financial, political, social, institutional and environmental aspects.

The problem that arises from the analysis is that the socio-political criteria, such as benefited population or strategic infrastructure that respond to social needs (such as schools, hospitals, and police), have not been standardized nor formalized in the UPMS (Wolters et al., 2011). This leads to politically based decisions instead of informed and well-directed public policies where the network is sustainably prioritized.

For the context of this research, it is important to note that the Federal Highway Administration (Geiger, 2005) considers three types of pavement maintenance activities: Preservation, Maintenance and Rehabilitation (P + M + R). The activity to be carried out in order to improve the pavement condition depends on the level of deterioration of the structure and its functionality. The most cost effective is Preservation, which is used on good-condition pavements, and the least cost effective is Rehabilitation, which is used on structurally damaged pavements. This document will use the term maintenance strategies to refer these three activities.

2. Pavement management and prioritization criteria

Pavement management is the process of planning the maintenance and repair of a network of roadways or other paved facilities to optimize pavement conditions over the entire network (U.S. Department of Transportation, 1986). Pavement management incorporates life cycle costs into a more systematic approach to minor and major road maintenance and reconstruction projects. The needs of the entire network, as well as budget projections, are considered before projects are executed (Shahin, 2005).

A pavement management system (PMS) is a planning tool used to aid decision making on maintenance and resource allocation. Shahin (2005) defines a PMS as "a set of tools or methods to help decision makers find cost-effective strategies to provide, assess and maintain a condition of pavement serviceability". These tools are very useful for road agencies to quantify all pavement maintenance needs and present alternative maintenance strategies under tight budgets (Elhadi and Mohammed, 2009).

One of the main objectives of PMS is the prioritization of the maintenance strategies based on a mix of several criteria. This gives the decision maker the information necessary to choose the best alternatives for the allocation of resources. Most PMS focus on technical–economic criteria (Wolters et al., 2011), but there are some that include socio-political criteria. Wolters et al. (2011) show that the city of Folsom, United States used criteria related to the priorities of the community, i.e., socio-political project selection for maintenance and rehabilitation projects. Additionally, Cafiso et al. (2002) identified social and political issues relevant to pavement maintenance decisions. Such as access to schools and health centers, safety of users and people living near the roads, improvement of the quality of life, promotion of tourism or economic activity, promotion of political stability and sense of accessibility to minorities in the sense of justice.

In the case of Chile, there has been some implementation of PMS, such as HDM III and HDM 4 (De Solminihac et al., 2003), due to the increase of PPP (Public Private Partnership) interurban road projects in the last 20 years. However, the management of urban pavements is still using a basic management system (MINVU, 1988) that does not consider a sustainable approach or socio-political factors. The consequences of these limitations are reflected in studies such as that of Artigas et al. (2003), which says that under current policies on urban road maintenance, the State of Chile may be incurring losses greater than 20% of the current value of the assets.

The few socio-political criteria identified in the literature review constitute a point of departure for our research. Because these criteria relate to cultures and institutions and are scarcely formalized in the literature, there is a need to formalize and quantify this type of criteria for the Chilean reality to implement the results in a new UPMS for the Chilean administration.

3. Research methodology

To achieve the proposed objectives, this research followed the methodology described in Fig. 1.

The methodology begins with the preliminary identification of the criteria through a personal interview that was specially designed to raise criteria currently used to prioritize maintenance strategies of urban pavements, and it was applied to the staff of the agencies involved in this type of project.

During the course of the interviews, respondents were allowed to note all the criteria they used in practice, without introducing criteria preconceived by researchers. These interviews produced a set of preliminary criteria.

To formalize and validate the raised criteria, the researchers carried out a second personal interview with experts and then facilitated an expert panel. The purpose of these activities was to individually and then collectively validate the raised criteria. This also included the formal definition of these criteria and how they should be quantified.

Finally, this research captured the relevance (priorities) of these formalized criteria for decision makers. The methodology for developing the prioritization polynomial was based on a modification of the Delphi method, with no iteration with the