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## Original Research Paper

# Value creation of road infrastructure networks: A structural equation approach



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## ABSTRACT

Although road agencies need to provide road infrastructure that is beneficial for road users, little is known about how the activities of the agencies influence the value creation of road infrastructure. From a service-dominant logic perspective, the importance of road maintenance and traffic management activities for the contribution of road infrastructure to the value-creation process of road users is investigated. Road agencies facilitate the value creation of road users by maintaining, upgrading or renewing road infrastructure, the provision of information about the current traffic situation, possible redirection routes in case of traffic jams, and suggestions for appropriate driving behavior. Based on a structured questionnaire, data were collected among motorists in Singapore and analyzed by means of a partial least square modeling approach. The analysis revealed that road cleanliness and road evenness have a significant effect on the experience of road maintenance. Important and significant indicators for the experience of traffic management are the clarity of road signs and the efficiency of traffic redirection. A main conclusion of the research is that for traffic-intensive networks, both road maintenance and traffic management activities are important contributors to the value creation of road infrastructure with a slightly stronger contribution of traffic management activities. Road agencies need to find appropriate maintenance strategies which reduce and coordinate simultaneous maintenance interventions on the network to such an extent that traffic management activities are able to minimize any considerable loss of traffic flow.

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## 1. Introduction

In modern society, road infrastructure has become an essential part of daily life. Individual road users, logistic firms, and public transportation agencies expect reliable and safe road infrastructure for traveling from one location to another and transporting goods and people. Road agencies need to properly plan, build, maintain, and operate road infrastructure for it to create value for road users. In recent decades road agencies have started to use performance measures to evaluate the effectiveness and efficiency of their service provision. Besides legal obligations and resource constraints, the increased attention towards the needs of road users has been a main motivation for implementing performance measures (Burde, 2008). Road user satisfaction surveys at the national and regional network levels have become a common tool for identifying deficiencies in road services, defining performance targets and measuring their achievements. Typically, these surveys often asked about the satisfaction with particular outcomes of road agency activities such as quality of road surface or lighting on roads (e.g. Hyman and Heffner, 2003; Huijgen et al., 2006; McKenzie, 2004). However, they pay less attention to how road users experience the services of road agencies and how these experiences influence the value creation of road infrastructure. Knowledge about the experiences of road users with the activities of road agencies and the perceived contribution of these activities to the value creation of road infrastructure are important for two reasons. First, the perspective of road agencies can differ from the perspective of road users in terms of the importance of activity outcomes for the value-creation process of the user (Levinson, 2003; Sinha et al., 2009). As shown by the study of Bonsall et al. (2005), the view of transport professionals on the seriousness of specified road problems for users can deviate from the road users' experiences of these problems. Second, many road agencies mainly rely on physical road conditions as the basis for decisions, which do not necessarily reflect the performance understanding of road users (Osman, 2012). Despite the need for incorporating the performance view of road users in decisions, there are only few attempts linking condition parameters and user perception of road quality (e.g. Giese et al., 2001; Haas and Hudson, 1996), and only quite recently, research has suggested that the experiences of road characteristics and traffic conditions have an influence on the utility of traveling (Ettema et al., 2013). In order to support user-oriented policy decisions on which activities should be constantly upheld or improved and which performance targets should be set, road agencies should not only develop a more thorough understanding of the experiences of road users with agency activities, but should also consider the influence of these experiences on the value that road infrastructure creates for its users.

Given the above, the aim of this research is to shed more light on the role of road agency activities for the value creation process of road users. The research builds upon an earlier study of Ling and Ng (2011), which explored the relationship between activity outcomes and road user satisfaction in

Singapore and found two activity outcomes (cleanliness of roads and efficiency of traffic redirection arising from road works) affecting satisfaction. Based on a structural equation approach, we extend the work of Ling and Ng (2011) by examining the relationship between the road user experience of road agency activities and the value that road users achieve through these activities. More specifically, our aim was to investigate the effect of road user experience with two main activity types: road maintenance and traffic management. Both activity types are central to the service provision of road agencies and can be expected to have a great impact on the value proposition of road infrastructure. It is this notion of value offering which forms the theoretical lens of our research. By adopting the perspective of service-dominant logic (Vargo and Lusch, 2004), we argue that road infrastructure itself does not possess any value but only incorporates value proposition for its users. Whether road infrastructure contributes to the value creation of its users is determined at the moment when the users are driving on the road and experiencing road maintenance and traffic management activities of the road agencies, which are manifested in the performance parameters of road infrastructure such as road condition and traffic flow (cf. Sandström et al., 2008).

The relationship between the experience of road agency activity and the contribution of road infrastructure to the value creation of its users is investigated in the context of Singapore. Singapore is a developed country with a complex network of roads. Being a small country with a large human to land ratio, and, consequently, with relatively high traffic on the roads, Singapore makes a good example for the challenge of providing reliable and safe infrastructure in many densely populated urban regions around the world. The tasks of maintaining and managing Singapore's high-traffic roads are performed by a statutory board called the Land Transport Authority (LTA). In this research we examine the experiences of motorists with the road maintenance and traffic management activities of the LTA and the influence of the activity experience on the value that is created when using road infrastructure. By doing so, the research contributes to the wider debate on stakeholder satisfaction and performance measurement in road infrastructure (e.g. Karlaftis and Kepaptsoglou, 2012; Osman, 2012; Pei et al., 2010; Poister, 1997; Rouse et al., 1997; Talvitie, 1999).

In the next section the structure of the conceptual model used in the research is presented followed by the description of the measurement model applied. Then, the research design is outlined. The paper continues with discussing presentation and discussion of the research results. It finishes with some managerial implications, limitations and recommendations for further studies.

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## 2. Conceptual model

Our research draws upon the service-dominant logic stream of literature which posits that value is created by customers during the consumption of services (Grönross, 2011; Vargo and Lusch, 2004). Value is not purely given by the presence of service attributes for which a customer is

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