永續運輸評量方法之建構 – 應用感受性系統模型理論與模糊認知圖

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摘　　要

永續運輸係以追求經濟效率、社會公平及環境保護的運輸系統為主要目標。在社會結構的變遷下，不同用路人族群所產生之多樣性需求，在以小汽車為主要運具的社會中常遭忽略。多樣性運輸需求的問題，目前在歐洲已受到學界的討論與探討分析。在有限的資源下，如何滿足不同用路人不同的需求，其涉及各種交通建設、各種運輸工具、及各種目標下的各種準則。這種複雜的系統，並非有限量化資料就可以分析系統內的變數關係。基於此，如何建構一個兼顧質化與量化，同時滿足經濟、社會及環境等相互衝突目標之系統分析方法即為本研究之目的。

本研究以多評估準則及多變量建立系統架構，藉由德國所建立之感受性系統模型（Sensitivity Model）進行系統評量。本研究研定公平性、發展面、可及性、機動性、環境面及安全性等 6 個構面 21 項評估準則，以道路系統及運具系統區分 28 項可控制變數組合，並建立 31 項中介指標。此外，由系統變數間之影響關聯程度，分別建構中介矩陣、目標達成矩陣及關聯性矩陣，藉以釐清各變數於系統中之定位。由於系統具回饋效果、部分系統變數屬質化特性、且變數間關聯性無法以確切量化方程式表達，故本研究採納權益關係人（Stakeholders）之共識意見（Consensus），以強調僅需了解系統變數間模糊因果關係之動態系統決策分析工具 – 模糊認知圖（Fuzzy Cognitive Map），建構影響分析模式，觀察都市運輸系統之動態變化。

本研究所建構之都市永續運輸評量方法，顯示由權益關係人參與評量過程具備其可行性，並可克服質化與量化變數不易整合之問題。該評量方法有別於傳統效益分析，係經由不同觀點權益關係人之認知與共識，確定有效且具關鍵性之政策方案，提供規劃人員在進行都市運輸系統改善方案選擇時參考。

關鍵詞：永續運輸、多樣性運輸、感受性系統模型、權益關係人、模糊認知圖

Constructing the Evaluation Method of Sustainable Urban Transportation with the Theory of Sensitivity Model and Fuzzy Cognitive Maps

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ABSTRACT

A sustainable transportation system should consider the "economic efficiency", "social equity", and "environment protection". Under the changing society, how to satisfy the demands from different road users has being become an issue. The academics in Europe are discussing and analyzing the issues of transportation diversity nowadays. How to satisfy the vary needs from different road users in the limited resource involves the various dimensions such as infrastructures, modes, and criteria in the many objectives. It is difficult to analyze the relations of the variables in the complicated system with the limited quantitative data. Because of above reasons, the purpose of this study is to construct a system including both qualitative and quantitative information to meet the conflicting goals with efficiency, equity, and environment at the same time.

This study constructs a system framework with multi-criteria and multi-variables, and estimates the system with Sensitivity Model built by German ecologists. We established 21 criteria in six dimensions including equity, development, accessibility, mobility, environment, and safety. Then we established 28 controllable variables in two dimensions of infrastructures and modes, and 31 uncontrollable intermediums. Furthermore, the intermediums matrix, relations matrix, and criteria matrix were set up according to the relationship among the variables in order to understanding the roles of variables in the system. Because of the feed back system and qualitative variables, it is hard to represent the relations among variables in equations. We utilized the consensus of stakeholders in the running of Fuzzy Cognitive Maps, and the decision analysis tool with fuzzy causal relationship among variables in dynamic system, to build the system relationships for dynamic urban transportation.

The method has been proven feasible after taking the stakeholders into account, and it could integrate the qualitative and quantitative variables. The method built in this study is different from the traditional cost-benefit analysis, and could find the effective and critical alternatives through the consensus of stakeholders.

Keywords:

Sustainable Transportation, Diversity of Transportation, Stakeholder, Sensitivity Model, Fuzzy Cognitive Maps (FCM)

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