USING DEMATEL AND ANP METHODS TO DEVELOP A MAINTENANCE RATING PROGRAM (MRP) IN TAIWAN

Jia-Ruey Chang*

Department of Leisure Management & Department of Civil Engineering and Environmental Informatics, MingHsin University of Science & Technology, Taiwan
** Corresponding author (jrchang@must.edu.tw)*

ABSTRACT: The study proposed a maintenance rating program (MRP) in Taiwan which combines the methods of DEcision MAking Trial and Evaluation Laboratory (DEMATEL) and Analytic Network Process (ANP) to evaluate maintenance activities accurately. In the view of the provincial and county roads in Taiwan, DEMATEL was employed to compute the effects between criteria through experts' interviews and questionnaire surveys, and ANP was used to determine the weights of elements in each criterion. The results showed that the five key factors for the maintenance activity evaluations are road safety, road surface, road construction, road management, and facility and landscape of road. The proposed MRP based on the DEMATEL and ANP methods is more suitable than the traditional decision-making methods to solve problems with different degrees of effects among criteria which are used to the evaluations of maintenance activities.

Keywords*: Maintenance Rating Program (MRP), Pavement, Maintenance Activity, DEcision MAking Trial and Evaluation Laboratory (DEMATEL), Analytic Network Process (ANP)*

1. INTRODUCTION

Field engineers are responsible for maintaining desired levels of service for various components in a road system such as roadway, roadside, and so on. These levels of service (LOS) is affected by a number of factors such as comfort, economics, safety, aesthetics and so on. Considering these complex factors, inconsistent decisions were made and resulted in unintended lower levels of maintenance activities [1]. This study develops a maintenance rating program (MRP) for the provincial and county roads in Taiwan by DEMATEL and ANP methods.

2. REVIEWS OF THE MAINTENANCE RATING PROGRAM (MRP)

The purpose of MRP is to provide information that should be used to schedule and prioritize routine maintenance activities. In Florida Department of Transportation (FDOT)'s MRP, each MRP criterion is comprised of multiple maintenance features and characteristics (elements) that represent specific maintainable items. [2]. In the Kentucky Transportation Cabinet (KYTC)'s MRP, the LOS provided on interstates, national highway system, state primary and secondary, rural secondary for all maintenance features (elements) will not be the same [3].

3. THE DEMATEL AND ANP METHODS

The DEMATEL can confirm interdependence among criteria and construct the interrelations between criteria to build an IRM (impact-relation map) [4]. The ANP is the general form of the analytic hierarchy process (AHP) which has been used in multi-criteria decision making to release the restriction of hierarchical structure [5].

4. DEVELOPMENT OF MRP IN TAIWAN

This study attempts to develop one appropriate and feasible framework of MRP focusing on both provincial and county roads in Taiwan through the questionnaire interviews. Five criteria and totally twenty-three elements are as follows:

- C1 (Road safety): unsafety resulted from man-hole covers (E1), slipping resulted from traffic marking (E2), insufficient lighting (E3), and wrong placed traffic signs (E4).

- C2 (Road surface): potholes and depressions on pavements (E5), subgrade flowed away (E6), damaged man-hole covers (E7), uneven pavements (E8), drainage failure (E9), and damaged gutter cover (E10).
- C3 (Road construction): information related to constructions (E11), notice of construction duration (E12), deficient refilling (E13), and repeatedly construction (E14).
- C4 (Road management): reduced or narrow lanes (E15), invading right-of-way (E16), insufficient parking lots (E17), and heavy traffic volume (E18).
- C5 (Facility and landscape of road): sign and signal failure (E19), messy and dirty road (E20), untidy landscape of roadside (E21), improper streetlamp (E22), and landscape images (E23).

The DEMATEL method is used to detect complex relationships and build the IRM (Fig. 1) of relations among five criteria. The total-influence matrix is shown in Table 1. A value under 0.9 resulted in too complex. The ANP is employed to deal with the dependent five criteria to obtain the weights of criteria and elements. This study adopts the normalized matrix, which is obtained by the DEMATEL method, to transform the unweighted supermatrix (which ignores the different effects among criteria) to a weighted supermatrix in the ANP to overcome the problem of interdependence and feedback among five criteria. The weights for elements in each criterion are shown in Table 2.

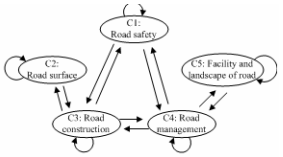

Fig. 1 The impact-relations-map of relations within proposed MRP.

Table. 1 Total-influence Matrix.

	C1	C2	C3	C4	C5
C1	1.21	0.82	1.12	0.92	0.64
C2	0.88	1.01	1.07	0.79	0.81
C3	0.95	0.93	0.97	0.97	0.84
C4	1.24	0.85	1.03	0.93	0.96
C5	0.72	0.68	0.75	0.92	0.91

Table. 2 The Weights for Elements in Each Criterion

C1: Road safety	E1	E2	E3	E4		
	0.201	0.047	0.104	0.020		
C2: Road surface	E5	E6	E7	E8	E9	E10
	0.091	0.015	0.108	0.062	0.034	0.024
C3: Road construction	E11	E12	E13	E14		
	0.009	0.043	0.060	0.029		
C4: Road management	E15	E16	E17	E18		
	0.009	0.059	0.023	0.016		
C5: Facility and landscape of road	E19	E20	E21	E22	E23	
	0.008	0.010	0.007	0.017	0.005	

5. CONCLUSIONS

This study developed a MRP focusing on the provincial and county roads based on the DEMATEL and ANP methods. The proposed MRP framework is more suitable than the traditional decision-making methods to solve problems with different degrees of effects among criteria. The proposed MRP has the highly potential to be practical to the maintenance activities evaluations in Taiwan.

ACKNOWLEDGMENTS

The author would like to thank the National Science Council of Taiwan for their financial support provided under the projects of NSC 99-2221-E-159 -020.

REFERENCES

[1] Roadway Maintenance Section of State Maintenance Office, *Florida Department of Transportation Maintenance Rating Program Handbook: Data Collection for Maintenance Rating Program*, Office of Maintenance, Florida Department of Transportation, Tallahassee, Florida, 2010.

[2] Meyer, M. D., "U. S. Domestic Scan Program: Best Practices in Transportation Asset Management," Scan-Tour Report, NCHRP Project 20-68, pp. 2-7~2-10, 2007.

[3] Maintenance Condition of Kentucky Highways, Statewide Maintenance Rating Program - FY 2010, Division of Maintenance, Operations and Pavement Management Branch, 2010.

[4] Tzeng, G. H., Chiang, C. H. and Li, C. W., "Evaluating intertwined effects in e-learning programs: a novel hybrid MCDM model based on factor analysis and DEMATEL", *Expert Systems with Applications*, 32 (4), pp. 1028-1044.

[5] Saaty, T. L., *Decision Making with Dependence and Feedback: Analytic Network Process*, RWS Publications, Pittsburgh, 1996.