Road Construction Lead to the Issue of National Compensation

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Abstract

The Highway consists of the roads used by vehicles and the other public infrastructure facilities around it that the lack of good management and the poor facilities usually causes the government compensation for damage. In order to solve these situations, the paper collected lots of cases in the study for conclusions. First, the research team divided the reasons into 6 categories. There are the factors in rock fall, bridge rupture, surface of road, gutter, trees beside the road, traffic signs and so on. Second, suggested 6 categories of 18 actions to solve them. Nowadays to improve actions the government shall be limited by budget, however ,the study uses the fuzzy AHP（Analytic Hierarchy Process, AHP）method to evaluate the actions, priority. The frames of references are technology, policy, economy and 11sub-references.

The study main findings in reducing national compensation issues for the provincial highway construction show that the priority rankings of improving alternatives of road defect are as below basing on defuzzification value: 1.Strengthen inspection; 2.Remove withered wood; 3.Put warning marks; 4.Design for earthquake; 5.Contractor's management; 6.Gutter flow; 7.Inspection after big disasters. The above improving factors are deserving attention really.

The contributions of this study are setting up a flow to evaluate the actions priority under the budget limitation.

Keywords: AHP, fuzzy, national compensation law, road of province

Introduction

The highway supports every facility in the current road for the vehicle and the range, including the national road, provincial highway, county road, township road and accommodation road (the first section of item 1 of article 2 of road law). But the highway transfers over the highway and maintains the department to safeguard after built and finished, Because of often set the fault of the road of deficient up or managing improperly etc. The traffic accident emerges to cause the country to compensate for the case in the highway.

In order to rush to run the traffic, the operational procedure and the time are compression in a situation that the foundation are not firm, the road is very apt to collapse. Ministry of Transportation and Communications point out that it appeal because of the road surface set management up improperly. It sends compensation reason, mostly, the rock fall, the collapse in heavy rain. the traffic sign and marking are set up etc. national compensation cases caused are most. Among them, because of little, very apt to fall into hole overturn after the hole tire have motorcycle, it is the cars of the traffic of supreme crash rate.

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The first regulation of article 3 of National Compensation Law “the publicly-owned communal facilities are deficient because of establishment or the management, it cause people the lives, health or property persons who damage, should shoulder compensation for damage responsibility of country “. So when the people cause the life, health or property to be damaged because of the fault of the road, can stipulate in accordance with National Compensation Law that asks to compensate to the country. However ask the traffic accident that the country compensated to happen, damage already it cause, it is whether to last means that relieve not passive after all with should research road hidden fault factor actively, support the reference of the highway while building or maintaining in the highway of competent authority, avoid the national compensation case that is produced because of the fault of the road, to hope can be reduced harm outside where people's life, health or the property suffer, the social cost which also reducible country paid, so study the provincial highway to build the research motive which causes the national compensation problem.

This research sums up the road fault type counted and carries on comparative analysis with relevant documents, and how to make a self-criticism in real case causing the country to compensate for from these road of fault types, and then understand the reason why the road the fault takes place, use to improve or reduce the fault which may be produced in road, thus reduce the emergence of the national compensation case.

Research methodology

Concept of Analytic Hierarchy Process

Analytic hierarchy process (AHP), is one of the useful methodologies and plays an important role in selecting alternatives (Labib et al.,1998; Fanti et al.,1998), introduced by Saaty (1980). AHP is an analytical tool enables people to explicitly rank tangible and intangible criteria against each other for the purpose of selecting priorities. The process involves structuring a problem from a primary objective to secondary levels of criteria and alternatives. Once the hierarchy has been established, a pair-wise comparison matrix of each element within each level is constructed. The AHP allows group decision making, where group members can use their knowledge, experience and values to break down a problem into a hierarchy and solve it by the AHP steps. Participants can weigh each element against each other element within each level, each level is related to the levels above and below it, and the entire scheme is tied together mathematically. For evaluating the numerous criteria, AHP has become one of the most widely used methods for the practical solution of multi-criteria decision making problems (Chan et al., 2000; Akash et al., 1999).

However, owing to the availability and uncertainty of information, it is very difficult to obtain the exact evaluation data. It does not take into account the uncertainty associated with the mapping of people’s judgment to an evaluation scale (Cheng, 1997). Thus, the AHP is mainly used in nearly crisp decision applications. In order to overcome the shortcomings of the AHP, fuzzy set principle is used to integrate AHP to determine the best alternative (Chen, 1996; Levary and Ke, 1999). The fuzzy set theory, which was first introduced by Zadeh (1965), mathematically assigns a grade of membership to each element in the fuzzy set. Thus, it can play a significant role in the decision-making environment which linguistic terms such as “very low”, “low”, “medium”, “high”, “very high” are frequently used to convey the estimations (Adamopoulos and Pappis, 1996).

Therefore, the integration of fuzzy set and AHP gives a much better and more exact representation of relationship between criteria and alternatives (Karsak and Tolga, 2001;

Choi and Oh, 2000;Yu and Skibniewski, 1999). This paper addresses this combination and proposes the fuzzy AHP which can deal with the national compensation issues in fuzzy terms in provincial highway construction.

Concept of Fuzzy Set Theory

A fuzzy set can be defined mathematically by assigning to each possible individual in the universe of discourse a value representing its grade of membership in the fuzzy set. This grade represents the degree to which that individual is similar or compatible with the concept represented by the fuzzy set. Thus, an individual may belong in the fuzzy set to a greater or lesser degree as indicated by a larger or smaller membership grade. These membership grades are very often represented by real-number values ranging in the closed interval between 0 and 1. Fuzzy set theory has been used to deal with complex and vague problems due to incomplete and imprecise information that characterized the real-world systems. It uses linguistic variables to model vagueness intrinsic to the human cognitive process.

Fuzzy set theory does not replace probability theory but rather provides a solution to problems that lack the mathematical rigor required by probability theory (Nguyen, 1985). Membership function, linguistic variables, natural language computation, linguistic approximation, fuzzy integrals, fuzzy weighted sum, and fuzzy inference are main concepts of fuzzy set theory applied to approximate characterization and decision making. A linguistic variable differs from numerical variable in that its values are not numbers but words or sentences in a natural or artificial language. Linguistic variables such as “good quality,” “poor performance,” “customer’s interest”, and “very pretty” describe the vague concept. Interested readers are referred to Zadeh (1965), Klir and Folger (1988).

A fuzzy AHP decision-making framework generally consists of the following steps:

1. Determining and specifying the types of fuzzy numbers and their membership functions to be used by decision makers (DMs);
2. Choose the selection criteria by DMs;
3. Constructing the scale of preference hierarchy structure to be used by DMs;
4. Establish fuzzy judgment matrix and define weigh vector;
5. Calculate weight numbers and form fuzzy scores of alternatives;
6. Ranking the fuzzy scores and determine the optimum alternative.

Improve the fault of provincial highway

Fault reason classification of provincial highway

Counting it in the national compensation case of general bureau of the highway in recent years, to 2006 since 2000, the fault of provincial highway will cause 123 altogether national compensation cases, divided into 13 classifications (such as Fig.1) ,Among them is short of causing with the management of the communal facilities, especially as the bridge is maintained, road surface hole, rock fall etc. such proportions the highest, in order to ensure human rights, prevent people from have absurd to injure, increase government financial burden, real should strengthen the safety measure of construction, do the best to manage the responsibility of maintaining communal facilities.

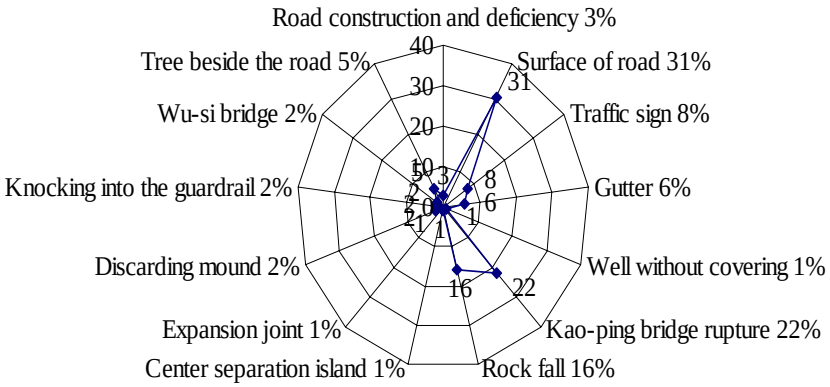

Figure1. 13 classifications of national compensation associated highway

Establish assess criteria and select of improvement alternative

The hierarchical structure adopted in this study to deal with the problems of provincial highway construction assessment for national compensation issues is shown in Fig. 2 and Fig. 3 . The key dimensions of the criteria for evaluation and selection of provincial highway construction alternatives were derived through comprehensive investigation and consultation with several experts, including two professor in construction engineering, two professor in civil engineering, two experienced architect and five experienced staff in professional engineering department of the Directorate General of Highways, Ministry of Transportation and Communications. These individuals were asked to rate the accuracy, adequacy and relevance of the criteria and dimensions and to verify their ‘‘content validity’’ in terms of provincial highway construction assessment. Synthesizing the literature review (Ye, 2004; He, 2001), the expert and government staff opinions provided the basis for developing the hierarchical structure used in this study. Furthermore, the five criteria selection principles suggested by Keeney and Raiffa (1976) have been used to formulate the provincial highway construction evaluation criteria in this study. There are three dimensions including Technology, Policy and Economy. From these, 11 evaluation criteria for the hierarchical structure were used in this study (Fig. 2). In addition, there are six dimensions including Rock Fall, Bridge Rupture, Tree beside the Road, Surface of Road, gutter and traffic sign from these, 18 evaluation alternatives for the hierarchical structure were used in this study (Fig. 3).

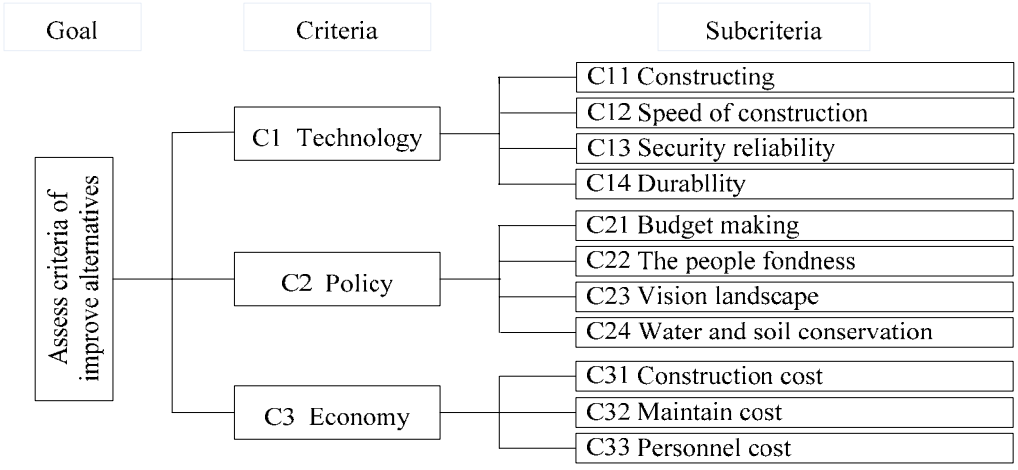

Figure 2. Assess criteria of improve alternatives in road defect

The questionnaire is designed and basic analysis

This research is with the fuzzy AHP method, design an expert's questionnaire and carry on research. This expert's questionnaire sends out 55 altogether to every relevant responsible institutions and experts and scholars, retrieve 55, 100% of rate of recovery, 51 effective questionnaires among them, accounting for 92.7% of the total questionnaire, 4 invalid questionnaires, accounts for 7.3% of the total questionnaire, the invalid reason is fill in unclearly and extreme value. In the valid questionnaire, there are 46 through questionnaires of consistency examination, occupy 90.2% of the result questionnaire, there are 5 not through questionnaires of consistency examination, has occupied 9.8% of the result questionnaire.

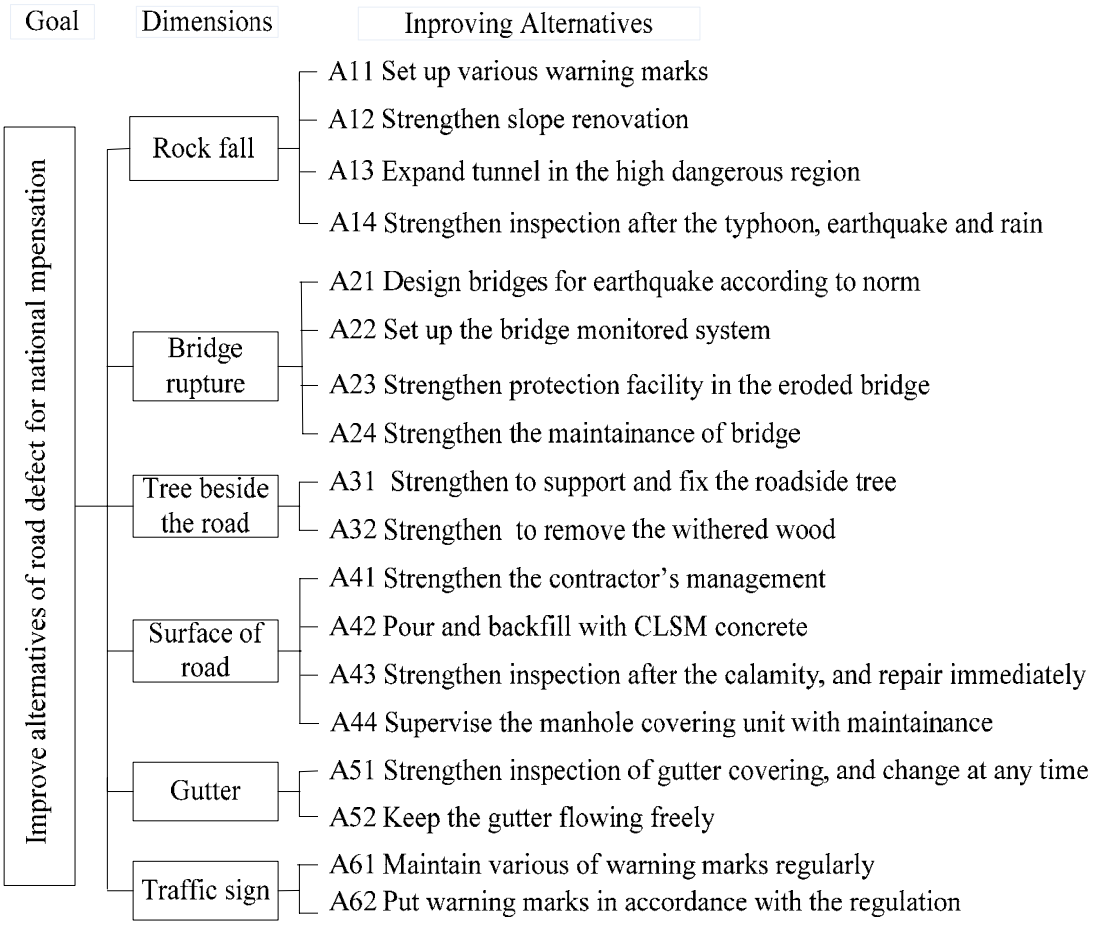

Figure 3. Improve alternatives of road defect for national compensation

Deffuzzication of assessment criterion

Set up by Fig. 2 in order to be selected the alternatives and assessed criterion, carry on questionnaire investigation, use the AHP method again, calculated that each assesses the weight value of criterion, via the result of consistency examination, can try to get every expert, scholar and practice policy-makers to offer each assess the criterion weight.

Can know by the fuzzy weight of the assessment criterion of the above, amounts to 11 items of assessment criterion from c11to c33 etc., views of relevant personnel different, the fuzzy weight of triangular fuzzy, range is relatively big, can relatively reflect relevant personnel's opinions, so this research adopts center law calculation (formula1), calculated de-fuzzy (DF) value of fuzzy weight with this formula (table1).

$$DF_i = \left[\left(UR_i - LR_i\right) + \left(MR_i - LR_i\right)\right]/3 + LR_i \qquad \forall i \text{..... ....} (1)$$

Table 1. De-fuzzy of the fuzzy weight of assess criterion of improve alternatives

Assess criterion	LRi	MRi	URi	DF.	Rank
C11 Constructing	0.032404	0.083666	0.157162	0.091077	8
C12 Speed of construction	0.022153	0.087998	0.175537	0.09523	7
C13 Security reliable	0.048196	0.108376	0.222016	0.126196	1
C14 Durability	0.051512	0.102037	0.224531	0.126027	2
C21 Budget making	0.028855	0.079756	0.151692	0.086768	9
C22 The people fond	0.022799	0.070571	0.164983	0.086118	10
C23 Vision landscape	0.029324	0.079396	0.132842	0.080521	11
C24 Water and soil conservation	0.029324	0.090830	0.194610	0.104921	5
C31 Construction cost	0.039871	0.092443	0.197947	0.110087	4
C32 Maintain cost	0.058824	0.110229	0.170492	0.113182	3
C33 Personnel cost	0.043057	0.094697	0.151616	0.096456	6

Analysis of selecting the alternatives

While carrying on the performance value of criterion to weigh, because of deterministic influence, and unable to show the possible performance value of criterion by confirming number value, so this research adopts the triangular fuzzy concept, deal with the performance value of criterion, use such five sections of types as the purpose parameter of fuzzy language, " very low ", " low ", " middle ", " high ", " very high ",etc. way, judged by their professional accomplishment of relevant bases of personnel, in the integer 0 to100, assert every linguistics variables range, it is express every linguistics variables value by triangular fuzzy, but to the same linguistics variables, because every relevant appraiser's own cognition or the position are different, so its range asserted is also different to some extent.

It is fuzzy to study to what the linguistics variables is judged, adopt the average way, integrate different relevant appraiser's fuzzy value to the same assessment criterion, namely adopted the operation of fuzzy addition and fuzzy multiplication, tried to get counting average fuzzy value of every assessment criterion of whole decision group.

Calculate the fuzzy weight of assessment criterion received according to the front section, and calculated performance value of improvement alternative in this section, can carry on last judging fuzzily synthetically. The fuzzy operation way to judge synthetically, include fuzzy multiplication and fuzzy addition, because fuzzy multiplication among them calculate complicated, It is expressed that generally similar product with it (Klir and Folger, 1988). According to this way can try to get near fuzzy value of the improvement alternative under fuzzily synthetically judge (columns 3~5 of table 2).

By above mentioned fuzzily synthetically judge, can try to get triangular fuzzy value of the improvement alternative in the whole goal. Because it is not the clear number value to fuzzy number, while carrying on every improvement alternatives in order to be selected the quality of the alternatives comparing, must adopt the fuzzy number sequencing that counted. Fuzzy number sequencing methods to count are numerous, it is the simplest and commonly used way that among them use the center law, can calculated out best defuzzification value, and then compare each size of defuzzification value, in order to carry on select result of alternatives in every within group and between group(columns 6~7 of table 2).

Table 2. Defuzzification of improve alternatives

Classification (factors)	Code name	Similar TFN			DF	Rank
		URi	MRi	LRi		
Rock fall	A11	0.189551	0.578881	1.326704	0.698378	12
	A12	0.175856	0.545125	1.275613	0.665531	15
	A13	0.166352	0.509444	1.206697	0.627498	18
	A14	0.194681	0.596327	1.372072	0.721027	7*
Bridge rupture	A21	0.202021	0.60416	1.382779	0.729653	4*
	A22	0.171676	0.535231	1.251314	0.652741	16
	A23	0.169540	0.530011	1.246465	0.648672	17
	A24	0.183953	0.566628	1.314025	0.688202	14
Tree beside the road	A31	0.191833	0.58616	1.348191	0.708728	11
	A32	0.210079	0.628224	1.421303	0.753202	2*
Surface of Road	A41	0.197842	0.600289	1.380281	0.726137	5
	A42	0.195514	0.590310	1.359510	0.715111	8
	A43	0.205923	0.625102	1.431084	0.754036	1*
	A44	0.18787	0.57219	1.323516	0.694526	13
Gutter	A51	0.190901	0.585186	1.351394	0.70916	10
	A52	0.196566	0.598485	1.374442	0.723165	6*
Traffic sign	A61	0.193768	0.588568	1.350955	0.711097	9
	A62	0.204947	0.615561	1.400632	0.74038	3*

Conclusions

According to the results of this study, the conclusions are as the followings. 1. The priority of progress alternative of rock fall factor is increasing the audit trail in distressed area. 2. The priority of progress alternative of bridge factor is stronger designing. 3. The priority of progress alternative of surface of road factor is increasing the auditing trail after the rains and repairing immediately. 4. The priority of progress alternative of barrow pit factor is keeping flowing. 5. The priority of progress alternative of trees beside the road factor is sending blasted branch. 6. The priority of progress alternative of traffic sign factor is increasing management of a general contractor.

The contributions of this study are setting up a flow to evaluate the actions priority under the budget limitation.

References

Adamopoulos, G.I. and Pappis, C.P., 1996. A fuzzy-linguistic approach to a multi-criteria sequencing problem. *European Journal of Operational Research,* 92 (3), 628-636.

Akash, B.A., Mamlook, R. and Mohsen, M.S., 1999. Multi-criteria selection of electric power plants using analytical hierarchy process. *Electric Power Systems Research,* 52 (1), 29-35.

Chan, F.T.S., Chan, M.H. and Tang, N.K.H., 2000. Evaluation methodologies for technology selection. *Journal of Materials Processing Technology,* 107 (1-3), 330-337.

Chen, S.M., 1996. Evaluating weapon systems using fuzzy arithmetic operations. Fuzzy sets and systems 77, 265-276.

Cheng, C.H., 1997. Evaluating naval tactical systems by fuzzy AHP basedon the grade value of membership function. *European Journal of Operational Research*, 96 (2), 343 – 350.

Choi, D.Y. and Oh, K.W., 2000. ASA and its application to multi-criteria decision making.

Fuzzy Sets and Systems, 114 (1),89-102.

Fanti, M.P., Maione, B., Naso, D. and Turchiano, B., 1998. Genetic multi-criteria approach to flexible line scheduling. *International Journal of Approximate Reasoning*, 19 (1-2), 5-21.

He C.H., 2001. *Research in deficient of the infrastructure set up or management on State Compensation Law.* Master thesis of department of law of Tung-Hai university, the Republic of China.

Karsak, E.E. and Tolga, E., 2001. Fuzzy multi-criteria decision-making procedure for evaluating advanced manufacturing system investments. *International Journal of Production Economics*, 69(1), 49-64.

Keeney, R.L. and Raiffa, H., 1976. *Decisions with multiple objectives: preference and value tradeoffs.* New York: Wiley.

Klir, G.J. and Folger, T.A., 1988. *Fuzzy sets, uncertainty and information.* Prentice-Hall, Englewood Cliffs, N.J.

Labib, A.W., O'Connor, R.F., Williams, G.B., 1998. Effective maintenance system using the analytic hierarchy process. *Integrated Manufacturing Systems*, 9 (2), 87-98.

Levary, R.R. and Ke, W., 1998. A simulation approach for handling uncertainty in the analytic hierarchy process. *European Journal of Operational Research*, 106(1), 116-122.

Nguyen, V. U., 1985. Tender evaluation by fuzzy sets. *Construction and Engineering Management*, 111(3), 231-243.

Saaty, T.L., 1980. *The Analytic Hierarchy Process.* McGraw-Hill, New York.

Ye J.X., 2004. *A Study of Road Infrastructure Fault Result in State Compensation Law.* Master thesis of research institute of transportation engineering and management of Feng Chia university, the Republic of China.

Yu, W. D. and Skibniewski, M.J., 1999. Quantitative constructability analysis with a neuro-fuzzy knowledge-based multi-criterion decision support system. *Automation in Construction*, 8 (5), 553-565.

Zadeh,L.A., ,1965. Fuzzy Sets, *Information and Control*, 8, 338-353..