ISAHP 1999, Kobe, Japan, August 12-14, 1999

AN APPLICATION OF AHP USING NON-ADDITIVE WEIGHT IN INFRASTRUCTURE PLANNING

Shin-ei Takano
Graduate School of Engineering, Hokkaido University
Kitaku Kita 13 Nishi 8, Sàpporo, Hokkaido, 060-8628, Japan
shey@eng.hokudai.ac.jp

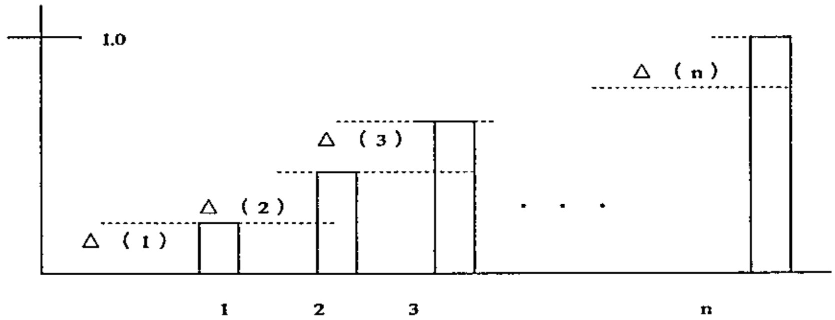
Introduction

A purpose of infrastructure planning is to make a public decision composed of various people. Therefore, it is necessary to consider the diversity of decision making deliberately, compared with individual case. In addition, the decision has a strong social influence force, and future generations are affected. In infrastructure planning, further examinations are necessary, even if an alternative evaluation is judged a superior one as the total average score is high. Because there is a possibility that the evaluation from a factor is extremely low and it may become an important problem. The other way, there is a possibility that even if the total average score is low, the evaluation from a factor is extremely high and a reexamination of this alternative brings about a good result.

Formulation of the evaluation method using fuzzy measure

In this study, an evaluation method using fuzzy measure is used in order to solve these problems. In this method, the alternative weight from evaluation factors is interpreted as degree of explanation. Then, maxi-max evaluation (MM evaluation) and maxi-min evaluation (MN evaluation) are calculated by using possibility measure and necessity measure.((3),(4)) These indexes are evaluations considered from advantage and disadvantage view points. In addition, in this study the average evaluation (N evaluation) with a meaning which is almost similar to normal evaluation is formulated.(5)

Degree of explanation



No. of evaluation factors arranged in ascending order of degree of explanation

Fig.1 Degree of explanation and Δ(j)

$$(A-\lambda_{max}\cdot I)\cdot W=0 \quad ---(1)$$

$$max\ (w_i)=1 \quad ---(2)$$

$$MM(i)=\sum_{j=1}^{n}\Delta(j)\cdot max\ f(i,k) \quad --(3)$$

$$MN(i)=\sum_{j=1}^{n}\Delta(j)\cdot min\ f(i,k) \quad --(4)$$

j: ascending order of degree of explanation
$E(j)$: degree of explanation at factor j
$\Delta(j)$: $E(j)-E(j-1)$

$$N(i) = \sum_{j=1}^{n} \Delta(j) \cdot mean \quad f(i,k) \text{ --- } (5)$$

$f(i,k)$: alternative weight from each evaluation factor

Applications to a underground passageway problem and a Shinkansen station problem

The evaluation method is applied to actual infrastructure planning examples of an underground passageway network problem and a Shinkansen station location problem. In an underground passageway network problem, 14 alternatives in Sapporo city are evaluated. The evaluation factors consist of effective utilization of underground facilities, public facilities connection, commercial buildings connection, business facilities connection, a formation of the city axis.(Fig.2) In Shinkansen station problem, seven alternatives are evaluated from eight evaluation factors and it is unique that weights of the evaluation factors are calculated from the result of a questionnairing. By these examples, it is shown that in this method the diversity of evaluations can be analyzed which is difficult in normal method, and the usefulness is verified.

Table 1 Estimated Result for a Underground Passage Problem

	MM Value		N Value		MNValue	
	Value	Rank	Value	Rank	Value	Rank
Passage 1	0.748	11	0.357	14	0.200	12
Passage 2	0.748	11	0.389	13	0.200	12
Passage 3	0.770	10	0.459	11	0.300	11
Passage 4	0.821	6	0.670	6	0.600	4
Passage 5	0.778	9	0.544	9	0.400	10
Passage 6	0.865	3	0.810	1	0.723	1
Passage 7	0.900	1	0.751	2	0.522	5
Passage 8	0.900	1	0.726	4	0.444	8
Passage 9	0.850	4	0.741	3	0.700	2
Passage 10	0.800	7	0.663	7	0.458	7
Passage 11	0.800	7	0.651	8	0.422	9
Passage 12	0.634	14	0.524	10	0.464	6
Passage 13	0.734	13	0.400	12	0.200	12
Passage 14	0.843	5	0.718	5	0.593	4

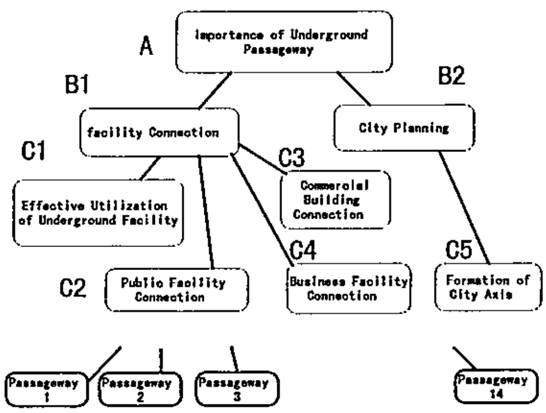
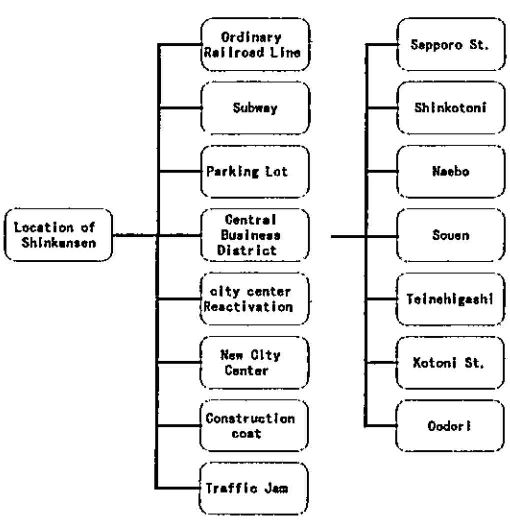


Fig.2 Underground Passageway Problem



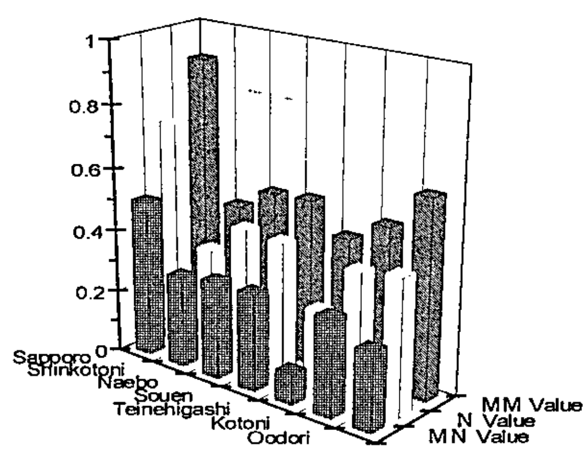


Fig.3 Shinkansen Station Location Problem **Fig.4 Estimated Result for Shinkansen Problem**