THE UNKNOWN IN DECISION MAKING
-the case of a network -

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Summary: *Most of us have concerns when we make a decision about not having all the important factors included. Even if an alternative has a high priority relative to other alternatives that priority is questionable because there may be other criteria that need to be identified and used that can change the ranks obtained for the alternatives. We offer a way to include the objects of these concerns into decision problems. We compare the importance of the unknown with other factors. Pairwise comparisons make it possible to tackle this idea explicitly and rather simply. One condition is that the unknown does not have such a high priority that it indicates total ignorance. The idea is to determine the sensitivity of the outcome with respect to the unknown to see if it is stable.*

Keywords: Unknown, decision making, analytic network process

1. Introduction

People who have clear and definite choices to make are often less likely to be concerned about other factors that might influence their choice. But when a decision is complex and elusive it is helpful to know according to one's beliefs, that what maybe left out is not too important.

If the importance of such an unknown criterion is thought to be significantly larger than the importance of the known factors as reflected by their priorities obtained through paired comparisons with the other criteria, then one cannot reliably say that one knows enough to make a decision. This observation equally applies if the unknown criteria can be attributed with more than about 10% of the overall influence. The unknown needs to fall on the lower side of the scale of priorities but still be comparable in relative terms with what is known. Sensitivity analysis would later show whether the best alternative is insensitive to the unknown factor. One would then adopt the best alternative for the decision. If it is sensitive to the unknown factor, then a second alternative that is sufficiently close to the first in priority may be insensitive to the unknown factor in which case it may be more desirable to adopt that alternative for the decision than the originally highest ranked alternative.

This type of analysis has already been done by adding *other* as a new criterion in a hierarchy (Ozdemir and Saaty, 2005). Our purpose in this paper is to evaluate the effect of the unknown in the case of a decision network. Section 2 gives an illustration of the analysis done for the hierarchical case as a reminder. Section 3 illustrates the affect of the unknown in a network.

2. Selecting a National Health Plan (Ozdemir, Saaty, 2005)

While national health plans vary, they all focus on decreasing costs. Currently, approximately 37 million Americans are uninsured and millions more are vastly underinsured. The U.S. has easily the most expensive health care system in the world. Despite the allocation of such large sums of money to health care, the U.S. ranks in the lower middle third in the quality of care among industrialized nations. The goal of this model is to choose a national health plan for the United States focusing on the effects of nationalized health care, health care costs, quality of care, probability of acceptance, and the overall

benefits to society. This is a three level hierarchy with the goal at the top, the criteria level in the middle and the alternatives at the bottom. Four types of health care systems are considered:

National Health System (NHS): Both the financing and distribution of health care services are the responsibility of the federal government. All health care is owned and provided by the government, and physicians are employees of the government. The benefits are: complete health insurance coverage for everyone, and relatively low overall health care costs. Low efficiency is a common criticism of NHS.

National Health Insurance (NHI): The concept of NHI is very similar to that of NHS; the government is responsible for financing health care services only, the distribution is provided by the market. NHI plans seem to decrease health care costs in general while simultaneously providing health insurance coverage for everyone. The rationing of health care is prevalent because the government has a restricted budget.

Employer Health Insurance (EHI): EHI calls for mandatory employer provision of health insurance for employees and their families.

School District Health Insurance (SDHI): This is a private sector approach aimed at extending coverage to the uninsured and underinsured by calling for health insurance based public school enrollment. By combining the children in public school and their families into one large statewide group, the plan greatly increases the purchasing power of each individual family, without changing the basic structure of the current health care system.

Table 1 gives the results with and without the criterion *other*. Without *other*, the model gives SDHI as the best alternative. On adding *other* as a criterion with priority 0.109, the best alternative is changed from SDHI to EHI.

Table 1. Synthesis for Final Answer

	Criteria					Alternatives			
	Health Care Costs	Quality of Care	Probablity of Acceptance	Overall Benefits to Society	Other	NHS	NHI	EHI	SDHI
Without *other*	0.081	0.522	0.049	0.348	-	0.128	0.188	0.321	**0.363**
With *other*	0.068	0.474	0.042	0.307	0.109	0.130	0.182	**0.345**	0.343

Sensitivity analysis has shown that if the priority of *other* is in creased from 0.109 to 0.162 in the new model, EHI remains the best but with priority 0.360.

We now attempt to analyze the effect of *other* when there is a decision network. Since networks have dependencies and feedback, adding a new criterion can influence several other criteria of the current problem directly or indirectly. That is why it is difficult to interpret the role of such a criterion on the overall outcome.

3. The Best Policy for the European Union & Turkey Relationship: a network example with and without *other* as criterion

Relations between Turkey and the European Union (EU) go back a long way in time. This conflict was first studied as an ANP problem by Ozdemir and Alilkalfa (2003).

The Analytic Network Process with dependence and feedback is a general framework for a detailed analysis of societal, governmental and corporate decisions that is available today to the decision-maker. It allows both interaction and feedback within clusters of elements (inner dependence) and between clusters

(outer dependence). Such feedback best captures the complex effects of interplay in human society, especially when risk and uncertainty are involved. Within the ANP networks of influence one includes all the factors and criteria, tangible and intangible that have bearing on making a best decision. The ANP deals with Benefits, Opportunities, Costs, and Risks (BOCR) separately and then combines them into a single overall answer (Saaty, 2001).

For the EU and Turkish problem, the aim is to choose the best of the following strategies for each side: Membership of Turkey in a short time, Non-membership of Turkey and grantingTurkey a private status by considering the benefits of both sides. These alternatives were regarded as acceptable by both parties. To determine the best policy two Analytic Network Process (ANP) models are constructed.

As an example, we will consider only the Turkey model. All subnets under each of the BOCR merits are composed of three criteria: Economic, political, and social.

We assume that the reader is familiar with the ANP, and concentrate on the criterion *other i*n our analysis.

We list all the criteria in Table 2. The 46 criteria were prioritized by pairwise comparisons and 11 of them with the highest priority marked in bold in Table 3 were selected. These are, *Finance from Community's budget and regional funds, Investments, Majority in parliament, Allocation of money to budget and regional funds, Compensation to minorities, Minorities, Borders, Straightened economy, Cultural and social union, Economic dependency, Future of EU*. We used these criteria to develop the decision networks under for each.

Table 2. Criteria and Priorities

Merits	Criteria	Subcriteria	Local Priorities	Global Priorities
Benefits (0.366)	Economic (0.593)	Controlling unrecorded economy	0,054	0,011
		Economic competitiveness	0,073	0,015
		Expansion of trade	0,105	0,022
		Finance from regional and structural funds	**0,202**	0,043
		Free movement of capital	0,053	0,011
		Free movement of goods	0,038	0,008
		Investments	**0,156**	0,033
		Privatization	0,035	0,007
		Stability in income distribution	0,115	0,024
		Tax reform	0,12	0,025
		Technology transfer	0,043	0,009
	Political (0.249)	Majority in parliament	**0.283**	0,026
		Progress in democracy	0.150	0,014
		Reduce overdependence on US	0.136	0,012
		Strategic and political status	0.214	0,020
		Strong government	0.170	0,015
	Social (0.157)	Adaptation standarts of EU	0.206	0,012
		Arrangements in human rights	0.207	0,012
		Arrangements in minority rights	0.03	0,002
		Arrangements in rule of law	0.239	0,014
		Domestic stability	0.111	0,006
		Educational benefits	0.062	0,004
		Environmental arrangements	0.052	0,003
		Free movement of people	0.089	0,005
Opportunities (0.152)	Economic (0.493)	Trade opportunities	0.25	0,019
		Straightened economy	**0.75**	0,056
	Political (0.195)	EU' s political experiences	0.25	0,007
		Political credits	0.75	0,022
	Social (0.310)	Cultural and social union	**0.666**	0,031
		Educational opportunities	0.333	0,016
Costs (0.307)	Economic (0.40)	Allocation of money to budget and regional funds	**0,556**	0,068
		Compensation for minorities	**0,322**	0,039
		Costs for applications of EU standarts	0,11	0,013
	Political (0.40)	Minorities	**0.40**	0,049
		Borders	**0.40**	0,049
		Relationships with other countries	0.20	0,025
	Social (0.20)	Cultural degeneracy	0.255	0,016
		Deformation of Islamic identity	0.249	0,015
		Ethnic conflicts	0.203	0,012
		Religional Conflicts	0.291	0,018
Risks (0.173)	Economic (0.40)	Economic dependency	**0.75**	0,052
		Lack of competitiveness	0.25	0,017
	Political (0.40)	Future of EU	**0.75**	0,052
		Conflicts upon enlargement	0.25	0,017
	Social (0.20)	Deformation of national identity	0.75	0,026
		Raising social tensions	0.25	0,017

Clusters in decision networks are constructed according to the influencing groups and issues related to them. These are: Turkish Government, Public Opinion, Media, Business Organizations, Trade Union Confederations, Security, Economic, Political, Social Advantages (disadvantages) and Military.

3.1 Results for the Turkish Model

According to Turkish ANP model, the subtractive formula (bB+oO-cC-rR) results indicate that Membership is the best option. The other alternatives have negative priority and are less preferred. The results obtained by using the probabilistic additive formula show that Membership takes the highest priority. Also, Private Status is the second in preference and Non-membership takes the last priority. After synthesizing with the additive formula, results indicate the Membership alternative as the most appropriate option. On the other hand, Non-membership alternative has the second priority and Private Status alternative has the least priority. Table 3 shows the overall results.

Table 3. Overall Results

Alternatives	Benefits (Norm[*].) (0.366)	Opportunities (Norm.) (0.152)	Costs (Norm.) (0.307)	Risks (Norm.) (0.173)	bB+oO-cC-rR	bB+oO+ c(1-C)+ r(1-R) (Norm.)	bB+oO+ c(1/C)+ r(1/R) (Norm.)
Membership	0.527	0.512	0.135	0.123	0.207	0.557	0.575
Non-Membership	0.077	0.080	0.220	0.396	-0.095	0.194	0.272
Private status	0.395	0.407	0.643	0.479	-0.073	0.248	0.152

[*]normalized

3.2 Analysis with and without *other*

Now we introduce the unknown criterion *other*. To analyze its effect, we select one of the networks, *Finance from regional and structural funds* and add *other* as a new cluster and a new criterion in that cluster. Finance from regional and structural funds represents EU structural funds that facilitate economic improvements, and these would help Turkey to modernize its infrastructure, while accession itself would bring increased trade and foreign investment. The actors in this network are mostly the same as the others but the connections have been made by considering the relations with respect to this criterion. We think that there are other factors missing in Finance with respec to the regional and structural funds network. New connections are placed into the network and the missing paired comparisons with respect to the new connections have been completed.

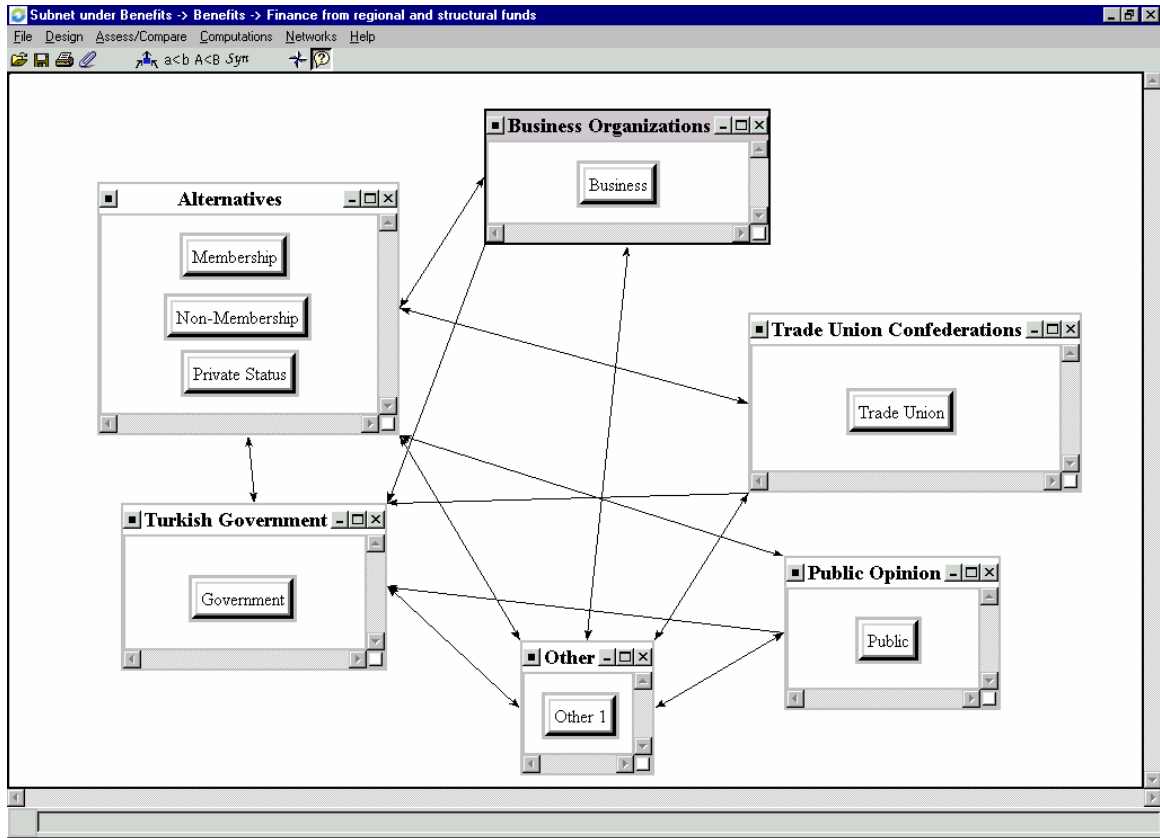Figure 3 shows the *Finance from regional and structural funds* network with *other*.

Figure 3. The Decision Network for Finance from Regional and Structural Funds Criterion -with *other*

The priorities of the alternatives for this network are exhibited in Table 4. The rank for the alternatives remains the same with and without *other*. But the best alternative has a lower priority when *other* is considered.

Table 4. Outcome for the Network
Finance from regional and structural funds

Alternatives	without *other*	with *other*
Membership	0.506	0.445
Non- Membership	0.077	0.167
Private status	0.417	0.388

The priorities of the elements in this network are obtained as in Table 5.

Table 5. Priorities of the Elements

Elements	without *other*	with *other*
Business	0.074	0.117
Public	0.200	0.102
Trade Union	0.039	0.082
Government	0.264	0.168
Other	-	0.372

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The outcome can be interpreted that by considering some other parties to take place in this network, the priorities are changed. Now, we check if the new criterion has an influence on the overall outcome of the entire problem. Table 6 summarizes the results with and without *other*. Similarly the best alternative remains the same but with a lower priority.

Table 6. Overall Outcome

Alternatives	without *other*	with *other*
Membership	0.554	0.544
Non- Membership	0.209	0.209
Private status	0.235	0.246

4. Discussion and Interpretation of the Results

We conclude that using "Other" can enrich our approach to decision making and appears to improve the accuracy of the outcome of a decision. We are unable to say exactly when *other* would be good to consider in a decision and when not if we do not have some data to check against.

In the analysis, *other* should not be treated as a criterion that has just been added to the system and then the missing comparisons are completed. It must be a criterion that the decision maker has strong feelings a tacit feeling about. He knows that there is something outside that cannot be defined clearly but may have influence on the problem.

In this study, we extended our previous hierarchy analysis about *other* to networks. Since networks have dependencies and feedbacks it is difficult to generalize the affect of such a new criterion on the overall outcome. Therefore more examples have been provided and analyzed. This study may motivate researchers to do further research on the subject.

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