APPLYING ANP FOR RAW MATERIAL SUPPLY
IN IRANIAN PAPER INDUSTRY

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Abstract

The aim of this article is to develop a strategic plan for selecting the best options for the supply of raw material to feed paper producing plants. The decision-making is examined within the framework of benefits, opportunities, costs, and risks (BOCR). A hierarchy is used to prioritize the BOCR themselves are prioritized using the Analytic Hierarchy Process (AHP) ratings approach. A control hierarchy is then created and prioritized using the Analytic Network Process (ANP) to evaluate the "control criteria" of the system. There are a total of 19 control criteria in the system and each controls a decision network evaluated using the ANP. The final synthesis of the system shows external procurement is the best choice.

Keywords: AHP, ANP, BOCR, paper industry.

Introduction

There is a tremendous demand for various types of paper in Iran, while Iranian plants cannot produce sufficient products to satisfy the demand. The most important obstacle that domestic paper manufacturers are facing is inadequate raw material supply. Therefore, nowadays this industry of Iran has a major problem regarding the raw material procurement. As the research by Aziz *et al.* (2003) shows, the supply of raw material for wood and paper industries is very important factor for successful operation and marketing, while there is a serious deficiency in this industry due to the lack of proper planning of raw material supply.

In this article, we apply AHP (Saaty, 1999) and ANP (Saaty, 2001a) as the tools for selecting the best choice in the field of raw material supply for paper producing plants in Iran. The main objective is to develop a guideline for strategic planning based on the appropriate decisions made by adopting this approach. Development of some reliable and stable suppliers needs a long range planning. It is not wise to consider only short term planning which is mostly established on the basis of price and availability. In strategic planning we need to consider various criteria influencing the decision. Therefore, it is required to develop a powerful and reasonable method for an accurate and inclusive decision making.

There are several alternatives to supply raw material for paper manufacturers, external resources, internal resources and a combination of them. However, some of these alternatives must be established within a period of five to ten years time, if accepted as the best choice. Domestic raw materials for paper manufacturing industry come from different sources, forest resources, non-forest resources such as poplar trees, bagasse (agricultural wastes) and waste paper. Some amount of raw materials are also imported from foreign source, for instance poplar, birch trees, softwood species and long

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fiber pulp, although at the moment is not significant. Table 1 shows situation of active and inactive paper making factories in Iran with respect to utilized raw material.

Table1. Situation of paper making factories in Iran, including active and inactive Factories (Commercial researches and studies organization & PPI, 1994)

Factory	Annual nominal capacity (1000 Ton)	Kinds of product	Kinds of utilized raw material	Portion from overall capacity (%)
Wood and paper mazandaran	175	Printing ,writing and newsprint paper	Internal(forest wood+poplar) , External(long fiber pulp)	24.6
Iran wood and paper	150	Printing , writing and packing paper	Internal(forest wood+poplar+ waste paper, External(long fiber pulp)	21.1
Pars	105	Printing and writing paper	Internal(Bagasse+lo ng fiber pulp)	14.7
Kaveh	35	Printing ,writing, packing paper and card board	Internal(waste paper)	4.9
Latif	15	Printing, writing and packing paper	Internal(waste paper)	2.1
Papirous	15	Packing paper	Internal(waste paper)	2.1
Nowzohoor	5	Hygienic paper	External(pulp)	0.8
Kahrizak	38	Packing paper	Internal(waste paper)	5.3
Karoon	70	Printing and writing paper	Internal Bagasse) External(long fiber pulp)	9.8
Harir Khoozestan	15	Hygienic paper	Internal (Bagasse pulp)	2.1
Shargh Packing paper making	9	Packing paper	Internal(waste paper)	1.3
Damavand packing paper making	15	Packing paper	Internal(waste paper)	2.1
Miscellaneous packing paper making	15	Packing paper	Internal(waste paper)	2.1
Gharb paper	50	---	Internal(forest wood and poplar)	7
Total	712			100
Overall actual product capacity	300			42

There is 1.2 million hectare trading forests in north of Iran. Iran is poor countries with regard to forest resources in the world, in this regard amount of wood exploitation from its almost area is limited. If related organizations do not programme to develop the forests, major paper factories for instance Wood and paper mazandaran and Iran wood

and paper that have been procured their raw materials from north forests will have serious problems in future(Mahdavi, 2003). Also at present, because of deficiency in raw material, Wood and paper mazandaran factory, imports Birch and poplar species abundantly from another countries to procure its raw material.

As mentioned before, the mangers make only operational decisions to run the industry in the short run period. In other words, they purchase raw materials which are available in the market and as a result, in many cases, not enough to meet the production goals. Clearly, this is not a logical and scientific method of decision making for this important industry.

The rest of paper is organized as follows. In section 2 we review the analytic network process (ANP) briefly. The elements of our ANP model, including alternatives, overall factors, the merits of benefits, costs, opportunities, risks and their control criteria are discussed in more details in section 3. The analysis of the results is discussed in section 4.

2. The analytic network process (ANP)

Since the most suitable technique for our study seems to be the analytic network process (ANP), we review it briefly in this section.

The Analytical Network Process (ANP), a generalization of the Analytic Hierarchy Process (AHP) method for multi criteria decision making, provides an even broader framework for decision making in complicated environments. The advantage of this new theory over the AHP (Analytic Hierarchy Process) is its ability to extend to cases of dependence and feedback and generalization of the super-matrix approach. It allows interactions and feedback within clusters (inner dependence) and between clusters (outer dependence). Feedback can better capture the complex effects of interplay in human society. The ANP provides a thorough framework to include clusters of elements connected in any desired way to investigate the process of deriving ratio scales priorities form the distribution of influence among elements and among clusters.

The ANP is a coupling of two parts. The first consists of a control hierarchy or network of criteria and sub-criteria that control the interactions in the system under study. The second is a network of influences among the elements and clusters. The network varies from criterion to criterion and a super-matrix of limiting influence is computed for each control criterion. Finally, each of these super-matrices is weighted by the priority of its control criterion and the results are synthesized through addition for all the control criteria.

A problem is often studied through a control hierarchy or system of benefits, a second for costs, a third for opportunities, and a fourth for risks. The synthesized result of the four control systems are combined by taking the quotient of the benefits times the opportunities to the costs times the risks to determine the best outcome. Other formulas may be employed at times to combine results.

The following are some of the features of the ANP that distinguish it from the AHP (Saaty, 2001b):

- Rather than a hierarchy, the basic structure of a network consists of clusters and nodes and logical connections between them. The judgment process is carried out by creating matrices of pair wise comparison judgments for nodes in a cluster linked to the same parent node.
- Sub-networks can be created for and attached to nodes in a network, and the sub networks have the same structure as any network. There can be many layers of sub-networks. The sub networks at the bottom contain the alternatives of the decision.
- Super matrices are created in the sub-networks and the results integrated with the higher levels of networks.

One can find some in which the ANP is applied for decision making. One example is making decision regarding the establishment of commercial ties with China (Saaty and Cho, 2001c).They concluded Preferred Normal Trade Relations (PNTR) as the best choice.

There is a comprehensive example how to make the decision on national missile defense program. The US government faces the crucial decision whether or not to commit itself to the deployment of a National Missile Defense (NMD) system. By applying an ANP model, deploying NMD alternative is the best alternative (Saaty, 2001d). Alikafa and Ozdemir (2003) used ANP and BOCR structure to determine the best policy for EU and Turkey relationship. This study concludes that Membership alternative seems to be more suggestible. The focus of the paper by Azis (2003) is to search for the most suitable form of RFA (Regional Financial Arrangement), the process of which involves a complex decision, having to include not just economic rationales but also political and other considerations. Poonikom *et al.* (2003) proposed a systematic framework using ANP for the selection of universities which offer engineering discipline. The purpose of the study by Ilker *et al.* (2004) is to develop a multi criteria model of organic food marketing strategies which are believed to improve the domestic market. The Analytic Network Process is utilized to construct such a model. The elements of the marketing combination of them are defined and the interrelationships among these elements are assessed via a Delphi type group decision making procedure. Cevik *et al.* (2004) presents an integrated framework based on ANP and utilizing Delphi Technique to select an ERP system. Piantanakulchai (2005) has used ANP *for prioritizing the potential highway alignments.* This study proposed ANP as a novel approach to tackle the multi criteria highway corridor selection problem. The general structure of ANP and essential roles of stakeholders and experts were discussed in the research. A simple numerical example was shown to illustrate the application of the model presented. It is generally believed that feeding more information to the model (or experts) would lead to better decision. The author suggests further study to interpret and investigate the effect of including more possible feedback blocks as added information to the proposed ANP model. Banai (2005)

Presents there is a paucity of reviews of development applications of ANP. This paper provides a survey of recent developments of ANP with reference to applications in the realm of urban and regional planning. Fiala (2005) presents ANP model is suitable to

analyze network economy. Some specific features of network economy as positive feedback, complementarily, network structure, dynamic environment are analyzed by ANP/DNP methods. The research shows a basic principle of the approach but its results cannot be generalized.

3. ANP model

In this section, a model is developed to plan the best choice for the supply of raw materials to feed the paper industry. This model is designed within the framework of ANP. The alternatives are evaluated by the merits of benefits, costs, opportunities, and risks (BOCR).

The Alternatives

There are three potential alternatives for procuring the paper producing plants raw material. First choice is domestic supply of raw material, the second one is importing and last choice is combination of them.

The merits

Merits of the research were divided into benefits, opportunities, costs, and risks. Benefits are favorable and inevitable criteria, costs are unfavorable and inevitable criteria. Opportunities are possible and positive events and risks are possible and negative events.

Overall factors

In this research the merits of benefits, costs, opportunities, and risks are influenced by following overall factors:

- Social and cultural factors: divided into two factors, 1) literacy and culture level; 2) population growth.

- Environmental factors related to 1) forest reclamation; 2) wood and non wood plantation issues.

- Economic factors related to economic issues.

- Governmental laws and regulations related to imports.

- Foreign trade regulations related to limits of exports from other countries.

Prioritizing BOCR

Since benefits, opportunities, costs and risks are not equally important, it is necessary to prioritize them. To do that, they are rated with the lowest level of each overall factors and then summing them up. Five possible rating from very high to very low

be used. The result of the influence of the overall factors on the merits and the rate of priority of the above mentioned merits are reported in table 2.

Table 2. Priority rating for the merits: Benefits, Costs, Opportunities and Risks
very high (1), high (0.51), medium (0.252), low (0.124), very low (0.065)

Risks	Opportunities	Costs	Benefits		
Very high	Very low	Very high	Medium	Foreign trade regulations(0.079)	
Very high	Medium	Very high	Low	Governmental regulations(0.273)	
High	Very high	Medium	Very high	Economic (0.456)	
Very low	Very high	Very low	Very high	Forest reclamation (0.333)	Environmental (0.154)
Very low	Very high	Low	Very high	Wood and non wood plantation (0.667)	
Medium	Medium	Medium	Medium	Population growth (0.25)	Social and cultural (0.038)
Very Low	High	Low	Very high	Literacy and cultural level(0.75)	
0.245	0.275	0.209	0.271	Overall priorities	

Table 2 shows that opportunities and benefits with the priority of 0.275 and 0.271 respectively, have higher priorities than costs and risks in this decision.

The Control criteria

Following the concept of BOCR merits, decisions are most generally approached by breaking them up into merits: benefits, costs, opportunities, and risks. For each merit a sub-network is created with control criteria. When costs and risks are being evaluated, the analysis is done from the perspective of which are more costly or more risky, so that reciprocals of the results are used in synthesizing the results for the final answer.

Four hierarchies are introduced to represent the merits. We describe in more details each hierarchy which includes objective (benefits, costs, opportunities, and risks), related sub-criteria.

Benefits to managers of paper producing plants or producers of the paper

    ■ **No harmful on environment**

        Procurement of raw material for the plants is not the cause of damages on environment.

    ■ **Wood and non wood plantation**

        Plantation of wood and non wood plants is very helpful to decrease the deforestation with regard to supply of raw material for the plants, for example plantation of eucalyptus and poplar trees, bagasse, bamboos and so on.

■ **Decreasing storage cost and increasing selling volume**

Supply of suitable and high quality raw material improves the quality of the products. As a result, it increases selling volume and decreases the storage cost.

■ **Creation of new jobs**

Procurement of proper and adequate local raw material increases the income of the area. Furthermore, it creates new jobs and improves local employment level by absorption of more labor force. The criteria consist of two sub-criteria; Increase of local income and absorption of local and skillful man force.

Opportunities to managers of paper producing plants or producers of the paper

■ **Economic growth of the area**

Creation of new producing plants increases the quality of procured material in favor of economic development of the area.

■ **Export possibilities**

Product export is procured via economic development and high quality products.

■ **The industry Expansion**

By generation of proper condition and procurement of requirement facilities, the expansion of the paper is accelerated.

■ **Investment attraction in future**

Potential of the region in terms of the industry expansion makes the investor interested in commissioning the industry in future.

■ **Access to ISO standards**

The managers can get international standards (ISO) for the products via reaching high quality production.

Costs to managers of paper producing plants or producers of the paper

■ **Purchase of raw material**

The finished cost for purchasing each cubic meter of forest wood, poplar or orchard wood from their supplying sources to produce the product.

■ **Raw material transportation cost**

Transportation costs from raw material supply areas to the plants site.

■ **Customs dues**
Customs dues, in case of raw material imports.

■ **Deforestation costs**
Unwarranted utilization of the forests results in higher destruction level.

Risks to managers of paper producing plants or producers of the paper

■ **Flood possibility**
Irregular utilization from the forests and soil erosion generation, facilitates proper conditions for flood accident

■ **Decrease of selling amount and increase of storage cost**
Improper supply and low quality raw material lower the quality level of products and consequently it decreases selling volume and increases storage cost of products in stock.

■ **Acknowledgment limitation to suppliers of external raw material**
In case of importing essential raw material from foreign countries, it is required to accept the supplier's restriction which may result in procurement of raw material, not necessarily proper or the best quality.

■ **Cutting forbidden issue by government**
Government may force stopping the cutting from the forests due to non-fulfillment, irregular and unwarranted utilization, which result in production shutdown.

■ **Delay in delivery of external raw material**
Procurement of raw material from foreign countries may cause delay in delivery time due to administrative channels and customs rules, and consequently forces the plant to be shut down.

Prioritizing Criteria and Alternatives

After pair wise comparisons between sub criteria for benefits, costs, opportunities and risks by ANP as well as pair wise comparisons of the criteria and choices against each other, following the above mentioned merits, the results are reported in Table 3.

As Table 3 shows, "No harmful on environment (0.364)", Economic growth of the area (0.346), Purchase of raw material (0.455) and Cutting forbidden (0.335) have the highest priority in terms of criteria of benefits, opportunities, costs and risks respectively. Also, with regard to alternatives, external supply (0.406), internal supply (0.420), external supply (0.437) and internal supply (0.478) have the highest priority in terms of criteria of benefits, opportunities, costs and risks respectively.

To apply the ANP, the Super Decision Software is used. In BOCR structure the following formula is used in calculations (Saaty, 2001d):

$$(Benefits)*(Opportunities)/(Costs)(Risks) \qquad\qquad (1)$$

Networks of Control Criteria

Fig. 1 shows the sub network under benefits which has been obtained by Super Decision Software.

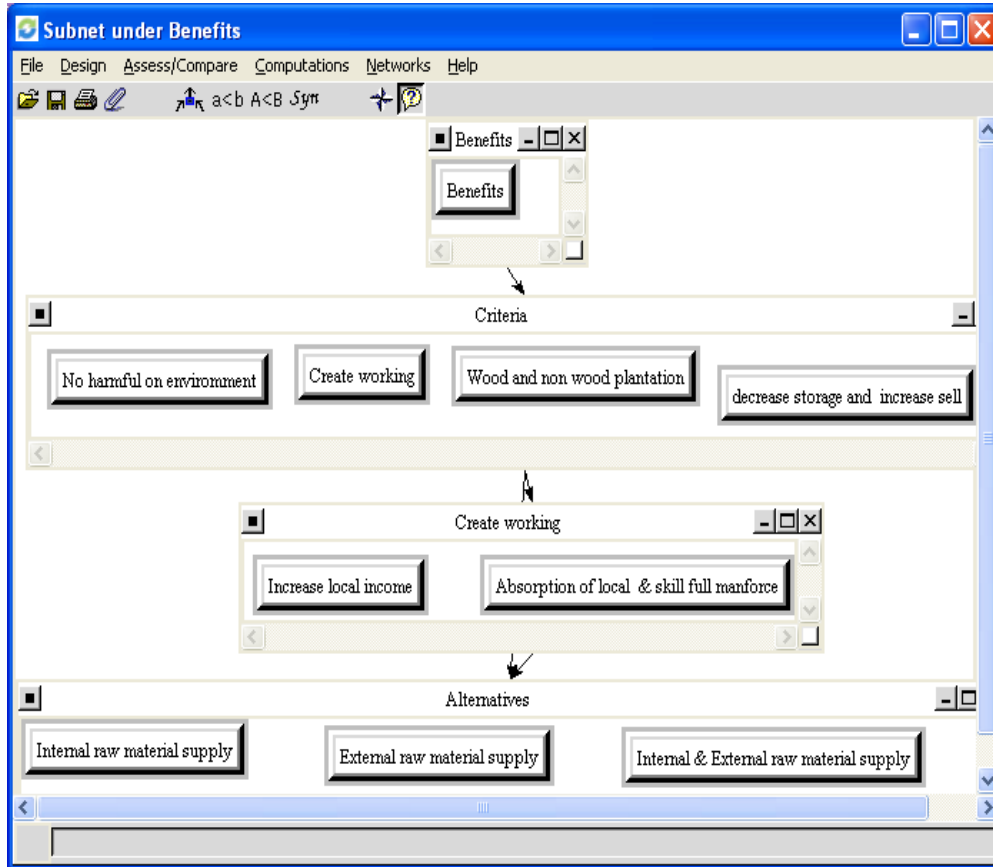**Fig. 1. Sub network under benefits**

Similarly, the networks for costs, opportunities and risks can be developed.

Table 3.   Synthesized Priorities of the 19 Criteria and Sub criteria

Combined Supply	External supply	Internal supply	Sub-criteria	Criteria	Merits
0.286	0.161	0.552	Increase of local income(0.523)	Create of working (0.13)	Benefits (0.271)
0.264	0.154	0.583	Increase of local and skillful man force(0.477)		
0.225	0.56	0.215	No harmful on environment(0.364)		
0.246	0.091	0.203	Wood and non wood plantation(0.203)		
0.258	0.537	0.304	Decrease of storage and increase of selling(0.304)		
0.245	0.406	0.348	Benefits Synthesized		
0.245	**0.406**	**0.348**	Benefits Normalized		
0.26	0.086	0.654	Economic growth of the area(0.346)		Opportunities (0.275)
0.298	0.447	0.255	Export possibilities(0.207)		
0.247	0.335	0.418	Industry development(0.15)		
0.28	0.358	0.363	Investment attraction in future(0.122)		
0.256	0.542	0.202	Access to ISO standards(0.175)		
0.267	0.312	0.420	Opportunities Synthesized		
0.267	**0.312**	**0.420**	Opportunities Normalized		
0.308	0.592	0.1	Purchase of raw material(0.455)		Costs (0.209)
0.249	0.661	0.09	Raw material transportation cost(0.129)		
0.232	0.687	0.082	Customs costs(0.078)		
0.225	0.093	0.682	Deforestation costs(0.338)		
0.266	0.437	0.296	Costs Synthesized		
0.266	0.437	0.296	Costs Normalized		
0.399	**0.243**	**0.358**	Costs Reciprocal		
0.227	0.078	0.695	Flood possibility(0.094)		Risks (0.245)
0.27	0.126	0.604	Decrease of selling and increase of storage(0.247)		
0.254	0.672	0.074	Acknowledgment limits to suppliers(0.127)		
0.215	0.075	0.71	Cutting forbidden(0.335)		
0.265	0.66	0.075	Delay in deliver of external raw material(0.197)		
0.244	0.279	0.478	Risks Synthesized		
0.244	0.279	0.478	Risks Normalized		
0.419	**0.367**	**0.214**	Risk Reciprocal		

Final Outcome

By integration of the weights of the merits of benefits, costs, opportunities and risks and the weights of choices against the above mentioned merits, the final scores are reported in Table 4.

Table 4. Final Outcome for Priorities of the Alternatives

	Benefits (0.271)	Opportunities (0.275)	Costs (0.20)	Risks (0.245)	Final Outcome Additive
Internal supply	0.348	0.42	0.358	0.214	0.336
External supply	0.406	0.312	0.243	0.367	0.337
Combined supply	0.245	0.267	0.399	0.419	0.325

As Table 4 shows the choice of External supply has the highest priority, and is the most suitable choice for procurement of raw material for paper producing plants. Considering the merits in decision making, External supply has the highest priority and the second and third is internal supply and combined supply, respectively.

4. Analysis

As shown in Table 2, opportunities and benefits are more important in the decision compared with costs and risks, because they have higher weight: Opportunities = 0.275, Benefits = 0.271. From Table 3 it is implied that "No harmful on environment (0.364)" has the highest priority in terms of benefits. At present, one of the most important problems of paper industry is the damage to the environment of the area. Irregular utilization of the forests, give rise to the forests destruction and as of its result, accelerating the lack of raw material resources for the industry. Therefore, importing raw materials can be a proper solution to feed the factories. The problem is due to non-fulfillment in performance of plantation and reclamation planning after the utilization. Accordingly, conservation of the environment has high priority in this regard. Economic growth of the area (0.346) is the most important criterion in terms of opportunities. Due to proper and high quality production, the area in which the plant is established will probably develop as industrial and business region and consequently ends up with more economic growth. Economic development also improves other opportunities sub-criteria. "Purchase of raw material (0.455)" has the highest priority in terms of costs, because of lack of the proper raw material to produce final product. Furthermore, due to use of it by various wood industries the demand increases and consequently, supply decreases.

Cutting forbidden (0.335) by the government is involved with an important risk. Area of the forests has been decreased extremely, due to irregular and unwarranted utilization and inadequate conservation and reclamation planning by responsible organizations in past decade. For this reasons, risk of completely cutting forbidden rule

will increase in future. As shown in Table 4, external supply with the highest priority is most suitable choice for industry to satisfy the need for raw materials. With regard to benefits and costs results as shown in Table 3, external supply choice has the highest priority. Internal supply has also the highest priority in terms of opportunities, in this regard. This alternative will generate proper conditions for the plants in future, but its result is not inevitable, against the results of inevitable criteria (benefits and costs). As shown in Table 3 with regard to the result of risks, using of internal resources has the highest priority and its rate is approximately, twice of other alternatives. However, with respect to Table 2 weight of risks (0.245) is much more than costs (0.209). Thus, the alternatives with high risks could not be selected or stands in subsequent priorities. Final synthesized shows external resource is the best choice to procure raw material for paper producing plants. Although, procurement of raw material from foreign countries has high costs to the factories, in long term planning, the high quality products, conservation and lack of harm on environment, avoiding deforestation rate are advantages.

5. Sensitivity Analysis

Since there may be different judgments on the comparison of priority rates of benefits, opportunities, costs, and risks or their sub-criteria, to achieve stability and compatibility of the analysis, we apply sensitivity analysis (Saaty, 2001d). Regarding the findings of BOCR hierarchy, we find out that the ratios of other criteria do not change by increasing or decreasing one of the criteria. For example, if the benefit weights increases from 0.346 to 0.5 the sum of other criteria will be equal to 0.5 and the proportion between them remains consistent and the new weights of other criteria will be as follows: Opportunities: 0.271, Costs:0. 094, Risks: 0.135. In this research, whenever the weight of benefits decreases from 0.272 to 0.25 there will be some changes in the establishment of priority for the choices of the benefits in such a way that the establishment of priority will be internal supply, combined supply and external supply respectively. The second change, may happen with decreasing the benefits from 0.272 to 0.243, in such a way that the establishment of priority for internal supply and combined supply change. Combined supply is the first priority and internal supply the second priority. If this decrease in benefits continues, this difference will again be greater (Fig. 2). If the weight of opportunities increases from 0.275 to 0.285, then the priorities for external supply and internal supply changes. Internal supply will be the first priority and external supply the second. The more increase, the more this difference. If the weight of opportunities decreases from 0.275 to 0.257, then the priority changes. Combined supply will be the second priority, internal supply the third. If the decrease in opportunities continues down to 0.164, then combined supply will be the first priority, external supply the second. If this decrease continues, difference between external supply and internal supply will be greater (Fig. 3). About the costs, whenever the weight of costs increase from 0.209 to 0.218, there will be the change in the establishment of priorities for the choices in such a way that at this point internal supply is the first, combined supply will be the second and external supply the third. If the increase in costs continues up to 0.271, then combined supply will be the first priority, internal supply the second. The more increase, the more this difference, (Fig. 4.) If the weight of risks increases from 0.244 to 0.26, then the priorities for combined supply and internal supply will change. Combined supply will be the second priority and internal supply the third. If the increase in risks continues up to 0.31, then combined supply is the first priority, external supply the second. The more

increase, the more this difference, (Fig. 5). Also, if the weight of risks decreases from 0.244 to 0.239, then the priority for external supply and internal supply will change. Internal supply will be the first priority and external supply the second. The more decrease, the more this difference (Fig. 5).
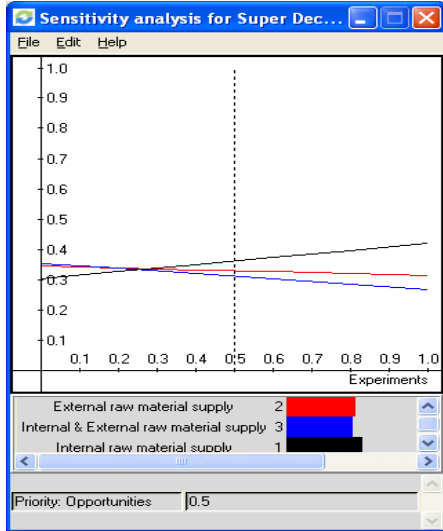

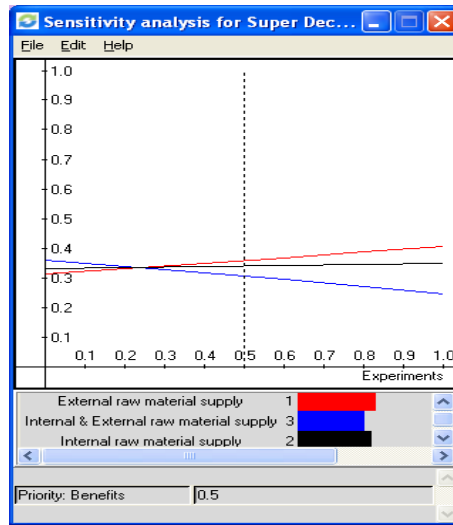**Fig. 2. Sensitivity analysis for benefits**
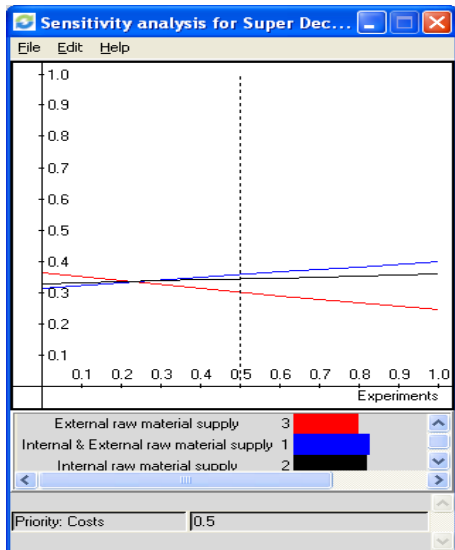

Fig. 3.   Sensitivity analysis for opportunities
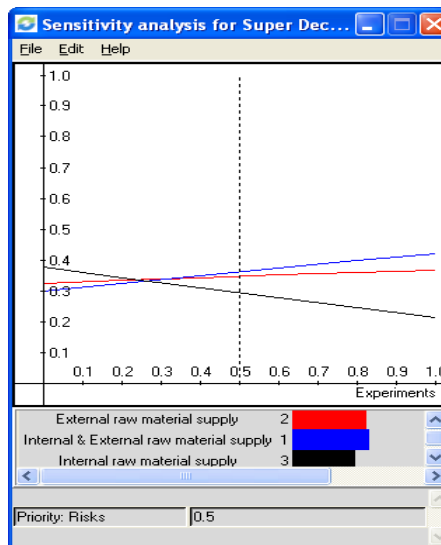

Fig. 4. Sensitivity analysis for costs

Fig. 5. Sensitivity analysis for risks

References

Azizi M., M. Modarres, S. Amir, M. Salehipour and K. Doosthoseini, 2003. The group decision making to determine effective criteria for wood industry location (Case of study: Iran). International Journal of Inquiry, Vol. 1, No. 1, 63-96.

Saaty T., 1999. Decision Making for Leaders, RWS Publications, 4922 Ellsworth Avenue, Pittsburgh, PA 15213.

Saaty T., 2001a. Decision Making with Dependence and Feedback: The Analytic Network Process, RWS Publications, Pittsburgh, PA.

Commercial researches and studies organization, 1994. Wood and paper book, Tehran.

Pulp & Paper International, 1994. A miller freeman publication.

Mahdavi, S., 2003. Investigation on utilization of *P. deltoides* and *E. camaldulensis* for newsprint and printing paper. Ph.D thesis, University of Tehran.

Saaty T., 2001b. Decision Making in Complex Environments, The Analytic Network Process for Decision Making with Dependence and Feedback, University of Pittsburgh.

Saaty T. and Y. Cho, 2001c. The Decision by the US Congress on China's Trade Status: a Multicriteria analysis. Socio-Economic Planning Sciences, 35, 243-252, Elsevier Science Ltd.

Saaty T., 2001d. Decision on National Missile Deffense Program. The 6th International Symposium on the AHP in Bern, Switzerland.

Alikafa E. P. and M. S. Ozdemir, 2003. The best policy for European Union and Turkey Relationship. Proceeding of the Seventh International Symposium on the Analytic Hierarchy Process, ISAHP2003, Bali, Indonesia, pp 97-110.

Azis Iwan J., 2003. Complex Decision in the establishment of Asian Regional Financial Arrangement, Proceeding of the Seventh International Symposium on the Analytic Hierarchy Process , ISAHP2003, Bali, Indonesia, pp 39-56.

Poonikom, K., C. Chansa-Ngavej and C. O'Brien, 2003. A Framework for Universities – Selection Decision using the Analytic Network Process (ANP). Proceeding of the Seventh International Symposium on the Analytic Hierarchy Process, ISAHP2003, Bali, Indonesia, p:403-416.

Ilker Y. Topcu, Sebnem Burnaz and Suha Urgan, 2004. Modeling marketing strategies in organic food through analytic network process. MCDM 2004 conference, Whistler, B.C. Canada August 6-11.

Cevik Sezi, Aktas Emel and Topcu Y. Ilker, 2004. Selection of an Enterprise Resource Planning System using Analytic Network Process: The case of Turkey. 20 the European Conference on Operation Research, OR and the Management of Electronic Services, July 4-7, Rhodes, Greece, Abstract book, p:87.

Piantanakulchai M., 2005. Analytic network process model for highway corridor planning. Proceeding of the 8th International Symposium on the Analytic Hierarchy Process, ISAHP2005, University of Hawaii, Honolulu, USA.

Banai R., 2005. Analytic Network Process: A Survey of Urban and Regional Planning Applications. Proceeding of the 8th International Symposium on the Analytic Hierarchy Process, ISAHP2005, University of Hawaii, Honolulu, USA.

Fiala P., 2005 Analysis of network economy by ANP/DNP. Proceeding of the 8th International Symposium on the Analytic Hierarchy Process, ISAHP2005, University of Hawaii, Honolulu, USA.