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Supply Chain Risk Assessment Using Analytic Network Processes

Case Study: Zagros Petrochemical Company
Located in South Pars Economic Zone

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Abstract. Considering the increase in the dynamics of logistics, sales markets and hence the uncertainty associated with planning, companies should be capable of make informed decisions under risk. The key characteristic of risks involved in supply chain is that the risks extend beyond the corporate boundaries. Furthermore, these extended boundaries can, in themselves, provide the source for the supply chain risks. The present research aims to identify the supply chain risks of Zagros Petrochemical Company, to prioritize the risks , and to make recommendations to managers to confront them. To achieve these objectives, Analytic Network Processes (ANP) are employed. The nature of the research method is applied survey. The data for this research were collected using questionnaires distributed among managers. It is concluded that boycott are the most important risk involved in the supply chain of Zagros Petrochemical Company.

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1. Introduction

A supply chain consists of a network of practitioners and various operational channels within and outside the company which influence the desirability of the supply chain outputs (Eng , 2006). Supply chain management activities aim to satisfy customer demands such that a product of the highest quality is delivered to customers at lowest price (Christopher, 2004).

Supply chain management is of paramount importance in competitiveness of service and industrial sectors. Recently, organizations attempt to create multiple parallel physical and informatic flows to approach efficient and advanced supply chains so as to produce high quality products at the appropriate time and in a cost-effective manner to customers (Jttner, 2005).

The application of supply chain management in organizations is accompanied by both advantages and risks which should be considered by companies. All oil projects and plans constitute the national resources and investments of a country which should be optimally utilized while providing the foundations for investment in other economic sectors (Mills, 2009).

As supply chains are of a much larger scale in these industries they are subject to higher levels of uncertainty. Thus, issues involved in management and the division of risks throughout the supply chain are of much higher significance. As supply chain risks influence supply chain outputs they eventually exert their effect on customers. Under these sets of circumstances, the determining factors include the correct identification of the supply chain and its organized management towards achieving competitive advantage, the appropriate reaction to opportunities and environmental threats, consideration of facilities and internal inefficiencies of the company, balancing the entire supply chain and timely delivery of products to customers. The risk management process concentrates on the identification of existing risks and lessening their

undesirable effects on the supply chain. It involves four phases: identification, assessment, control or management, and tracking risk-oriented events (Ritchie & Brindley, 2007). Measures adopted in risk management include avoidance, decreasing, transfer or sustaining/enduring the risks.

Various factors influence the creation of supply chain risks. Nevertheless, the level of influence and the importance of these factors are not to be equated. Thus, assessment and prioritization of risk factors are from among the most important stages involved in risk management. This is undertaken to determine the priority of each risk, as compared to other risks, in terms of the specified characteristics such that the decision maker be able to allocate and assign the existing resources to confront each risk and to optimally use the facilities, budget, and his/her limited time. Therefore, it is necessary to prioritize these factors in an accurate and scientific manner subsequent to identifying them.

Prioritization of supply chain risks can be conducted quantitatively and qualitatively. One of the most important approaches to risk management is the use of multi-criteria decision-making.

The present paper attempts to employ Analytic Network Processes (ANP), as a quantitative approach, to prioritize risks and to allocate existing resources for the purpose of confronting each risk factor. To implement the risk management process in the network, each network member should identify its own risk so as to manage it by themselves. This is because the risks of each company are dependent upon the goals and objectives of the same company and the main goal of a company is to make profits, to survive and to develop whose pursuit mean differently in different companies. On the other hand, as corporate interrelationships within the network render them dependent the results emanating from these dependencies should also be considered in network risk management. Thus, each company should assess and manage its own risk and conditions from its own perspective. As a result, the present case study attempts to identify supply chain risk factors relevant to Zagros Petrochemical Company prioritizing them using Analytic Network Process (ANP). For this purpose, the following research questions are considered:

1) What are the risks interfering with or disrupting the supply chain?
2) What are the most salient supply chain risks in Zagros Petrochemical Company?

2. Literature Review

2.1 Risks

Risk has been generally defined as the likelihood of danger, damage, harm and injury or any other undesirable outcome (Harland et al., 2003). Risks are evident in all modern-day processes and commercial activities. This is indicative of the fact that it is likely for a process or activity not to occur as planned leading to unfavourable outcomes. Risk has been defined differently in various disciplines (Davis, Spekman, 2004).

2.2 The Risk Management Process As Applied to Networks

Within the process of risk management the decisions required to accept a risk are identified or the decisions necessary to implement measures to lessen the likelihood of occurrence of risks and their effects are adopted. In other words, risk management is the systematic application of management policies, procedures, and processes relevant to activities involved in identifying, analyzing and controlling risks (Ritchie, Brindley, 2007). The risk management process consists of four stages (Lin et al., 2009):

1-Evaluation of the risks involved: To identify the risks confronting a supply chain one can make use of instruments and tools such as brainstorming, process inspection, business model analysis, questionnaires, expert interviews, checklist preparation, etc (Bredell, 2004; Hallikas, 2004; Harland, 2003).

2-Evaluation of the specified risks: At this stage of the risk management process, the risks are measured. Thus, evaluation and prioritization of the risks to adopt appropriate management decisions on the risks relevant to corporate conditions and network level become necessary. The potential effects of an event must be identified from the

perspective adopted by the company. The rationale for this is that an event detrimental to a company may not be harmful to other companies at all or even be beneficial to some.

3-Selection and implementation of measures appropriate to risk management: Companies should always analyse risks while taking appropriate management decisions to protect and safeguard the company and the network. Bredell (2004) distinguishes these measures, which are similar to those of risk management, as follows:

I. Risk Avoidance: An informed decision to avert a risky situation.

II. Risk Reduction: Decreasing the frequency of occurrence and lessening the effects emanating from the risk.

III. Risk Transfer: Finding resources which are more capable of managing risks. Risk Transfer is not necessarily to be equated with Reduction of the risks.

IV. Risk Taking: Supply chain organizations only accept definitive risks.

4-Risk Monitoring: In today's highly dynamic world, modifying domestic, internal and external environments of a company signifies a change in risks. Under these circumstances, new risks should be identified and appropriate measures must be adopted to confront them.

To implement the risk management process in the network, each network member should initially identify and manage its own risk(s). On the other hand, corporate interrelationships enhance dependencies of the companies within the network the results emanating from these dependencies should also be taken into consideration in risk management. For the purpose of risk management, one should be cognizant of the resources and various network risks.

2.3 The Supply Chain

A supply chain is a network comprising of independent and semi-independent commercial processes ranging from the procurement of raw materials to the use of the end product by the customer. In doing so, it connects many companies eventually offering services and physical products to customers. These processes are carried out either in multiple companies or in a specific one (Christopher, 2004). In general, there are to different

supply chains: the internal and the external.

The internal supply chains are mainly concerned with production logistics, procurement and distribution and the external supply chains deal with supply chain members and the interrelationships among the suppliers and customers (Chopra, 2004). The internal supply chain consists of all the activities relevant to the flow of internal supply within a company whose main goal is to integrate these activities thus connecting various subdivisions of the company within its entirety.

In the event of occurrence of a problem within the internal supply chain of a company this can harm the large-scale supply chains even if the external supply chain is managed in an optimal manner. Various researcher have proposed succinct and comprehensive definitions for supply chain which include the following:

Researcher (s)	**Year**	**Definition**
Swaminathan, Smith & Sadeh	1998	A supply chain can be defined as a network comprising of independent or semi-independent commercial enterprises which are collectively responsible for the preparation, production, and distribution of the product and the associated activities such as after-sales services.
Mentzer	2000	A supply chain can be defined as a series of processes and flows occurring within and between the stages and various combinations so as to satisfy customer demand(s).
Kaihara	2003	A supply chain refers to a network of substructures whose main responsibilities are to purchase material, transform the material into intermediate products and to distribute the end product among customers. This occurs in both manufacturing and service organizations.
Chopra & Meindl	2004	A supply chain is composed of all the stages involved, directly or indirectly, in satisfying and responding to customer demand. It incorporates manufacturers, suppliers, storage houses, retailers, and even customers.

Table 1: Definitions for supply chain

2.4 The Supply Chain Risk

The recent developments in technology, commercial structures and business activities enhance the dynamics and change all aspects of our daily life. This assists in accelerating and intensifying the rate of change and enlarging the scale of commercial outcome emanating from such changes. Supply chain risks are typical examples of these changes themselves.

In 2004, Christopher defined supply chain risk as the risk existent in an information, material and product flow ranging from the original suppliers to the delivery of the end product (Christopher, 2004).

Risks have always existed in the supply chain. Therefore, they should not be considered as a new phenomenon. Business organizations are always subject to the supplier's unsuccessful attempts to deliver the right quantity, at the right time, with the right quality and at the right price (Ritchie, Brindley, 2004). There are three major reasons why there is growing concern with risk management in supply chains:

1. The strategies and structures relevant to the supply chain have gathered momentum and develop while securing competitive edge: The movement towards more effective supply chains in recent years has led to supply chains which are more vulnerable to interventions and disruptions (Jttner, 2005).

2. Technological changes have provided opportunities for amending the scale and the relationss between supply chains (Ritchie, Brindley, 2007).

3. In recent years, safety concepts have been incorporated throughout supply chain due to common disruptions. In a global market intertwined with technology, an earthquake in Asia can seriously disrupt business and trade in North America or even Europe. For instance, the Fluid Typhoon in America caused the Daimler Chrysler spare part factory in southern Carolina to be submerged under water as a result of which seven other factories in North America had to close down for seven days (McGillivray, 2000).

2.4.1 Classification of Supply Chain Risks

Researchers have provided various classifications for supply chain risks which are as follows:

Table 2: Classifications for supply chain risks

Researcher & Year	Classification Introduced
Barnes (2005)	1) Strategic Risks: risks due to failure or success of plans. 2) Financial Risks: Risks due to failure or success in financial control. 3) Operational Risks: Risks resulting from human errors (dangerous behaviours and personnel behaviour risks). 4) Commercial Risks: Risks emanating from failure or success in commercial relations 5) Technical Risks: Risks due to damage to physical assets and properties.
Christopher (2004)	1) Supply Risks: This is probably the most important supply chain risk which can give rise to other risks. When one pays for a product or service s/he is subjected to the risk that the supplier may not deliver the right quantity and quality at the right time which is referred to as the supply risk. 2) The Process Risk: This is the risk associated with the fact that a product might not be produced in time with the right quantity and quality. 3) The Demand Risk: This is the risk emanating from the fact that there might not be demand for a product or there may be insufficient demand. 4) Control Risk: This is the result of inadequate quality control. 5) Environmental Risk: The risk associated with the environmental effects which are caused by the physical, social, political, legal, operational and economic environments.

Researcher & Year	Classification Introduced
Chopra, s., Sodhi (2004)	They distinguish nine supply chain risks in order to develop risk mitigation strategies. These are: disruptions, delays, malfunctions related to information systems, networking, predictions, intellectual properties procurement, customers (receipt risks), inventory, and capacity.
Blackhurst et al. (2006)	They provided a specific classification for risks and their sources. This classification was the first to hierarchically classify risk factors based on internal and external factors. These factors are as follows: internal factors (controllable, relatively controllable, uncontrollable) and external factors (controllable, relatively controllable, uncontrollable).
Ziegenbein et al. (2004)	They analyzed five risks (i.e. supply, demand, process, planning, control and environment risks) from the viewpoint of the central company.
Paulsson (2004)	This scholar subdivided supply chain risks into four categories; operational disruption, tactical disruption, and strategic uncertainty.
Kleindorfer, Van Wassenhove	This scholar subdivided supply chain risks into only two categories; disruption/intervention risks and the risks resulting from lack of coordination between supply and demand.

Generally speaking, it can be said that supply chain risk management is concerned with managing external and internal supply chain risks which is accomplished through the coordinated approach, among supply chain members, towards lessening the vulnerability of the supply chain. The risks involved are not necessarily those occurring among supply chain members. Supply chain risk management can also be applied to management of the risks within a specific company. Nevertheless, supply chain risk management aims to avoid the occurrence of failures in the supply chain which can lead to ripple effects influencing the entire supply chain. To find and to analyzes these risks is the key to supply chain risk management. On the other hand, an appropriate classification in risk management assists managers act most optimally when prioritizing and adopting suitable managerial measures.

3. Techniques Involved in Evaluation of Supply Chain Risks

As was mentioned earlier, to manage supply chain risks the existing risk factors should be initially identified and classified subsequent to which they are managed with effective tools (Chopra, Sodhi ,2004). As risk factors in a factory depend on corporate objectives (Hallikas et al.) irrespective of the type of industry and expert opinion, it is not possible to determine several specific factors as supply chain risk factors for all industries. Thus, an approach should be adopted whereby expert opinions and Multiple-Criterion Decision-Making techniques are employed to evaluate and rank supply chain risk factors.

The following is an overview of Multiple-Criterion Decision-Making techniques in evaluation of supply chain risk factors.

While applying Multiple-Criterion Decision-Making Models it is of crucial importance to select the appropriate method. This is because there are numerous methods used in Multiple-Criterion Decision-Making Models each of which possesses its own characteristics and limitations which makes them inapplicable in some decision-making problems. From among the criteria employed for selecting the appropriate method, one

can refer to the effectiveness or the ineffectiveness of indexes as exerting influence on one another, their quantitative or qualitative nature, negative or positive effects, accessibility or lack of accessibility to the relative weight of indexes, the need or lack thereof for information as obtained from decision-makers in the course of the process and similar instances.

1. Linmap: Due to the nonexistence of constraining assumptions in this method, it can be employed in prioritization of supply chain risks. Nevertheless, the requirement for pair-wise comparisons among the options (i.e. risks) might render the use of this method problematic.

2. Topsis: In this method, the desirability of each index should be uniformly increasing or decreasing such that the best existing value for each characteristic/index is indicative of its ideal status while its worst existing value represents negative ideals. Considering its simplicity, this method is desirable.

3. MDS: In case there is a large number of indexes which are mostly qualitative and an effective number ambiguous or unspecified, one can make use of this method. The disadvantage is dependence on decision-maker's accurate and numerous judgments.

4. Electre: In this method, options which do not have any mathematical priority over one another are evaluated with reference to non-rank and paired comparisons while ineffective options are omitted. This method is not impeded by any constraints which would render its supply chain risk ranking impractical.

5. Linear Allocation: In this method, the given assumptions in a problem are ranked on the basis of points obtained for each characteristic/index and the final ranks of options are depicted via a linear compensation process. The solution process proceeds in such a way as to render redundant the need to bring to scale quantitative and qualitative indexes.

6. Permutations: In this method, the analyst needs a decision-making matrix and the weightings for each index. The method does not investigate the intensity of superiority of an option as compared to another. It only shows the superiority of an option over another.

7. Taxonomy: This method is capable of dividing a set into roughly-homogenous subsets ranking them in terms of the level of their acquisi-

tion of identical indices/characteristics.

8. AHP: This method has been developed on the basis of the hierarchical structure of indexes. The risk ranks are extracted on the basis of identical indexes.

9. ANP: The ANP is mainly used for problems whose characteristics are not independent. It deals with the assumption of independence between the characteristics (an AHP limitation) (Lee & Wu, 2005). This method was introduced by Saaty in 1996. ANP is a necessary tool for connecting and delineating our understanding of a decision-making problem. In this method, one can overcome the limitations of the linear hierarchical structures and their mathematical consequences (Saaty, 2004).

The ANP not only provides better and deeper understanding of the intricate and complex relationships between evaluation criteria for decision-making but it is capable of securing trust and confidence in decision-making (Jharkharia & Shankar, 2007). The interrelations among decision-making network nodes are subdivided into two categories: external and internal dependency. External dependency occurs when elements existing in a node exert an effect on elements of another. Internal dependency, on the other hand, takes place when elements existing in a node influence each other (Saaty & Vargas, 2006). Internal dependencies are represented by a looped arrow. It is noteworthy that solving a problem using networks relies on the expertise of the model-maker and the formation of a network does not follow a specific procedure. Thus, the solution to each problem is uniquely complicated and no single rule can be proposed for the solution of a network problem.

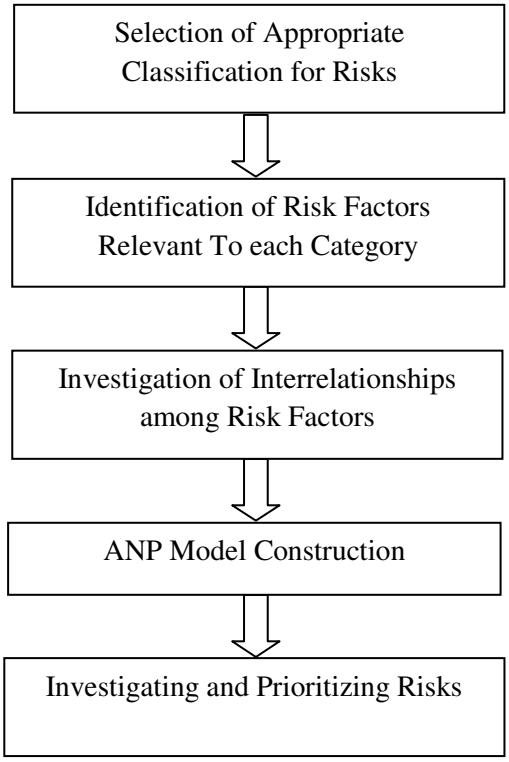
4. The Proposed Model

4.1 The Selection of Appropriate Classification for Risks

Supply chain risk is a concept which can be viewed from different perspectives. As a result, there are numerous classifications for this type of risk while one cannot consider one classification superior to another as these classifications are not entirely distinct and independent. In fact, each classification yields effectively to the views of the researcher and

the specific environmental and industrial background. This means that while risk management is being investigated in the petrochemical industry a classification might be selected which may not be suitable for other industrial conditions such as the electronics industry. Having said that, to achieve the main objective of the present paper, i.e. to study supply chain risks in Zagros Petrochemical Company, it becomes necessary to decide on the type of classification suitable for supply chain risks in the petrochemical industry.

4-The Proposed Model



4-1 The Selection of Appropriate Classification for Risks

5. Case Study

I. The Selection of Classification Appropriate to the Risks
Reviewing the literature and conducting semi-structured interviews with senior managers of Zagros Petrochemical Company and the specific conditions governing supply chain it was concluded that the following classification offers better agreement with the conditions governing supply chain. Therefore, it has been used as the primary basis for designing the questionnaire. The classification is generally based on classification proposed by Jttner (2005). The researcher (Jttner , 2005) categorizes the supply chain risks into three types: internal risk sources, external risk sources, and the source relying on connections between chain members.

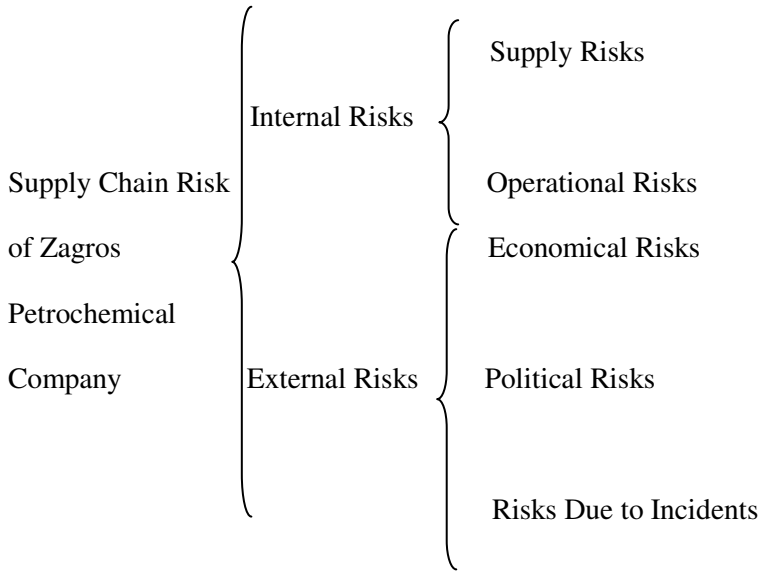


Figure 2: Classification of Risk Factors

II. Identification of Risk Factors Specific to Each Classification: To identify supply chain risks and respond to the first research question a questionnaire comprising of 58 items was designed. To design the questionnaire, a literature review was initially undertaken. Considering the classification assigned for the supply chain risks (internal, external and

connections) the criteria relevant to this classification were identified. Subsequently, the criteria were finalized and customized with reference to interviews held with five experts adding Iran's specific criteria and omitting some other criteria due to the specific conditions governing the supply chain. Furthermore, these criteria are measured via a five-point Likert scale.

The questionnaire was distributed among 28 senior and intermediate managers and supervisors of the company. To measure the reliability of the questionnaire Chronbach's Alpha was calculated (?=91.7) which is indicative of the high reliability of the questionnaire. Responses were transferred to Excel and factors whose probability of occurrence exceeded 50 were deemed by experts to be risk factors. The following is a list of these factors:

Table 3: risk factors

1- Factors Related to Supply(S)	(S1) Quality problems of the supplier (feed and parts)
	(S2) Quantity problems of the suppliers (feed and parts)
	(S3) Increase in supplier's supply costs
	(S4)Failure of the supplier to abide by the terms of agreement (lack of timely delivery and the requested quantity)
	(S5) Referring only to one supplier
	(S6) Lack of conformance between parts supplied by contractors and the standards defined by the company
	(S7) Fluctuations in the lead time
	(S8) Insufficient knowledge of the supplier about the product or the requested service
2- Factors related to the operations (O)	(O1) Lack of relevant valuable individual and organizational knowledge
	(O2) human errors
	(O3) Problems arising from inappropriate use of equipment
	(O4) Lack of proper interaction between organizational units
	(O5) Deficiencies in human resource management
3- Factors related to supply chain relations (R)	(R1) Problematic regulation on establishment of relations among chain members
	(R2) Lack of cooperation and appropriate affinity among chain members
4- Economic Factors (E)	(E1) Changes in the exchange rate of the dollar and other currencies
	(E2) Economic recession
	(E3) Instability in the financial market
5- The political factor	(P1) Boycott
6- The legal factor (L)	(L1) changes in the large-scale national policies

III. Investigation of Relations between Risk Factors: To draw the decision-making network ANP modeling was employed. The ANP model is constructed through consideration of major and minor agents and factors in the previous stage. Thus, the quality of relating these major factors or agents and the minor agents and factors are specified. To specify the relations mentioned, in drawing the decision network, the relations matrix, whose rows and columns constitute the effective factors/agents, is initially determined. Then, an effective factor/agent is check marked in the matrix with reference to responses made by experts (See Table 4).

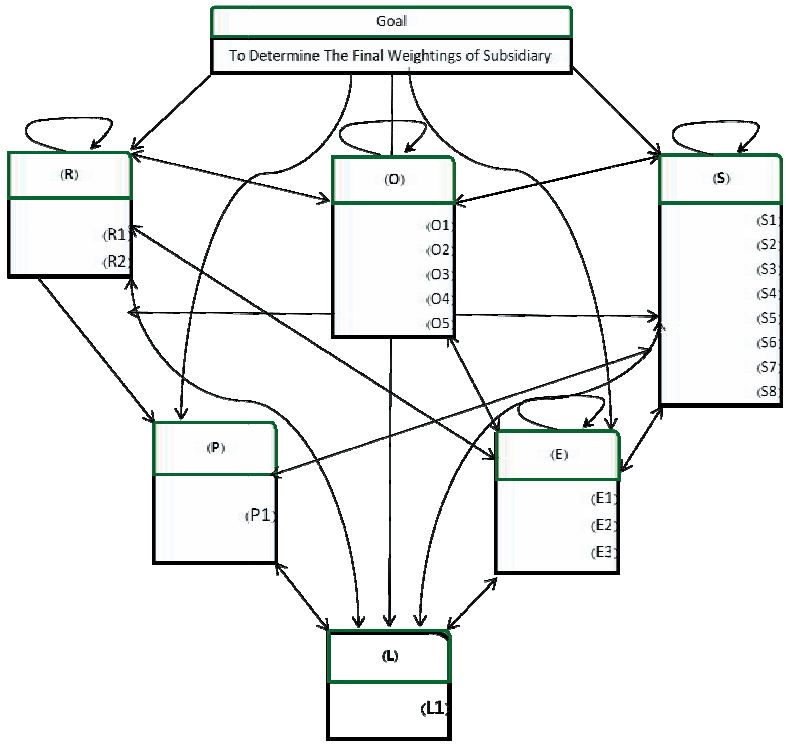
Table 4: The Relations Matrix

	۳				۲		۱															
	L	P	E			R		O					S									
	L1	P1	E3	E2	E1	R2	R1	O5	O4	O3	O2	O1	S8	S7	S6	S5	S4	S3	S2	S1		
		√					√			√			√		√	√					S1	
						√											√	√			S2	
	√	√	√	√	√											√			√	√	S3	
		√	√			√							√	√					√	√	S4	
		√												√	√		√	√	√	√	S5	S
													√			√		√		√	S6	
	√	√	√				√									√	√	√			S7	۱
											√			√	√	√	√	√	√	√	S8	
						√		√	√	√	√				√	√		√			O1	
										√											O2	
									√		√	√									O3	O
								√				√									O4	
									√	√	√	√									O5	
	√	√		√										√			√	√			R1	
	√	√					√	√	√			√		√			√	√			R2	R
	√		√	√										√		√		√		√	E1	۲
	√	√	√		√		√	√						√		√		√			E2	E
	√	√		√													√	√	√	√	E3	
	√		√	√	√									√	√	√	√	√	√	√	P1	P
		√	√	√	√	√	√									√		√			L1	L

V. ANP Model Construction

The ANP model is composed of three stages. In the first stage, the aim is to determine the weights of the subsidiary factors of the risk and to prioritize them in the supply chain of Zagros Petrochemical Company. In the second stage, the major factors are incorporated. Subsidary factors relevant to each major agent/factor are included in the third stage. Subsequent to the establishment of relations between the factors, as was the case in the previous stage, the relations are defined in Super Decision software. The results emanating from the ANP model are indicated in Figure 3.

Figure 3: The Decision Network Model



V. Investigation and Prioritization of Risks: Subsequent to the establishment of the decision network model the pairwise comparisons questionnaire, one of the software outputs, is distributed among eligible subjects (managing board). After calculating the geometric mean of responses, the inconsistency ratio was evaluated (Max=0.0722, Min=0). Thus, it can be asserted that there has been good agreement in responses.

Using the Super Decision software, the SuperMatrix and Weighted Super Matrix were calculated. It has to be mentioned that in the matrix the sum of all figures in a column in a cluster equals one. To transform the Super Matrix into the Weighted Super Matrix it is necessary to calculate the weightings for each matrix block. To calculate the block weightings pairwise comparisons should be carried out between the clusters. Through multiplying these weightings by each block of the SuperMatrix, the Weighted Super Matrix is obtained (Tables 5,6,7).

To obtain the final weightings for the subsidiary factors the weightings for major factors are obtained from the matrix clusters (See Table 5). Then, the relative weightings of subsidiary factors are extracted from the unweighted matrix (Table 6). Through Multiplication of these weightings the ultimate weightings of subsidiary factors are obtained (Table 7).

Table 5: The Balanced Matrix of Clusters

	Goal	Supply Risk	Operation Risk	Relation Risk	Economic Risk	Politic Risk	Legal Risk
Goal	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Supply Risk	0.282568	0.633329	0.118540	0.073340	0.077536	0.375757	0.176736
Operation Risk	0.278279	0.106524	0.812682	0.053111	0.058009	0.000000	0.000000
Relation Risk	0.061175	0.041572	0.068778	0.637856	0.042452	0.000000	0.120625
Economic Risk	0.091500	0.056222	0.000000	0.055914	0.634794	0.323568	0.206537
Politic Risk	0.187125	0.114963	0.000000	0.115987	0.129858	0.000000	0.496102
Legal Risk	0.099352	0.047389	0.000000	0.063791	0.057351	0.300674	0.000000

Table 6: Unweighted Super Matrix

			Goal	1													2		3				
				S								O					R		E			P	L
				S1	S2	S3	S4	S5	S6	S7	S8	O1	O2	O3	O4	O5	R1	R2	E1	E2	E3	P1	L1
Goal			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	S	S1	0.171	0.000	0.000	0.309	0.253	0.194	1.000	0.000	0.235	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.239	0.000	0.160	0.111	0.000
		S2	0.101	0.000	0.000	0.311	0.313	0.222	0.000	0.000	0.119	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.203	0.109	0.000
		S3	0.098	0.000	0.360	0.000	0.000	0.151	0.253	0.220	0.139	0.294	0.000	0.000	0.000	0.000	0.278	0.273	0.319	0.556	0.412	0.178	0.450
		S4	0.191	0.000	0.640	0.000	0.000	0.232	0.000	0.491	0.159	0.000	0.000	0.000	0.000	0.000	0.360	0.498	0.000	0.000	0.225	0.226	0.000
		S5	0.114	0.282	0.000	0.380	0.000	0.000	0.207	0.274	0.117	0.207	0.000	0.000	0.000	0.000	0.000	0.000	0.215	0.258	0.000	0.126	0.550
		S6	0.090	0.390	0.000	0.000	0.000	0.232	0.000	0.000	0.134	0.499	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.153	0.000
		S7	0.133	0.000	0.000	0.000	0.239	0.087	0.000	0.000	0.097	0.000	0.000	0.000	0.000	0.000	0.362	0.229	0.228	0.186	0.000	0.097	0.000
		S8	0.102	0.328	0.000	0.000	0.195	0.000	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	O	O1	0.350	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.639	0.194	0.567	0.000	0.177	0.000	0.000	0.000	0.000	0.000
		O2	0.105	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.131	0.000	0.248	0.000	0.117	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		O3	0.153	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.312	1.000	0.000	0.000	0.137	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		O4	0.107	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.165	0.000	0.113	0.000	0.179	0.000	0.356	0.000	0.000	0.000	0.000	0.000
		O5	0.284	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.392	0.000	0.000	0.806	0.000	0.000	0.467	0.000	1.000	0.000	0.000	0.000
2	R	R1	0.498	1.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0.000	0.000	0.525
		R2	0.502	0.000	1.000	0.000	1.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.475
3	E	E1	0.313	0.000	0.000	0.302	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.482	0.000	0.349	0.327
		E2	0.307	0.000	0.000	0.306	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.507	0.000	1.000	0.359	0.389
		E3	0.380	0.000	0.000	0.392	1.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.493	0.518	0.000	0.293	0.285
	P	P1	1.000	1.000	0.000	1.000	1.000	1.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	0.000	1.000	1.000	0.000	1.000
	L	L1	1.000	0.000	0.000	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000

Table 7: Weighted Super Matrix

			Goal	1													2		3				
				S								O					R		E			P	L
				S1	S2	S3	S4	S5	S6	S7	S8	O1	O2	O3	O4	O5	R1	R2	E1	E2	E3	P1	L1
Goal			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	S	S1	0.048	0.000	0.000	0.230	0.189	0.000	0.320	0.000	0.201	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.024	0.000	0.014	0.042	0.000
		S2	0.029	0.000	0.000	0.231	0.234	0.188	0.000	0.000	0.102	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.017	0.041	0.000
		S3	0.028	0.000	0.338	0.000	0.000	0.128	0.253	0.167	0.119	0.035	0.000	0.000	0.000	0.000	0.066	0.021	0.032	0.043	0.036	0.067	0.080
		S4	0.054	0.000	0.600	0.000	0.000	0.197	0.000	0.348	0.136	0.000	0.000	0.000	0.000	0.000	0.086	0.039	0.000	0.000	0.019	0.085	0.000
		S5	0.032	0.199	0.000	0.282	0.000	0.000	0.207	0.194	0.100	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.020	0.000	0.047	0.097
		S6	0.025	0.276	0.000	0.000	0.000	0.096	0.000	0.000	0.115	0.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.057	0.000
		S7	0.038	0.000	0.000	0.000	0.074	0.000	0.000	0.083	0.000	0.000	0.000	0.000	0.000	0.086	0.018	0.023	0.014	0.000	0.037	0.000	0.000
		S8	0.029	0.232	0.000	0.000	0.146	0.000	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	O	O1	0.097	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.639	0.194	0.567	0.000	0.010	0.000	0.000	0.000	0.000	0.000
		O2	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.144	0.107	0.000	0.248	0.000	0.117	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		O3	0.043	0.119	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.254	1.000	0.000	0.000	0.137	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		O4	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.134	0.000	0.113	0.000	0.179	0.000	0.020	0.000	0.000	0.000	0.000	0.000
		O5	0.079	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.318	0.000	0.000	0.806	0.000	0.000	0.026	0.000	0.058	0.000	0.000	0.000
2	R	R1	0.030	0.046	0.000	0.000	0.000	0.000	0.000	0.047	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.676	0.000	0.042	0.000	0.000	0.063
		R2	0.031	0.000	0.062	0.000	0.049	0.000	0.000	0.000	0.000	0.069	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.057
3	E	E1	0.029	0.000	0.000	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.306	0.000	0.113	0.067
		E2	0.028	0.000	0.000	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.181	0.000	0.418	0.000	0.706	0.116	0.080
		E3	0.035	0.000	0.000	0.026	0.066	0.000	0.000	0.063	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.407	0.329	0.000	0.095	0.059
	P	P1	0.187	0.128	0.000	0.135	0.136	0.154	0.000	0.129	0.000	0.000	0.000	0.000	0.000	0.000	0.375	0.123	0.000	0.130	0.144	0.000	0.496
	L	L1	0.099	0.000	0.000	0.056	0.000	0.154	0.000	0.053	0.000	0.000	0.000	0.000	0.000	0.000	0.206	0.068	0.075	0.057	0.064	0.301	0.000

Table 8: Prioritization of risk factors based on the final weight

No.	Initials	Risk Name	Weight
1	P1	Boycott	0.18713
2	L1	changes in the large-scale national policies	0.09935
3	O1	Lack of relevant valuable individual and organizational knowledge	0.09746
4	O5	poor human resource management	0.07913
5	S4	Failure of the supplier to abide by the terms of agreement (lack of timely delivery and the requested quantity)	0.05409
6	S1	Quality problems of the supplier (feed and parts)	0.04827
7	O3	Problems arising from inappropriate use of equipment	0.04269
8	S7	Fluctuations in the lead time	0.03756
9	E3	Instability in the financial market	0.03479
10	S5	Referring only to one supplier	0.03231
11	R2	Lack of cooperation and appropriate affinity among chain members	0.0307
12	R1	Problematic regulation on establishment of relations among chain members	0.03048
13	O4	Lack of proper interaction between organizational units	0.02991
14	O2	human errors	0.02909
15	S8	Insufficient knowledge of the supplier about the product or the requested service	0.0288
16	S2	Quantity problems of the suppliers (feed and parts)	0.02862
17	E1	Changes in the exchange rate of the dollar and other currencies	0.02859
18	E2	Economic recession	0.02812
19	S3	Increase in supplier's supply costs	0.02763
20	S6	Lack of conformance between parts supplied by contractors and the standards defined by the company	0.02529

6. Conclusion

Risk management is concerned with identification of risk factors. Considering the limitations of organizations in accessing sufficient resources, the presentation of approaches and allocation of the resources needed to confront supply chain risks are conducted with reference to risk prioritizations. Thus, prioritization of these factors is of paramount importance. Considering the above table and the order of items in the table salient conclusions can be obtained. Among the most important conclusions are: Two factors mentioned in the table fall into the category of factors existing in the external factors which is indicative of the fact that external factors and factors existing in this category such as sanctions and large-scale national policy change are more significant as compared to other factors. It is evident that the weighting for sanctions possesses a larger weighting as compared with those of other factors in the table which should be given special attention by managers of Zagros Petrochemical Company. The third and the fourth factor in the table fall into the category of internal and operational factors. This demonstrates the fact that the disruption and intervention factors in Zagros Petrochemical Company's operation unit play a major role in causing supply chain risks. From among the salient features and distinctions between these factor and others one can refer to the existence of the human being as a complex and dynamic but teachable entity having changing thoughts and behaviours. In the case of supply chain risks, other chain members can contribute to the creation of risks. Nevertheless, it seems that , considering the specific conditions governing Zagros Petrochemical Company's supply chain managers and other practitioners can play a part in creation and prevention of risks . Thus, it can be reasonably argued that investment in this realm will eventually exert remarkable and positive effects on risks.

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