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Investigation and Selection of Overseas Suppliers with Emphasis on Risk Indicators in Iran

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ABSTRACT

The present study was done with aimed to investigate and select overseas suppliers with emphasis on risk indicators in Iran's manufacturing companies in Khorasan province. This research was applied in terms of its purpose and is also part of descriptive-analytical research. A questionnaire was used to collect information. Given that contracting or contracting by low-cost overseas suppliers is an attractive topic in the global economy, Unfortunately, these decisions are made without due consideration to the requirements, market demand and proper delivery system, which usually results in bad results. Determining the risk factors affecting the supply chain of a manufacturing company, determining the decision making options for adopting its purchasing or manufacturing policies, and how to interact with the company's experts can help companies make better decisions about making or purchasing final products or parts. By reviewing the literature of research and using expert opinions, a list of effective criteria for the assessment and selection of overseas suppliers was identified in five general categories (demand, supply, infrastructure, regulatory, environmental, and catastrophic risks). According to the results of this study, among the main criteria, the risk of supply has the highest weight, so it is more important than other major criteria.

Keywords: Risk Indicators, Demand Risks, Supply Risk, Infrastructure Risk, Regulatory and Environmental Risks
JEL Classifications: M30, M31

1. INTRODUCTION

Almost since the 1980s, many reputable companies have left some or all of their activities outsourced to foreign countries. Due to access to raw materials and lower wage costs, they can profit from its competitive advantage (Schoenherr et al., 2008). Following the successful operation of this type of outsourcing, other companies, including manufacturing or services, are encouraged to do this kind of activity and the scope of this outsourcing has been unearthed over the next few years. Transmission of production or service operations of a company to a company abroad is leading to the creation of a complex network, which can result in a higher risk, especially the risks in the supply chain. These risks may include poor product quality or service performance, less reliability, supply disruptions, disasters, and communication problems. In other words, the benefits of transferring activities abroad must be so high that they can offset these risks so that this kind of activity is affordable (Schoenherr et al., 2008). Although today, most companies are considering manufacturing or purchasing decisions both inside the country and abroad, little research has been done on the risks involved in this process. Given that almost all companies face some kind of such risks, the risk assessment in the chain has become one of the most important issues. In this research, a coherent approach and structure is presented to assess the supply chain risks associated with external outsourcing decisions. In this research, it is not simply about making decisions about making or purchasing from other countries, but rather by expressing the risks associated with these types of decisions, and then paying attention to outsourcing. If the decision is to divest the operation abroad, then the question should be asked which country should be chosen to face less risks. Identifying the risk factors affecting the supply chain of a manufacturing company, determining the choices for making purchasing policies or the production of that company and how it interacts with the company's experts, suggests the application of the proposed method, Generally, the suggestions given by the research to this company can help the company make better decisions about making or purchasing final products or parts of it, thanks to questions like "How to decide

on external sources of funding?" Risks should be considered, and how can a decent decision be made according to the nature of the multi-criteria nature of the problem?

2. RESEARCH BACKGROUND

In his 2015 study Gligor et al., "Effective consequences of agile supply chain," Chief Strategic Management of Supply Chain Affects Corporate Performance. If companies use their agility strategy in their supply chains, customer productivity will increase, and cost-efficiency will increase if they use lean strategy in the supply chain. In addition to investigating the effect of supply chain agility on customer performance, this study attempts to measure the impact of agility on cost efficiency and ultimately how these factors affect corporate performance. In 2006, Coronel and Treader, in their study "Supply Chain Strategies and Their Impact on Supply Chain Performance and Corporate Performance," They point out that supply chain strategies include agility and purity, as well as information systems strategies in the supply chain, affect company performance. This study, using the flexibility of information systems as a moderator, evaluates the effect of supply chain agility on supply chain performance and company performance.

In 2014, Jabbour et al. reviewed the quality management, maturity of environmental management, green supply chain implementation practices and performance in Brazilian small and medium-sized enterprises at the presence of ISO 14001. The research was conducted in 95 companies from green supply chain groups that have an ISO 14001 certificate in Brazil. The results show that comprehensive quality management has a positive and significant impact on the activities and performance of the green supply chain and improves it. Therefore, it is suggested to chain managers to prioritize the implementation of quality related activities and their management in organizations and if possible, extend it to all sections and chain members to increase its impact. Also, the success of the green supply chain will improve the company's performance.

Nassiri and Pour, in their 1394 research paper entitled "An Integrated Model for Choosing Suppliers and Assigning Supply in the Supply Chain," stated that suppliers have a clear role in the proper operation of a supply chain and their proper choice is of particular importance. In this research, an integrated model of multi-criteria decision making and mathematical programming for selecting suppliers and order allocation in the supply chain is presented. The proposed structure consists of two sub-models of qualitative and quantitative. Under the qualitative model, using the prioritization fan based on the similarity of the ideal solution (TOPSIS) to the qualitative assessment of the suppliers. Then, in the sub-model, the volume of ordering is determined by the suppliers based on the priorities defined in the qualitative stage using multi-dimensional mathematical programming. The solving method in this research is the multi-objective fuzzy approach, which is widely used because of the ability to calculate the degree of supply of various objective functions in the model in solving multi-objective problems. One of the most prominent features of the model is the attention to the different levels of quality and the rate of failure associated with it, as well as the assumption of the supplier's change in detail. Finally, to show the validity of the model and the efficiency of the solution method, a number of sample problems are presented and solved.

Mantian et al. in his article in 2015 Titled "Developing a Strategic Model for Choosing Suppliers." Using Structural Equation Modeling and Fuzzy Logic Modeling Approaches, we have designed and developed a model to select the appropriate supplier by using structural equation modeling and fuzzy logic model approaches in Khuzestan Steel Company. The statistical population of this study consists of all staff related to the evaluation and selection of suppliers in the steel company, which was 200 people. Sampling method of this sampling study is available. Data collection tools are questionnaire form; two questionnaires are provided for two levels of supplier selection. A Comprehensive Method A two-level method is proposed for a structural equation modeling approach and a fuzzy logic approach. In order to analyze the data, Lisrel, SPSS and Matlab software were used. After reviewing the literature, and according to the opinions of the experts of Khuzestan Steel Plant, 8 criteria include high level of quality, supplier delivery performance, service level level, cost and price level, high level of management and organization benchmark, financial position, technology level and technical capabilities and supplier's credentials and history were identified for the supplier's assessment and selection. After analyzing the results, the indicated eight criteria significantly affect the supplier's choice. Also, according to the findings, after confirmation of fitness and appropriateness of the supplier's choice of measurement model and determining the weight and relative importance of the research criteria at the first level, and determine the location of choices for choosing a steel company in Khuzestan to determine the supplier of alloy components in the second level and confirm the consistency and accuracy of these decisions. Combining the results and final output of the proposed research model showed that supplier A has the highest significance and highest rank due to the calculated scores and thus the best option for the Khouzestan steel company to supply the alloy components. Subsequently, suppliers of D, C, and B are ranked next.

3. RESEARCH METHOD

Based on the purpose of the research, fundamental and applied research is divided. The present research can be considered based on the purpose of applied research. This research can also be considered as part of descriptive-analytic research. In this type of research, the researcher, in addition to illustrating what is described, explains why and why the situation and its dimensions are discussed. The statistical population of this study consists of all industry and academic experts with at least 5 years of specialized research experience and their field of study related to the subject matter of the research. In this research, a targeted sampling method will be used and at least 12 interviews and paired comparison questionnaires will be distributed among the research experts. The library method (books, articles, and dissertations in English and Persian) is used to collect information in the theoretical and research topics, and a questionnaire is used to collect information in the main part of the research. For this purpose, the first step is to use books, essays, dissertations, and internet scrolling. In the

second step, a questionnaire is used to measure the relationship of variables. The questionnaire is a pairwise comparison questionnaire based on the criteria and sub-criteria that experts are asked to complete by comparing the questionnaire with their knowledge. These comparisons are the inputs of the hierarchical analysis process. To obtain weights, data is entered into the model. In this research, the hierarchical analysis technique (AHP) was used to analyze the data. In this technique, the relationship between down-and-down criteria and sub-criteria is examined. In AHP, target levels, benchmarks, sub-criteria, and options are independent of each other at each level. On the basis of a one-way relationship or linear one-way top-down linear weighting in the hierarchical process with subtractive pairwise matrices, and in the end, multiplied from bottom to top in matrices, the final weight of the options was determined and the ranking also ends.

4. DATA ANALYSIS

4.1. Describe the Research Model and used Components

The first step in the process of hierarchical analysis is to form a hierarchical structure or hierarchical tree. To form the hierarchical structure of the problem, first, the research model factors, namely, the purpose of research, criteria, sub criteria and research options, should be identified. By reviewing the research literature and using expert opinions, a list of effective criteria for assessing and selecting overseas suppliers was identified in five general categories. In this study, three suppliers were identified and selected as research options. Table 1 shows lists the criteria and research options along with the codes used for it.

At this stage, by identifying the criteria, the sub criteria and the research options can be the hierarchical structure of the problem. Figure 1 shows the hierarchical structure of research.

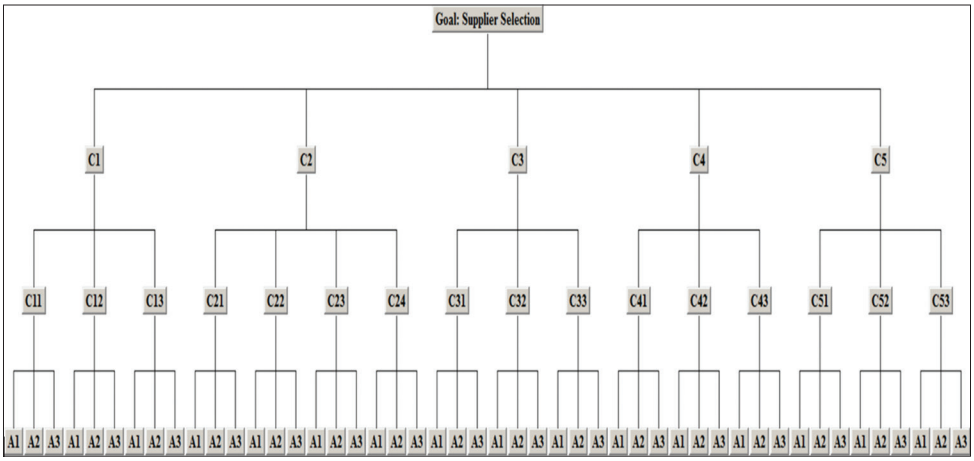
4.2. Calculate Relative Weight of Main Research Criteria

After identifying the hierarchical structure of the research, it is necessary to calculate and evaluate the weight of the research criteria towards the target. In order to calculate the weight of the research criteria toward the goal, a paired questionnaire of criteria was developed for the purpose. After making a paired questionnaire, the criteria for research were compared with the goal of the decision makers to complete them. By completing the questionnaires, we collect the collected data into the Expert

Table 1: List of research criteria

Symbol	Subcategories	Symbol	Criteria	Number
C11	Seasonal imbalances	C1	Risk of demand	1
C12	Risk of competitors			
C13	Market risk			
C21	Operational and Manufacturing Risk	C2	Supply risks	2
C22	Risk of raw materials			
C23	Quality risk			
C24	Risk of Capacity Limit			
C31	Shipping risk	C3	Infrastructure risks	3
C32	Risk of machinery			
C33	Information risk			
C41	Government risk	C4	Regulatory and environmental risks	4
C42	International risk (sanctions and .)			
C43	Environmental risk			
C51	Risk of natural events	C5	Catastrophic risks	5
C52	The risk of terrorist attacks			
C53	Socio-cultural risk (strike and .)			

Figure 1: Hierarchical structure of research



Quiz software to evaluate and weigh the main criteria of the research towards the goal. If the level of incompatibility of the matrix is equal to the maturity criterion is acceptable (<0.1), then the paired questionnaire should be returned to the experts to be reviewed. The Figure 2 and Table 2 gives the matched pair matrix of the main criteria relative to the target, along with its incompatible rate. The figure numbers and, respectively, the relative weight of the main criteria and the order of their importance.

As it is seen, among the main criteria of the C2 criterion, that is, the highest supply risks, so it is more important than other major criteria. Demand and infrastructure risks also rank second and third respectively (Figure 3 and Table 3).

4.3. Calculation of Relative Weight of Research Sub Criteria

In the previous section, the weight of the main criteria was obtained using the Paired Comparison Questionnaire and Excelent Chuis software. In this section, we try to use a paired questionnaire to calculate the relative weight of the sub-criteria of each of the main criteria. To this end, the data collected by the paired peer review questionnaire from the experts was introduced into the Excel software, in order to obtain the relative weight of each of the following criteria in relation to its original criterion. Subsequently, the calculations relating to the sub-criteria of each of the major criteria are presented separately.

4.4. Calculations of Sub-criteria of Demand Risk

Table 4 presents the paired comparison questionnaire for the sub-criteria of demand risk, along with its incompatibility rate. The Figure 4 also shows the importance and weight of each subscale of the risk of demand.

4.5. Calculation of Sub-risk Factors

The Table 5 shows the subcategory of the subcriteria of supply risk, along with its incompatibility rate. The Figure 5 also shows the weight and ordering for each sub-risk of supply.

4.6. Calculation of Sub-criteria for Infrastructure Risk

The Table 6 shows the subcategory of the sub-criteria of infrastructure risk with its incompatibility rate. The Figure 6 also shows the weight and arrangement for each of the sub-criteria of infrastructure risk.

4.7. Calculation of Regulatory and Environmental Risk Sub-criteria

Table 7 of the paired t-test shows the sub-criteria of regulatory and environmental risk, along with the amount of incompatibility rate. Figure 7 also shows the weight and arrangement for each of the sub-criteria of regulatory and environmental risk.

4.8. Calculation of Catastrophic Risk Sub-criteria

Table 8 of the paired comparison questionnaire shows the disadvantaged risk sub-criteria, along with the amount of incompatibility rate. Figure 8 also shows the weight and sequence for each of the disadvantaged risk sub-criteria.

Figure 2: Relative weight of the main criteria

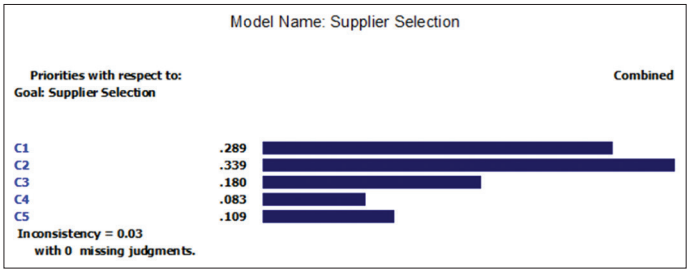


Figure 3: Arrange the importance of each of the major criteria according to their weight

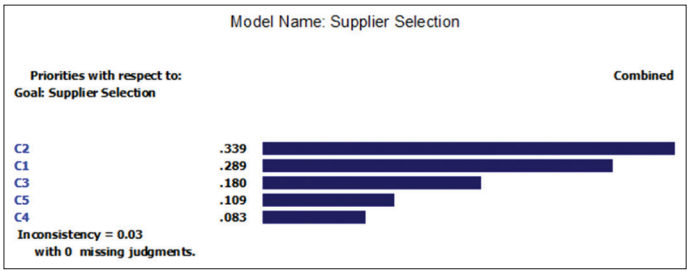


Figure 4: Weight and order of importance of each of the sub-criteria of demand risk

Table 2: List of research options

Options	Symbol	Number
Supplier Company 1	A1	1
Manufacturer Company 2	A2	2
Manufacturer Company 3	A3	3

Table 3: Comparison of the matrix of the main criteria relative to the target

	C1	C2	C3	C4	C5
C1		1.90637	2.44949	3.30193	2.74946
C2			1.51309	3.4641	2.62074
C3				2.0	2.13983
C4					1.5874
C5	Incon: 0.03				

Table 4: Comparison matrix of sub-criteria of demand risk

	C11	C12	C13
C11		1.90637	2.44949
C12			2.5698
C13	Incon: 0.04		

Table 5: Comparison paired matrix sub-risk factors

	C21	C22	C23	C24
C21		1.81712	1.90637	2.5698
C22			2.62074	2.80397
C23				1.81712
C24	Incon: 0.02			

4.9. Evaluate and Prioritize Research Options

After calculating the weight of the main criteria and the sub criteria of the research, we must calculate the weight of the research options in relation to each of the sub-criteria. At this stage, the relative weight of options was calculated in relation to each of the research sub criteria and then the final weight of the research options was calculated. In order to calculate the weight of the options, in comparison with the sub criteria of each of the main criteria, the paired comparison matrix must be firstly established and sub-criteria are given to the decision makers. If the paired comparison questionnaire is compatible, the results will be presented. In the following, the relative weight of research options is presented separately from the sub-criteria of each of the main criteria.

4.10. Calculate the Weight of the Research Options

In the previous sections, the relative weight of the main research criteria was calculated relative to the target and the relative weight of the sub-criteria was compared to the main criteria. At this stage, the relative weight of the options was calculated in relation to each of the sub-criteria of the research.

Figure 5: Weight and order the importance of each sub-risk of supply

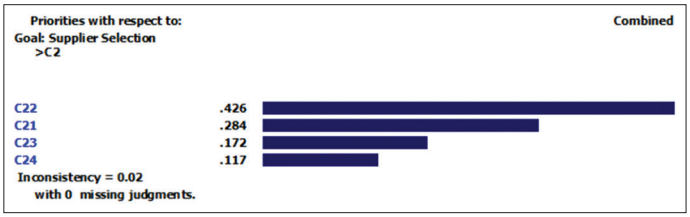


Figure 6: Weight and order of importance of each of the sub-criteria of infrastructure risk

Figure 7: Weight and arrangement of the importance of each of the sub-criteria of regulatory and environmental risk

Figure 8: Weight and arrangement of the importance of each of the sub-criteria of regulatory and environmental risk

In this step, having the relative weight of all the main factors of the research structure, we can calculate the final weight of the options. The Table 9 shows the final weight of the research options. The Figure 9 also shows the options based on their weight and rank.

As you can see, among the research options, the A2 option, the second-largest supplier, has gained the highest and so ranked No. 1. Options 1 and 3 respectively have won the next rank.

5. ANALYSIS AND INTERPRETATION OF RESEARCH RESULTS

In this research, by reviewing the literature of research and using expert opinions, a list of effective criteria for the assessment and selection of overseas suppliers was identified in five general categories (demand, supply, infrastructure, regulatory, environmental and catastrophic risks). Also, three suppliers were identified and selected as research options, and the hierarchical structure of the problem was formed. After identifying the hierarchical structure of the research, we calculated and evaluated the main criteria of the research and their sub-categories. In this regard, a paired questionnaire of criteria was developed for the purpose. By completing the questionnaires by decision makers, the collected data entered the Expert Quiz software to evaluate and calculate their weight (Figure 10).

As it is seen, among the main criteria of the C2 criterion, the highest-possible supply risks, therefore, are more important than other major criteria. After calculating the weight of the

Table 6: Paired comparison matrix of sub-criteria for infrastructure risk

	C31	C32	C33
C31		2.44949	2.28943
C32			1.5874
C33	Incon: 0.03		

Table 7: Paired comparison matrix of regulatory and environmental risk sub-criteria

	C41	C42	C43
C41		2.0	2.03965
C42			2.62074
C43	Incon: 0.02		

Table 8: Paired comparison matrix of disastrous risk sub-criteria

	C51	C52	C53
C51		2.28943	1.69838
C52			2.74946
C53	Incon: 0.01		

Table 9: Weight of each of the research options

The final weight	Options
0.391	A1
0.428	A2
0.181	A3

Figure 9: The final weight of the research options in order of importance

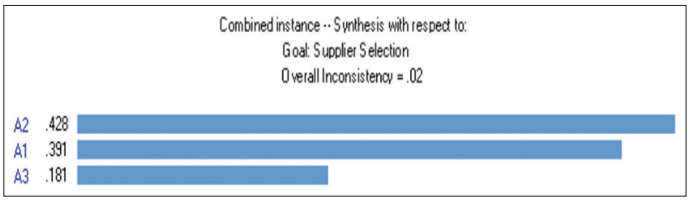
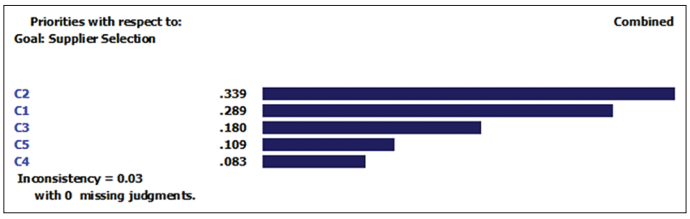


Figure 10: Arranges the importance of each major criterion according to their weight



main criteria and sub criteria of the research, we calculated the weight of the research options in relation to each of the sub-criteria. For this purpose, the matrix of paired comparison matrix is made up of sub-criteria and is available to decision makers. In the following, the relative weight of the research options is presented separately from the sub-criteria of each of the main criteria. The results of the supplier assessment are shown in Table 10.

As you can see from the research options, the A2 option, the second supplier, has the highest weight, and thus ranked No. 1. Options 1 and 3 respectively have won the next rank.

6. THEORETICAL APPLICATIONS

Here are some theoretical uses of the research, including:

1. According to the results of this research, the supply of risks in the field of overseas suppliers' selection and selection is at the top of the list. Therefore, it is suggested to managers of organizations to pay close attention to this issue with regard to supplying their customers and to reduce the risk of supply.
2. Considering the results of this study, it is suggested to managers of organizations to be careful when choosing their suppliers and to ensure the necessary reliability by researching the raw material and operational risks.
3. According to the results of this study, demand risks for the selection and selection of overseas suppliers is in the second priority. Therefore, it is suggested to managers of these organizations to minimize these risks by choosing the right strategies for marketing.

7. MANAGEMENT APPLICATIONS

In this section, the applications of the research to its management applications are addressed to the managers of the organizations according to the results of the hypotheses. Here are some examples.

1. Awareness and understanding of managers of effective measures in the assessment and selection of overseas suppliers will make it more effective to reduce the risks of selecting suppliers.
2. Considering that the ultimate goal of most organizations is to earn profits, have a larger market share and gain competitive advantage and ultimately improve the organization's performance, and reducing the risks of supplier selection will also improve the overall performance of the organization. The results of this research Managers will help reduce their vendor choices by paying attention to supply risks as their first priority and sub-criteria.
3. The optimal allocation of organizational resources is always considered as one of the main concerns of managers. Using the results presented in this study, managers will have a better view of different dimensions and will be able to invest and allocate resources from inefficient or low-impact sectors to invest in dimensions that will greatly reduce the risk of choice vendors.

Table 10: Weight of each research option

Priority	Options	The final weight
First	A2	0.428
Second	A1	0.391
Third	A3	0.181

8. PROPOSALS FOR FUTURE RESEARCH

In the last section of this research, here are some suggestions for future research for researchers interested in this field, so that the road of research into sales performance is clear and flammable.

1. First, it is suggested that research be carried out in a number of different periods and intervals, in order to better assess different criteria for the selection of overseas suppliers and to have more sustainability results.
2. In this research, we tried to determine the indices defined independently of each other. However, the method employed could, depending on the values of the objective function for maximization and minimization problems, show the degree of dependency between the options, but the dependence The indicators should also be considered. To this end, one aspect of future research for this study is to examine the supply chain risk assessment with theories such as the analytical network process (ANP) that can take these kinds of dependencies into decision making Or the ANP process can also be used to combine hierarchical analytic methods (in a non-deterministic or fuzzy manner) with multi-objective decision-making methods such as ideal planning, which could be a very interesting research topic for these types of decisions.
3. Certainly, the researcher was not able to identify all the factors affecting the selection of overseas suppliers, and there have been factors that are beyond the reach of the researcher. Investigating uncertain factors can help reduce the risks of selecting suppliers.
4. In the future, we can also add more factors to the selection of overseas suppliers, such as the environmental conditions of the country in question, or the culture of that country, to produce more comprehensive results.

5. To ensure the accuracy of the results, these relationships can also be tested in other organizations.
6. It may be that the industry under study is a factor influencing research. Therefore, it is suggested that this research be carried out in other industries and its results should be compared with the results of this study.

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