**Business and Economics Research Journal**
Volume 3 Number 3 2012
pp. 121-143
ISSN: 1309-2448
www.berjournal.com

# Subcontractor Selection Using Analytic Hierarchy Process

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**Abstract**: *Turkish textile firms work under a heavily competitive atmosphere in terms of prices due to globalization. Firms have to take into consideration several criteria like cost, quality and delivery -on-time in order to survive the global market conditions and to maintain profitability. To meet these criteria, contractor companies have to select the best subcontractor. Therefore, the selection of subcontractor for the contractor company is a problem. The aim of this study is to solve the problem of Yeşim Textile, a contractor company, about the selection of the best subcontractor for its customer Nike. To solve the problem, firstly, the main criteria and relevant sub-criteria, which are of importance for Yeşim and Nike, were defined. Then, authorities from the firms were interviewed in order to formulate pairwise comparison matrices using the Saaty's importance scale. In a sense, this matrix is the model of this study. The model, named AHP, was analyzed using the Expert Choice software. Best subcontractors for Yeşim were determined based on the model results. In addition, these results were analyzed for the firm's decision makers.*

**Keywords**: Analytical hierarchy process (AHP), Decision making, Multi criteria analysis, Contractor, Subcontractor

**JEL Classification**: C44, D81, L29

## 1. Introduction

Under today's global market conditions, firms, in order to be able to remain profitable, need to produce goods that offer additional value for their customers, these goods should have good quality and competitive prices, and they should be delivered to customers on time. Under these heavy competition conditions, factors like orders' sizes, prices, qualities, costs and delivery on time prompted firms to cooperate with subcontractors. In addition, most firms operating in the Turkish textile sector are subcontracting for transnational firms like Nike, Zara, Gap, Adidas, Esprit, Victory Secret and Hugo Boss.

In recent years, Turkish textile firms have been obliged to compete in terms of price with companies from China, India, Pakistan and other Far-Eastern countries. Therefore, in order to survive and remain profitable, firms have to subcontract part of the orders they receive by considering various criteria such as cost, quality and delivery-on-time. Moreover, the global company requires, in contracts signed with the contractor, the criteria it defines to be met also by subcontractors. In addition, there also exist other criteria specified by contractor firms. Then, the problem here is to select the subcontractors that are able to satisfy the criteria specified by the owner and contractor firms in the best way.

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The aim of the study is to determine what subcontractors should produce the orders that Yeşim received from Nike using the AHP multi criteria decision making method. Apart from the Introduction, the study consists of four sections. Firstly, the literature on subcontractor selection is reviewed. Then, the analytical hierarchy process is defined and solution stages are explained. In the fourth section, the model is formulated about how the application works at Yeşim Textile. Finally, based on the analysis results, the benefits brought by this study to the respective firm are discussed.

## 2. Literature Review

Although the literature review pointed to numerous studies carried out using the AHP model in many different fields, not many studies were found on the subject of contractor and subcontractor selection. Kumaraswamy and Matthews (2000) underscore the importance of the techniques and subcontracts developed that could be used in improving the partnership between the client and the contractor. The aim in the study carried out by Fong and Choi (2000) is to select the most qualified contractor. In the study, a new alternative selection instrument is suggested in order to assess more comprehensively the multi-directional performance potential of the contractor. It is argued, when the suggested AHP technique is used, that the exchange in the bid price could be achieved by taking into consideration the time and quality criteria along with qualitative and quantitative criteria. Al Harbi's (2001) study also aims to determine how AHP method can be applied in project management. Topçu (2003) argues that contractors in the public sector who offer the lowest cost generally get the tender. In addition, he offered a decision making model, which considers criteria like cost, time and quality, for the building contractor selection. Banaitiene and Banaitis (2006) focus on the evaluation of contractors of criteria for selecting contractors. The aim in that study is to assess the qualities of Lithuanian construction companies with respect to the criteria. Sha and Che (2006) applied several analytical models, including AHP, to the multi-phase design of a complex supply chain network. Tomlin (2006) studied strategies for managing supply chain disruption risk for a dual-sourcing environment given supply uncertainty and volume flexibility Wu et al (2007) examine the selection of best subcontractor using the widespread plan-do-check-act (PDCA) quality cycle. Yik and Lai (2007), finally, demonstrate in their study how the multi-layered subcontracting system works in the Hong-Kong construction industry. Levary (2008) The method of AHP is used to evaluate of foreign suppliers and to rank them. In three different countries of the suppliers are evaluated supplier reliability, country risk, transportation risk and reliability of the supplier's suppliers within the framework of a total of four criteria. Sari et al (2008) proposed an AHP model to contribute in the selection of the partner companies in the dynamic environment. Their AHP model was linked with a generic multi-criteria analysis model, and provided a means of structuring the decision problem and estimating importance weights for the objectives of the various stakeholder groups.

## 3. Analytical Hierarchy Process

The analytical hierarchy process (AHP) is a multi-criteria decision making method developed in the 1970s by Thomas L. Saaty (Saaty and Vargas, 2001). AHP can be defined as the method of expressing the components and variables of a complex and unstructured situation, assigning quantitative values to subjective judgements about the comparative importance level of each alternative, and synthesizing by demonstrating the variables' degrees of priority based on above quantitative results (Saaty, 2005). The analytical hierarchy process is used in the solution of decision-making problems encountered in many different fields since it is a method that makes possible the use of both qualitative and quantitative

decision criteria in the process of assessing and selecting among decision criteria. For example, AHP is used in issues that are of importance for the enterprise like project selection, investment decisions, risk management, contractor selection, subcontractor selection and evaluation of management strategies as well as in issues like planning, marketing, benchmarking and manufacturing.

In the classification of a decision problem in the AHP approach, a hierarchical structure is used. Hierarchy is indeed a specific type of system and based on the assumptions that the defined elements can be grouped under different categories and that each element in a group can be influenced by only one element in the other group. It is assumed that each element in a group is independent. When there is dependency between them, dependency and independency should be examined separately and then these two relationships should be combined (Saaty, 1988).

### 3.1. Solution Stages of AHP Problems

In the decision making process with the AHP method, *the first stage* is the definition and configuration of the problem. At this stage, the problem is defined, alternatives and criteria are determined, and assessment criteria based on objectives are developed. While forming hierarchy in this method, the determination of the elements to be included in the system is of importance. The configuration of AHP begins when the criteria and alternatives to be included in the model are determined. It is useful to benefit from a team of experts while determining them.

*The second stage* is the modelling stage that includes the setting of hierarchy, and the steps of pairwise comparison matrix, synthesis, consistency and final decision. Firstly, a hierarchical structure is formed by determining the targets, criteria, sub-criteria and alternatives related to the decision problem. Then, the elements in the hierarchy are compared and pairwise comparison matrices are created in order to define priorities. While formulating matrices, a scale is used in order to be able to compare between the criteria. This scale is presented in Table 1 (Saaty, 1988; Doumpos and Zopounidis, 2003).

Pairwise comparison matrix consists, firstly, of the main criteria, then of the sub-criteria under each main criterion, and finally of matrices that compare the alternatives considering all criteria. Answers to two questions are sought in these comparisons. The first of them is about which of the two elements under the criteria are more important, whereas the second one is about how many times more one of the elements is important than the other.

After the pairwise comparison matrix is created, the priority of each of the compared elements is calculated and relative importance vectors are obtained, which comprises the synthesis step. After the relative importance vectors are calculated, the reliability ratios of pairwise comparison matrices are determined and the upper limit for these ratios 0.10 (Niemira and Saaty, 2004; Harker and Luis, 1987). A reliability ratios below 0.10 indicates that the element's importance level is significant, whereas a ratio above 0.10 points out that the decision maker is inconsistent in his judgements (Bodin and Gass, 2003).

**Table 1:** Relative Importance Scale

| Intensity of importance | Definition | Explanation |
|---|---|---|
| 1 | Equal importance | Two activities contribute equally to the objective |
| 2 | Weak | Between equal and moderate |
| 3 | Moderate importance | Experience and judgment slightly favor one activity over another |
| 4 | Moderate plus | Between moderate and strong |
| 5 | Strong importance | Experience and judgment strongly favor one activity over another |
| 6 | Strong plus | Between strong and very strong |
| 7 | Very strong or demostrated importance | An activity is favored very strongly over another; its dominance demonstrated in practice |
| 8 | Very, very strong | Between very strong and extreme |
| 9 | Extreme importance | The evidence favoring one activity over another is of the highest possible order of affirmation |

The following steps are followed while calculating the reliability ratio: Firstly, for each line of the pairwise comparison matrix, weights of the elements in columns are summed up. Then, the element in each column of the pairwise comparison matrix is divided to the total column weight in order to calculate the normalized matrix. Priorities vector is formed by taking the average of each line of the normalized matrix. All priorities matrix is obtained by multiplying the comparison matrix, given at the beginning, by the vector obtained after the priorities matrix is calculated. Then, each element of all priorities matrix is divided into the element of the priorities vector. By taking the average of the elements of the new matrix, maximum eigenvalue ($\lambda_{max}$) is determined. In order for the pairwise comparison matrix to be consistent, the maximum eigenvalue of the matrix should be equal to the number of activities (n value). While $\lambda_{max}$ = n in the condition of consistency, the value of deviation from consistency is expressed as $CI = (\lambda_{\max} - n)/(n-1)$, and this is called consistency index (CI). *Consistency ratio* (CR) is obtained by dividing the *consistency index* ( CI ) into the *random index* ( RI) value.

In a sense, $CR = CI / RI$ .

Random index (RI) here is the average values of the pairwise comparison matrices created randomly depending on “n”. Random index values prepared for 1-10 dimensional matrices are presented in Table 2 (Saaty, 1988).

**Table 2:** Random Index Values

| ***n*** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| ***RI*** | 0.00 | 0.00 | 0.58 | 0.90 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.49 |

After the consistencies of pairwise comparison matrices are tested, the final step of AHP is the final decision. At this step, final relative weights of alternatives are determined. Before doing this, it is necessary to calculate the composite relative importance vector for the main criteria that has sub-criteria. Calculations are made by multiplying the relative importance values that alternatives in each line of the matrix take for the sub-criterion with the relative importance values of each sub-criterion; and summing up these values obtained after multiplications. After these calculations, the final relative importance vector for alternatives can be found. To do this, the relative importance values that alternatives in each line of the matrix take for the main criteria are multiplied with the relative importance values of each criteria; and summing up these values obtained after multiplications gives us the relative importance value. Thus, the best alternative according to the judgements of the decision maker is found.

## 4. Application

In order to create the AHP model that will determine the subcontractors to which Yeşim Textile should convey the orders received from Nike, it is firstly needed to define the company criteria. These criteria were determined by interviewing quality guarantee manager, subcontractors monitoring manager and social suitability manager. Besides, to solve the problem, a research team was formed consisting of experts. From manufacturing, purchasing and marketing departments under the management of above specified managers. After the interview we conducted with the research team, it was decided to solve the problem with the AHP method since it involved numerous qualitative and quantitative criteria like quality, social suitability and cost.

In the AHP model, six subcontractor firms were assessed with respect to eight main criteria and 29 sub-criteria. The main criteria in the model are presented below. Among them, the main criteria of compliance with the plan, social suitability and firm's location were developed by us after the interview by considering the characteristics of the firms and added to the model.

*Main criteria of quality control systems* include sub-criteria of input control system, product acceptance rate, sewing, final control of production, corrective and preventive actions and application effectiveness of quality control techniques.

*Main criteria of social appropriateness* includes sub-criteria of lack of child employment, discrimination/harassment, appropriateness of working, wages and appropriateness, appropriateness of the operation of management system, occupational health and safety, environmental suitability, and lack of uninsured employment.

*Main criteria of cost* comprise sub-criteria of employment cost, travelling, custom, billing costs and transportation cost.

*Main criteria of compliance with the plan* involve sub-criteria of labour capacity, compliance with demand shift, capacity usage ratio and delivery on time.

*Main criteria of technical capacity* include sub-criteria of existing production technology, monitoring new technologies, R&D infrastructure and employees' working skills.

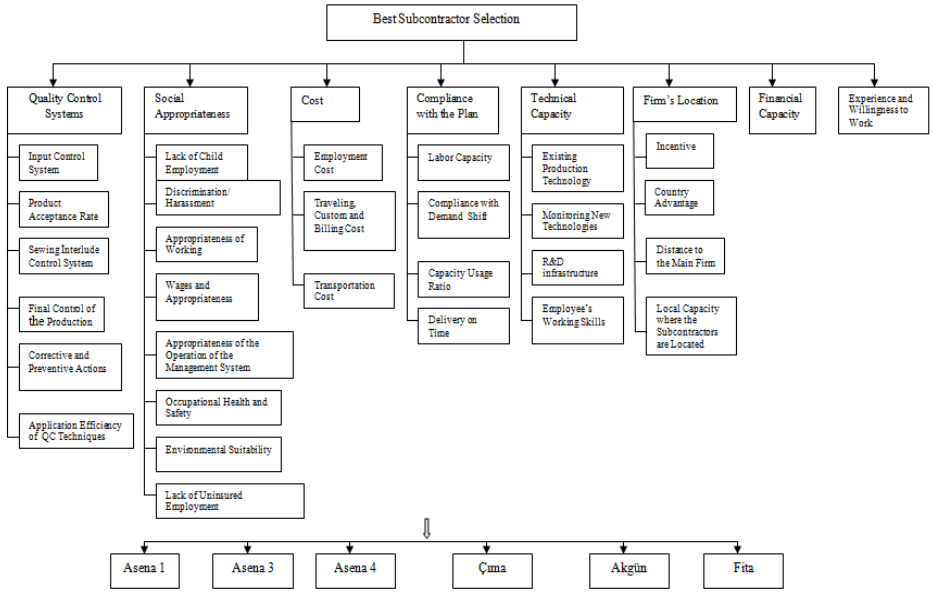
*Main criteria of firm's location* include sub-criteria of incentive, country advantage, distance to the main firm and local capacity where the subcontractors are located.

*The main criteria of financial capacity, experience and willingness to work* do not have sub-criteria.

The alternative subcontractors in the model are Asena 1, Asena 3, Asena 4, Çima, Akgün and Fita.

Based on the above data, the hierarchical structure of the AHP model, presented in Figure 1, was formed.

**Figure 1**: Hierarchical Structure of Subcontractor Selection Problem




The second step after the hierarchical structure of the AHP model is formed is the determination of relative importance of elements, that is, the pairwise comparisons made between elements at each level. Pairwise comparisons consist of matrices where firstly the main criteria, then the sub-criteria, and finally alternatives are compared by taking into consideration all the criteria. Pairwise comparisons were obtained by using the relative importance scale, developed by Saaty and presented in Table 1.

After forming the pairwise comparison matrices, the Expert Choice software was used in the analysis of the model. Firstly, judgement values on 38 pairwise comparison matrices

were recorded in Expert Choice. After completing data entry, to investigate whether these data (judgements) are consistent, consistency ratios of all of 38 pairwise comparison matrices were calculated. After analyzing judgements' consistencies (according to the criteria of having values below 0.10, as indicated earlier), our model was analyzed in Expert Choice. Outputs obtained after running the software, related to the relative importance vectors about the main criteria, sub-criteria and alternatives in the model, are presented in Table 3.

**Table 3:** Final Relative Weights of Main and Sub-Criteria of the AHP Model

**Goal:** Best subcontractor selection
**Quality Control Systems** (Global: 0.149)
Input control system (Global: 0.014)
Product acceptance rate (Global: 0.067)
Sewing interlude control system (Global: 0.015)
Final control of the production (Global: 0.011)
Corrective and preventive actions (Global: 0.011)
Application efficiency of QC techniques (Global: 0.031)
**Social Appropriateness** (Global: 0.170)
Lack of child employment (Global: 0.049)
Discrimination/harassment (Global: 0.049)
Appropriateness of working hours (Global: 0.011)
Wages and appropriateness of payment (Global: 0.007)
Appropriateness of the operation of the management system (Global: 0.004)
Occupational health and safety (Global: 0.018)
Environmental suitability (Global: 0.006)
Lack of uninsured employment (Global: 0.025)
**Cost** (Global: 0.153)
Employment cost (Global: 0.115)
Traveling, custom, billing cost (Global: 0.018)
Transportation cost (Global: 0.020)
**Compliance with the Plan** (Global: 0.266)
Labor capacity (Global: 0.022)
Compliance with demand shift (Global: 0.012)
Capacity usage ratio (Global: 0.070)
Delivery on time (Global: 0.162)
**Technical Capacity** (Global: 0.074)
Existing production technology (Global: 0.031)
Monitoring new technologies (Global: 0.006)
R&D infrastructure (Global: 0.006)
Employee's working skills (Global: 0.031)
**Firm's Location** (Global: 0.040)
Incentive (Global: 0.014)
Country advantage (Global: 0.016)
Distance to the main firm (Global: 0.005)
"Local capacity where the subcontractors are located" (Global: 0.004)
**Financial Capacity** (Global: 0.128)
**Experience and Willingness to Work** (Global: 0.021)

After the analysis of the model, the criterion with the highest weight was found to be the criteria of compliance with the plan (26.6%), which was followed by social appropriateness (17%), cost (15.3%), quality control systems (14.9%), financial capacity (12.8%), technical capacity (7.4%), firm's location (4%), experience and willingness to work (2.1%), respectively. As for the sub-criteria of the main criteria; the most important sub-criteria under quality control systems is product acceptance percentage (0.067), the most important sub-criteria under social appropriateness is lack of child employment and discrimination (0.049), under the main criteria of cost is labor cost (0.115), under the main criteria of compliance with the plan is delivery on time (0.162), and under technical capacity is existing manufacturing technology and employees' working skills (0.031). Finally, it could be stated that the most important sub-criteria under the main criteria of firm's location is country advantage.

**Table 4:** Alternatives' Importance Values and Ranks

| Alternatives | Importance Values | Rank |
|---|---|---|
| Fita | 0.201 | 1 |
| Çima | 0.180 | 2 |
| Asena4 | 0.165 | 3 |
| Asena1 | 0.163 | 4 |
| Asena3 | 0.154 | 5 |
| Akgün | 0.138 | 6 |

Notes: Ideal mode results are presented.

Six firms' importance values and ranks are presented in Table 4.In the analysis of the model, Fita was found to be the best subcontractor with the value of 0.201, followed by Çima (0.180), Asena 4 (0.165), Asena 1 (0.163), Asena 3 (0.154) and Akgün (0.138), respectively.

## 5. Conclusion

The subcontractor selection problem we covered in this study pertains to the multi variable decision making process. Therefore, how the AHP model, one of the multi variable decision making techniques, should be used in the solution of this problem was demonstrated in detail. Eight main criteria were covered in our model. For each of these eight criteria, except the main criteria of financial capacity and experience and eagerness to get the job, sub-criteria were defined. The AHP model we developed for Yeşim Textile consisted of eight main criteria and twenty nine sub-criteria. This model was analyzed using the Expert Choice software and final relative weights of each main criteria, sub-criteria and alternatives were obtained. After the solution of the model, the criterion with the highest weight was found to be compliance with the plan (26.6%). This means that the most important criterion for Yeşim Textile while assessing subcontractors is compliance with the plan, because Yeşim could not deliver the orders received from Nike if the subcontractor does not comply with the plan. In this case, Yeşim Textile could not satisfy its customer and will have to pay reclamation as a requirement of the agreement signed with Nike. The second most important criterion in subcontractor selection was found to be social appropriateness (17%), followed by cost (15.3%), quality control systems (14.9%), financial capacity (12.8%), technical capacity (7.4%), firm's location (4%), experience and willingness to work(2.1%), respectively.

In conclusion, in this study, the criteria firms operating in the textile sector should take into consideration while selecting subcontractors were determined and the uses of the AHP model in solving subcontractor selection problems through effective decisions were demonstrated.

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## Appendix

### 1- Pairwise comparison matrix of main criteria

| | Quality Control Systems | Social Appropriateness | Cost | Compliance with the Plan | Technical Capacity | Firm's Location | Financial Capacity | Experience and Willingness to Work |
|---|---|---|---|---|---|---|---|---|
| Quality Control Systems | 1 | 1 | 1 | 1 | 3 | 3 | 1 | 5 |
| Social Appropriateness | 1 | 1 | 1 | 1 | 5 | 3 | 1 | 7 |
| Cost | 1 | 1 | 1 | 1 | 3 | 3 | 1 | 7 |
| Compliance with the Plan | 1 | 1 | 1 | 1 | 5 | 5 | 7 | 7 |
| Technical Capacity | 1/3 | 1/5 | 1/3 | 1/5 | 1 | 5 | 1/3 | 7 |
| Firm's Location | 1/3 | 1/3 | 1/3 | 1/5 | 1/5 | 1 | 1/3 | 2 |
| Financial Capacity | 1 | 1 | 1 | 1/7 | 3 | 3 | 1 | 7 |
| Experience and Willingness to Work | 1/5 | 1/7 | 1/7 | 1/7 | 1/7 | 1/2 | 1/7 | 1 |

Consistency ratio =0.08

### 2- Pairwise comparison matrix of the quality control systems' sub-criteria

| | Input Control System | Product Acceptance Rate | Sewing İnterlude Control System | Final Control of the Production | Corrective and Preventive Actions | Application Efficiency of QC Techniques |
|---|---|---|---|---|---|---|
| Input Control System | 1 | 1/7 | 1 | 1 | 3 | 1/5 |
| Product Acceptance Rate | 7 | 1 | 5 | 7 | 3 | 3 |
| Sewing Interlude Control System | 1 | 1/5 | 1 | 1 | 1 | 1 |
| Final Control of the Production | 1 | 1/7 | 1 | 1 | 1 | 1/3 |
| Corrective and Preventive Actions | 1/3 | 1/3 | 1 | 1 | 1 | 1/3 |
| Application Efficiency of QC Techniques | 5 | 1/3 | 1 | 3 | 3 | 1 |

Consistency ratio =0.08

### 3- Pairwise comparison matrix of the social appropriateness' sub-criteria

| | Lack of Child Employment | Discrimination/ Harassment | Appropriateness of Working | Wages and Appropriateness | Appropriateness of the Operation of the Management System | Occupational Health and Safety | Environmental and Suitability | Lack of Uninsured Employment |
|---|---|---|---|---|---|---|---|---|
| Lack of Child Employment | 1 | 1 | 5 | 7 | 9 | 4 | 6 | 3 |
| Discrimination/ Harassment | 1 | 1 | 5 | 7 | 9 | 4 | 6 | 3 |
| Appropriateness of Working | 1/5 | 1/5 | 1 | 2 | 5 | 1 | 1 | 1/4 |
| Wages and Appropriateness | 1/7 | 1/7 | 1/2 | 1 | 2 | 1/3 | 2 | 1/5 |
| Appropriateness of the Operation of the Management System | 1/9 | 1/9 | 1/5 | 1/2 | 1 | 1/3 | 1/2 | 1/3 |
| Occupational Health and Safety | 1/4 | 1/4 | 1 | 3 | 3 | 1 | 7 | 1 |
| Environmental and Suitability | 1/6 | 1/6 | 1 | 1/2 | 2 | 1/7 | 1 | 1/7 |
| Lack of Uninsured Employment | 1/3 | 1/3 | 4 | 5 | 3 | 1 | 7 | 1 |

Consistency ratio =0.06

### 4- Pairwise comparison matrix of the cost' sub-criteria

| | Employment Cost | Traveling, Custom and Billing Cost | Transportation Cost |
|---|---|---|---|
| Employment Cost | 1 | 7 | 5 |
| Traveling, Custom and Billing Cost | 1/7 | 1 | 1 |
| Transportation Cost | 1/5 | 1 | 1 |

Consistency ratio =0.01

### 5- Pairwise comparison matrix of the compliance with the plan' sub-criteria

| | Labor Capacity | Compliance with Demand Shift | Capacity Usage Ratio | Delivery on Time |
|---|---|---|---|---|
| Labor Capacity | 1 | 3 | 1/5 | 1/9 |
| Compliance with Demand Shift | 1/3 | 1 | 1/5 | 1/9 |
| Capacity Usage Ratio | 5 | 5 | 1 | 1/3 |
| Delivery on Time | 9 | 9 | 3 | 1 |

Consistency ratio =0.07

**6- Pairwise comparison matrix of the technical capacity' sub-criteria**

| | Existing Production Technology | Monitoring New Technologies | R&D infrastructure | Employee's Working Skills |
|---|---|---|---|---|
| Existing Production Technology | 1 | 5 | 5 | 1 |
| Monitoring New Technologies | 1/5 | 1 | 1 | 1/5 |
| R&D infrastructure | 1/5 | 1 | 1 | 1/5 |
| Employee's Working Skills | 1 | 5 | 5 | 1 |

Consistency ratio =0.00

**7- Pairwise comparison matrix of the firm's location' sub-criteria**

| | Incentive | Country Advantage | Distance to the Main Firm | Local Capacity where the Subcontractors are Located |
|---|---|---|---|---|
| Incentive | 1 | 1 | 3 | 3 |
| Country Advantage | 1 | 1 | 5 | 3 |
| Distance to the Main Firm | 1/3 | 1/5 | 1 | 2 |
| Local Capacity where the Subcontractors are Located | 1/3 | 1/3 | 1/2 | 1 |

Consistency ratio =0.05

**8- Pairwise comparison matrix for subcontractor of the input control system' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 1/5 | 3 | 1/5 |
| Asena 3 | 1 | 1 | 1 | 1/3 | 3 | 1/3 |
| Asena 4 | 1 | 1 | 1 | 1/3 | 3 | 1/3 |
| Çıma | 5 | 3 | 3 | 1 | 5 | 3 |
| Akgün | 1/3 | 1/3 | 1/3 | 1/5 | 1 | 1/3 |
| Fita | 5 | 3 | 3 | 1/3 | 3 | 1 |

Consistency ratio =0.06

**9- Pairwise comparison matrix for subcontractor of the product acceptance rate' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 3 | 3 | 1/5 | 1 | 1/5 |
| Asena 3 | 1/3 | 1 | 1/3 | 1/5 | 1/3 | 1/5 |
| Asena 4 | 1/3 | 3 | 1 | 1/5 | 1/3 | 1/5 |
| Çıma | 5 | 5 | 5 | 1 | 5 | 1 |
| Akgün | 1 | 3 | 3 | 1/5 | 1 | 1/3 |
| Fita | 5 | 5 | 5 | 1 | 3 | 1 |

Consistency ratio =0.06

**10- Pairwise comparison matrix for subcontractor of the sewing interlude control system' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 3 | 1 | 1/5 | 1/3 | 1/5 |
| Asena 3 | 1/3 | 1 | 1/3 | 1/3 | 1/3 | 1/3 |
| Asena 4 | 1 | 3 | 1 | 1/3 | 1 | 1/3 |
| Çıma | 5 | 3 | 3 | 1 | 3 | 1 |
| Akgün | 3 | 3 | 1 | 1/3 | 1 | 1/3 |
| Fita | 5 | 3 | 3 | 1 | 3 | 1 |

Consistency ratio =0.06

**11- Pairwise comparison matrix for subcontractor of the final control of the production' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 3 | 1 | 1/5 | 1/3 | 1/5 |
| Asena 3 | 1/3 | 1 | 1/3 | 1/5 | 1/3 | 1/5 |
| Asena 4 | 1 | 3 | 1 | 1/3 | 1/3 | 1/3 |
| Çıma | 5 | 5 | 3 | 1 | 3 | 1 |
| Akgün | 3 | 3 | 3 | 1/3 | 1 | 1/3 |
| Fita | 5 | 5 | 3 | 1 | 3 | 1 |

Consistency ratio =0.04

**12- Pairwise comparison matrix for subcontractor of the corrective and preventive actions' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 3 | 1/3 | 1/5 | 1/3 | 1/5 |
| Asena 3 | 1/3 | 1 | 1/3 | 1/5 | 1/3 | 1/5 |
| Asena 4 | 3 | 3 | 1 | 1/3 | 1 | 1/3 |
| Çıma | 5 | 5 | 3 | 1 | 5 | 1 |
| Akgün | 3 | 3 | 1 | 1/5 | 1 | 1/5 |
| Fita | 5 | 5 | 3 | 1 | 5 | 1 |

Consistency ratio =0.05

**13- Pairwise comparison matrix for subcontractor of the application efficiency of QC techniques' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 5 | 1 | 1/3 | 1/3 | 1/3 |
| Asena 3 | 1/5 | 1 | 1/3 | 1/5 | 1/5 | 1/5 |
| Asena 4 | 1 | 3 | 1 | 1/3 | 1/3 | 1/3 |
| Çıma | 3 | 5 | 3 | 1 | 2 | 1 |
| Akgün | 3 | 5 | 3 | 1/2 | 1 | 1/2 |
| Fita | 3 | 5 | 3 | 1 | 2 | 1 |

Consistency ratio =0.04

**14- Pairwise comparison matrix for subcontractor of the lack of child employment' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Asena 3 | 1 | 1 | 1 | 1 | 1 | 1 |
| Asena 4 | 1 | 1 | 1 | 1 | 1 | 1 |
| Çıma | 1 | 1 | 1 | 1 | 1 | 1 |
| Akgün | 1 | 1 | 1 | 1 | 1 | 1 |
| Fita | 1 | 1 | 1 | 1 | 1 | 1 |

Consistency ratio =0.00

**15- Pairwise comparison matrix for subcontractor of the discrimination'/harassment' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Asena 3 | 1 | 1 | 1 | 1 | 1 | 1 |
| Asena 4 | 1 | 1 | 1 | 1 | 1 | 1 |
| Çıma | 1 | 1 | 1 | 1 | 1 | 1 |
| Akgün | 1 | 1 | 1 | 1 | 1 | 1 |
| Fita | 1 | 1 | 1 | 1 | 1 | 1 |

Consistency ratio =0.00

**16- Pairwise comparison matrix for subcontractor of the appropriateness of working hours' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 3 | 5 | 3 |
| Asena 3 | 1 | 1 | 1 | 3 | 5 | 3 |
| Asena 4 | 1 | 1 | 1 | 3 | 5 | 3 |
| Çıma | 1/3 | 1/3 | 1/3 | 1 | 3 | 1 |
| Akgün | 1/5 | 1/5 | 1/5 | 1/3 | 1 | 1/3 |
| Fita | 1/3 | 1/3 | 1/3 | 1 | 3 | 1 |

Consistency ratio =0.01

**17- Pairwise comparison matrix for subcontractor of the wages and appropriateness of payment' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Asena 3 | 1 | 1 | 1 | 1 | 1 | 1 |
| Asena 4 | 1 | 1 | 1 | 1 | 1 | 1 |
| Çıma | 1 | 1 | 1 | 1 | 1 | 1 |
| Akgün | 1 | 1 | 1 | 1 | 1 | 1 |
| Fita | 1 | 1 | 1 | 1 | 1 | 1 |

Consistency ratio =0.00

**18- Pairwise comparison matrix for subcontractor of the appropriateness of the operation of the management system' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 3 | 5 | 3 |
| Asena 3 | 1 | 1 | 1 | 3 | 5 | 3 |
| Asena 4 | 1 | 1 | 1 | 3 | 5 | 3 |
| Çıma | 1/3 | 1/3 | 1/3 | 1 | 3 | 1 |
| Akgün | 1/5 | 1/5 | 1/5 | 1/3 | 1 | 1/3 |
| Fita | 1/3 | 1/3 | 1/3 | 1 | 3 | 1 |

Consistency ratio =0.01

**19- Pairwise comparison matrix for subcontractor of the occupational health and safety' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 3 | 5 | 3 |
| Asena 3 | 1 | 1 | 1 | 3 | 5 | 3 |
| Asena 4 | 1 | 1 | 1 | 3 | 5 | 3 |
| Çıma | 1/3 | 1/3 | 1/3 | 1 | 3 | 1 |
| Akgün | 1/5 | 1/5 | 1/5 | 1/3 | 1 | 1/3 |
| Fita | 1/3 | 1/3 | 1/3 | 1 | 3 | 1 |

Consistency ratio =0.01

**20- Pairwise comparison matrix for subcontractor of the environmental suitability' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1/3 | 1/5 | 1/3 | 1 | 1/5 |
| Asena 3 | 3 | 1 | 1 | 3 | 5 | 1 |
| Asena 4 | 5 | 1 | 1 | 3 | 5 | 1 |
| Çıma | 3 | 1/3 | 1/3 | 1 | 3 | 1/3 |
| Akgün | 1 | 1/5 | 1/5 | 1/3 | 1 | 1/5 |
| Fita | 5 | 1 | 1 | 3 | 5 | 1 |

Consistency ratio =0.02

**21- Pairwise comparison matrix for subcontractor of the lack of uninsured employment' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 3 | 5 | 3 |
| Asena 3 | 1 | 1 | 1 | 3 | 5 | 3 |
| Asena 4 | 1 | 1 | 1 | 3 | 5 | 3 |
| Çıma | 1/3 | 1/3 | 1/3 | 1 | 3 | 1/3 |
| Akgün | 1/5 | 1/5 | 1/5 | 1/3 | 1 | 1/3 |
| Fita | 1/3 | 1/3 | 1/3 | 3 | 3 | 1 |

Consistency ratio =0.02

**22- Pairwise comparison matrix for subcontractor of the employment cost' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 7 | 7 | 7 |
| Asena 3 | 1 | 1 | 1 | 7 | 7 | 7 |
| Asena 4 | 1 | 1 | 1 | 7 | 7 | 7 |
| Çıma | 1/7 | 1/7 | 1/7 | 1 | 1 | 1 |
| Akgün | 1/7 | 1/7 | 1/7 | 1 | 1 | 1 |
| Fita | 1/7 | 1/7 | 1/7 | 1 | 1 | 1 |

Consistency ratio =0.00

**23- Pairwise comparison matrix for subcontractor of the traveling, custom, billing cost' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 1/7 | 1/7 | 1/7 |
| Asena 3 | 1 | 1 | 1 | 1/7 | 1/7 | 1/7 |
| Asena 4 | 1 | 1 | 1 | 1/7 | 1/7 | 1/7 |
| Çıma | 7 | 7 | 7 | 1 | 1 | 1 |
| Akgün | 7 | 7 | 7 | 1 | 1 | 1 |
| Fita | 7 | 7 | 7 | 1 | 1 | 1 |

Consistency ratio =0.00

**24- Pairwise comparison matrix for subcontractor of the transportation cost' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 1/9 | 1/9 | 1/9 |
| Asena 3 | 1 | 1 | 1 | 1/9 | 1/9 | 1/9 |
| Asena 4 | 1 | 1 | 1 | 1/9 | 1/9 | 1/9 |
| Çıma | 9 | 9 | 9 | 1 | 1 | 1 |
| Akgün | 9 | 9 | 9 | 1 | 1 | 1 |
| Fita | 9 | 9 | 9 | 1 | 1 | 1 |

Consistency ratio =0.00

**25- Pairwise comparison matrix for subcontractor of the labor capacity' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 3 | 1/5 | 1/3 | 1/3 | 1/3 |
| Asena 3 | 1/3 | 1 | 1/3 | 1 | 1 | 1 |
| Asena 4 | 5 | 3 | 1 | 3 | 3 | 3 |
| Çıma | 3 | 1 | 1/3 | 1 | 1 | 1 |
| Akgün | 3 | 1 | 1/3 | 1 | 1 | 1 |
| Fita | 3 | 1 | 1/3 | 1 | 1 | 1 |

Consistency ratio =0.09

**26- Pairwise comparison matrix for subcontractor of the compliance with demand shift' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 3 | 3 | 1/7 | 1/7 | 1/7 |
| Asena 3 | 1/3 | 1 | 1 | 1/7 | 1/7 | 1/7 |
| Asena 4 | 1/3 | 1 | 1 | 1/7 | 1/7 | 1/7 |
| Çıma | 7 | 7 | 7 | 1 | 1/2 | 1/2 |
| Akgün | 7 | 7 | 7 | 2 | 1 | 3 |
| Fita | 7 | 7 | 7 | 2 | 1/3 | 1 |

Consistency ratio =0.07

**27- Pairwise comparison matrix for subcontractor of the capacity usage ratio' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çınna | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 1/7 | 1/7 | 1/7 |
| Asena 3 | 1 | 1 | 1 | 1/7 | 1/7 | 1/7 |
| Asena 4 | 1 | 1 | 1 | 1/7 | 1/7 | 1/7 |
| Çınna | 7 | 7 | 7 | 1 | 3 | 1 |
| Akgün | 7 | 7 | 7 | 1/3 | 1 | 1/3 |
| Fita | 7 | 7 | 7 | 1 | 3 | 1 |

Consistency ratio =0.07

**28- Pairwise comparison matrix for subcontractor of the delivery on time' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çınna | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 3 | 3 | 1/5 | 1/3 | 1/7 |
| Asena 3 | 1/3 | 1 | 1/3 | 1/5 | 1/3 | 1/7 |
| Asena 4 | 1/3 | 3 | 1 | 1/5 | 1/3 | 1/7 |
| Çınna | 5 | 5 | 5 | 1 | 5 | 1/3 |
| Akgün | 3 | 3 | 3 | 1/5 | 1 | 1/5 |
| Fita | 7 | 7 | 7 | 3 | 5 | 1 |

Consistency ratio =0.09

**29- Pairwise comparison matrix for subcontractor of the existing production technology' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çınna | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 1/3 | 1/5 | 1/3 |
| Asena 3 | 1 | 1 | 1 | 1/3 | 1/5 | 1/3 |
| Asena 4 | 1 | 1 | 1 | 1/3 | 1/5 | 1/3 |
| Çınna | 3 | 3 | 3 | 1 | 1/3 | 1 |
| Akgün | 5 | 5 | 5 | 3 | 1 | 3 |
| Fita | 3 | 3 | 3 | 1 | 1/3 | 1 |

Consistency ratio =0.01

**30- Pairwise comparison matrix for subcontractor of the monitoring new technologies' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çınma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 1 | 1/5 | 1/5 |
| Asena 3 | 1 | 1 | 1 | 1 | 1/5 | 1/5 |
| Asena 4 | 1 | 1 | 1 | 1 | 1/5 | 1/5 |
| Çınma | 1 | 1 | 1 | 1 | 1/5 | 1/5 |
| Akgün | 5 | 5 | 5 | 5 | 1 | 1 |
| Fita | 5 | 5 | 5 | 5 | 1 | 1 |

Consistency ratio =0.00

**31- Pairwise comparison matrix for subcontractor of the R&D infrastructure' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çınma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 1 | 1/5 | 1/5 |
| Asena 3 | 1 | 1 | 1 | 1 | 1/5 | 1/5 |
| Asena 4 | 1 | 1 | 1 | 1 | 1/5 | 1/5 |
| Çınma | 1 | 1 | 1 | 1 | 1/5 | 1/5 |
| Akgün | 5 | 5 | 5 | 5 | 1 | 1 |
| Fita | 5 | 5 | 5 | 5 | 1 | 1 |

Consistency ratio =0.00

**32- Pairwise comparison matrix for subcontractor of the employee's working' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çınma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 3 | 3 | 1/7 | 1/7 | 1/7 |
| Asena 3 | 1/3 | 1 | 1 | 1/7 | 1/7 | 1/7 |
| Asena 4 | 1/3 | 1 | 1 | 1/7 | 1/7 | 1/7 |
| Çınma | 7 | 7 | 7 | 1 | 1/3 | 1 |
| Akgün | 7 | 7 | 7 | 3 | 1 | 3 |
| Fita | 7 | 7 | 7 | 1 | 1/3 | 1 |

Consistency ratio =0.07

**33- Pairwise comparison matrix for subcontractor of the incentive' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 9 | 9 | 9 |
| Asena 3 | 1 | 1 | 1 | 9 | 9 | 9 |
| Asena 4 | 1 | 1 | 1 | 9 | 9 | 9 |
| Çıma | 1/9 | 1/9 | 1/9 | 1 | 1 | 1 |
| Akgün | 1/9 | 1/9 | 1/9 | 1 | 1 | 1 |
| Fita | 1/9 | 1/9 | 1/9 | 1 | 1 | 1 |

Consistency ratio =0.00

**34- Pairwise comparison matrix for subcontractor of the country advantage' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 9 | 9 | 9 |
| Asena 3 | 1 | 1 | 1 | 9 | 9 | 9 |
| Asena 4 | 1 | 1 | 1 | 9 | 9 | 9 |
| Çıma | 1/9 | 1/9 | 1/9 | 1 | 1 | 1 |
| Akgün | 1/9 | 1/9 | 1/9 | 1 | 1 | 1 |
| Fita | 1/9 | 1/9 | 1/9 | 1 | 1 | 1 |

Consistency ratio =0.00

**35- Pairwise comparison matrix for subcontractor of the distance to the main firm' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 1/9 | 1/9 | 1/9 |
| Asena 3 | 1 | 1 | 1 | 1/9 | 1/9 | 1/9 |
| Asena 4 | 1 | 1 | 1 | 1/9 | 1/9 | 1/9 |
| Çıma | 9 | 9 | 9 | 1 | 1 | 1 |
| Akgün | 9 | 9 | 9 | 1 | 1 | 1 |
| Fita | 9 | 9 | 9 | 1 | 1 | 1 |

Consistency ratio =0.00

**36- Pairwise comparison matrix for subcontractor of the local capacity where the subcontractors are located' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 1/5 | 1/5 | 1/5 |
| Asena 3 | 1 | 1 | 1 | 1/5 | 1/5 | 1/5 |
| Asena 4 | 1 | 1 | 1 | 1/5 | 1/5 | 1/5 |
| Çıma | 5 | 5 | 5 | 1 | 1 | 1 |
| Akgün | 5 | 5 | 5 | 1 | 1 | 1 |
| Fita | 5 | 5 | 5 | 1 | 1 | 1 |

Consistency ratio =0.00

**37- Pairwise comparison matrix of the financial capacity' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 5 | 3 | 5 |
| Asena 3 | 1 | 1 | 1 | 5 | 3 | 5 |
| Asena 4 | 1 | 1 | 1 | 5 | 3 | 5 |
| Çıma | 1/5 | 1/5 | 1/5 | 1 | 1/3 | 1 |
| Akgün | 1/3 | 1/3 | 1/3 | 3 | 1 | 1/3 |
| Fita | 1/5 | 1/5 | 1/5 | 1 | 3 | 1 |

Consistency ratio =0.00

**38- Pairwise comparison matrix of the experience and willingness to work' sub-criteria**

| | Asena 1 | Asena 3 | Asena 4 | Çıma | Akgün | Fita |
|---|---|---|---|---|---|---|
| Asena 1 | 1 | 1 | 1 | 1/3 | 3 | 3 |
| Asena 3 | 1 | 1 | 1 | 1/3 | 3 | 3 |
| Asena 4 | 1 | 1 | 1 | 1/3 | 3 | 3 |
| Çıma | 3 | 3 | 3 | 1 | 3 | 3 |
| Akgün | 1/3 | 1/3 | 1/3 | 1/3 | 1 | 1 |
| Fita | 1/3 | 1/3 | 1/3 | 1/3 | 1 | 1 |

Consistency ratio =0.03

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