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INCORPORATING MULTI-CRITERIA CONSIDERATIONS INTO SUPPLIER SELECTION PROBLEM USING ANALYTICAL HIERARCHY PROCESS: A CASE STUDY

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Abstract

Supplier selection is one of the most critical functions for the success of a company competing in contemporary manufacturing industry. Numerous approaches exist in the literature regarding this important decision problem. In this study, Analytic Hierarchy Process is proposed as an effective tool in selecting an optimal supplier among a group of decision alternatives. Suggested methodology is illustrated by a case study.

Keywords: Supplier Selection, Analytical Hierarchy Process,

Introduction

As far as the requirements of today's competitive manufacturing environment -such as quality practices, JIT manufacturing practices, quick response, low cost and flexibility- are concerned, it is obvious that a company must attain at least a competitive level of these practices among its rivals, to maintain its market position. The procurement side plays an important role and the performance of suppliers is crucial in the company's battle to meet these requirements. Thus, selection of a reliable supplier is very important for the success of the company. Nydick and Hill [1992] pointed out that the objective of this selection stage is to find the optimal supplier. Muralidharan et al. [2002] argued that purchasing the right quality of material in the right quantity from the right source at the right time and at a reasonable price is the key objective of the purchasing department, and concluded that quality, cost and on-time delivery are the three most important criteria in supplier selection. The basic criteria introduced by several researchers are quality, price, delivery and service [Nydick and Hill 1992; Mohanty and Deshmukh 1993; Lambert et al. 1997; Krause et al. 2001; Muralidharan et al. 2002]. Verma and Pullman [1998] noted that it is difficult for any one supplier to excel in

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all dimensions of performance. Furthermore, every company has its own purchasing characteristics; for example, a computer producer which distinguishes itself by quick shipment to its customers may consider on time delivery as the most important criterion, while a car producer known with its excellent quality cars may be paying more attention to the quality of items supplied. It is essential to note that some of these supplier selection criteria are quantitative and some of them are qualitative in nature moreover, the importance of each criterion varies from one company to another. Therefore, supplier selection problem is an unstructured, multi-criteria decision problem which has both a qualitative and an analytical side. In this study a methodology, the Analytic Hierarchy Process, is employed to capture the decision makers' multiple criteria considerations regarding the supplier selection process. The proposed methodology is illustrated by a case study.

1. Literature Review

Literature reveals numerous studies regarding both the analysis of the supplier selection process and the methods used in the selection decisions. Kannan and Tan [2002] mentioned that supplier selection research can be categorized as either descriptive, shedding light on the practice, or prescriptive, modeling the selection process. A detailed review of the methods used to solve the supplier selection problem is shown in Table 1.

Table 1: Summary of methods used to solve supplier selection problem

Analytic Hierarchy Process	Nydick and Hill [1992]
	Mohanty and Deshmukh [1993]
	Barbarosoglu and Yazgac [1997]
Group Decision Making- Aggregation	Muralidharan et al. [2002]
Vendor Performance Index	Willis et al. [1993]
Standardized Unitless Rating	Li et al. [1997]

…continue

Total Cost of Ownership Models	Smytka and Clemens [1993] Degraeve and Roodhooft [1999] Degraeve et al. [2000] Bhutta and Huq [2002]
Outranking Methods	Boer et al. [1998]
Mathematical Models	Weber and Ellram [1993] Sadrian and Yoon [1994] Rosenthal et al. [1995] Ghodysypour and O'Brien [1998]
Suppsel Model	Jayaraman et al. [1999]
Statistical Analysis	Ronen and Trietsch [1988] Verma and Pullman [1998]
Data Envelopment Analysis	Liu et al. [2000]
Principal Component Analysis	Petroni and Braglia [2000]
Thurstone Scaling Technique	Thompson [1991]
Analytic Network Process	Sarkis and Talluri [2002]
Vendor Survey Plan	Lee and Wellan [1993]

Emerging concepts of buyer-supplier relationships like integration, value adding focus, cooperation and information sharing gave rise to the attention of both academics and practitioners in the purchasing field. The literature shows a trend that purchasing practices are seen as an important contributing tool for companies to establish a competitive advantage as others.

Mohanty and Deshmukh [1993] pointed out that selecting the right sources of supply is a major aspect of strategic business processes.Correspondingly, Jayaraman et al. [1999] stated that determining the configuration of the supplier base is an essential side of purchasing management. Kannan and Tan [2002] attempted to identify the impact of supplier selection and assessment on the buying company's business performance and found that it has a positive impact on supplier performance and on the performance of the buying company. As seen in the practice, and implied by Vonderembse and Tracey [1999], in order to achieve low cost, high quality, flexibility and quick response objectives, companies are increasingly taking better supplier selection approaches into account. Many researchers articulated that the ultimate outcome of the supplier selection endeavors is developing mutually beneficial long term strategic partnerships [Nydick and Hill 1992; Barbarosoglu and Yazgac 1997; Gustin et al. 1997; Jayaraman et al. 1999; Muralidharan et al. 2002].

2. Selection Model and Methodology

An intrinsic characteristic of the supplier selection problem is that some of the criteria used for evaluating suppliers are quantitative and some of them are qualitative in nature. Additionally, as mentioned before; the importance of each criterion varies from one company to another. For this reasons, supplier selection problem must be approached as an unstructured, multi-criteria decision problem which has both a qualitative and an analytical side. A hierarchical model, which will be effective in capturing the decision makers' multiple criteria considerations, can be used to facilitate the supplier selection process.

In order to construct the hierarchical model, the initiatory step is to define the criteria to assess the performance of the suppliers. In this study, seven criteria representing the fundamental characteristics of suppliers to be evaluated are used. The criteria used in this study and their explanations are illustrated in Table 2.

Table 2: The criteria used in the hierarchical model.

Criteria	Explanation
Product Quality and Performance [PDQ]	The extend to which the supplier's products meets the specifications, tolerance limits and expectations of the company.
Lead time [LDT]	Lead time competitiveness of a supplier compared to its competitors.
Price [PRC]	Price competitiveness of a supplier compared to its competitors.
Punctuality [PNC]	Obedience of a supplier to the delivery schedule.
Quality Practices [QLP]	Willingness of a supplier to be involved in JIT, Quality Management implications of the company.
Flexibility [FLX]	Flexibility of the supplier both in the delivery schedule and amounts to be delivered.
Level of Cooperation [LOC]	Attention of the supplier to the quality problems and willingness of information exchange

After defining the evaluation criteria, a three-level hierarchy including overall goal, criteria used in the study and alternatives, is constructed regarding to supplier selection problem. Figure 1 shows the hierarchical structure of the supplier selection problem.

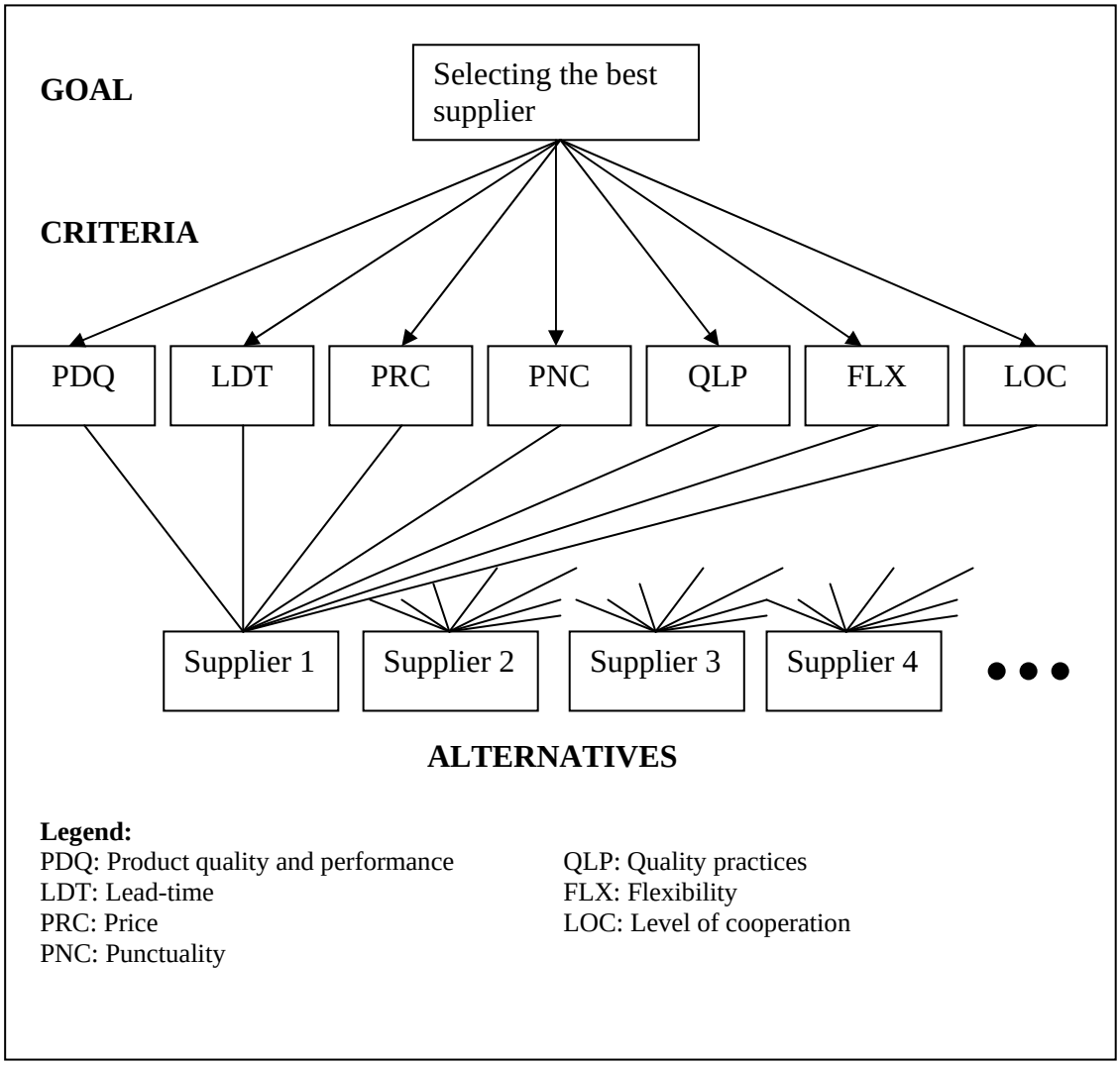

Figure 1: Hierarchical Structure of the Supplier Selection Problem

In this study, the Analytic Hierarchy Process (AHP) is employed to decompose this complex hierarchy by capturing the decision makers' attitude towards the pre-determined criteria. A very concise definition of AHP is specified by Nydick and Hill [1992]: "AHP is a decision-making method for prioritizing alternatives when multiple criteria must be considered".

AHP is originally developed by Thomas Lorie Saaty when solving a contingency planning problem, later it has received great attention by many researchers and was applied to a multitude of areas such as decision making, selection, resource allocation, forecasting, conflict resolution, ranking and prioritizing, performance assessment and financial planning. A further discussion of application areas can be found in Saaty and Forman [1996].

As stated by Saaty [1986], AHP enables us to cope with the intuitive, the rational and the irrational, all at the same time, when we make multi-criteria and multi actor decisions; we can use the AHP to integrate our perceptions and purposes into an overall synthesis as well.

Schoner and Wedley [1989] briefly explained the basic steps of the methodology:

1. Decomposition of the problem into a hierarchy of perspectives, criteria and alternatives,
2. Paired comparison of items on any hierarchical level with respect to their relative impact or contribution toward those items on the immediately higher level, and,
3. Composition of the resulting priorities (importance weights) into composite values that reflect the overall importance of each alternative.

Step 1 reflects the way we decomposed the supplier selection problem into some specific elements of a hierarchy. In AHP methodology, the objective of the decision making process placed at the top of the hierarchy, the criteria and the sub-criteria lie down the hierarchy at descending levels. All possible decision alternatives or specific courses of action constitute the last level of the hierarchy. Step 2 immediately implies that we launch a prioritization process to determine the relative importance of the elements of our hierarchy. The result of this stage is a set of pair wise comparison matrices, which are based on managerial implications of the decision maker(s). Step 3 is the synthesis stage of the process, in this stage a synthesis of the judgments is carried out by finding a priority vector for each comparison matrix. This procedure is called “The principal eigenvector extraction” [Wind and Saaty 1980]. Once we have all the eigenvectors of the hierarchy, weighting these priority values with the others in the lower levels of the hierarchy down to last level will result in an ultimate priority vector which will include an evaluation score for each possible decision alternative or course of action.

The selection model proposed in this study is simply based on afore mentioned principles of the AHP. At the last stage, a numerical value -The Weighted Performance Score- is utilized to form the basis of the decision regarding selection of any optimal supplier. The weighted performance score is calculated as follows:

$$WPS_i = \sum_{j}^{N} SS_{ij} \times C_j$$

Where;

WPS_i : Weighted performance score for the i^{th} supplier

SS_{ij} : Evaluation score of the i^{th} supplier regarding to the j^{th} criteria

C_j : Evaluation score of the j^{th} criteria of the purchasing department of the company

N : Number of criteria used in the decision-making process

2.1. Implementation of the Selection Model: Case Study

The purpose of the case study is to demonstrate how AHP can be utilized to solve the supplier selection problem. A manufacturing company trying to select a reliable supplier among four choices is considered. Two questionnaires, shown in Appendix 1, are employed for data gathering process. The first questionnaire is to identify the criteria evaluations of the purchasing department of the company, and the other is used to assess the company's judgments about each possible supplier with respect to the criteria introduced before. The questionnaires are employed to manager of purchasing department. Tailored scales are utilized to enable paired comparisons in both questionnaires. These scales are very similar to the "fundamental scale" which is suggested by Saaty [1980]. Fundamental scale is a 9 point scale and it is very practical to use for paired comparisons. By definition, its purpose is to assess the dominance of each element over other elements with respect to each element of the immediate higher levels of the hierarchy [Wind and Saaty 1980]. After collecting the data from the manufacturing company which focuses on producing replacement parts for textile machines, AHP implementation is carried out.

A summary of the results is illustrated in Table 3.

Overall Score Calculation and Consistency

Weighted Performance Scores for each supplier

Suppliers	PDQ	LDT	PRC	PNC	QLP	FLX	LOC	Overall WPS
Supplier1	0,099	0,053	0,132	0,015	0,007	0,019	0,025	**0,349**
Supplier2	0,018	0,092	0,061	0,024	0,007	0,038	0,037	**0,278**
Supplier3	0,034	0,068	0,012	0,051	0,007	0,004	0,006	**0,181**
Supplier4	0,006	0,087	0,021	0,048	0,007	0,008	0,009	**0,186**

Consistency Measure

Weighted sum vector	Consistency Vector		
1,2648	8,04076	**Lambda Max**	7,729
2,59345	8,66223		
1,85905	8,05605	**Consistency Index**	0,121
0,93641	6,78326		
0,2427	8,33373	**Consistency Ratio**	0,092
0,50755	7,42355		
0,52437	6,80417		

** Calculations related to Table 3 are shown in Appendix 2.

According to the results, the lead-time competitiveness of a supplier is found to be the most important criterion for the company, price competitiveness of a supplier is also found to be essential in shaping the company's decision regarding to the suppliers. These two criteria evidently outranked others according to company's judgments. In conformity with the Weighted Performance Scores, Supplier 1 has the highest rating and dominated other choices. Based on AHP approach in supplier selection process, the wiser course of action for the company is to select Supplier 1.

Consistency of the model is tested with the Consistency Ratio measure of the AHP method. As noted in a study by Saaty and Vargas [1994] the term;

$$\frac{\lambda_{Max} - n}{n-1}$$

is the variance of the error term regarding to the decision makers' judgments in the pair wise comparison matrix, where λ_{Max} is the maximum eigenvalue of the pair wise comparison matrix. This term is named as Consistency Index and it can be used as a measure of deviations from the consistency, when we apply the AHP method. Saaty [1980], presented the results of

a simulation study conducted by Wharton Business School aiming to find the average consistency index values of randomly chosen n*n square comparison matrices. These values are referred to as "Random Indexes" by Saaty [1980]. If we divide consistency index by corresponding Random Index value, we ultimately get the Consistency Ratio measure. The consistency ratio of 0.1 or smaller is accepted to be natural by Saaty and Vargas [1994]. According to the results of this case study, ultimately a consistency index ratio of 0.092 is reached. This is a pretty good value when compared to the level proposed by Saaty and Vargas, indicating that the company's evaluations regarding to selection criteria include some randomness.

Summary and Conclusions

In this study, utilization of a multiple criteria decision methodology, the Analytic Hierarchy Process, is proposed for evaluating the sources of supply. Suggested procedure is implemented to a manufacturing company, to illustrate how this methodology will be effective in capturing the judgments of the decision makers. It is seen that Analytic Hierarchy Process is very useful for managers in formulating their own decision criteria, assigning different importance levels to these criteria, and carry out a scientific analysis of possible decision alternatives with regard to the formulated decision scheme.

Since every input is subject to change in supplier selection analysis, -namely; prices, lead-times, supplier choices, etc. - decision makers will take the flexibility advantage of Analytic Hierarchy Process. They can both add new criteria, assign new weights to the existing criteria, and add new decision alternatives to the decision analysis. In these situations, Analytic Hierarchy Process will serve as a dynamic decision tool for the decision makers. The procedure suggested in this study will be valuable either for the company or for other decision makers (purchasing managers, supply chain managers and others) interested in enhancing their supply chain strategy by making better decisions.

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Appendix 1: Questionnaires

QUESTIONNAIRE 1 : CRITERIA EVALUATIONS

Instructions: A set of criteria, which can be used in supplier selection decisions, are presented below. Please evaluate the relative importance of these criteria for your company. Please compare one criterion with another at a time with using the scale provided.

CRITERIA

Criteria	Explanation
Product Quality and Performance [PDQ]	The extent to which the supplier's products meets the specifications, tolerance limits and expectations of your company.
Lead time [LDT]	Lead time competitiveness of a supplier compared to its competitors.
Price [PRC]	Price competitiveness of a supplier compared to its competitors.
Punctuality [PNC]	Obedience of a supplier to the delivery schedule.
Quality Practices [QLP]	Willingness of a supplier to be involved in JIT, Quality Management implications of your company.
Flexibility [FLX]	Flexibility of the supplier both in the delivery schedule and amounts to be delivered.
Level of Cooperation [LOC]	Attention of the supplier to the quality problems and willingness of information exchange

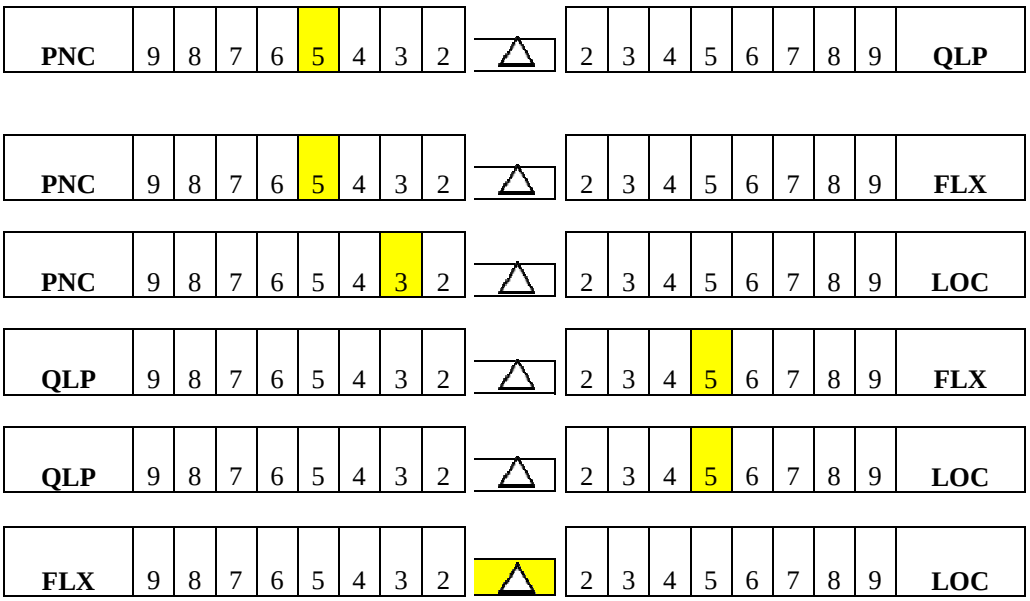
SCALE

Importance	Definition	Explanation
1	Equal Importance	Two criteria are equally important for your company in supplier selection decisions.
3	Weak importance of one over another	Your experience and judgment slightly favor one criteria over another.
5	Essential or strong importance	Your experience and judgment strongly favor one criteria over another.
7	Demonstrated importance	A criteria is strongly favored and its dominance is demonstrated in practice
9	Absolute importance	The evidence favoring one criteria over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two	When compromise is needed

adjacent judgments

EVALUATIONS

PDQ	9	8	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**LDT**
PDQ	9	8	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**PRC**
PDQ	9	8	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**PNC**
PDQ	9	8	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**QLP**
PDQ	9	8	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**FLX**
PDQ	9	8	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**LOC**
LDT	9	8	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**PRC**
LDT	9	8	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**PNC**
LDT	9	8	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**QLP**
LDT	9	8	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**FLX**
LDT	9	8	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**LOC**
PRC	9	8	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**PNC**
PRC	9	8	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**QLP**
PRC	9	8	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**FLX**
PRC	9	8	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**LOC**


PNC 9 8 7 6 5 4 3 2 2 3 4 5 6 7 8 9 QLP
PNC 9 8 7 6 5 4 3 2 2 3 4 5 6 7 8 9 FLX
PNC 9 8 7 6 5 4 3 2 2 3 4 5 6 7 8 9 LOC
QLP 9 8 7 6 5 4 3 2 2 3 4 5 6 7 8 9 FLX
QLP 9 8 7 6 5 4 3 2 2 3 4 5 6 7 8 9 LOC
FLX 9 8 7 6 5 4 3 2 2 3 4 5 6 7 8 9 LOC

QUESTIONNAIRE 2 : SUPPLIER EVALUATIONS

Instructions: Please evaluate the strength of your suppliers regarding to each criteria introduced in Questionnaire 1. Please compare one supplier with another at a time with using the scale provided.

SCALE

Importance	Definition	Explanation
1	Equal Importance	Two suppliers have equal importance for your company when compared with regard to the criteria under consideration.
3	Weak importance of one over another	Your experience and judgment slightly favor one supplier over another when compared with regard to the criteria under consideration.
5	Essential or strong importance	Your experience and judgment strongly favor one supplier over another when compared with regard to the criteria under consideration.
7	Demonstrated importance	A supplier is strongly favored over another and its dominance is demonstrated in practice
9	Absolute importance	The evidence favoring one supplier over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgments	When compromise is needed

EVALUATIONS

WITH REGARD TO PRODUCT QUALITY AND PERFORMANCE CRITERION

SUPPLIER 1	9	**8**	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**SUPPLIER 2**
SUPPLIER 1	9	**8**	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**SUPPLIER 3**
SUPPLIER 1	9	**8**	7	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**SUPPLIER 4**
SUPPLIER 2	9	8	7	6	5	4	3	2	△	2	3	4	**5**	6	7	8	9	**SUPPLIER 3**
SUPPLIER 2	9	8	7	**6**	5	4	3	2	△	2	3	4	5	6	7	8	9	**SUPPLIER 4**
SUPPLIER 3	9	8	**7**	6	5	4	3	2	△	2	3	4	5	6	7	8	9	**SUPPLIER 4**

WITH REGARD TO LEAD TIME CRITERION

SUPPLIER 1	9	8	7	6	5	4	3	2	△	2	3	**4**	5	6	7	8	9	**SUPPLIER 2**
SUPPLIER 1	9	8	7	**6**	5	4	3	2	△	2	3	4	5	6	7	8	9	**SUPPLIER 3**
SUPPLIER 1	9	8	7	6	5	4	3	2	△	**2**	3	4	5	6	7	8	9	**SUPPLIER 4**
SUPPLIER 2	9	8	7	**6**	5	4	3	2	△	2	3	4	5	6	7	8	9	**SUPPLIER 3**
SUPPLIER 2	9	8	7	6	5	4	3	2	△	2	3	**4**	5	6	7	8	9	**SUPPLIER 4**
SUPPLIER 3	9	8	7	**6**	5	4	3	2	△	2	3	4	5	6	7	8	9	**SUPPLIER 4**

WITH REGARD TO PRICE CRITERION

SUPPLIER 1	9	8	7	**6**	5	4	3	2	△	2	3	4	5	6	7	8	9	**SUPPLIER 2**
SUPPLIER 1	9	8	7	**6**	5	4	3	2	△	2	3	4	5	6	7	8	9	**SUPPLIER 3**
SUPPLIER 1	9	8	7	**6**	5	4	3	2	△	2	3	4	5	6	7	8	9	**SUPPLIER 4**

SUPPLIER 2	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 3**

SUPPLIER 2	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 4**
SUPPLIER 3	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 4**

WITH REGARD TO PUNCTUALITY CRITERION

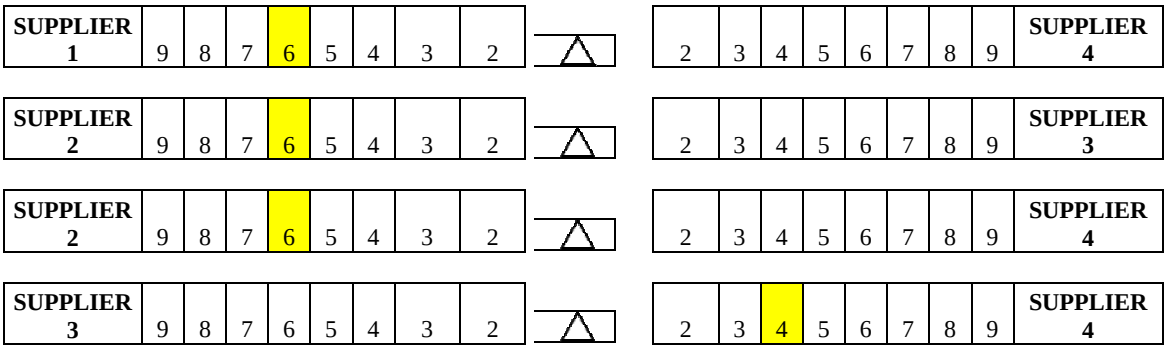
SUPPLIER 1	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 2**
SUPPLIER 1	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 3**
SUPPLIER 1	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 4**
SUPPLIER 2	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 3**
SUPPLIER 2	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 4**
SUPPLIER 3	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 4**

WITH REGARD TO QUALITY PRACTICES CRITERION

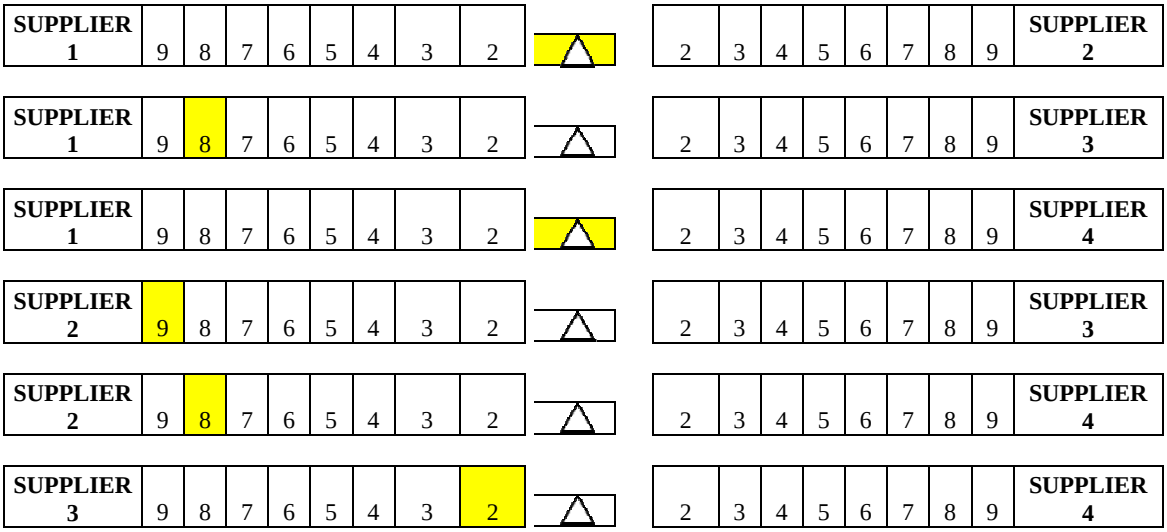
SUPPLIER 1	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 2**
SUPPLIER 1	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 3**
SUPPLIER 1	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 4**
SUPPLIER 2	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 3**
SUPPLIER 2	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 4**
SUPPLIER 3	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 4**

WITH REGARD TO FLEXIBILITY CRITERION

SUPPLIER 1	9	8	7	6	5	4	3	2		2	3	4	5	6	7	8	9	**SUPPLIER 2**



WITH REGARD TO LEVEL OF COOPERATION CRITERION



Appendix 2: Calculation of data by AHP via Excel Spreadsheet

Pairwise Comparisons of Criteria

	PDQ	LDT	PRC	PNC	QLP	FLX	LOC
PDQ	1,000	1,000	0,250	1,000	4,000	5,000	2,000
LDT	1,000	1,000	5,000	5,000	5,000	3,000	3,000
PRC	4,000	0,200	1,000	4,000	4,000	4,000	3,000
PNC	1,000	0,200	0,250	1,000	5,000	5,000	3,000
QLP	0,250	0,200	0,250	0,200	1,000	0,200	0,200
FLX	0,200	0,333	0,250	0,200	5,000	1,000	1,000
LOC	0,500	0,333	0,333	0,333	5,000	1,000	1,000
COLUNM TOTALS	7,950	3,267	7,333	11,733	29,000	19,200	13,200

	PDQ	LDT	PRC	PNC	QLP	FLX	LOC	ROW TOTALS
PDQ	0,126	0,306	0,034	0,085	0,138	0,260	0,152	1,101
LDT	0,126	0,306	0,682	0,426	0,172	0,156	0,227	2,096
PRC	0,503	0,061	0,136	0,341	0,138	0,208	0,227	1,615
PNC	0,126	0,061	0,034	0,085	0,172	0,260	0,227	0,966
QLP	0,031	0,061	0,034	0,017	0,034	0,010	0,015	0,204
FLX	0,025	0,102	0,034	0,017	0,172	0,052	0,076	0,479
LOC	0,063	0,102	0,045	0,028	0,172	0,052	0,076	0,539

Priority vector

PDQ	**0,157**
LDT	**0,299**
PRC	**0,231**
PNC	**0,138**
QLP	**0,029**
FLX	**0,068**
LOC	**0,077**
	1,000

Pairwise Comparisons of Suppliers

WITH REGARD TO PRODUCT QUALITY AND PERFORMANCE CRITERION

	S1	S2	S3	S4
S1	1,000	8,000	8,000	8,000
S2	0,125	1,000	0,200	6,000
S3	0,125	5,000	1,000	7,000
S4	0,125	0,167	0,143	1,000
COLUMN TOTALS	1,375	14,167	9,343	22,000

	S1	S2	S3	S4	Row Totals	Priority vector
S1	**0,727**	**0,565**	**0,856**	**0,364**	**2,512**	**0,63**
S2	**0,091**	**0,071**	**0,021**	**0,273**	**0,456**	**0,11**
S3	**0,091**	**0,353**	**0,107**	**0,318**	**0,869**	**0,22**
S4	**0,091**	**0,012**	**0,015**	**0,045**	**0,163**	**0,04**

WITH REGARD TO LEAD TIME CRITERION

	S1	S2	S3	S4
S1	1,000	0,250	6,000	0,500
S2	4,000	1,000	6,000	0,250
S3	0,167	0,167	1,000	6,000
S4	2,000	4,000	0,167	1,000
COLUMN TOTALS	7,167	5,417	13,167	7,750

	S1	S2	S3	S4	Row Totals	Priority vector
S1	**0,140**	**0,046**	**0,456**	**0,065**	**0,706**	**0,18**
S2	**0,558**	**0,185**	**0,456**	**0,032**	**1,231**	**0,31**
S3	**0,023**	**0,031**	**0,076**	**0,774**	**0,904**	**0,23**
S4	**0,279**	**0,738**	**0,013**	**0,129**	**1,159**	**0,29**

WITH REGARD TO PRICE CRITERION

	S1	S2	S3	S4
S1	1,000	6,000	6,000	6,000
S2	0,167	1,000	6,000	6,000
S3	0,167	0,167	1,000	0,250
S4	0,167	0,167	4,000	1,000
COLUMN TOTALS	1,500	7,333	17,000	13,250

	S1	S2	S3	S4	Row Totals	Priority vector
S1	**0,667**	**0,818**	**0,353**	**0,453**	**2,291**	**0,57**
S2	**0,111**	**0,136**	**0,353**	**0,453**	**1,053**	**0,26**
S3	**0,111**	**0,023**	**0,059**	**0,019**	**0,212**	**0,05**
S4	**0,023**	**0,023**	**0,235**	**0,075**	**0,357**	**0,09**

WITH REGARD TO PUNCTUALITY CRITERION

	S1	S2	S3	S4
S1	1,000	1,000	0,333	0,167
S2	1,000	1,000	0,333	1,000
S3	3,000	3,000	1,000	1,000
S4	6,000	1,000	1,000	1,000
COLUMN TOTALS	11,000	6,000	2,667	3,167

	S1	S2	S3	S4	Row Totals	Priority vector
S1	**0,091**	**0,167**	**0,125**	**0,053**	**0,435**	**0,11**
S2	**0,091**	**0,167**	**0,125**	**0,316**	**0,698**	**0,17**
S3	**0,273**	**0,500**	**0,375**	**0,316**	**1,464**	**0,37**
S4	**0,545**	**0,167**	**0,375**	**0,316**	**1,403**	**0,35**

WITH REGARD TO QUALITY PRACTICES CRITERION

	S1	S2	S3	S4
S1	1,000	1,000	1,000	1,000
S2	1,000	1,000	1,000	1,000
S3	1,000	1,000	1,000	1,000
S4	1,000	1,000	1,000	1,000
COLUMN TOTALS	4,000	4,000	4,000	4,000

	S1	S2	S3	S4	Row Totals	Priority vector
S1	**0,250**	**0,250**	**0,250**	**0,250**	**1,000**	**0,25**
S2	**0,250**	**0,250**	**0,250**	**0,250**	**1,000**	**0,25**
S3	**0,250**	**0,250**	**0,250**	**0,250**	**1,000**	**0,25**
S4	**0,250**	**0,250**	**0,250**	**0,250**	**1,000**	**0,25**

WITH REGARD TO FLEXIBILITY CRITERION

	S1	S2	S3	S4
S1	1,000	0,200	6,000	6,000
S2	5,000	1,000	6,000	6,000
S3	0,167	0,167	1,000	0,250
S4	0,167	0,167	4,000	1,000
COLUMN TOTALS	6,333	1,533	17,000	13,250

	S1	S2	S3	S4	Row Totals	Priority vector
S1	**0,158**	**0,130**	**0,353**	**0,453**	**1,094**	**0,27**
S2	**0,789**	**0,652**	**0,353**	**0,453**	**2,247**	**0,56**
S3	**0,026**	**0,109**	**0,059**	**0,019**	**0,213**	**0,05**
S4	**0,026**	**0,109**	**0,235**	**0,075**	**0,446**	**0,11**

WITH REGARD TO LEVEL OF COOPERATION CRITERION

	S1	S2	S3	S4
S1	1,000	1,000	8,000	1,000
S2	1,000	1,000	9,000	8,000
S3	0,125	0,111	1,000	2,000
S4	1,000	0,125	0,500	1,000
COLUMN TOTALS	3,125	2,236	18,500	12,000

	S1	S2	S3	S4	Row Totals	Priority vector
S1	**0,320**	**0,447**	**0,432**	**0,083**	**1,283**	**0,32**
S2	**0,320**	**0,447**	**0,486**	**0,667**	**1,920**	**0,48**
S3	**0,040**	**0,050**	**0,054**	**0,167**	**0,310**	**0,08**
S4	**0,320**	**0,056**	**0,027**	**0,083**	**0,486**	**0,12**

Priority Vectors						
0,627971	0,176475	0,572655	0,108798	0,25	0,273525	0,320743
0,113908	0,307677	0,263312	0,174591	0,25	0,561855	0,48009
0,217266	0,226042	0,052882	0,365886	0,25	0,053176	0,077603
0,040855	0,289805	0,089187	0,350725	0,25	0,111444	0,121565

Criteria Weights						
0,157299	0,2994	0,23074	0,138062	0,029123	0,06837	0,077007

Weighted Performance Scores for each supplier							**Total WPS**	
0,098779	0,052837	0,132134	0,015021	0,007281	0,018701	0,0247	**S1**	0,349452
0,017918	0,092119	0,060756	0,024104	0,007281	0,038414	0,03697	**S2**	0,277562
0,034176	0,067677	0,012202	0,050515	0,007281	0,003636	0,005976	**S3**	0,181462
0,006426	0,086768	0,020579	0,048422	0,007281	0,007619	0,009361	**S4**	0,186456

Consistency Measure

	PDQ	LDT	PRC	PNC	QLP	FLX	LOC
PDQ	1,000	1,000	0,250	1,000	4,000	5,000	2,000
LDT	1,000	1,000	5,000	5,000	5,000	3,000	3,000
PRC	4,000	0,200	1,000	4,000	4,000	4,000	3,000
PNC	1,000	0,200	0,250	1,000	5,000	5,000	3,000
QLP	0,250	0,200	0,250	0,200	1,000	0,200	0,200
FLX	0,200	0,333	0,250	0,200	5,000	1,000	1,000
LOC	0,500	0,333	0,333	0,333	5,000	1,000	1,000

PDQ	0,157
LDT	0,299
PRC	0,231
PNC	0,138
QLP	0,029
FLX	0,068
LOC	0,077

Weighted sum vector
1,265
2,882
2,093
1,131
0,243
0,508
0,592

Consistency Vector
8,041
9,627
9,071
8,195
8,334
7,424
7,692
Sum **58,384**
Lambda Max **8,341**

Conistency Index
0,223

Consistency Ratio
0,169