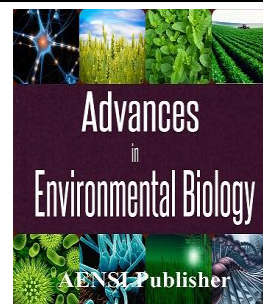




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## Supplier Selection Criteria Used to Develop Dematel

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## ABSTRACT

In recent years attention has been great emphasis on the importance of supplier selection. Selection and evaluation of suppliers is an important responsibility that must be taken into consideration purchasing managers. Critical of the choice of suppliers due to the effects of the elements of the organization's products. Suppliers are an integral part of the supply chain and supplier management because they are not part of the organization requiring specialized skills are in negotiating the impact of supplier selection criteria are discussed. The decision to effectively and precisely select a supplier is an important part of production and supply chain management in many companies performed to enhance their organizational performance. According to the importance of this matter we determine the main factors in selecting a supplier using laboratory studies and different literature review and then 10 key index were determined using questionnaire and Delphi method using parametric t-test. After all, these indexes were categorized with an acceptable convergence and formed a dematel questionnaire and distributed between 20 people and then the relationship between these indexes and the effectiveness of the supplier selection factors were analyzed using dematel method. Finally, we determined that a more effective understanding of market imbalances and improve the quality of higher unaffected.

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## INTRODUCTION

In raw material supplier analyze and selection in supply chain problem and problems like using old methods in supplier selection analysis, inability to buy qualifies raw materials, change in the process of material delivery leading to a gap in the production process, improper responsibility toward clients and on time goods delivery to propose proper management of supply chain to analyze and select supplier is much important. In this regard, the evaluation and selection of suppliers of raw materials is a subject of serious debate in the field [7]. In this study, we try to use some common indexes and goals to survey and select suppliers and also to select the best supplier we use fuzzy dematel that leads to proper results in this respect [4].

Suppliers must be selected properly because they can be very positive or very detrimental effects on the overall performance of an organization to create so, the proper supplier selection is a vital part of the organization structure [13]. Webber and his coworkers pointed it out in 1991 according to which we can use multiple factors can be used for selection because of the decision making complexity and so is the matter of the raw material supplier selection. The selection of the proper supplier is a vital part of the organization's structure raw material is also true. Evaluation and selection of suppliers of raw materials is generally a problem of decision making with multiple criteria [2]. A special feature of this issue in the evaluation of qualitative and quantitative criteria that would decide the particular complexities associated with it. On the other hand, according to the proposed problems, difficulties like on time product delivery, improper responsibility toward clients, change in the material delivery and providing nonqualified raw material had increased the importance of the supplier selection problem [8].

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#### *Background of the study:*

An article using a method IDEA / AHP to evaluate and select suppliers to offer a complete rating for supplier selection based on them. There are some factors and indexes known for the supplier evaluation that are divided into categorized as input or output. Finally, this study summarizes that suppliers should be ordered in a two stage model and then evaluated and selected [1]. A study titled proposing a mathematical model to select supplier using DEA hybrid viewpoint and the total ownership expenses, insists that the total ownership expenses method is a new method used for the supplier selection and evaluation.

Finally, this study summarizes that this approach provides the necessary information relating to the supplier evaluation and selection. A study titled evaluation and selection of suppliers in the supply chain with single supplier in the fuzzy approach states that the proper supplier selection can reduce the purchasing expenses and enhance the organization competency.

Recently, with the emergence of the supply chain management, most of researchers have found out that proper supplier selection and management is a tools used for the supply chain competency enhancement and finally this study summarizes that the supplier selection problem is inherently faced with imprecise and fuzzy data and it seems proper to use the fuzzy sets to evaluate this kind of uncertainty. A study titled the supplier selection using fuzzy hierarchical analysis process and the fuzzy multipurpose linear programming for supply chain improvement states that a proper approach to select the proper supplier in the supply chain is studying the Carbon distribution problem using fuzzy AHP and the multipurpose linear programming.

In this study, factor analysis weights used. The weights of different factors which are fuzzy multi-objective linear programming are used to select suppliers. Finally, this study concludes that the selection of suppliers is a major strategic decisions for the company's long-term survival [10]. A study titled fuzzy multi variable approach for the green supplier evaluation in the green supply chain, provides a survey on the green supply chain management to propose a fuzzy multipurpose condition for the green supply chain provider. In this study, supplier evaluation criteria identified. The use of expert opinions and judgments of the management of industrial and environmental experts; the most significant criteria for the selection of suppliers. Finally, this study concludes that the final decision is the decision of the experts and managers in the evaluation process. [11].

#### *Research methodology:*

The aim of the research can be basic research, applied and action research classified [5]. This study is an application one since we can use its results to enhance the supplier selection using the DEMATEL method. This paper describes an issue that is discussed in terms of the cross and in the field of survey research data collection. In this study, the following steps are required to perform the study. Step 1) a list of the factors in supplier selection, Step 2) Set the Delphi questionnaire to identify factors influencing, Step 3) conduct parametric statistical tests to identify factors influencing, Step 4) are preparing the dematel, Step 5) collect the data needed to identify the relationship between the variables, Step 6) and the effectiveness of this method dematel identify relationships between variables, Step 7) Conclusions and recommendations. It should be mentioned that this study population to gather data and information consisted of 20 experts in the tile and ceramics industry.

#### *Techniques dematel:*

Dematel method for integrated solutions for communities around the world are sparse and conflicting. Materials dematel recently in Japan, because of its ability to visualize complex causal relations campaign has been very popular. Specifically, the dematel on graphs which are distinct from the factors involved in causation is built. Directed graphs, which are known as graphs, undirected graphs are more useful because they are directional diagrams show the sub-systems. The plot may have a fundamental meaning that is the written relationship between different parts of the system where values show the power to penetrate and the graph shows it.

Hence, dematel relationship between cause and effect factors to convert a structural model to understand the system. Dematel could be the most important criteria that affect benchmarks are provided. Dematel a number of criteria for evaluating the impact of reduced operating simultaneously, the effectiveness of specific agents based companies can improve the effectiveness of graph drawings. So, dematel to supplier performance to find key factor criteria to improve performance and provide information for decision-making in supplier selection supply chain to assess. Dematel the relationship between cause and effect factors in a smart structural model of the system, as described in the previous sections can be reversed. Suppose that a system consists of elements in the form of  $K = \{K_1, \dots, K_n\}$  with peer to peer special relationships determined for E mathematical relationship modeling. Suppose that a set of elements and relationships tete particular, is modeled mathematically by the equation E is determined. Next, using the relation E as a direct relationship matrix equally in both dimensions indexed by the elements of the set T portrays.

Then, in addition to the case where the number 0 in cell (i, j) appears, if the integral is a positive value means that: (1) providing a pair of "\*\*\*\*" in connection with E's. (2) Here we have a relationship where the  $K_i$  element affects the  $K_j$ . This study Dematel method for analyzing the data in this method uses the following

basic steps Dematel corrects. First, the scale comparative pair wise, there may be four stages of design, where the numbers 1, 2, 3 and 4 respectively show the "impact is very low", "low impact", "High Impact", "huge impact", respectively. A primary direct relationship matrix T that is an n\*n matrix gained by the reach pair comparisons in different effecting conditions where  $T_{ij}$  is a degree where i affects j or  $T = [T_{ij}]_{n \times n}$ . Then, the direct relationship matrix S, ie  $S = [S_{ij}]_{n \times n}$ ,  $0 \leq S_{ij} \leq 1$  can be calculated using formulas 1 and 2 where all the main diagonal elements are zero.

$$K = \frac{1}{\max_{1 \leq i \leq n} \sum_{j=1}^n a_{ij}} \quad (1)$$

$$S = K * T \quad (2)$$

The total correlation matrix M can be calculated using formula 3 in which i used as a matrix identifying obtained.

$$M = X(I - X)^{-1} \quad (3)$$

Finally, a causal diagram can be drawn in a set of (D+R, D-R) to obtain the horizontal axis (D+R) is created by adding the D and R, and the vertical axis (D-R) by subtracting R is obtained from D (Chang et al, 2011).

$$M = m_{ij}, \quad i, j = 1, 2, \dots, n \quad (4)$$

$$COL = \left[ \sum_{j=1}^n m_{ij} \right]_{n \times 1} \quad (5)$$

$$ROW = \left[ \sum_{i=1}^n m_{ij} \right]_{1 \times n} \quad (6)$$

#### Study findings:

##### Step 1:

The survey of the literature and preliminary study of 56 indicators have been identified as shown in Table 1.

**Table 1:** (Talebi et al, 1390)

Questions relating to the Index
Automatic production line suppliers (automatically or manually replace the product with CAM/CAD)
Trust and reciprocity between buyer and seller
Integration and participation in production planning and buying
The use of information and communication technology tools
Management and logistics planning
During the production approach (from the suppliers)
Understanding market imbalance (confusion)
Reduce costs (transport cost of raw materials)
Quality improvement (final product)
Customer Satisfaction
Fast production and improve product
Restructuring of production processes in dynamic Improve product
Changes to improve the product
Reducing the delivery time and product
shelf life and meet the diverse demand and new technology
Ability to perform instrumental activities continuously and respond to unpredictable changes
Low demand and short product life
Reduced manufacturing cycle time
Dynamic structured manufacturing process
Reducing production costs (due to the quality of raw materials)
Re-structuring of the product and production with minimum cost
Improve the quality
Quality (the ability of suppliers to meet quality specifications)
Preterm delivery (the ability of suppliers to meet delivery schedules)
Historical supplier performance (in terms of establishing supplier)
Commercial experience (in terms of product development and the post to other buyers)
Insurance policies in terms of transfer of material damage
Facilities and Production Capacity
Price
Technical capabilities (including facilities for research and development)
Financial Status
Compatibility with the purchaser (buyer accepted procedures and protocols of the supplier)
Communication System
Position among competitors in the industry
Tend to trade on the long-term

Management and organization
Operational controls (including reporting, quality control, inventory control systems)
After sales service
Dealing with the seller
We think the seller (as a unit of preferred suppliers)
Packaging capability (the ability of suppliers to meet product requirements Packed)
History of labor relations
The geographical location of the plant site
Educational programs (educational assistance for product availability from supplier)
Two-way communication
Sensitivity Market
Speed of delivery
New products
Joint planning and focus (the supplier buyer)
The integration process of two-way transportation of raw materials
Use of IT tools Improve service levels
Reducing transportation costs
Reduce(no confidence) uncertainty
Develop responsibility
Reducin resistance to change in the desired order

**Step 2:**

We built a questionnaire according to indexes determined in step 1, using the Delphi method and distributed between 20 experts in the Persian tile and ceramic industry. In this stage the questionnaire justifiability was confirmed informally according to the university masters and experts' idea. The cronbakh alpha for this questionnaire was 0.871 and since it is more than 0.7 this questionnaire is in a high level of scientific justice.

**Step 3:**

After the questionnaire was completed and evaluating its justifiability and stability in step 2, to determine important factors in the process of the supplier determination we used parametric t-test with the SPSS 20 software. Since the level of significance (sig) is lower than 0.05 so the zero assumption in this research that refers to unimportant factors is not confirmed and the apposite assumption referring to important factors is confirmed. Hence we propose the result of this test in table2.

**Table 2:** Result of t-test.

$C_1$	Indexes / Indexes icon sign	The significant level
$C_1$	understanding of market imbalance (confusion)	0.028
$C_2$	Quality Improvement (final product)	0.000
$C_3$	high demand and short product life	0.005
$C_4$	Quality Improvement	0.000
$C_5$	facilities and production capacity	0.016
$C_6$	compatibility with the purchaser (buyer accept the procedures and guidelines of the supplier)	0.025
$C_7$	geographic location relative to the location of the factory	0.008
$C_8$	Education programs (educational assistance for product availability from supplier)	0.016
$C_9$	two-way communication	0.030
$C_{10}$	improve service levels	0.010
$C_{11}$	reduction (uncertainty) instability	0.039

**Stages 4 and 5:**

According to the surveys performed in stage 3 and the known indexes and according to the 11 verified indexes, to evaluate the relationship between these indexes, the DEMATEL questionnaire was designed. The population of the questionnaire, 20 patients (ceramic tile industry experts) distributed 15 questionnaires were completed and analyzed.

**Step 6 (The study data description using the DEMATEL technique):**

In this stage and according to the findings from previous stages we survey the factors affecting the supplier selection and the relationship between them using the DEMATEL technique. This process involves several steps, which are described in the following section, we will. Step one: formed direct relationships matrix, the resulting matrix of integration and community survey data (tile industry experts), as well as dematel inventory data set.

**Table 3:** Formed direct relationships matrix.

	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	C <sub>7</sub>	C <sub>8</sub>	C <sub>9</sub>	C <sub>10</sub>	C <sub>11</sub>
C <sub>1</sub>	0	2	3	3	2	3	2	2	2	3	3
C <sub>2</sub>	2	0	2	2	3	2	2	2	3	3	3
C <sub>3</sub>	2	2	0	3	3	3	2	2	2	2	2
C <sub>4</sub>	2	2	3	0	3	3	2	3	2	3	3
C <sub>5</sub>	2	3	3	3	0	3	2	2	2	2	3
C <sub>6</sub>	3	3	3	3	3	0	2	2	2	3	2
C <sub>7</sub>	2	2	2	2	2	2	0	2	2	3	2
C <sub>8</sub>	2	2	2	3	2	2	2	0	2	3	2
C <sub>9</sub>	2	2	2	3	2	2	2	2	0	3	2
C <sub>10</sub>	3	3	2	3	2	3	3	3	3	0	2
C <sub>11</sub>	3	3	2	3	2	2	2	3	3	2	0

Second step: is the normalization phase. The direct relationship matrix based on the data obtained according to Equation 1, the normal matrix.

**Table 4:** Result of normalization phase.

	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	C <sub>7</sub>	C <sub>8</sub>	C <sub>9</sub>	C <sub>10</sub>	C <sub>11</sub>
C <sub>1</sub>	0	0.074074	0.111111	0.111111	0.074074	0.111111	0.074074	0.074074	0.074074	0.111111	0.111111
C <sub>2</sub>	0.074074	0	0.074074	0.074074	0.111111	0.074074	0.074074	0.074074	0.111111	0.111111	0.111111
C <sub>3</sub>	0.074074	0.074074	0	0.111111	0.111111	0.111111	0.074074	0.074074	0.074074	0.074074	0.074074
C <sub>4</sub>	0.074074	0.074074	0.111111	0	0.111111	0.111111	0.074074	0.111111	0.074074	0.111111	0.111111
C <sub>5</sub>	0.074074	0.111111	0.111111	0.111111	0	0.111111	0.074074	0.074074	0.074074	0.074074	0.111111
C <sub>6</sub>	0.111111	0.111111	0.111111	0.111111	0.111111	0	0.074074	0.074074	0.074074	0.111111	0.074074
C <sub>7</sub>	0.074074	0.074074	0.074074	0.074074	0.074074	0.074074	0	0.074074	0.074074	0.111111	0.074074
C <sub>8</sub>	0.074074	0.074074	0.074074	0.111111	0.074074	0.074074	0.074074	0	0.074074	0.111111	0.074074
C <sub>9</sub>	0.074074	0.074074	0.074074	0.111111	0.074074	0.074074	0.074074	0.074074	0	0.111111	0.074074
C <sub>10</sub>	0.111111	0.111111	0.074074	0.111111	0.074074	0.111111	0.111111	0.111111	0.111111	0	0.074074
C <sub>11</sub>	0.111111	0.111111	0.074074	0.111111	0.074074	0.074074	0.074074	0.111111	0.111111	0.074074	0

The third step: matrix M according to equation 3

**Table 5:** Formed matrix M according to equation 3.

0.728853	0.826353	0.857593	0.970586	0.82751	0.888861	0.73767	0.800636	0.795663	0.938035	0.855438
0.766521	0.726003	0.792989	0.902776	0.824972	0.823075	0.709721	0.769269	0.797656	0.902564	0.824124
0.741274	0.768931	0.701131	0.904292	0.802053	0.829256	0.686196	0.743861	0.739194	0.843756	0.768016
0.821515	0.851969	0.882175	0.899505	0.88319	0.914343	0.75964	0.855486	0.819364	0.965046	0.880024
0.794151	0.854732	0.854832	0.966423	0.756852	0.884961	0.734194	0.79696	0.793108	0.903872	0.85379
0.853549	0.88411	0.885252	1.000853	0.886271	0.817526	0.76146	0.825388	0.821362	0.968219	0.853065
0.686228	0.710731	0.709779	0.806247	0.710596	0.736819	0.567411	0.688622	0.685328	0.81121	0.708879
0.714556	0.74011	0.740199	0.871747	0.741051	0.768348	0.662571	0.649156	0.713582	0.844487	0.739225
0.714556	0.74011	0.740199	0.871747	0.741051	0.768348	0.662571	0.718122	0.644617	0.844487	0.739225
0.87288	0.90302	0.873059	1.023488	0.874064	0.936169	0.810532	0.875891	0.871737	0.893305	0.871916
0.819784	0.848025	0.818058	0.961174	0.819	0.848089	0.730226	0.823683	0.819782	0.900911	0.749091

The fourth step: is calculated according to the matrix in the last stages of the parameters col and row relationships will be calculated according to equations 5 and 6.

**Table 6:** Row relationships calculated according to equations 5 and 6.

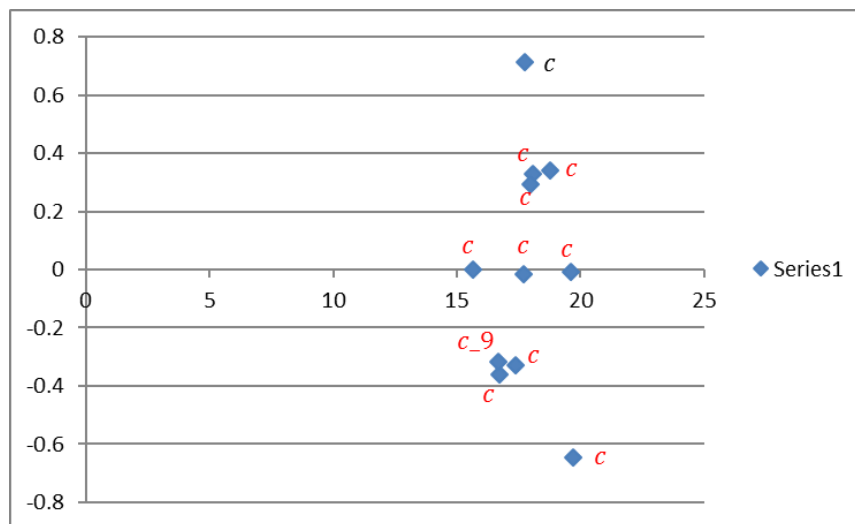
ROW	COL
9.227199	8.513866
8.83967	8.854094
8.527959	8.855267
9.532256	10.17884
9.193876	8.866608
9.557057	9.215797
7.821851	7.82219
8.185033	8.547074
8.185033	8.501393
9.80606	9.815892
9.137821	8.842794

The fifth step: by checking out the fourth step and the values obtained for charting cause and effect must coordinate of each point (index) based on the total ROW + COL and ROW-COL obtained as follows.

**Table 7:** Coordinate of each point (index) based on the total ROW + COL and ROW-COL.

	ROW+COL	ROW-COL
<b>c<sub>1</sub></b>	17.74106527	0.7133334
<b>c<sub>2</sub></b>	17.69376333	-0.014424
<b>c<sub>3</sub></b>	17.383226	-0.327308
<b>c<sub>4</sub></b>	19.71109493	-0.646582
<b>c<sub>5</sub></b>	18.06048329	0.3272678
<b>c<sub>6</sub></b>	18.77285336	0.3412603
<b>c<sub>7</sub></b>	15.64404167	-0.000339
<b>c<sub>8</sub></b>	16.73210682	-0.362042
<b>c<sub>9</sub></b>	16.68642596	-0.316361
<b>c<sub>10</sub></b>	19.62195199	-0.009833
<b>c<sub>11</sub></b>	17.98061561	0.295027

Step Six: charting cause and effect with respect to the coordinates obtained from Step Five. This chart shows the amount of impact and effectiveness of the indicators (indicators in the selection of suppliers) in a two-dimensional space.

**Fig. 1:** Amount of impact and effectiveness of the indicators.

#### Conclusions and recommendations:

According to the surveys in this study and the importance of the supplier selection in supply chain problem and problems like classical methods in supplier evaluation, supplying improper raw material, change in the raw material delivery leading to gap in the production process, improper responsibility toward clients and on time delivery of products to the consumption market to propose proper supply chain management with the purpose of raw material supplier selection, is very important. The main objective of this study provide a model for assessing the relevance and the effectiveness of selected indicators related to suppliers in the industry, ceramic tiles (tiles QuickBooks Enterprise Hub) was in Yazd. In this study we got to the following results according to the lead – effect curve and the DEMATEL technique algorithm.

Understanding of market imbalance (confusion) (C1) the greatest impact on the project's optimal choice of suppliers Relationship Company Tiles Porn Hub according to experts and the algorithm is DEMATEL. Quality Improvement (C4) and the most important factors in this project has the most impact and is also the location of the geographic location of the plant (C7) is less important than other factors. If the resulting causal diagram is divided into four zones in the first quarter, C1, C5, C6, C7, C10, C11, and in the fourth quarter, C2, C3, C4, C8, C9 has less influence.

In this study, according to analysis and results of the dematel algorithm, the Persian tile Iranian company should pay attention to the market imbalance (fuzziness) index that is of the most effectiveness and the quality enhancement index that is more important than other indexes and these indexes should be considered more seriously than the others. In directing future researches in this respect, it is recommended that some up-to-dated indexes be considered that are effective in selecting the supplier in the tile industry raw material supplement. We can also use network process analysis (ANP) and qualified function development (QFD) techniques to study the quality enhancement in services provided by the supplier.

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