Developing a Multi-Criteria Decision Making Model for PESTEL Analysis

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Abstract

Although the conceptual structure and nature of PESTEL (Political, Economic, Socio-cultural, Technological, Environment and Legal) analysis requires an integrated approach to analysis, the technical framework of PESTEL does not adequately support such an approach. PESTEL analysis, as it stands, mainly provides a general idea about the macro environmental conditions and situation of a company. This study presents a model to address problems encountered in the measurement and evaluation process of PESTEL analysis. The integrated structure of PESTEL factors and sub-factors were modeled by AHP (Analytic Hierarchy Process) and ANP (Analytic Network Process) techniques. Relationships between PESTEL factors were determined by DEMATEL (Decision Making Trial and Evaluation Laboratory). Global weights of the sub-factors were calculated using ANP. The PESTEL analysis model proposed in the study could determine the extent to which the macro environment of a company provides suitable conditions to achieve the aims of the company.

Keywords: strategic management; macro environmental analysis, PESTEL analysis, ANP, DEMATEL

1. Introduction

Globalization and technological advancements have increased the potential for interaction among people living in different geographic locations. Within this process of change, national boundaries lose their relative importance in terms of everyday economic activities. Today, the importance and value of goods and services produced outside national political geographies have increased. As a result, the concept of international competition has become increasingly important (Eren, 2002). This process of change rapidly differentiates the structure of the continually broadening and changing environment in which companies conduct their activities. A macro environmental factor that was historically less important to achieving the goals of a company might therefore become increasingly important today. For example, new phenomena and concepts such as environmental protection, environmental health, transparency, and accountability have become important parameters that need to be taken into account in commercial activities. In its broadest sense, change affects the structure, decision-making, business methods, and actions of companies. Today, it is not possible for a company to survive in the long term without considering this dynamic process. A company has no chance to make a mistake and also to carry out activities by chance in an expanding and highly unstable environment. As a result, while carrying out its operations, a company must increasingly take into account the environment within which it operate. To meet such needs, company decision-makers should adopt a strategic approach to the management of macro environmental events, occurrences, and operations.

Strategic analysis, is the first of the basic stages of strategic management, and involves the analysis of current factors relevant to the environmental within which the company carries out its operations (Ülgen & Mirze, 2007). In general terms, the concept of environment involves far, near and internal environments, including all types of factors related to the activities of the company. In terms of the company, this comprises both internal and external environments. The internal environment involves the resources and capabilities of the company, whereas external environment involves factors beyond the control of the company but which, nevertheless, are relevant to- and affect the company. A basic characteristic of the factors affecting external environment is that they are a parameter (Dinçer, 2004). Therefore, it is difficult or impossible for companies to control and direct external factors. The external environment comprises the macro environment and sectoral environment. The sectoral environment is where the company supplies inputs, sells its customers the goods and services it produces;

and where it also competed with rivals who produce similar goods (Ülgen & Mirze, 2007). On the other hand, the macro environment of a company consists of the political, economic, socio-cultural, technologic, ecologic, legal factors (Eren, 2002) that directly or indirectly affect the operations of the company (Ülgen & Mirze, 2007).

Environmental analysis is important for developing a sustainable competitive advantage; identifying opportunities and threats; and providing opportunities for productive co-operation with other companies. A review of the literature reveals that different approaches and techniques were used for the analysis of macro environment (Lynch, 2009). The model examined in the present study is PESTEL (Political, Economic, Socio-cultural, Technological, Environment and Legal) analysis. PESTEL analysis has different definitions within the literature, such as PEST (Dare, 2006) and STEPE (Richardson, 2006). The original form of PESTEL was first conceived by Aguilar as ETPS (economic, technical, political, and social). This was subsequently reorganized as STEP for the Arnold Brown Institute of Life Insurance for use in strategic evaluation of trends. In was later modified to address macro analysis of the external environment or scanning for environmental change, and was defined as STEPE. In the 1980s, the legal dimension was added to this approach (Richardson, 2006). Apart from a technique for strategic analysis, PESTEL analysis began to be used in different fields (Katko, 2006; Richardson, 2006; Shilei & Yong, 2009).

PESTEL analysis has two basic functions for a company. The first is that it allows identification of the environment within which the company operates. The second basic function is that it provides data and information that will enable the company to predict situations and circumstances that it might encounter in future. PESTEL analysis is therefore a precondition analysis, which should be utilized in strategic management (Dinçer, 2004). Although the present form of PESTEL analysis provides important foundational knowledge in, conceptual terms, for analysis of the macro environment, it has some limitations in terms of measurement and evaluation.

The first problem encountered in the measurement and evaluation dimension of PESTEL analysis is that it does not adopt a quantitative approach to measurement. Since PESTEL factors generally have a qualitative structure, measurement cannot be generally made, or is otherwise qualitatively evaluated. Using such an evaluation, does not allow the factors constituting the external environment of the company to be objectively or rationally analyzed. Thus, the present technical framework of PESTEL analysis should be developed in terms of measurement and evaluation. A second issue is that, although the conceptual dimension of PESTEL analysis prescribes a holistic approach (Dinçer, 2004), this is not reflected in the measurement and evaluation dimension. The analyzed factors are generally measured and evaluated independently. However, effect degrees in practice, factors within the external environment would not be expected to have equal influence on commercial activities. While some of the factors have significant or critical effects on company operations or success, others might have a limited effect (Dinçer, 2004). Therefore, the factors and sub-factors in PESTEL analysis may differ in their relative importance. This requires the use of a technique that allows for measurement of the relative importance of factors and sub-factors in evaluating the macro environment of the company. Another issue that should be taken into account in a holistic perspective is the relations and interactions between PESTEL factors. Independent measurement and evaluation of each macro environmental PESTEL factor might not reflect the real situation. For example, it is not possible to consider legal arrangements or economic conditions in isolation from political conditions. As Eren (2002) reported, a political situation might give rise to economic and socio-cultural implications. PESTEL analysis should adopt an approach based on the inter-dependence of the factors.

The above mentioned limitations of the present approach to PETSEL do not allow a detailed and objective analysis of the macro environment. Previous studies on the macro environment by PESTEL analysis (Dare, 2006; Katko, 2006; Shilei & Yong, 2009; Vitkiene, 2009; Mayaka & Prasad, 2012) were generally limited to determining and categorizing the factors. Although the conceptual structure and nature of PESTEL analysis requires an integrated approach, the technical framework of PESTEL does not support this method. PESTEL analysis, as it stands, mainly provides a general idea about the macro environment and situation of a company. This study presents a measurement and evaluation method to address such limitations.

The following sections of the study are arranged as follows: section 2 presents the model proposed to evaluate the macro environment by PESTEL analysis. The proposed method is applied in section 3; the results are discussed and further suggestions are made in section 4.

2. Model and Methods

This section explains the model proposed to address the limitations identified in the measurement and evaluation dimension of PESTEL analysis. The multi-criteria decision-making techniques used in the model are explained.

2.1 Proposed Model for PESTEL Analysis

The steps of the proposed PESTEL model are as follows:

Step 1: Identifying PESTEL factors and sub-factors and the form of hierarchic structure of PESTEL model.

Step 2: Determining and mapping the potential inter-dependences between PESTEL factors by DEMATEL (Decision Making Trial and Evaluation Laboratory).

Step 3: Determining the local weights of independent PESTEL factors.

Step 4: Determining the inner dependence matrix of PESTEL factors based on the DEMATEL digraph.

Step 5: Calculating the interdependent weights by ANP (Analytic Network Process)

Step 6: Determining the PESTEL sub-factors weights by AHP (Analytic Hierarchy Process).

Step 7: Determining the global weights by multiplying the weights in step 5 by those in step 6.

Step 8: Evaluating the PESTEL sub-factors and calculating the macro environment level by multiplying global weights of sub-factors by evaluation values. Depending on the value calculated for the macro environment, the following decisions are made:

- $0.80 \leq$ macro environment level ≤ 1.00: The macro environment is highly supportive of the company's current aims.

- $0.60 \leq$ macro environment level< 0.80: The macro environment is good for the company's current aims.

- $0.40 \leq$ macro environment level< 0.60: The macro environment is moderate for the company's aims.

- $0.0 \leq$ macro environment level< 0.40: The macro environment is not supportive of the company's aims.

2.2 Methods

The DEMATEL, AHP, and ANP methods were used in applying the proposed model. Dependences and relations between PESTEL factors were determined by the DEMATEL method. The local and global weights of PESTEL factors and sub-factors were calculated by the AHP and ANP methods.

2.2.1 DEMATEL

The DEMATEL method was originally developed by the Science and Human Affairs Program of the Battelle Memorial Institute of Geneva, between 1972 and 1976. It was designed to study and resolve complicated and intertwined problems (Tzeng, Chiang, & Li, 2007; Wu, 2008). This method is one of the structural modeling techniques that can identify the interdependences among the elements of a problem through a casual diagram by representing the basic concept of contextual relationships and the strengths of the influences among the factors (Tzeng et al., 2007; Wu & Lee, 2007; Wu, 2008). The procedure used for the DEMATEL method based on Tzeng et al. (2007), Liou, Tzeng, and Chang (2007), Wu and Lee (2007) and Wu (2008), as follows:

Step 1: Compute the average matrix. Each respondent was asked to evaluate the direct influence between any two factors on an integer scale ranging from 0 to 4, where higher value indicates greater influence. X_{ij} represents the degree to which the respondent thinks factor i affects factor j. For i=j the diagonal elements are set to zero. For each respondent, an nxn non-negative matrix can be stated as $X^k=[X_{ij}^k]$, where, k is the number of respondents with $1 \leq k \leq H$, and n is the number of factors. Thus, X^1, X^2, X^3,……X^H are the matrices from H respondents. To take into account all opinions from H respondents, the average matrix $A=[a_{ij}]$ is as follows:

$$a_{ij} = \frac{1}{H}\sum_{k=1}^{H} x_{ij}^k \tag{1}$$

Step 2: Calculate the normalized initial direct-relation matrix. Normalize the initial direct matrix D by D=AxS,

where, $S = \frac{1}{\max\limits_{1 \leq i \leq n} \sum_{j=1}^{n} a_{ij}}$. Each element in matrix D falls between zero and one.

Step 3: Calculate the total relation matrix T by $T=D(I-D)^{-1}$, where I is the identity matrix. Define r and c can be to be nx1 and 1xn vectors representing the sum of rows and sum of columns of matrix T, respectively. Suppose r_i be to be the sum of the ith row in matrix T, then r_i summarizes both the direct and indirect effects of factor to the on the other factors. If c_i denotes the sum of the jth column in matrix T, then c_j shows both direct and indirect effects on factor j from the other factors. When j=i the sum (r_i+c_j) shows the total effects given and received by factor . Thus (r_i+c_j) indicates the degree of importance that factor i plays in the entire system. In contrast, the reciprocal (r_i-c_j) depicts the net effect that factor i contributes to the system. Moreover, if (r_i-c_j) is positive, factor

is a net cause; if (r_i-c_j) is negative, factor i is a net receiver or result (Liou et al., 2007).

Step 4: Set a threshold value to obtain the digraph. Because matrix T provides information on how one factor affects another, it is necessary for a decision maker to set up a threshold value to filter out some negligible effects. Only the effects greater than the threshold value are chosen and shown in the digraph. The digraph can be acquired by mapping the dataset of (r+c, r-c).

2.2.2 AHP and ANP

AHP was first developed by Saaty (1980), and used in decision-making processes related to different areas. AHP is regarded as the most convenient method for solving complicated problems, and was therefore used in several studies (Bayazit & Karpak, 2007; Cheng & Li, 2007). The original assumption of AHP is independence of criteria (Saaty & Takizawa, 1986; Saaty, 1996; Meade & Sarkis, 1998). However, many decision-making problems cannot always be structured hierarchically; among the elements of a problem, there can be interaction and dependence (Saaty & Takizawa, 1986; Saaty, 1996; Lee & Kim, 2000; Yüksel & Dağdeviren, 2007). Structuring a problem that includes functional dependence and allows for feedback among clusters is defined as a network system. Saaty (1996) proposed the use of ANP to solve the problem of dependence among alternatives or criteria. The main difference between AHP and ANP is that ANP is capable of handling interrelationships between the decision levels and attributes by obtaining the composite weights through the development of a ''supermatrix''. The supermatrix is a partitioned matrix, where each sub matrix is formed of a set of relationships between two elements or clusters in a connection network structure (Shyur, 2006). In the literature, the process of ANP was defined in different steps (Bayazit & Karpak, 2007; Cheng & Li, 2007). In this study, the ANP process includes three sub-steps, according to the method proposed by Shyur (2006):

Step 1: Base on independence among criteria, decision makers evaluate all criteria pairwise. Decision makers respond to questions such as: "which criteria should be emphasized more in a macro environment, and how much more?" Their responses were evaluated according to Saaty's 1–9 scale (Table 1). Each pair of criteria is judged only once. A reciprocal value will be automatically assigned to the reverse comparison. Once the pairwise comparisons were completed, the local weight vector w1 was computed as the unique solution to

$$Aw_1 = \lambda_{max}w_1 \tag{2}$$

where λmax is the largest eigenvalue of the pairwise comparison matrix A. The obtained vector was further normalized by dividing each value by its column total to represent the normalized local weight vector w2.

Table 1. Saaty's 1–9 scale for AHP (Saaty, 1996)

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one over another
5	Strong importance	Experience and judgment strongly favor one over another
7	Very strong importance	Activity is strongly favored and its dominance is demonstrated in practice
9	Absolute importance	importance of one over another affirmed on the highest possible order
2,4,6,8	Intermediate values	Used to represent compromise between the priorities listed above
Reciprocal of above non-zero numbers	if activity *i* has one of the above non-zero numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared with *i*	

Step 2: The effects of the interdependence that exists between the evaluation criteria were resolved. The impacts of all criteria on each other are also analyzed using pairwise comparisons. Questions such as: "*which criterion will influence criterion 1 more: criterion 2 or criterion 3; and by how much more?*" were answered. Different pairwise comparison matrices were formed for each of the criteria. These pairwise comparison matrices were needed to identify the relative impacts of the interdependent relationships among the criteria. The normalized

principal eigenvectors for these matrices were calculated and shown as column components in interdependence weight matrix of criteria B, where zeros were assigned to the eigenvector weights of the criteria, from which a given criterion is given.

Step 3: The interdependence weights of the criteria were calculated by synthesizing the results from the previous two steps, as follows:

$$w_c = Bw_2^T. \tag{3}$$

3. Application of the Proposed PESTEL Analysis Model

The proposed PESTEL model was evaluated via a case study of a company based in Ankara, Turkey. First, an expert team was organized, consisting of two managers of the company and the researcher. The response data used in the study reflected the views of expert team. The application of the proposed model was performed according to the steps in section 2.1.

Step 1: Identifying PESTEL factors and sub-factors to form a hierarchical structure of PESTEL model.

In this step, the relevant PESTEL factors and sub-factors were decided. PESTEL factors are derived from the themes: political, economic, socio-cultural, technological, environmental, and legal factors. However, because these factors do not enable detailed analysis of the macro environment of the company, the expert team identified detailed sub-factors that were relevant to the targets and aims of the company. Sub-factors were categorized according to the literature (Dinçer, 2004; Ülgen & Mirze, 2007; Lynch, 2009), as follows:

Politic Sub-factors (POL)

- Relations with European Union (POL1)
- Regional relations (POL2)
- Democratization process (POL3)
- Developments in north Africa and middle east (POL4)
- Political stability (POL5)

Economic sub-factors (ECO)

- National income (ECO1)
- Investment incentives (ECO2)
- Monetary policy (ECO3)
- Fiscal policy (ECO4)
- Foreign investment (ECO5)
- Current deficit (ECO6)
- Energy cost (ECO7)
- Foreign debt (ECO8)
- Unemployment (ECO9)

Social-cultural sub-factors (SOC)

- Life style (SOC1)
- Level of education (SOC2)
- Awareness of citizenship (SOC3)
- Obey the rules (SOC4)
- Will to work of the people (SOC5)
- Democracy culture (SOC6)

Technological sub-factors (TEC)

- Technologic investment policies of government (TEC1)
- New patents (TEC2)
- Support the research and development activities by government (TEC3)

- Adaptation to new technologies (TEC4)
- Rate of change in technology (TEC5)

Environmental sub-factors (ENV)

- Transportation infrastructure (ENV1)
- Traffic safety (ENV2)
- Public health (ENV3)
- Urbanization level (ENV4)
- Disaster management (ENV5)
- Green issues (ENV6)

Legal sub-factors (LEG)

- Competition laws (LEG1)
- Judicial system (LEG2)
- Consumer rights (LEG3)
- Implementation of laws (LEG4)
- International treaties (LEG5)

Secondly, the hierarchical structure of factors and sub-factors was formed, as seen in Figure 1. The model consists of three levels. The first level includes the objective function that is "to analyze the company's macro environment". The second level contains the 6 main factors of the PESTEL analysis. The second level of the model also displays potential relationships between PESTEL factors. The third level of the model consists of 36 sub-factors clustered within the main factors.
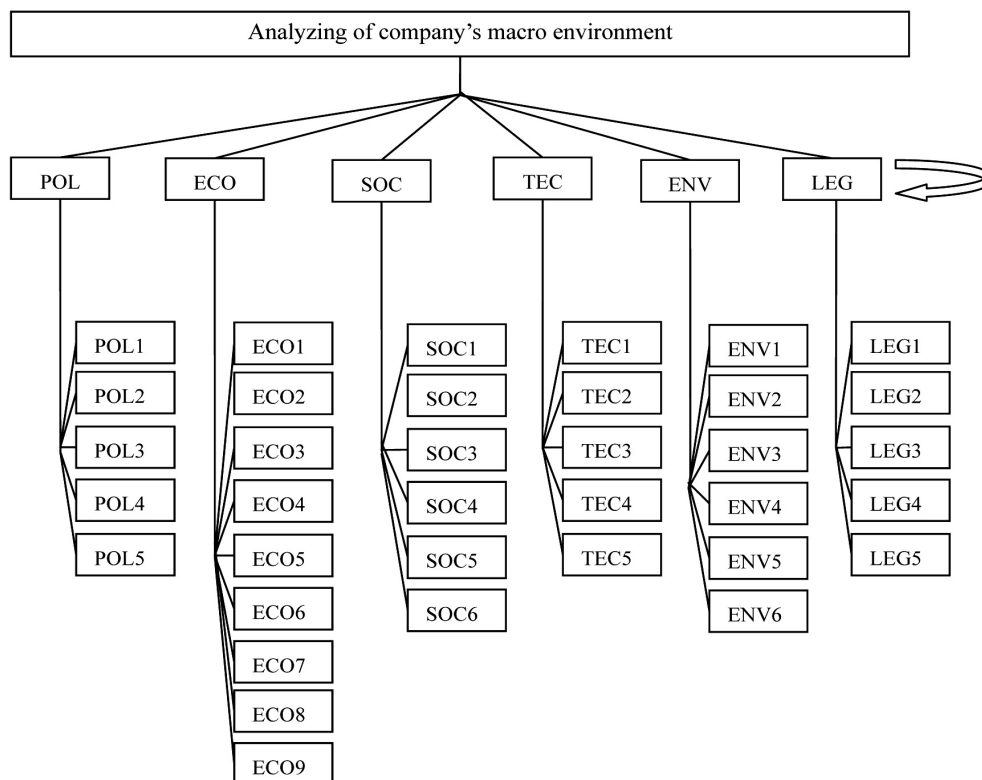
Figure 1. The hierarchical model of PESTEL

Step 2: The potential dependences among PESTEL factors were identified and mapped via DEMATEL. Thus, the initial direct-relation matrix (A) was formed according to the views of the expert team.

$$A = \begin{bmatrix} 0 & 4 & 2 & 0 & 1 & 4 \\ 2 & 0 & 3 & 2 & 1 & 2 \\ 3 & 2 & 0 & 0 & 3 & 1 \\ 0 & 3 & 1 & 0 & 1 & 2 \\ 1 & 1 & 0 & 1 & 0 & 2 \\ 2 & 1 & 1 & 1 & 2 & 0 \end{bmatrix}$$

The initial direct-relation matrix was then normalized, as shown in D.

$$D = \begin{bmatrix} 0 & 0.364 & 0.182 & 0 & 0.091 & 0.364 \\ 0.182 & 0 & 0.273 & 0.182 & 0.091 & 0.182 \\ 0.273 & 0.182 & 0 & 0 & 0.273 & 0.091 \\ 0 & 0.273 & 0.091 & 0 & 0.091 & 0.182 \\ 0.091 & 0.091 & 0 & 0.091 & 0 & 0.182 \\ 0.182 & 0.091 & 0.091 & 0.091 & 0.182 & 0 \end{bmatrix}$$

Matrix T was then calculated as follows:

$$T = D(I-D)^{-1} = \begin{bmatrix} 0.580 & 0.924 & 0.657 & 0.312 & 0.612 & 0.971 \\ 0.663 & 0.596 & 0.664 & 0.412 & 0.565 & 0.770 \\ 0.688 & 0.692 & 0.397 & 0.246 & 0.651 & 0.666 \\ 0.365 & 0.624 & 0.399 & 0.204 & 0.414 & 0.577 \\ 0.329 & 0.378 & 0.227 & 0.224 & 0.233 & 0.474 \\ 0.504 & 0.502 & 0.385 & 0.267 & 0.484 & 0.446 \end{bmatrix}$$

Direct and indirect effects between PESTEL factors are shown in Table 2; the threshold value is 0.502.

Table 2. The sum of influences given and received among PESTEL factors

PESTEL Factors	D+R	D-R
Political	7.185	0.927
Economic	7.386	-0.045
Socio-cultural	6.066	0.611
Technological	4.248	0.919
Environmental	4.822	-1.094
Legal	6.493	-1.318

The results of the DEMATEL analysis are shown in Figure 2. When the digraph of relations among PESTEL factors was analyzed, it was found that the political factor is affected by the socio-cultural, legal, and economic factors. In addition, the political factor has inner dependency. The economic factor has inner dependency, and is affected by the political, socio-cultural, technological, and legal factors. The socio-cultural factor is affected by the economic and politic factors. The technological factor was found to be independent of the other PESTEL factors. The environmental factor is affected by the socio-cultural, political, economic, and legal factors. All of the other PESTEL factors affected the legal factors. As can be seen from Figure 2, the analysis suggests that the PESTEL factors are not independent of each other.
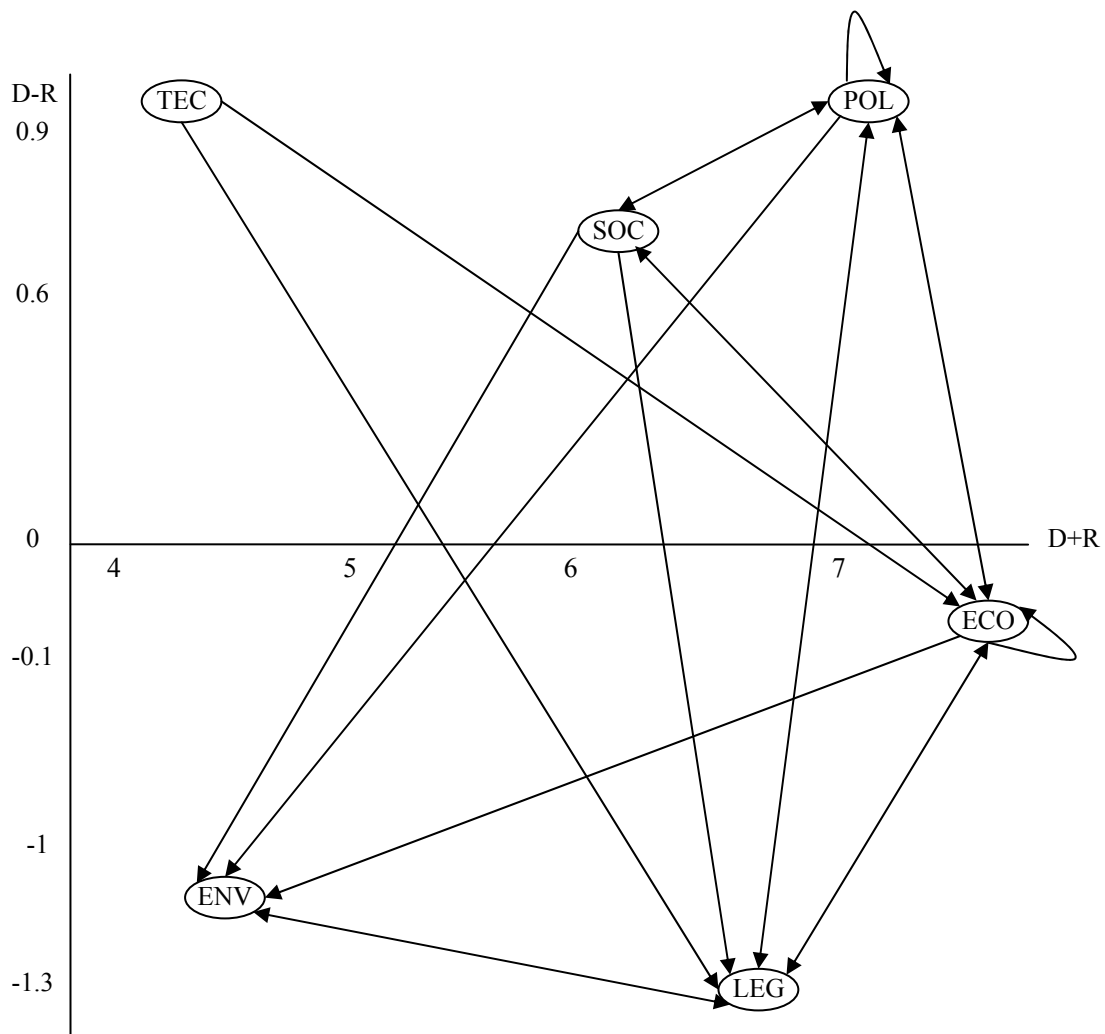
Figure 2. The digraph of showing causal relations among PESTEL factors

Step 3: Determining the local weights of the independent PESTEL factors.

In this step, the local weights of PESTEL factors were calculated. A pairwise comparison matrix was then formed by the expert team by using Saaty's scale (Table 1).The local weights of PESTEL factors based on the non-relations are given in Table 3. The consistency ratio (CR) of pairwise comparison matrix was calculated, and is shown in the last row of Table 3.

Table 3. Pairwise comparison matrix of PESTEL factors by assuming that there is no dependence among them and local weights

PESTEL Factors	POL	ECO	SOC	TEC	ENV	LEG	Weights
Political (POL)	1	1/2	2	3	3	3	0.243
Economic (ECO)		1	3	4	2	2	0.303
Social (SOC)			1	2	3	1/3	0.124
Technological (TEC)				1	2	1/2	0.083
Environmental (ENV)					1	1/3	0.071
Legal (LEG)						1	0.176
CR=0.07							

Step 4: Determining the inner dependence matrix of PESTEL factors based on the digraph derived using DEMATEL.

Determining of the inner dependence matrix pairwise comparison matrices took account of Figure 2. Inner dependence matrices are given in Tables 4–8; consistency ratios are indicated in the last row of each table.

Table 4. The inner dependence matrix of the factors with respect to political factor

PESTEL Factors	POL	ECO	SOC	LEG	Weights
Political (POL)	1	1/3	2	3	0.222
Economic (ECO)		1	5	5	0.554
Social (SOC)			1	3	0.147
Legal (LEG)				1	0.077
CR=0.04					

Table 5. The inner dependence matrix of the factors with respect to economic factor

PESTEL Factors	POL	ECO	SOC	TEC	LEG	Weights
Political (POL)	1	1/3	2	2	3	0.204
Economic (ECO)		1	5	4	5	0.486
Social (SOC)			1	2	2	0.134
Technological (TEC)				1	2	0.107
Legal (LEG)					1	0.070
CR=0.02						

Table 6. The inner dependence matrix of the factors with respect to social factors

PESTEL Factors	POL	ECO	Weights
Political (POL)	1	1/2	0.333
Economic (ECO)		1	0.667
CR=0.00			

Table 7. The inner dependence matrix of the factors with respect to environmental factors

PESTEL Factors	POL	ECO	SOC	LEG	Weights
Political (POL)	1	1/2	1/3	1/5	0.085
Economic (ECO)		1	1/2	1/4	0.140
Social (SOC)			1	1/3	0.233
Legal (LEG)				1	0.542
CR=0.01					

Table 8. The inner dependence matrix of the factors with respect to legal factors

PESTEL Factors	POL	ECO	SOC	TEC	ENV	Weights
Political (POL)	1	2	3	2	3	0.354
Economic (ECO)		1	2	1/3	1/3	0.116
Social (SOC)			1	1/2	1/4	0.079
Technological (TEC)				1	1/2	0.188
Environmental (ENV)					1	0.263
CR=0.08						

The inner dependence matrix of the PESTEL factors (ID) was formed according to the weights of the inner dependence of the factors, as follows:

$$
ID = \begin{bmatrix}
0.222 & 0.204 & 0.333 & 0.166 & 0.085 & 0.354 \\
0.554 & 0.486 & 0.667 & 0.166 & 0.140 & 0.116 \\
0.147 & 0.134 & 0 & 0.166 & 0.233 & 0.079 \\
0 & 0.107 & 0 & 0.166 & 0 & 0.188 \\
0 & 0 & 0 & 0.166 & 0 & 0.263 \\
0.077 & 0.070 & 0 & 0.166 & 0.542 & 0
\end{bmatrix}
$$

Step 5: Calculating the interdependent weights.

Interdependent weights of the PESTEL factors were calculated by multiplying the local weights found in the third step by the inner dependence matrix (ID) determined in the fourth step. The interdependent local weights of the PESTEL factors were calculated as follows:

$$
w_{PESTEL} = \begin{bmatrix} POL \\ ECO \\ SOC \\ TEC \\ ENV \\ LEG \end{bmatrix} = \begin{bmatrix}
0.222 & 0.204 & 0.333 & 0.166 & 0.085 & 0.354 \\
0.554 & 0.486 & 0.667 & 0.166 & 0.140 & 0.116 \\
0.147 & 0.134 & 0 & 0.166 & 0.233 & 0.079 \\
0 & 0.107 & 0 & 0.166 & 0 & 0.188 \\
0 & 0 & 0 & 0.166 & 0 & 0.263 \\
0.077 & 0.070 & 0 & 0.166 & 0.542 & 0
\end{bmatrix} \times \begin{bmatrix} 0.243 \\ 0.303 \\ 0.124 \\ 0.083 \\ 0.071 \\ 0.176 \end{bmatrix} = \begin{bmatrix} 0.239 \\ 0.408 \\ 0.120 \\ 0.079 \\ 0.060 \\ 0.092 \end{bmatrix}
$$

Step 6: Determining the PESTEL sub-factors weights by AHP.

This step consists of the formation of pairwise comparison matrixes of PESTEL sub-factors, evaluation of each matrix (scale range 1–9) according to the views of the expert team, calculation of local weights, and determination of the consistency ratio.

Table 9. Pairwise comparison matrix of politic sub-factors and weights

Politic Sub-factors	POL1	POL2	POL3	POL4	POL5	Weights
POL1	1	1/3	1	1/3	1/3	0.089
POL2		1	3	2	1/2	0.265
POL3			1	1/3	1/3	0.089
POL4				1	1/2	0.206
POL5					1	0.351
CR=0.03						

Table 10. Pairwise comparison matrix of economic sub-factors and weights

Economic Sub-factors	ECO1	ECO2	ECO3	ECO4	ECO5	ECO6	ECO7	ECO8	ECO9	Weights
ECO1	1	4	3	3	5	3	2	3	2	0.242
ECO2		1	1/3	1/3	1/2	1/5	1/6	1/3	1/3	0.031
ECO3			1	2	3	2	1/2	2	2	0.128
ECO4				1	2	1/3	1/3	1/2	1/2	0.062
ECO5					1	1/2	1/4	1/3	1/3	0.042
ECO6						1	1/2	3	2	0.128
ECO7							1	2	3	0.188
ECO8								1	1/2	0.081
ECO9									1	0.097
CR=0.04										

Table 11. Pairwise comparison matrix of social sub-factors and weights

Social Sub-factors	SOC1	SOC2	SOC3	SOC4	SOC5	SOC6	Weights
SOC1	1	1/5	2	1/4	1/4	1/5	0.054
SOC2		1	6	3	3	2	0.354
SOC3			1	1/5	1/4	1/5	0.039
SOC4				1	1/2	1/3	0.135
SOC5					1	2	0.209
SOC6						1	0.209
CR=0.06							

Table 12. Pairwise comparison matrix of technological sub-factors and weights

Technological Sub-factors	TEC1	TEC2	TEC3	TEC4	TEC5	Weights
TEC1	1	3	1/3	1/4	1/3	0.100
TEC2		1	1/5	1/6	1/4	0.049
TEC3			1	2	3	0.383
TEC4				1	2	0.288
TEC5					1	0.179
CR=0.05						

Table 13. Pairwise comparison matrix of environmental sub-factors and weights

Environmental Sub-factors	ENV1	ENV2	ENV3	ENV4	ENV5	ENV6	Weights
ENV1	1	8	2	1/2	3	3	0.284
ENV2		1	1/2	1/3	1/2	2	0.078
ENV3			1	1/2	2	3	0.161
ENV4				1	3	4	0.312
ENV5					1	2	0.104
ENV6						1	0.060
CR=0.05							

Table 14. Pairwise comparison matrix of legal sub-factors and weights

Legal Sub-factors	LEG1	LEG2	LEG3	LEG4	LEG5	Weights
LEG1	1	1/3	2	1/3	1/2	0.109
LEG2		1	3	2	3	0.374
LEG3			1	1/3	1/4	0.074
LEG4				1	1/2	0.204
LEG5					1	0.239
CR=0.06						

Step 7: Global weights were computed by multiplying the interdependent weights of the factors (obtained in step 5) by the local weight factors (step 6). The results are shown in the last column of Table 15.

Table 15. Computed global weights of PESTEL sub-factors

PESTEL factors	Interdependent weights	PESTEL sub-factors	Local weights	Global weights
	0.239	POL1	0.089	0.022
		POL2	0.265	0.064
Politic		POL3	0.089	0.022
		POL4	0.206	0.05
		POL5	0.351	0.083
	0.408	ECO1	0.242	0.098
		ECO2	0.031	0.012
		ECO3	0.128	0.052
		ECO4	0.062	0.026
Economic		ECO5	0.042	0.017
		ECO6	0.128	0.052
		ECO7	0.188	0.076
		ECO8	0.081	0.033
		ECO9	0.097	0.039
	0.120	SOC1	0.054	0.007
		SOC2	0.354	0.044
		SOC3	0.039	0.006
Social		SOC4	0.135	0.017
		SOC5	0.209	0.025
		SOC6	0.209	0.025
	0.079	TEC1	0.100	0.008
		TEC2	0.049	0.004
Technological		TEC3	0.383	0.03
		TEC4	0.288	0.022
		TEC5	0.179	0.014
	0.060	ENV1	0.284	0.018
		ENV2	0.078	0.005
		ENV3	0.161	0.01
Environmental		ENV4	0.312	0.018
		ENV5	0.104	0.006
		ENV6	0.060	0.003
	0.092	LEG1	0.109	0.011
		LEG2	0.374	0.035
Legal		LEG3	0.074	0.006
		LEG4	0.204	0.018
		LEG5	0.239	0.022

Step 8: The current situation of each sub-factor was determined according to the views of the expert team. The analysis used the scale in Table 16, adapted from Yüksel and Dağdeviren (2006: 2010). The results are shown in the third column of Table 17. The numerical values of the evaluations are given in the fourth column of Table 17.

Table 16. Evaluation scale for sub-factors of PESTEL

Levels of current situation of sub-factors	Value of level
Certainly acceptable (CE)	1.00
Acceptable (AE)	0.75
Partially acceptable (PA)	0.50
Partially unacceptable (PU)	0.25
Certainly unacceptable (CU)	0.00

As may be seen evaluations and calculations performed in this step were given in Table 17. In Table 17 last column that indicates the level of each PESTEL sub-factors that were calculated by multiplying global weights and scale values of evaluations. In the last line of Table 17, the total level of sub-factors that indicates the level of the macro environment of the company was given according to sub-factors. In this study, the total macro environment of the company is represented by the sum of the current levels of each sub-factor, calculated as 0.5993. Following the decisions made during step 8, the results indicate that the level of the macro environment is moderately favorable to the company's aims in the current situation.

Table 17. Computed macro environment level with the proposed PESTEL analysis model

PESTEL sub-factors	Global weights (gw)	Linguistic Evaluations	Scale Value (sv)	Level of sub-factors gw×sv
POL1	0.022	PA	0.50	0.0110
POL2	0.064	PA	0.50	0.0320
POL3	0.022	PA	0.50	0.0110
POL4	0.05	PA	0.50	0.0250
POL5	0.083	AE	0.75	0.0623
ECO1	0.098	PA	0.50	0.0490
ECO2	0.012	AE	0.75	0.0090
ECO3	0.052	AE	0.75	0.0390
ECO4	0.026	AE	0.75	0.0195
ECO5	0.017	AE	0.75	0.0128
ECO6	0.052	PA	0.50	0.0260
ECO7	0.076	PU	0.25	0.0190
ECO8	0.033	AE	0.75	0.0248
ECO9	0.039	PA	0.50	0.0195
SOC1	0.007	AE	0.75	0.0053
SOC2	0.044	PA	0.50	0.0220
SOC3	0.006	AE	0.75	0.0045
SOC4	0.017	PU	0.25	0.0043
SOC5	0.025	CE	1.00	0.0250
SOC6	0.025	AE	0.75	0.0188
TEC1	0.008	CE	1.00	0.0080
TEC2	0.004	PU	0.25	0.0010
TEC3	0.03	CE	1.00	0.0300
TEC4	0.022	CE	1.00	0.0220

TEC5	0.014	CE	1.00	0.0140
ENV1	0.018	AE	0.75	0.0135
ENV2	0.005	PU	0.25	0.0013
ENV3	0.01	AE	0.75	0.0075
ENV4	0.018	PU	0.25	0.0045
ENV5	0.006	PU	0.25	0.0015
ENV6	0.003	PU	0.25	0.0008
LEG1	0.011	AE	0.75	0.0083
LEG2	0.035	PA	0.50	0.0175
LEG3	0.006	AE	0.75	0.0045
LEG4	0.018	PA	0.50	0.0090
LEG5	0.022	AE	0.75	0.0165
Macro environment level				0.5993

4. Conclusion and Future Research

This study proposed a method to develop the measurement and evaluation dimension of PESTEL analysis. PESTEL analysis is used to determine to what extent macro environmental conditions are appropriate to realize the goals and targets of company. The model proposed in the present study demonstrated that PESTEL factors and sub-factors can be modeled by AHP method in an analytical and systematic manner. The proposed model made it possible to determine the positions and relative importance of all of the factors and sub-factors used in the PESTEL analysis. This allowed the integrated evaluation of PESTEL factors via the AHP model. In addition, it was found that PESTEL factors and sub-factors can be measured more rationally and objectively with the AHP model. The study also found that the DEMATEL method can be used to determine potential relationships between PESTEL factors; and that the resulting matrixes can be solved by the ANP method. A general analysis of the results showed the extent to which the macro environment of a company could be determined by the proposed PESTEL analysis model.

The validity of the proposed model was analyzed in terms of method, content, and success. The case study revealed that the method had an acceptable level of validity. Analysis of the content and results showed that, based on the statements of decision makers of the company, the model provided significant and considerable information. However, further, more detailed studies should be conducted in order to obtain a more generalizable evaluation.

In the present study, it was assumed that there can be a relationship between main PESTEL factors. However, this relationship can also be present between PESTEL sub-factors. Sophisticated studies can be carried out on the relationships between sub-factors. In the present study, crisp numbers were used to form matrixes. However, it is not always possible to precisely quantify factors and variables. PESTEL factors have ambiguity and vagueness in their structure. Thus, PESTEL analysis may be further developed in future studies by using fuzzy numbers to measure these types of factors.

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