# CRITICAL FACTORS AFFECTING TURKISH SMES SUSTAINABLE LONGEVITY

Gamze Ogcu Kaya[a], Ömer F. Demirel[b] ,Ali Türkyılmaz[c], Metin Şatır[d]

[a]*Department of Industrial Engineering, Bursa Orhangazi University, Yıldırım, 16310, Bursa, TURKEY*
[b]*Department of Industrial Engineering, Istanbul Technical University, Maçka, 34367, Istanbul, TURKEY*
[c]*Department of Industrial Engineering, Fatih University, Buyukçekmece, 34500, Istanbul, TURKEY*
[d] *Small and Medium Enterprises Development Organization (KOSGEB) , Mamak, 06260, Ankara, TURKEY*

## ABSTRACT

Small and Medium sized enterprises (SMEs) are companies which have limited resources such as capital, personnel number, revenue etc. In most countries, SMEs constitute huge portion of the economy and strength of SMEs leads to strength of the economy. In today's highly competitive business environment the sustainable survival of an SME is critical performance indicator. In this study, we have tried to identify the factors which are significant for the sustainable longevity of SMEs. Support Vector Machines (SVM) methodology is used to form our model to reveal the factors affecting SMEs sustainable longevity.

**Keywords:** *Sustainable longevity; Support vector machines; SMEs; Turkey*

# TÜRK KOBİ'lerinin SÜRDÜRÜLEBİLİR UZUN ÖMÜRLÜ OLMASINI ETKİLEYEN KRİTİK FAKTÖRLER

## ÖZET

Küçük ve Orta büyüklükteki işletmeler (KOBİ) sermaye, personel sayısı, gelir miktarı gibi sınırlı kaynakları olan şirketlerdir. Çoğu ülkede KOBİ'ler ekonominin büyük kısmını oluşturmaktadırlar ve KOBİ'lerin güçlü olması tüm ekonominin güçlü olmasına yol açar. Günümüzün rekabetçi iş ortamında, KOBİ'lerin sürdürülebilir yaşamı kritik performans göstergesidir. Bu çalışmada, KOBİ'lerin sürdürülebilir uzun ömrü için önemli olan faktörleri belirlemeye çalıştık. Destek Vektör Makineleri (DVM) metodolojisi sürdürülebilir uzun ömürlü KOBİ'leri etkileyen faktörleri ortaya çıkaran modeli oluşturmak için kullanılmıştır.

**Anahtar kelimeler:** *Sürdürülebilir ömür; Destek vektör makineleri; KOBİ'ler; Türkiye*

## 1. INTRODUCTION

Today, Turkey is the 18th largest economy in the world with a population of 75 million and a gross domestic product of US$785 billion (World Bank, 2013). According to Turkish government's statement, the aim is to continue economic growth and make the country one of the world's 10 largest economies by 2023. SMEs have played an important role in the country's economy and its development. Their flexibility in manufacturing provides the ability to adapt changes quickly which makes them respond to economic changes in a short time and position themselves accordingly. This adaptability doesn't exist in larger companies since mostly they have strict and change resisting environment with a more corporate structure. Today, the economy of the country still depends mainly on SMEs' activities. SMEs form the backbone of the private sector in Turkey. Based on annual industry and service statistics published by Turkish Statistical Institute 99.9% of all enterprises in year 2009 are SMEs which corresponds to 64.7% of total country endorsement. Also 59.6% of total exports and 39.9% of total imports of the country in year 2011 are realized by SMEs.

Performance of SMEs taking part in a country's economy directs the way of the economy and is the key factor for development of the economy. Although there are many performance indicators we selected sustainable longevity in this study since it is a more realistic one. Other performance indicators like growth rate, market share, efficiency, productivity, sales amount

or only profit amount or employee number are not capable of representing the company's situation individually. Since sustainable longevity is a significant indicator, it is also significant to determine drivers of the sustainable longevity. Determination of key factors in sustainable longevity leads to sustainable longevity of the company which is the way to higher performance and success in economy.

In this study, Support Vector Machine (SVM) method is used for determining sustainable longevity factors for SMEs. The following section gives background information on SMEs, methods used for performance assessments including sustainable longevity and support vector machine methodology. Section 3 discusses use of multiple regression and support vector machine for the analysis, selection of the most appropriate method and its application on sustainable longevity factor identification. Finally based on results of SVM application, the highlights of how management can make use of the results and the conclusions are presented.

## 2. LITERATURE REVIEW

There are plenty of studies in the literature pointing out the importance of SMEs in all economies. Jutla et al. (2002) emphasized that SME sector counts for approximately 80 percent of economic growth. The authors proposed a model for government support to small and medium sized companies in their e-business adaptation and thus opening new ways of trading for SMEs. With an increase in e-business readiness, the authors indicated that the firms will have better performance in the global market. In their research on Austrian SMEs, Hoffmann and Schlosser (2001) revealed the fact that more than 99 percent of Austrian companies belong to the class of SMEs which shows how important SMEs are for competitiveness of the country's economy.

Significance of SMEs can also be seen from the work of Peres and Stumpo (2000) which gives share of SMEs in the manufacturing sector of Latin America and Caribbean based on employment and production values. The study showed that SMEs play essential role especially in employment. Moreover presence of SMEs in different sectors is presented and the authors concluded that the food and chemical industries have high percentages in the production of SMEs in all countries. Ayyagari et al (2007) presented that more than 60% of total employment in manufacturing are due to SMEs in most of the countries.

The study of Mateev, et al. (2013) is in line with other studies on SMEs vital presence in economies and their role for macroeconomic growth. It is indicated that employment has been mostly performed by SMEs in European Union countries during their economic growth. According to the study, the percentage increase in number of SMEs is more than two times of the corresponding increase in large enterprises which shows the importance of SMEs for economic growth. F. Pissarides et al. (2003) stated that manufacturing enterprises with employee number less than 25 forms 89.9% of all manufacturing companies of Czech Republic in year 1993 which accounted for the growth of share of SMEs in economic growth. Underlining the important role of SMEs for economy, the authors studied objectives and also constraints of small and medium enterprises by making a survey of 437 top managers. Mueller and Spitz-Oener (2006) stated that in year 2000, small and medium-sized private companies counted for more than 30 per cent of turnover in German with an increasing growth pattern. The similar situation applies for the United States, as it is stated in the work of Pearson and Ellram (1995); SMEs count for near 96% of US manufacturers and half of US manufacturing employees belong to SMEs. Also Chaston, Badger, and Sadler-Smith (2001) stated that only 14,000 entities from 5.7 million companies employ more than 500 workers that counts for large enterprises.

Performance of a company can be evaluated in many ways. Some of the performance measures rely only on financial data whereas some others are more operational performance indicators. Appiah-Adu and Singh (1998) measured performance of SMEs based on their new product success, sales growth and return on investment. Abor (2007) analyzed the relation between debt policy and performance of SMEs where performance is measured by gross profit margin which is division of gross profit into sales and return on assets which is division of net profit by total assets. Another study that considers performance of a company is the work of Karagozoglu and Lindell (2004) where the authors focused on SMEs performance and have taken performance as a measure of the company's sales growth and profitability. Foreman-Peck et al. (2006) studied two SMEs performance which are profitability and growth. Profitability is calculated as the ratio of profit to turnover and growth is calculated based on annual growth in turnover and in employment. Productivity and profitability are taken as performance indicators in the work of Patterson et al. (2004) where the first indicator is the labor productivity calculated as the logarithm of the financial value of net sales per employee and the second indicator is the profit of the company. Other performance measures include: number of markets or foreign ventures which is proposed by Lu and Beamish, 2001, sales growth by Grant (1987) and return on assets used by Shaked (1986). Profit growth, sales growth, market share are used as performance measures in the study by Kaynak and Kara (2004) where they analyzed the relationship between market orientation and a company's performance.

Mueller and Spitz-Oener (2006) studied the relationship between company performance and managerial ownership where they focused on SMEs performance. The authors measured performance in an unusual way since it measured by a survey-based profit which the subtraction of the number of times a company has informed decreasing profit from the number of times a company has informed increasing profit. Results of the study showed that SMEs performance increases in managerial ownership with a percentage of up to 40 per cent. Fening et al. (2008) have seen SME performance from the view of profitability, customer satisfaction, sales growth and employee morale in their study where they searched the impact of quality management practices on SME performance by making a survey comprising of 200 small firms with less than 50 workers.

Profitability is used as performance indicator in many studies. Olutunla and Obamuyi (2008) focused on SMEs profitability and its relation between bank loans, age of business and the number of employees. The authors presented that there is a strong relationship between profitability and the number of employees where there is interdependence between the SMEs profitability and bank loans. Qian (2002) also considered SMEs profitability where he studied the relation between company profitability and multi nationality and product diversification. The profitability

measure used in the study is profit margin or return on sales. Return on sales is calculated as the ratio of net profit to sales. Garcı´a-Teruel and Martı´nez-Solano (2007) studied SMEs profitability and effects of working capital management on it by making investigation on Spanish small and medium sized enterprises. Profitibality is calculated as the return on assets (ROA) which is the ratio of earnings, before tax and interest to assets. Return on assets is also used for profitability indicator by Lu and Beamish (2006) with another indicator, return on sales (ROS) in their study that they investigated the impact of exporting and foreign direct investment on profitability and growth.

Performance indicators mentioned above consider company from only one perspective ranging from financial evaluation to operational evaluation. But there needs to be a more comprehensive evaluation which is the corporate sustainability of a company. Sustainability is a general concept which takes into account not only the current situation of a company but also its effects on resources that will be needed in the future. Sustainability has three sub divisions which are social sustainability, environmental sustainability and economical sustainability (United Nations General Assembly). First of the studies concerning sustainability is the Brundtland Report published by World Commission on Environment and Development (WCED) in year 1987. In the report, the commission focused on deterioration of the environment and natural resources and economic and social consequences of this deterioration. They emphasized the need for sustainable development and governmental level changes for sustainability.

Jennings and Zandbergen (1995) see sustainability as a linkage between ecological system and social system where the authors defined economic system under the social system. They stated that social development consideration within local eco-systems while maintaining economic development is a concern of modern societies. Sustainability aggregates economical issues with social and environmental considerations while ensuring that current needs are satisfied and on the other hand resources are preserved for future generations. Environmental sustainability consideration is related with being environment friendly and doing the business in a way that is respectful to ecosystems. Environmental sustainability can be achieved by careful attention for decreasing emissions, using recycled and renewable resources etc. Social sustainability consideration is related with being respectful to social issues. This kind of sustainability can be achieved by respecting human and labor rights and gender equality etc. Economic sustainability is related with financial condition of the company. Economic sustainability can be achieved by increasing market share, cost reduction or sales revenue increase etc.

There are many works on developing assessment methodologies for company sustainability. Coalition for Environmentally Responsible Economics (CERES)

proposed the GRI framework which has a hierarchical structure consisting of more than 100 indicators of social, environmental and economic sustainability. The Wuppertal Institute generated indicators for sustainability where environmental sustainability has measures like resource use and state indicators, social sustainability has measures like housing, social security and health care and economic sustainability has measures including growth rate, innovation and competition. One of the sustainability indicator frameworks is proposed by The United Nations Commission on Sustainable Development (CSD). The commission proposed a framework for sustainability on national level rather than company level with giving insights to companies for making contribution to national sustainability.

Another measure for evaluating company performance is sustainable longevity. Survival of a company is important because a company death is very costly for shareholders and stakeholders. Sustainable longevity of the firm is strictly related to its sustainability. A sustainable company respecting environment and social system while increasing economic performance is likely to have longer life span than others. In the work of Sahut et al.(2012) it is stated that most of the conditions leading to sustainable longevity of the company are resulting from sustainability principles like a strong corporate culture based on values, a relevant and fair valuation of human capital, a controlled growth and financial prudence, strategic alliances with the stakeholders, and a good governance. So, it is clear that sustainability of a company results with its sustainable longevity.

Although sustainable longevity of the company is a desired situation and the study of (Geus, 1997) suggests that natural life span of a company can be more than two centuries, real life experiences show the opposite. Statistics in the study of Burgelman and Grove (2007) about survival of the top 100 U.S. industrial companies listed in Fortune magazine in 1965 shows that only 34 out of 100 companies can survive till year 2005. Sustainable longevity is more important for SMEs since they are less resistible to changes in outside conditions. SMEs face with more uncertainty than large companies in changes in the environment. For instance an economical crisis affects SMEs more than larger companies since they have limited resources including capital, time, knowledge and skilled personnel. Also there are studies like the one of (Barron et al. 1994) showing that large companies have higher life spans than SMEs.
Sustainable longevity is such an important need, but there are relatively few studies like Geus (1997), Collins and Porras (2004) attempting to explain factors of firm longevity factors. Geus (1997) found four factors leading to longevity of a company as: conservatism in financing, sensitivity to the world around them, awareness of their identity and tolerance of new ideas. Addressing the fact that SMEs have critical roles in economy, sustainable longevity of these enterprises is vital for economic development of a country. According to the study of Pasanen (2000), many

companies face a threatening condition to their existence which makes sustainable longevity a significant performance indicator.

In this study, Support Vector Machine (SVM) methodology is used for exploring critical effects of sustainable longevity of small and medium sized enterprises. Introduced by Vapnik (1995), Support Vector Machine (SVM) is a widely used technique in the literature for classification purposes. It has a broad application in different sectors. Lee (2007) used SVM for corporate credit rating prediction and tested its performance against multiple discriminant analysis; case-based reasoning and three-layer fully connected back-propagation neural networks and concluded that SVM outperforms the other methods. Corporate credit rating is also studied in the work of Huang et al. (2004) in which they used the United States and Taiwan markets for making comparison between back propagation neural network and SVM. Application areas of SVM is not restricted to finance related issues, for instance Delgado-Gómez studied sale performance prediction of insurance company candidates and they proposed SVM methodology for the problem. SVM methodology is applied for salesmen selection of insurance company and it is presented that SVM has a higher performance than the method used for the problem. Supplier selection is another application area of SVM; Guo et al. (2009) proposed a new support vector machine technology for the problem. Guo et al. (2006) used support vector methodology to forecast electricity load and the authors concluded that the method overcomes artificial neural network method since SVM can catch global optima with a higher forecasting accuracy than artificial neural network.

Another application area of SVM is the health care industry. In their work on breast cancer detection, Hussain et al. (2011) used support vector machine as the tool and stated that it gives better performance than other classification methods. The authors investigated effect of different kernel function types in SVM since use of different kernel functions is very influential on the method performance. Lam et al. (2009) considered contractor prequalification with use of support vector machine methodology by different kernel functions and different data sets. Since the results of SVM is more promising than the results of artificial neural network the authors concluded that SVM can be used as decision support tool for prequalification purposes.

Although there are studies on determining critical factors of sustainable longevity, none of them used support vector machine as the methodology. Alexander et al. (2003) used interview data from four health companies which constitute partnerships in order to figure out significant factors contributing to collaborative capacity sustainability. In the study of Gunn (2010) the author studied factors leading to sustainable longevity for e-learning institutions and she conducted interviews with academicians and support personnel of e-learning institutions in New Zealand.

Another research on sustainability determinants is the work of Zurbrügg et al. (2012) in which the authors investigated factors of sustainability for solid waste management by making an analysis of a waste recovery project in Indonesia with a questionnaire based survey. Most of the sustainable longevity studies are based on surveys and interviews for gathering factors on sustainable longevity, but in this study the overall relations can be seen with the use of SVM by sorting the most important factors to less important ones.

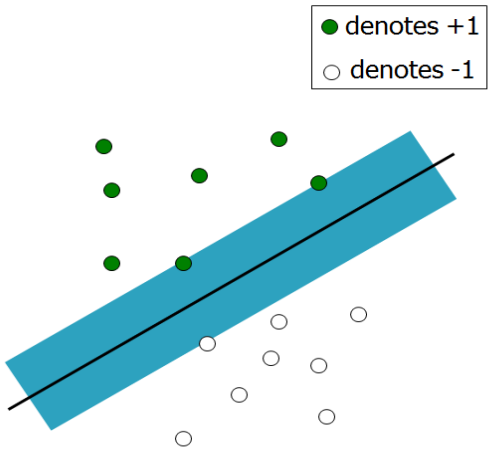


**Fig. 1** Simplest Illustration of SVM

The hyper plane separating two classes which can be found by minimization of training error can be formulated mathematically as follows:

$$\text{Minimize } \left(\frac{1}{2}\|w\|^2 + C\sum_{i=1}^{n}\xi_i\right)$$

$$\text{subject to } y_i(w^T x_i) + b \geq 1 - \xi_i \qquad i = 1,\ldots,n$$

$$\xi_i \geq 0 \qquad i = 1,\ldots,n$$

The above quadratic problem with linear constraints can be reformulated by defining Lagrangian multipliers $\alpha$ and $\beta$ and the Lagrangian equation becomes:

$$\left(\frac{1}{2}\|w\|^2 + C\sum_{i=1}^{n}\xi_i\right) - \sum_{i=1}^{n}\alpha_i\left[(y_i(w^T x_i)+b) - 1 + \xi_i\right] - \sum_{i=1}^{n}\beta_i\xi_i$$

Taking derivatives with respect to w, b and $\xi_i$ for finding stationary points of this Lagrangian equation:

$$\frac{\partial L}{\partial w} = w - \sum_{i=1}^{n}\alpha_i y_i x_i = 0$$

$$\frac{\partial \mathrm{L}}{\partial b} = \sum_{i=1}^{n} \alpha_i y_i = 0$$

$$\frac{\partial \mathrm{L}}{\partial \xi_i} = \alpha_i + \beta_i - C = 0$$

After taking partial derivatives, by substituting w as $\sum_{i=1}^{n} \alpha_i y_i x_i$ in the Lagrangian equation, the Lagrangian dual formulation becomes:

$$\max \ \frac{1}{2}\sum_{i=1}^{n} \alpha_i - \frac{1}{2}\sum_{ij} \alpha_i \alpha_j y_i y_j x_i x_j$$

*s.t.*

$$\sum_{i=1}^{n} \alpha_i y_i = 0 \quad \text{and} 0 \le \alpha_i \le C$$

Solution includes dot product of training points; the formulation above is generalized into nonlinear class by introducing Kernel function. Kernel functions are used for mapping input vectors into a high-dimensional feature space. The dot products (xi.xj) are generalized by using non-linear kernel function defined as K (xi, xj) = (ϕ (xi). ϕ (xj) where ϕ (.) provides the mapping from lower dimension to the space of much higher dimensionality.

Mostly used kernels in SVM are linear, radial basis function (RBF) and sigmoid. These kernel functions are calculated as follows:

- Linear Kernel: $K(\mathbf{x}_i, \mathbf{x}_j) = \mathbf{x}_i^T \mathbf{x}_j$
- Radial Basis Kernel: $K(\mathbf{x}_i, \mathbf{x}_j) = \exp(-\frac{\left\|\mathbf{x}_i - \mathbf{x}_j\right\|^2}{2\sigma^2})$
- Sigmoid Kernel: $K(\mathbf{x}_i, \mathbf{x}_j) = \tanh(\beta_0 \mathbf{x}_i^T \mathbf{x}_j + \beta_1)$

By using these kernel functions, the decision function derived by the SVM classifier is computed as follows for a two-class problem:

$$f(x) = \mathrm{sgn}(\sum_{i=1}^{n} \alpha_i y_i K(x, x_i) + b$$

## 3. METHODOLOGY

### 3.1. *The theoretical model*

Performance measurement related terminologies are defined in the study of Coelli et. al. (2003) as: production function, technique and allocation, scale efficiency, cost function, distance function, efficiency and productivity, technical change, total factor efficiency and cost efficiency. With the guidance of the study of Coelli et al. we developed a performance assessment model for evaluating sustainable longevity Turkish SMEs. The model includes following critical input variables which affect the sustainable longevity of the SMEs.

*Proximity to market w.r.t. competitors* is the condition of the company in its closeness to the customers in the market. This factor is an indicator of company's strength in transferring goods to consumers or perception of the customer needs due to being close to the market.
*Ability to control costs* is the power of the enterprise in controlling costs of raw material, cost of production etc. while making its production.
*Potential Labor Force* is the company's capability of employment. It shows potential number of employees the company can have which is an indicator of its financial status or corporate structure.
*Product Quality* the quality of the product the company produces among products of other industry players.
*Prompt Advantage* the prompt capability of the enterprise which also shows its financial status and liquidity.
*Certification* shows the companies attitude based on its certifications, primarily quality certifications.
*Product Assortment* the diversity of products the company produces with respect to other market players.
*Distribution Channel* the power of the company's distribution channel which is an important indicator of its sales or potential sales and its reputation
*Pricing Policy* the company's flexibility in determining price of the product it produces, if the enterprise can determine its pricing policy, it can continue selling products to the customers even the prices become higher.
*Service* is an indicator of level of service quality that the company provides. This service can be even before the sales which is at the introductory stage of product or after the sales which includes support or maintenance activities
*Capital* is the level of the capital amount of the company with respect to other companies.
*Machinery-Equipment Track* is the strength of the production facility the company has. The number of machines, equipment and also technology are indicators of company's production power.

The factors or independent variables mentioned above are considered as causes of company sustainable longevity which is the dependent variable. *Sustainable longevity* is defined as the duration passed from foundation of the firm. For determination of important factors influencing SMEs sustainable longevity, Multiple Regression and Support Vector Machine (SVM) are used in the empirical analysis. General structure of the regression model is demonstrated in Figure 2.

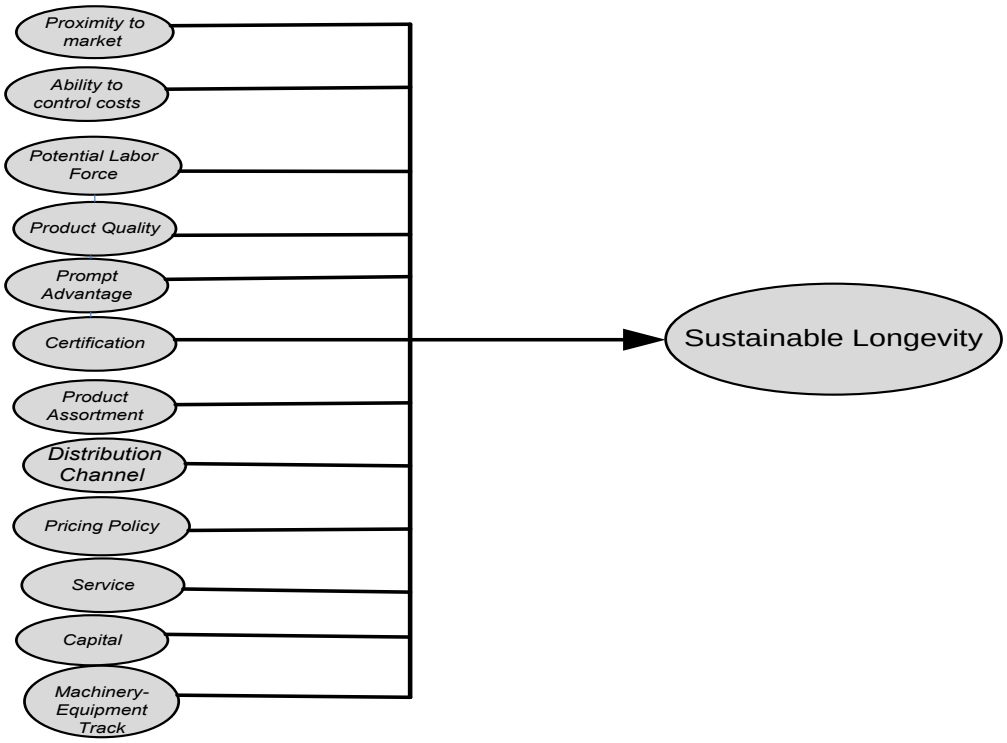


**Fig. 2** The Theoretical Model

### 3.2. *Data Analysis and Results*

After developing model for the analysis, data is gathered from 866 SMEs registered to KOSGEB, Turkish Small and Medium Industry Development Organization that supports SMEs to increase their share in the economy, competitiveness and level of welfare, and to make integration between SMEs and economic developments.

SMEs are expected to report their strategic road map to KOSGEB in order to benefit from different founds. The strategic road map is a questionnaire evaluating the company's past and current performance, and future plans regarding their vision. Top and medium level managers or project managers are responsible for filling the questionnaire through face-to face interviews or getting help from KOSGEB representatives.

For analyzing critical effects of sustainable longevity for 866 SMEs; we implemented the model with 12 factors (independent variables) and 1 dependent variable which is the sustainable longevity. Factors are the subjective evaluation of the company responsible for their situation in all factors within other market players and all of them are represented in 5 point Likert Scale (1 = very weak to 5 = very strong). Below is the illustration of descriptive statistics of factors.

**Table 1** Descriptive Statistics of KOSGEB Data

| **Factor** | **Minimum** | **Maximum** | **Mean** | **Std. Deviation** |
|---|---|---|---|---|
| Proximity to market w.r.t. competitors | 2.00 | 5.00 | 3.82 | 0.72 |
| Ability to control costs | 1.00 | 5.00 | 3.71 | 0.72 |
| Potential Labor Force | 1.00 | 5.00 | 3.85 | 0.70 |
| Product Quality | 2.00 | 5.00 | 4.30 | 0.61 |
| Prompt Advantage | 1.00 | 5.00 | 3.50 | 0.78 |
| Certification | 1.00 | 5.00 | 3.43 | 0.97 |
| Product Assortment | 1.00 | 5.00 | 3.97 | 0.75 |
| Distribution Channel | 1.00 | 5.00 | 3.42 | 0.75 |
| Pricing Policy | 1.00 | 5.00 | 3.72 | 0.67 |
| Profitability | 1.00 | 5.00 | 3.66 | 0.78 |
| Capital | 1.00 | 5.00 | 3.41 | 0.87 |
| Machinery-Equipment Track | 1.00 | 5.00 | 3.64 | 0.86 |

Small and medium sized enterprises that are used in the study belong to different sectors each of which constitute import role in the Turkish economy. These 866 SMEs belong to 13 distinct sectors which are: Chemicals and Chemical products, Plastic and RubberProducts, Manufacturing of Electrical machinery and apparatus, Basic Metal Industry, Fabricated Metal Products Excluding Machinery and Equipment, Machinery and Equipment Manufacturing, Medical and precise and optical instruments, Furniture and Other Products, Food products and beverages, Manufacturing Based on Tanning and Dressing of Leather Wearing Apparel, Dressing and Dyeing of Fur, Other Non-Metallic Mineral Products and Textile Manufacturing. Distribution of 866 companies to these sectors is represented by the following table.

**Table 2** Sectorial Distribution of SMEs

| **Sector** | **Number of Companies** |
|---|---|
| Plastic and Rubber Products | 104 |
| Fabricated Metal Products Excluding Machinery and Equipment | 104 |
| Furniture and Other Products | 101 |
| Manufacturing of Electrical machinery and apparatus | 95 |
| Food products and beverages | 90 |
| Chemicals and Chemical products | 89 |
| Machinery and Equipment Manufacturing | 89 |
| Textile Manufacturing | 59 |
| Other Non-Metallic Mineral Products | 56 |
| Basic Metal Industry | 42 |
| Dressing and dyeing of fur | 34 |
| Medical and precise and optical instruments | 2 |
| Manufacturing Based on Tanning and Dressing of Leather Wearing Apparel | 1 |

Since we concentrated on sustainable longevity of SMEs, we should give descriptive statistics on sustainable longevity. In the figure below, distribution of companies based on their life span is presented. The firms date back to 19 years on average, with a median of 17 years. Firm ages ranged from 5 to 64 years. As can be seen from the figure, majority of the firms are under 26 years.

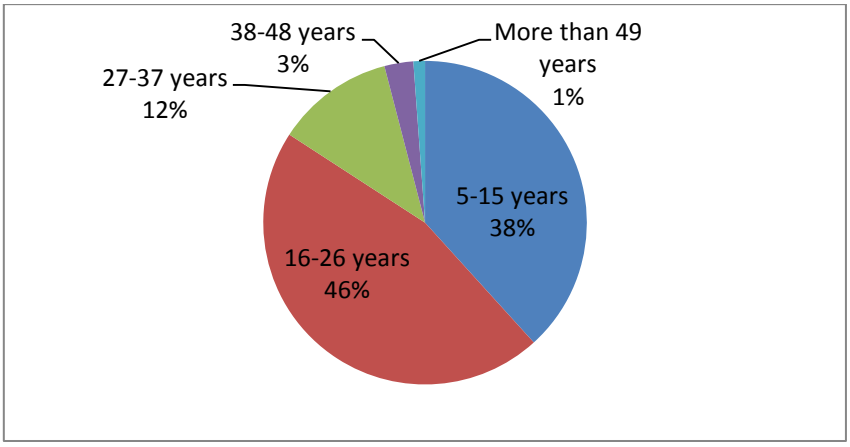


**Fig. 3** Age of SMEs

Results of Multiple Regression are presented in the Table 3.

**Table 3** ANOVA Results of Regression Model

| **ANOVA** | | | | | | |
|---|---|---|---|---|---|---|
| **Model** | | **Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
| **1** | **Regression** | 1380,378 | 12 | 115,032 | 1,504 | ,118 |
| | **Residual** | 48945,331 | 640 | 76,477 | | |
| | **Total** | 50325,709 | 652 | | | |

It can be seen from the ANOVA results that our regression model is not valid. Since significance value (0.118) is greater than p value (0.05), we reach the result that our model is not valid. The table below has also shown that the model is invalid.

**Table 4** Model Summary of Regression Model

| **Model Summary** | | | | |
|---|---|---|---|---|
| **Model** | **R** | **R Square** | **Adjusted R Square** | **Std. Error of the Estimate** |
| **1** | ,166(a) | ,027 | ,009 | 8,745117 |

Since adjusted R square value is very small, we conclude that the model is not valid again and also that the dependent variable can't be explained by independent variables of the model.

Based on the results of multiple regression, we have concluded that the sustainable longevity of SMEs cannot be explained with traditional models. This situation is due to the reason that there is not a solely linear relationship between independent variables and the dependent variable which is sustainable longevity of the company. So, we should use advanced models for the evaluation which can cope with nonlinearity between variables. Since Support Vector Machine technique is a strong and successful methodology, we will use SVM as the tool to explain corporate sustainable longevity.

As mentioned previously, there are different SVM methods using different types of Kernel Functions which are linear, radial basis function and sigmoid. In order to determine which kernel type to use, data is run with all kernel types and results are compared based on the error values they result with. 75% of data is used for training and the remaining 25% is kept for testing purposes. The model is initially trained using data from 1 to 650, i.e. "training sample". Then forecasting performance of each model is evaluated by realizing sample tests on the remaining 216 data points

which is called the "test sample". In order to assess the performance of method, the test data sets were used. In the following table, model performances are compared based on mean absolute error value of the related kernel type.

**Table 5** Model Performances for Different Kernel Functions

| | **Radial Basis Function** | **Sigmoid** | **Linear** |
|---|---|---|---|
| **Training Data** | 6,01% | 26,56% | 6,28% |

As can be seen from the table, training performance of Radial Basis Function is higher than the other functions. But in order to make a comparison between the forecasted values of all kernel functions, mean absolute error value for the testing sample are used.

**Table 6** Forecasting Performances for Different Kernel Functions

| | **Radial Basis Function** | **Sigmoid** | **Linear** |
|---|---|---|---|
| **Testing Data** | 6,27% | 34,91% | 6,56% |

Based on performance results, radial basis function kernel seems as the best performing among others. Since it is logical to use radial basis function, we choose to use it and make subsequent analysis for clarifying reasons behind corporate sustainable longevity with radial basis function kernel. Independent variable importance on dependent variable, sustainable longevity, based on radial basis function can be seen at the figure below.

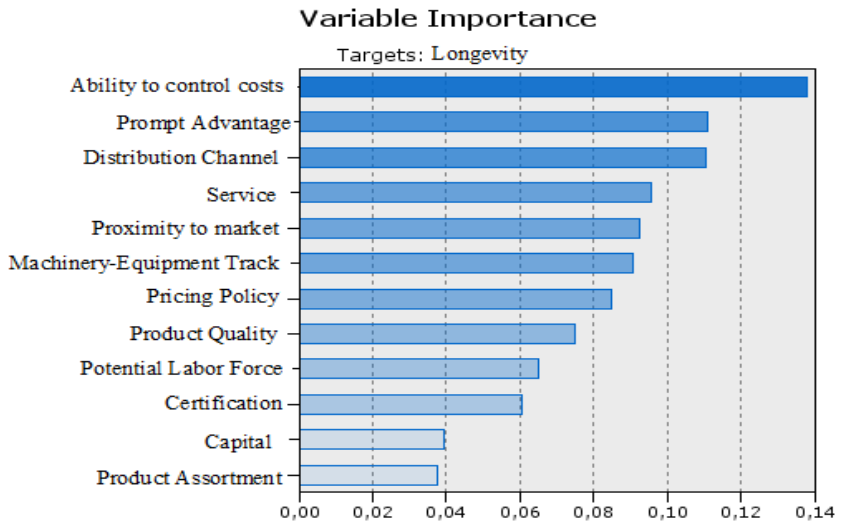


**Fig. 4** Factor Importance with Radial Basis Function

Finally, we sort independent variables based on their effects on dependent variable with the SVM using radial basis function kernel function and identify critical factors of SMEs sustainable longevity. Based on RBF kernel SVM results, ability to control costs is the most significant effect of sustainable longevity. This result shows that it is very important to manage costs effectively for sustainable longevity of the company. The result is not a surprising one since it is vital for survival of a company to control its costs and make its production regarding to controlled costs. For a company that can't manage its costs, for instance in a production environment where costs are determined by suppliers, the company becomes more sensitive to outside effects and less competitive. The second important factor is the prompt advantage which presents that for a company to have longer life span, it should focus on the prompt advantage that it supplies to its customers. The following significant factor is the distribution channel of the company, which makes sense since a stronger distribution channel of a company leads to less lead times, more customer satisfaction and high company value. The fourth important factor is the service level of the company, which is a logical result since the service quality of a company affects customer's perception of the company. The next important factor is the proximity to market which is a key factor for a company to reach high number of customers and continue its existence. Then machinery-equipment track of the company comes as the following important factor which shows machine and equipment use of company for the production and based on the results, it is an important factor to be cared. Importance level of each factor can be seen in the table above.

## 4. CONCLUSIONS AND MANAGERIAL IMPLICATIONS

In this study, two important issues of today's competitive environment: SMEs and corporate sustainable longevity are handled. SMEs constitute huge portion of Turkey's economy like most of the other economies in the world. This makes it necessary to carry studies on SMEs sustainable longevity and to increase it. Turkish Government is also aware of this need and provides financial support to SMEs, especially to those having growth potential. KOSGEB is the most important institution founded for this purpose which has the aim of increasing SMEs market share and leading them through their economic development.

In order to increase sustainable longevity of SMEs, one should understand the drivers of sustainable longevity. For fulfilling this purpose, we use support vector machine methodology and come along with the critical factors affecting SMEs sustainable longevity. Unlike traditional methods, support vector machine is capable of revealing linear and nonlinear relations between factors and the independent variable. In order

to test performance of the method, we applied it to SMEs data gathered from KOSGEB which is composed of 866 SMEs from 13 different sectors. The data is adequate for representing the overall condition of SMEs in Turkey. At the former stage of the application, we used multiple regression method as a traditional method and support vector machine methodology as advanced method and after evaluating their performances, we figure out that SVM is stronger than traditional methods.

Support vector machine technique is used for determining critical factors of sustainable longevity. According to results, ability to control costs is the most significant effect of sustainable longevity. This result is logical since it is important to have control over costs for doing work in a more professional and qualified way. The other important factors are the prompt advantage, distribution channel and service level of the company. These factors are also important in practice since with high competition most of the companies can catch a certain limit in quality and price levels which limits their competitiveness in those fields. So control over costs, prompt advantage, distribution channel and service level of the company become as the significant effects of corporate sustainable longevity. The study is valuable since it gives insights to market players in SMEs and giving them guidance for increasing their sustainable longevity by pointing to the most critical ways of fulfilling this improvement.

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