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RESEARCH ARTICLE

Controller Design for Roll Motion of a Planing Hull From a Safe Transportation Perspective

Güvenli Ulaşım Bakış Açısıyla Bir Kayıcı Teknenin Yalpa Hareketi İçin Kontrolcü Dizayni

Hakan Demirel[1], **Fuat Alarçin**[2]

ABSTRACT

The issue of safe navigation in the maritime sector is becoming more important day by day. This situation is valid not only in terms of passenger and cargo transportation, but also in different maritime operations. Based on this point, much equipment is used in order to perform safe navigation in ships for different sea states such as wind, wave, etc. This equipment is classified as active and passive systems and can be applied to different types of ships. Active stabilizer systems are frequently used, especially for ship types where speed and maneuverability are high, as instantaneous responses are important. Although there are many active systems used, active roll stabilizer fin systems are the most common. At this point, this paper describes an application of LMI (Linear Matrix Inequality) based robust and saturated H_2 state feedback control to roll motion of the planing hull via the fin stabilizer. In the mathematical model, nonlinearities are expressed through damping and restoring terms. Based on the planing hull roll motion mathematical model, we also present a state space model suitable for simulation and control applications. Non-dimensional lift coefficients of the fin stabilizer for different angles of attack are calculated with Star CCM+ package software. Both controlled and uncontrolled conditions are examined for the maximum lift coefficient. As a result, the efficiency of the proposed approach for safe transportation was demonstrated with the simulation results and an effective study was carried out by reducing the amplitudes of the roll motion to reasonable levels.

Keywords: LMI (Linear Matrix Inequality), Fin Stabilizer, Safety Transportation, Controller Design, Roll Motion

ÖZ

Denizcilik sektöründe güvenli seyir konusu her geçen gün daha da önem kazanmaktadır. Sadece yolcu ve yük taşımacılığı açısından değil, farklı deniz operasyonlarında da bu durum geçerliliğini korumaktadır. Bu noktadan yola çıkarak gemilerde, denizlerde karşılaşılabilecek farklı şiddetteki rüzgar, dalga vb durumlarda güvenli seyir gerçekleştirilebilmesi amacıyla birçok ekipman kullanılmaktadır. Bu ekipmanlar aktif ve pasif sistemler olarak sınıflandırılmakta ve farklı gemi tiplerine uygulanabilmektedir. Özellikle hız ve manevra kabiliyetinin yüksek olduğu gemi türleri için anlık tepkilerin önemli olması nedeniyle aktif dengeleyici sistemler sıklıkla kullanılmaktadır. Kullanılan birçok aktif sistem olmakla beraber, aktif yalpa dengeleyici fin sistemleri en yaygın olanıdır. Bu bağlamda, çalışmada aktif yalpa dengeleyici fin sistemi ile kayıcı bir teknenin yalpa hareketi için, Doğrusal Matris Eşitsizlikleri tabanlı, dayanıklı ve doyumlu H_2 durum geri beslemeli kontrol uygulaması tanımlanmaktadır. Matematik modelde doğrusal olmayan ifadeler, sönüm ve doğrultucu moment terimleriyle ifade edilmektedir. Kayıcı teknenin yalpa hareketinin matematik modeline dayalı olarak ayrıca durum-uzay modeli, kontrol uygulaması ve simülasyon için sunulmaktadır. Aktif fin yalpa dengeleyici sistemin farklı açılardaki boyutsuz kaldırma katsayıları Star CCM+ programıyla hesaplanmıştır. Kontrollü ve kontrolsüz durumlardaki yalpa genlikleri maksimum kaldırma katsayısı için incelenmiştir. Sonuç olarak, güvenli bir ulaşım için önerilen yaklaşımın verimliliği simülasyon sonuçlarıyla gösterilmiş ve yalpa hareketinin genlikleri makul seviyelere düşürülerek etkili bir çalışma gerçekleştirilmiştir.

Anahtar Kelimeler: Doğrusal Matris Eşitsizlikleri, Yalpa Dengeleyici Fin, Güvenli ulaşım, Kontrolcü Dizaynı, Yalpa Hareketi

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1. Introduction

Controlling roll motion of ships has a significant role in severe sea states. Large amplitude roll motion can easily cause capsizing due to the effects of wind, wave and flow. In order to reduce the roll motion, fin stabilizers, anti-rolling tanks, gyroscopic stabilizers, bilge keels and rudder roll stabilizer etc., have been used on ships (Perez, 2005; Chadwick, 1955).

In the literature, there are many roll stabilizer system applications. Saari & Khichane (2013) applied H_∞ control on a container ship to reduce the undesirable rolling effect taking into account the real conditions using the rudder. Alarcin & Gulez (2007) described the use of a neural network controller for roll stabilisation of a fishing boat using the rudder. Alternatively, active u-tank stabilizer can be used for roll reduction. Holden et al. (2009) used active u-tank stabilizer for roll motion reduction and suggested a nonlinear backstepping controller to stability of roll. Marzouk & Nayfeh (2009) investigated the performance of passive and active anti-roll tank systems and compared their performance in various sea states.

Nevertheless, the fin stabilizer is the most effective device to weaken the rolling motion. Hickey et al. used PID controller for reducing roll motion with fin stabilizer (Hickey, Johnson, & Katebi, 1999). Ghassemi et al. (2010) obtained effective results using a combined neural network and PID for roll control of ship with small draught. Bai (2014) applied the Adaptive Fuzzy Output-Feedback Method to ship roll stabilization with the fin control system and revealed the effectiveness of the proposed approach with simulations.

A number of control problems were investigated by many researchers, in these studies, different models examined and various control methods were applied (Ku et al., 2015; Qi et al., 2014; Guo et al., 2012; Xiuyan et al., 2014; Townsend et al., 2014).

In this paper, the control of nonlinear roll motion of a planning hull is examined. Section 2 deals with the mathematical model based on nonlinear restoring moment and damping impact including the fin roll stabilizer system dynamics. Section 3 expresses designing LMI - based robust and saturated H_2 state feedback controller. Section 4 and 5 discuss results and conclusion.

2. Mathematical Model of Roll Motion

Different type equations of nonlinear roll motion are suggested by many researchers. These equations can occur from several representations of damping and restoring moments associated with the mathematical model. In the present study, B1 type damping and quantic restoring are used for the mathematical model (Taylan, 1990) and expressed as;

$$(\mathrm{I}+\mathrm{I}_{xx})\ \ddot{\varphi}+\mathrm{B}_{\mathrm{L}}\dot{\varphi}+\mathrm{B}_{\mathrm{N}}\dot{\varphi}|\dot{\varphi}\ |+\Delta(\mathrm{C}_1\varphi+\mathrm{C}_3\varphi^3+\mathrm{C}_5\varphi^5\ )=\ M_W+M_F \tag{1}$$

$$M_W=\omega_{\mathrm{e}}^2\,\alpha_m\,I\cos(\omega_e t) \tag{2}$$

$$M_F=-\frac{\rho V^2 A_f C_L}{\mathrm{I}+\mathrm{I}_{xx}}\left(\alpha_f+\frac{\dot{\varphi}lf}{V}\right)lf \tag{3}$$

If the equation is divided through $I+I_{xx}$, the equation is expressed as below

$$\ddot{\varphi}+\delta_1\dot{\varphi}+\delta_n\dot{\varphi}|\dot{\varphi}|+\Delta(m_1\varphi+m_3\varphi^3+m_5\varphi^5)= \lambda_e\omega_e^2\alpha_m\cos(\omega_e t)-\delta_2\alpha_f-\delta_3\dot{\varphi} \quad (4)$$

Where,

$$\delta_1=\frac{B_L}{(I+I_{xx})} \quad (5)$$

$$\delta_n=\frac{B_N}{(I+I_{xx})} \quad (6)$$

Among all ship motions, roll motion is the most important response of a ship to calculate because large-amplitude roll motions may lead to capsizing, cargo shift, loss of deck cargo, and other undesirable consequences. The roll damping plays a very important role for roll motion so that it should be calculated correctly for a better estimation of roll motion. One of the most common methods to calculate the roll damping coefficient is Ikeda's estimation method. According to Ikeda (1978) , see also Himeno (1981), the total equivalent linear roll damping coefficient can be divided into five components. These components are composed of skin friction damping, eddy damping, wave damping, lift damping and bilge keel damping. The method was proposed to predict the roll damping of a conventional cargo ship and furthermore it was developed for a hard-chine hull, high speed displacement type ships and planning crafts. In this paper, Ikeda's estimation method was used to calculate the roll damping coefficients of the used model (Ikeda & Katayama, 2000).

As mentioned above, the roll damping coefficient can be divided into five components;

$$B_{44}=B_F+B_W+B_E+B_{LD}+B_{BK} \quad (7)$$

where B_F is the frictional damping, B_W is the wave damping, B_E is the eddy damping, B_{BK} is the bilge keel damping and B_{LD} is the lift damping. In this study, there is no bilge keel attached to the hull so that this component is zero. Eddy damping contribution decreases due to the high speed. Therefore, the lift component of the roll damping becomes dominant at high forward speed as mentioned by Katayama and Ikeda (1995) Figure 1 shows the results of the roll damping coefficients at various forward speeds.

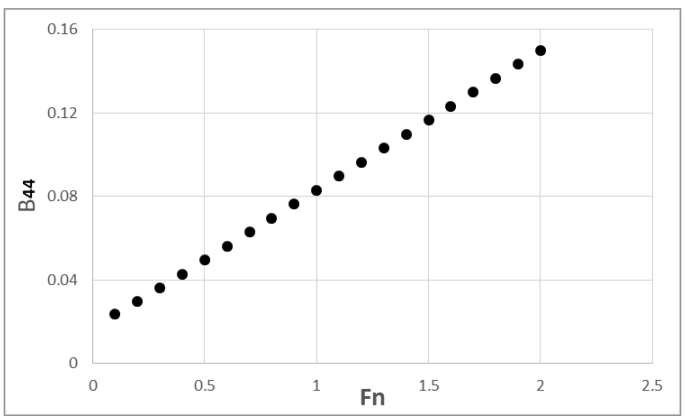

Figure 1. Roll damping values

As shown in Fig.1, the roll damping coefficient increases with the forward speed. The regime of the curve is linear due to the biggest amount of contribution is provided by the lift and wave component. These roll damping coefficient values were used to determine the roll motion of the vessel.

$$m_1 = \frac{\Delta GM}{I + I_{xx}} \tag{8}$$

$$m_3 = \frac{4\omega\varphi^2}{\varphi_v^{\,2}}\left(\frac{3A_{\varphi_v}}{GM\varphi_v^{\,2}} - 1\right) \tag{9}$$

$$m5 = -\frac{3\omega_\varphi^{\,2}}{\varphi_v 4}\left(\frac{4A_{\varphi_v}}{GM\varphi_v^{\,2}} - 1\right) \tag{10}$$

The above mentioned restoring coefficients are determined via the GZ-Φ_V curve. The right arm curve of the planning hull is represented in Fig.2. This figure indicates the correlation between GZ and ΦV. The area under the curve expresses that the planning hull is stable against external disturbances.

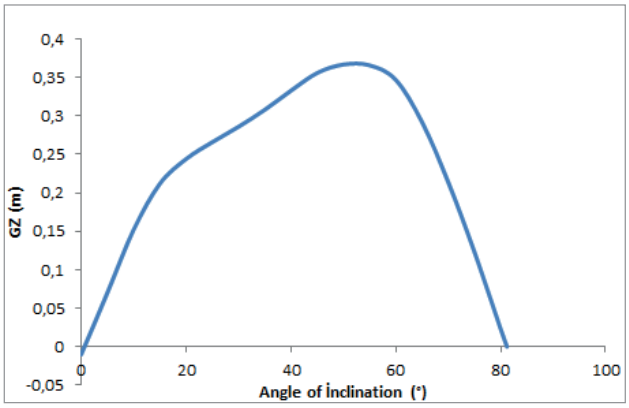

Figure 2. GZ- Φ_V curve

After these significant calculations, the nonlinear roll motion equation can be expressed in state-space form as below,

$$\dot{x}(t) = \left(A + \Delta A\right)x(t) + B_1 w(t) + B_2 u(t) \tag{11}$$

where $x(t) \in \Re^n$ is the state vector, $u(t) \in \Re^m$ is the control input, $w(t) \in \Re^m$ is the disturbance input. Then A, B_1 and B_2, are known real constant state-space matrices with suitable dimensions.

ΔA is a matrix valued function indicating time-varying parameter uncertainties. The parameter uncertainties are accepted to be norm bounded and of the following form,

$$\Delta A = GF(t)E_A \tag{12}$$

where G and E_A are known, constant, real matrices in suitable dimensions which define the structure of uncertainties, and $F(t)$ is an unknown matrix function with Lebesgue mensurable elements and satisfies $F^T(t)F(t) \leq I$ for all $t \geq 0$. State-space matrices are expressed as below associated with equation 11 and 12.

$$A=\begin{bmatrix} 0 & 1 & 0 \\ -m1-((m3_{\max}+m5_{\max})/2) & -\delta l-((\delta 2_{\max}+\delta 2_{\min})-((\delta \eta_{\max})/2) & -((\delta 1_{\max}+\delta 1_{\min})/2) \\ 0 & 0 & -t1 \end{bmatrix}$$

$$B_1=\begin{bmatrix} 0 & \lambda_e(\omega_e \wedge 2)\alpha_m & 0 \end{bmatrix}^T$$

$$B_2=\begin{bmatrix} 0 & 0 & t2 \end{bmatrix}^T$$

$$G=\begin{bmatrix} 0 & 0 & 0 \\ -((m3_{\max}+m5_{\max})/2) & -((\delta 2_{\max}-\delta 2_{\min})/2) & -((\delta 1_{\max}-\delta 1_{\min})/2) \\ 0 & 0 & 0 \end{bmatrix}$$

$$E_A=I_{3x3}$$

As a result of these calculations, the necessary values are obtained for controller design and design procedure is explained detail in the following part.

3. LMI Based Robust and Saturated H_2 State Feedback Controller Design

In this section, the LMI based robust and saturated H_2 state feedback controller are designed for roll motion stabilization of a planning hull, using the theorem given below,

$$\begin{aligned} \dot{x}(t)&=\left(A+GF\left(t\right)E_A+B_2K\right)x(t)+B_1w(t) \\ z(t)&=\left(C+DK\right)x(t) \end{aligned} \tag{13}$$

where $x(t)\in\Re^n$ is the state vector, $z(t)\in\Re^p$ is the controlled output vector. Then A, B_2, B_1, C and D are known real constant state-space matrices with suitable dimensions.

For closed loop system, H_2 norm is expressed in following form:

$$\left\|T_{zw}\right\|_2=\sqrt{iz\left(\left(C+DK\right)X_c\left(C+DK\right)^T\right)} \tag{14}$$

X_c as follows,

$$\underbrace{\left(A+GF\left(t\right)E_A+B_2K\right)}_{\Psi}X_c+X_c\Psi^T+B_1B_1^T=0 \tag{15}$$

The above-mentioned expression is the solution of the Lyapunov equation.

If Ψ is Hurwitz , by accepting $X\succ X_c$, the following inequalities are obtained (Dullerud & Paganini, 2013).

$$\Psi X+X\Psi^T+B_1B_1^T\prec 0 \tag{16}$$

$$iz\left(\underbrace{\left(C+DK\right)}_{\Phi}X_c\Phi^T\right)<iz\left(\underbrace{\left(C+DK\right)}_{\Phi}X\Phi^T\right) \tag{17}$$

By defining $L \in \Re^{mxn}$, $L := KX$

$$\underbrace{AX + GF(t)E_A X + B_2 L}_{\Omega} + \Omega^T + B_1 B_1^T \prec 0 \tag{18}$$

$$iz\left(\underbrace{(CX + DL)}_{\Lambda} X^{-1}\Lambda^T\right) < iz(Q) \tag{19}$$

inequalities are obtained.

Inequality (18) is defined as LMI using the following Lemma (Petersen & Hollot, 1985).

Lemma [18]: $\overline{\Gamma} = \overline{\Gamma}^T$, J and H matrixes have suitable dimensions, the following expression is applied at this point

$$\overline{\Gamma} + JF(t)H + H^T F^T(t)J^T \prec 0 \tag{20}$$

In addition, for $t \geq 0$, $\varepsilon > 0$ and $F^T(t)F(t) \leq I$ can be used following LMI,

$$\overline{\Gamma} + \frac{1}{\varepsilon} JJ^T + \varepsilon H^T H \prec 0 \tag{21}$$

$J:=G$ and $H = E_A X$ are accepted for Lemma (Petersen & Hollot, 1985). Applying the Schur complement (Boyd, Ghaoui, Feron & Balakrishan, 1994), (17) and (18) matrix inequalities are expressed as described in (22) and (23)

$$\begin{bmatrix} \underbrace{AX + B_2 L}_{\Pi} + \Pi^T + B_1 B_1^T + \mu G G^T & XE_A^T \\ E_A X & -\mu I \end{bmatrix} \prec 0 \tag{22}$$

$$\begin{bmatrix} Q & \Lambda \\ \Lambda^T & X \end{bmatrix} \succ 0 \tag{23}$$

In addition, actuator saturation constraints are given as below,

$$\begin{bmatrix} X & L^T \\ L & u_{\max}^2 I \end{bmatrix} \succ 0 \tag{24}$$

$$\begin{bmatrix} Y & I \\ I & X \end{bmatrix} \succ 0 \tag{25}$$

For $iz(Y) < \alpha$ and $iz(Q) < \eta$

The minimum $\alpha + \eta$ optimization problem can be solved using the constraints of $X = X^T \succ 0, L = L^T \succ 0, Y = Y^T \succ 0, Q = Q^T \succ 0, \mu > 0$ and as a result $u(t) = LX^{-1}x(t) = Kx(t)$ is determined

4. Simulation Results

In this paper, a roll stabilization controller is designed by using fins as the control actuators for the planning hull. The fin stabilizer geometry chosen is the NACA 0015 foil section which is widely used in the literature. The flow analyses are performed using commercial computational fluid dynamics (CFD) software based on the finite volume method. The flow problem is modelled in a 3-dimensional manner while the flow is considered as steady, incompressible and fully turbulent. The maximum lift coefficient value is used for controller design. The Computational Fluid Dynamics (CFD) calculations for the lift are illustrated in Figure 3.

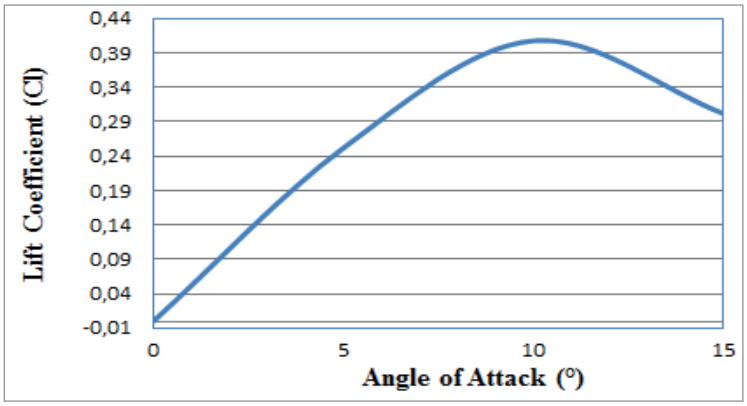

Figure 3. Lift coefficients versus angle of attack graph

The dynamic characteristics of the planning hull and the fin stabilizer particulars (NACA 0015) are given in Table 1.

Table 1. Principal particulars of the planing hull and fin roll stabilizer

Principal Particulars	Symbol	Parameter
Length between perpendiculars	L_{bp}	*16.95 m*
Breadth	B	*4.94 m*
Depth	D	*2.78 m*
Draught	T	*1.229 m*
Displacement	Δ	*54.788 m*^{3}
Metacentric height	GM	*0.921 m*
Vertical center of gravity	KG	*2.196 m*
Block coefficient	C_B	*0.36*
Max speed	V_{max}	*15 kn*
Min speed	V_{min}	*6 kn*
Fins area	A_F	*2.08 m*^{2}
Fins lift coefficient	C_L	*0.4*
Vanishing angle of stability	φ_v	*81.2*^{0}

Robust and saturated control via LMIs was applied to the dynamics of the roll motions of the planning hull. Application of the proposed control system is illustrated in the following figures for different speeds.

For 6 kn;

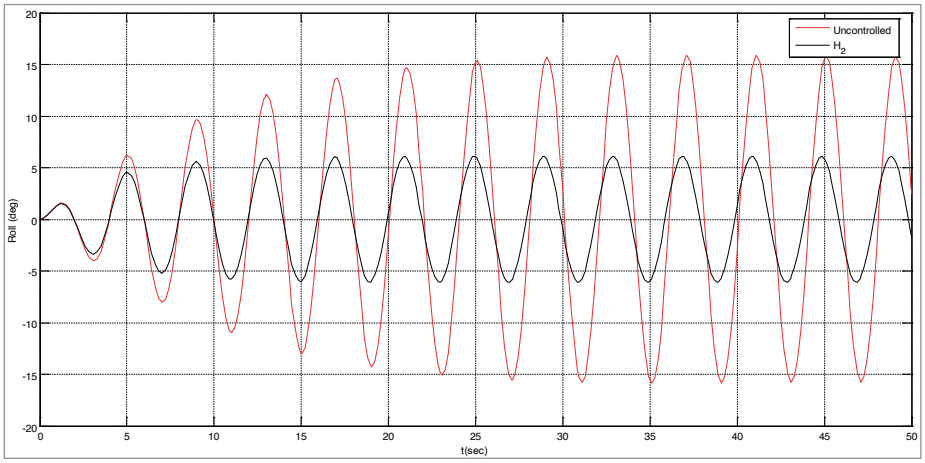

Figure 4. Roll angle response for uncontrolled and controlled condition

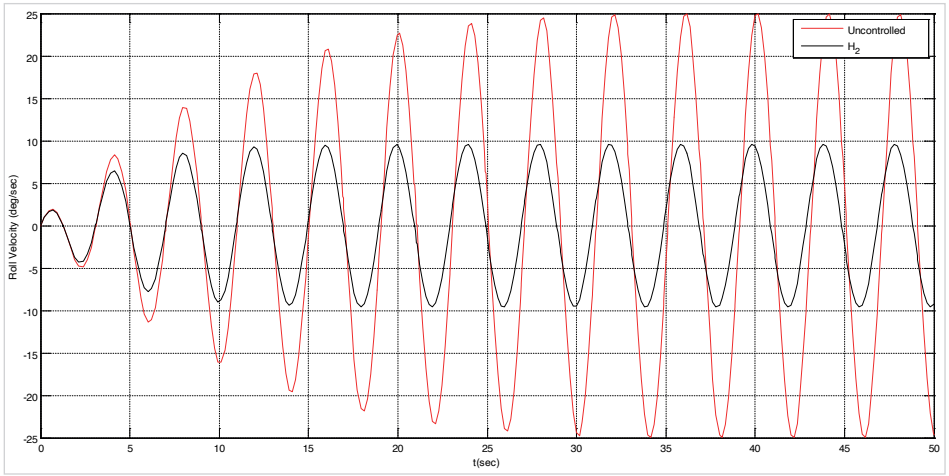

Figure 5. Roll velocity response for uncontrolled and controlled condition

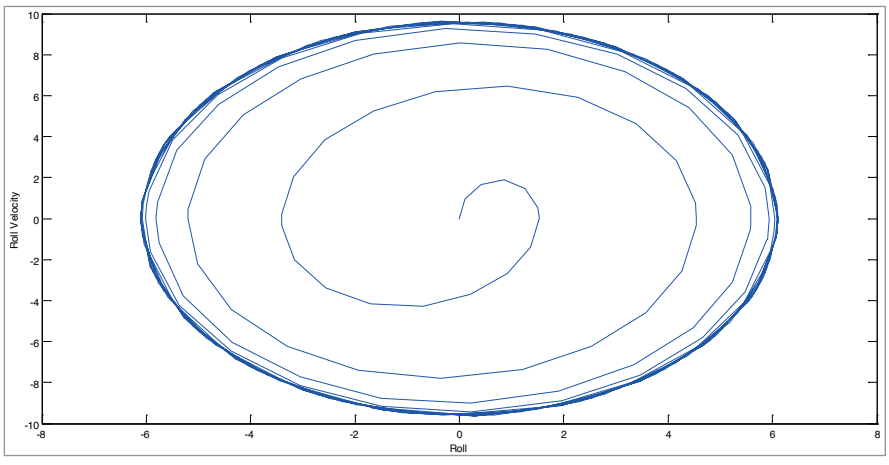

Figure 6. Phase diagram for controlled condition

For 15 kn;

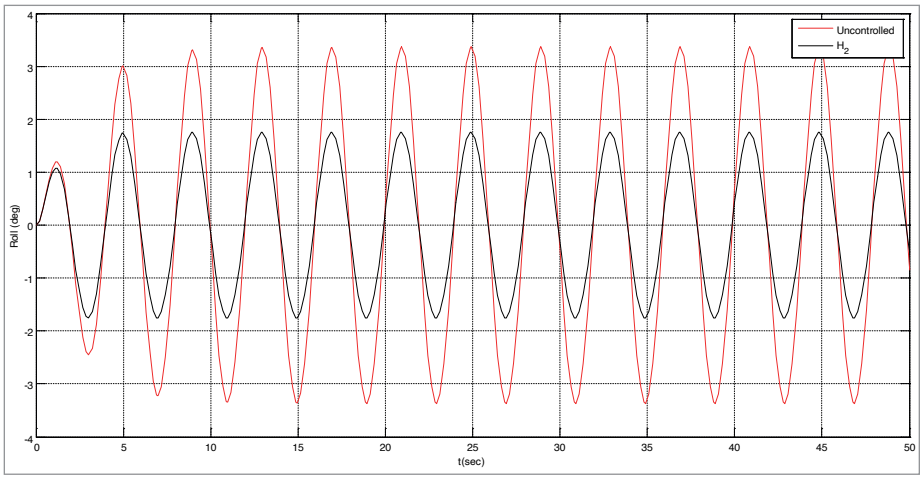

Figure 7. Roll angle response for uncontrolled and controlled condition

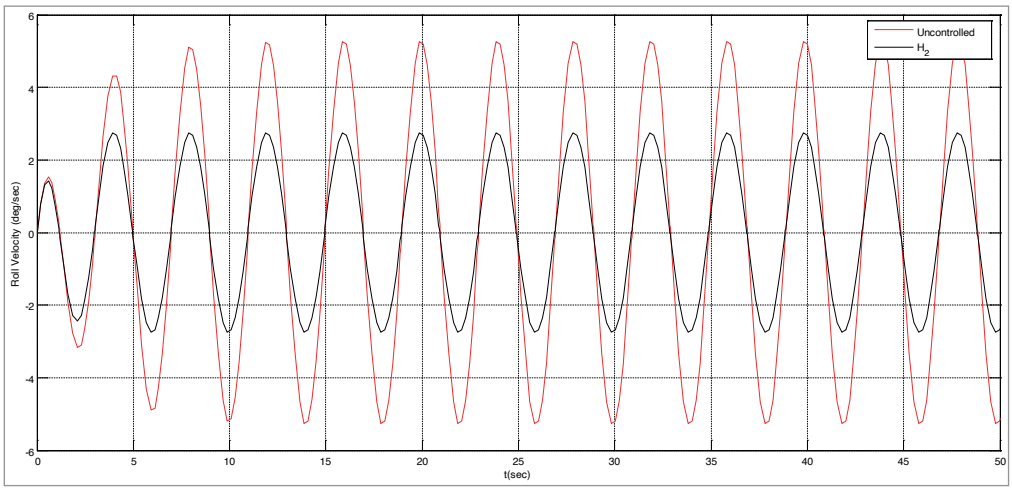

Figure 8. Roll velocity response for uncontrolled and controlled condition

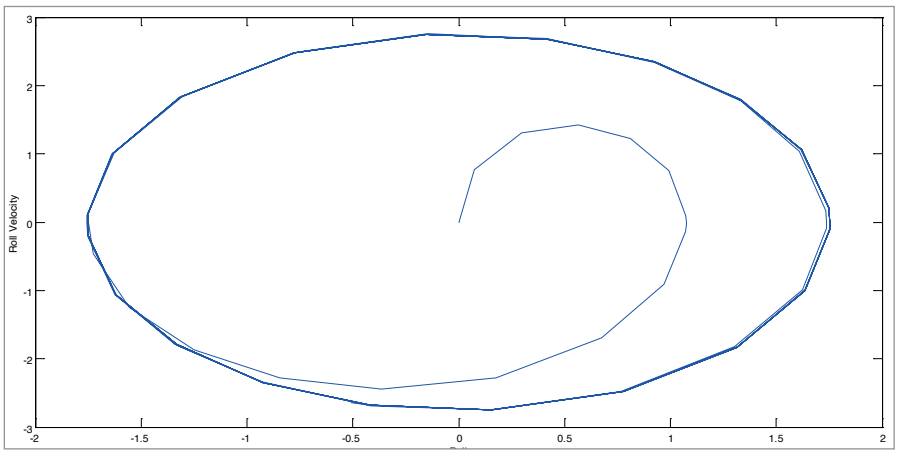

Figure 9. Phase diagram for controlled condition

The simulations show that the obtained results are applicable and effective for controlling roll motion of the planning hull. Robust and saturated H_2 state feedback controller achieved considerable roll reduction against external disturbances.

5. Conclusion

This paper deals with the LMI based robust and saturated H_2 state feedback control problem for the roll motion of planning hull with the fin stabilizer system. The Computational Fluid Dynamics (CFD) calculations for the lift coefficients are determined using Star CCM + software. The maximum lift coefficient is used for controller design. The robust and saturated H_2 state feedback controller algorithm for the planning hull has been designed and simulation results have been presented. According to the simulation results, it can be observed that LMI based robust and saturated H_2 state feedback controller shows significant improvement in roll reduction for safety transportation.

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RESEARCH ARTICLE

Tedarikçilerle Süreç Entegrasyonunun Firma Performansı Üzerindeki Etkisinde Ürün Performansının Aracı Rolü

The Mediating Role of Product Performance on the Effect of Process Integration with Suppliers on Firm Performance

Bülent Yıldız[1], Ahmet Çetindaş[2]

ÖZ

Bu çalışmada tedarikçilerle süreç entegrasyonunun firma performansı üzerindeki etkisinde ürün performansının aracılık rolü araştırılmıştır. Ayrıca süreç entegrasyonunun firma performansı üzerindeki etkisinde piyasa belirsizliğinin düzenleyici rolü analiz edilmiştir. Bu amaçla İstanbul'da faaliyet gösteren 156 imalat firmasından anket ile veri toplanmıştır. Araştırma kapsamında yapısal eşitlik modeli kurularak analiz edilmiştir. Analiz sonucunda süreç entegrasyonu ve ürün performansının firma performansını pozitif yönde anlamlı olarak etkilediği bulgusuna ulaşılmıştır. Ayrıca ürün performansının da firma performansını pozitif yönde anlamlı olarak etkilediği tespit edilmiştir. Süreç entegrasyonunun firma performansı üzerindeki etkisinde ürün performansının aracılık rolü boostrap yöntemi ile yapılmıştır. Analiz neticesinde ürün performansının aracılık rolü bulunduğu tespit edilmiştir. Araştırma sonucunda piyasa belirsizliğinin düzenleyici rolüne ulaşılamamıştır.

Anahtar Kelimeler: Tedarikçi süreç entegrasyonu, Ürün performansı, Piyasa belirsizliği

ABSTRACT

This study investigates the mediating role of product performance on the effect of the supplier process integration on Firm performance. Additionally, the moderator effect of market uncertainty on the effect of process integration on firm performance is also analyzed. For this purpose, data were collected by surveys from 156 manufacturing companies operating in Istanbul. A structural equation model was established and analyzed. As a result of the analysis, it was found that process integration had a positive effect on company performance. In addition, it has been determined that product performance has a positive effect on firm performance. The mediation role of product performance on the effect of process integration on firm performance was made by a bootstrap method. The mediating role of product performance could be found but the moderating role of market uncertainty could not be proven.

Keywords: Supplier process integration, Product performance, Market uncertainty

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EXTENDED ABSTRACT

As emphasized in this study, integration with suppliers is possible with the integration of processes. A process is a set of activities designed to produce a specific output for a particular customer or market (Davenport, 1993). Process integration, on the other hand, refers to the management of various activities that aim to combine relevant business processes within and across companies, and to eliminate duplicate or redundant processes in order to create a better functioning supply chain (Chen vd., 2009).

Process integration with suppliers requires regular communication between cross-organizational work teams and partners. Firm integration ensures that inter-organizational business processes work in collaboration. Thus, it improves firm performance by creating synchronous processes (Frohlich ve Westbrook, 2001) throughout the supply chain and provides operational synergy, resulting in higher productivity.

Mellat-Parast and Spillan (2014) stated that supply chain process integration is the most important indicator of the competitive position of the company, and determined its positive effect on firm competitiveness. Chen et al. (2009) dimensioned process integration with suppliers as internal process integration and external process integration, and found that external process integration positively affects firm performance. Langerak et al. (2007) also investigated the effect of product performance on firm performance, and found a positive effect. Narasimhan and Kim (2002) investigated the moderating effect of market uncertainty in the relationship between planning integration and profitability, and found that profitability increased in markets with low uncertainty. Liao and Tu (2008) found that the integration of production processes had more impact on production performance under conditions of high environmental uncertainty. For these reasons, the hypotheses of the research are determined as follows.

H1: Process integration with the supplier has a positive effect on firm performance.

H2: Process integration with the supplier has a positive effect on product performance.

H3: The effect of process integration on firm performance is mediated by product performance.

H4: Product performance has a positive effect on firm performance.

H5: Market uncertainty has a moderating effect on the effect of Process Integration with Supplier on firm performance.

The research was applied on SMEs operating in Istanbul and Gebze. The sample of the research consists of 156 industrial companies.

Exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and reliability analyzes were performed to test the validity and reliability of the scales. As a result of EFA, factor loads were obtained at over 0.50 for all scales, and KMO values were obtained at over 0.70. Reliability analysis showed that the alpha coefficient value for all scales was determined by over 0.70. CFA showed, that the scales meets the goodness of fit criteria. As a result of the correlation analysis, it was found that there was a significant relationship between variables in the same direction at the level of 0.01 significance.

As a result of structural equation analysis of the model, the process integration with suppliers positively affected product performance and firm performance; It has also been determined that product performance affects firm performance positively.

The bootstrap method was used to test the mediation role of product performance on the impact of process integration with suppliers on firm performance. In order to test the mediating role of product performance, the significance of indirect effects was examined, and the bootstrap method was used for this. The highest likelihood method was used in 95% confidence interval consisting of 1000 samples and the Monte Carlo parametric bootstrap option was chosen. Indirect effects confidence interval lower value was determined as 0.204, and the confidence interval upper value was found as 0.377. It was found that the significance level of indirect effects is below 0.01, which means it is meaningful. The fact that the confidence interval lower and upper value ranges do not include zero, and being meaningful indicates that product performance has an intermediary role in the impact of strategic integration with suppliers on firm performance.

Path analysis was conducted to analyze the moderating role of market uncertainty in the impact of process integration with suppliers on firm performance. For this purpose, an interaction variable is formed, which is the multiplication of the process integration and the market uncertainty variables. As a result of the moderating impact analysis, it was seen that process integration and market uncertainty had a positive effect on firm performance. However, the interaction variable did not significantly affect firm performance. This finding shows that market uncertainty has no moderating effect on the effect of process integration on firm performance. The reason for this is thought to be related to the fact that market uncertainty includes a more market-oriented perspective. According to this finding, it will be possible to say that the uncertainties in the market are not related to the procurement processes. As a result of the research, the H1, H2, H3 and H4 hypotheses were supported, while the H5 hypothesis could not be supported.

1. Giriş

İşletmelerin tedarikçileriyle entegre olmaları farklı boyutlarda ve farklı seviyelerde gerçekleşebilmektedir. Bir üretici, stratejik işbirliği yaparak ve firmalar arası süreçleri işbirliği içinde yöneterek tedarikçileriyle entegrasyon sağlayabilir (Flynn vd., 2010).

Entegrasyon, firmaların iş birliği yaparak operasyonel ve stratejik verimlilik elde etmesini sağlar (Rodrigues vd., 2004). Tedarikçi entegrasyonu ise, firmaların tedarikçileriyle örgütler arası stratejileri yapılandırmak, senkronize süreçler geliştirmek ve bilgiyi paylaşmak için işbirliği yaptığında gerçekleşir (Flynn vd., 2010). Tedarikçi entegrasyonu, bir üretici ile tedarikçileri arasındaki bilgi ve fiziksel akışların verimliliğini ve etkinliğini arttırmayı amaçlar; bu da rakiplerine karşı üstünlük elde etmesini, kesintisiz olarak işlemlerini sürdürebilmesini ve uyumlu tedarik ağları kurmasına yardımcı olur (Yeung vd., 2009; Lai vd., 2012; Zhao vd., 2013). Tedarikçi entegrasyonu bir dizi uygulama ve faaliyet içerir ve farklı açılardan incelene bilmektedir. Farklı araştırmacılar tedarikçi entegrasyonunu bilgi paylaşımı, tedarikçilerle uzun vadeli ortaklıklar geliştirme, yeni ürün geliştirmeye tedarikçi katılımı, ürün entegrasyonu ve süreç entegrasyonu şeklinde farklı boyutlarda tanımlamaktadır (Swink vd., 2007; Danese ve Romano, 2011; Koufteros vd., 2010; Jayaram, 2008).

Tedarikçilerle entegrasyon bu çalışmada da vurgulandığı üzere süreçlerin entegrasyonuyla mümkün olabilmektedir. Süreç, belirli bir müşteri veya pazar için belirli bir çıktı üretmek üzere tasarlanmış bir faaliyetler bütünüdür (Davenport, 1993). Süreç entegrasyonu ise, şirketler içinde ve genelinde ilgili iş süreçlerini sorunsuz bir şekilde birleştirmeyi ve daha iyi işleyen bir tedarik zinciri oluşturmak amacıyla süreçlerin yinelenen veya gereksiz kısımlarını ortadan kaldırmayı amaçlayan çeşitli faaliyet gruplarının yönetimini ifade eder (Chen vd., 2009)

Tedarikçilerle süreç entegrasyonu, organizasyonlar arası çalışma ekipleri ve ortaklar arasında düzenli iletişim gerektirir. Firma entegrasyonu, organizasyonlar arası iş süreçlerinin işbirliği içinde çalışmasını sağlar. Böylelikle tedarik zinciri boyunca senkronize süreçler yaratarak (Frohlich ve Westbrook, 2001) firma performansını arttırır ve operasyonel sinerji sağlayarak daha yüksek verimlilik ile sonuçlanır.

Tedarikçilerle süreç entegrasyonu, firmaların ortak karar verme ve problem çözmelerini, faaliyetleri koordine etmelerini, ilişkileri sürdürmelerini, olası çatışmaları önlemelerini ve müşterilere daha iyi hizmet vermelerini sağlayan süreçleri senkronize etmelerini kolaylaştırır (Palomero ve Chalmeta 2014).

Tedarikçi entegrasyon süreçlerinin ürün performansı üzerindeki etkileri literatürde çok fazla çalışılmamıştır (Lau vd., 2010). Ancak ürün geliştirme literatürü, tedarikçilerin ürün geliştirme sürecine entegre edilmesi durumunda, ürün geliştirme maliyetlerinin düşürülmesine, daha az kusurla daha yüksek kaliteyle üretim yapılmasına ve pazara daha kısa zamanda giriş yapılabileceğini ifade etmektedir.

Pazar belirsizliği kavramı, firmaların faaliyet gösterdiği pazarlarda müşterilerin ve rakiplerin davranışlarının ön görülemediği ve tahmin etmenin zor, hatta imkansız olduğu durumlar için kullanılmaktadır. Pazar belirsizliğini çevresel belirsizliğin bir alt boyutu olarak incele-

yen birçok çalışma mevcuttur (Wong vd., 2011; Li, 2002). Çünkü hızlı değişimler sonucu şekillenen pazarlarda firmalar bu değişimleri tahmin etmekte zorlanacaktır.

Belirsizliğin yüksek olduğu çalkantılı pazarlarda faaliyet sürdüren firmalar, pazarı yakından takip ederek pazar odaklı tutum sergilediğinde belirsizliğin risklerinden kendini koruyabilmektedir (Jaworski ve Kohli, 1993). Pazar odaklılık müşterilerden ve rakiplerden öğrenme biçimidir (Noble vd., 2002). Pazar odaklılık, müşterilerin ihtiyaçlarını ve rakiplerin eylemlerini izleme ve pazar belirsizliklerine ve karmaşıklıklarına uyum sağlama sürecinin önemli bir parçasıdır (Liu ve Atuahene-Gima, 2018).

Belirsiz taleplerle ilgili olan pazar belirsizliği kavramı bazı yazarlar tarafından talep belirsizliği olarak ele alınmaktadır. Talep belirsizliği stabil olmayan müşteri siparişleri, değiştirilmek durumunda olan üretim planları (Lee vd., 2009: 192) ve farklı müşteri isteklerini karşılamayı gerektirmektedir. Dolayısıyla belirsiz pazarlarda tedarikçisiyle entegre olan firmalar bu ön görülemeyen müşteri davranışlarına hazırlıklı olacak ve tedarikçisiyle entegre ettiği süreçler sayesinde mevcut karmaşıklıkları çözebileceği düşünülmektedir (Bonaccorsi ve Lipparini, 1994; Monczka vd., 2000).

2. Literatür Taraması ve Araştırma Hipotezlerinin Kurulması

2.1. Süreç Entegrasyonunun Ürün ve Firma Performansı Üzerindeki Etkisi

Birçok çalışma tedarikçi entegrasyonunu performansla ilişkilendirmiş ve anlamlı ilişkiler bulmuştur (Swink vd., 2006; Frohlich ve Westbrook, 2001). Çalışmaların birçoğunda, tedarikçi entegrasyonu tedarik zinciri entegrasyonun bir boyutu olarak ele alınmış ve diğer boyutları olan iç entegrasyon ve müşteri entegrasyonu ile birlikte araştırılmıştır (Wong vd., 2011).

Tedarikçi entegrasyonu, planlamada işbirliği, stratejik ortaklık, ortak ürün geliştirme, bilgi paylaşımı ve bunun gibi iş birliği gerektiren süreçleri içerir (Ettlie ve Reza, 1992; Lai vd., 2010; Ragatz vd., 2002). Mellat-Parast ve Spillan (2014) tedarik zinciri süreç entegrasyonunun, firmanın rekabetçi pozisyonunun en önemli göstergesi olduğunu ifade etmiş ve firma rekabetçiliği üzerine pozitif etkisini saptamıştır. Tedarikçilerle süreç entegrasyonunu iç süreç entegrasyonu ve dış süreç entegrasyonu şeklinde boyutlandıran Chen vd. (2009) dış süreç entegrasyonun firma performansını pozitif yönde etkilediğini bulgulamıştır.

Önceki çalışmalardan yola çıkarak çalışmanın ilk hipotezi aşağıdaki gibi kurulmuştur:

H1: Tedarikçiyle süreç entegrasyonunun firma performansı üzerinde pozitif yönde anlamlı etkisi vardır.

Önceki çalışmalardan anlaşıldığı üzere firma performansının dışında farklı performans türleri de süreç entegrasyonuyla ilişkilendirilmiştir. Lau vd. (2007) 251 Hong Kong firması üzerinde yapmış olduğu araştırmada, tedarik zinciri entegrasyonu sonucu gelişecek olan ortak ürün geliştirme yeteneğini ölçmüş ve ürün performansına etkisini incelemiştir. Sonuçlar tedarikçileriyle ortak ürün geliştirme yapan firmaların daha iyi ürün performansı sergilediğini göstermiştir. Yine Çin'de yapılan bir başka araştırmada ise tedarikçilerle işbirliği yapmanın

ürün performansına etkisi görülmüştür (Zhang ve Hartley, 2018). Tsai ve Hsu (2014) ise çalışmalarında çapraz departmanlar arasında entegrasyonun ürün performansına etkisini incelemiş ve pozitif yönde anlamlı etkiye rastlamıştır. Tedarikçi performansının ürün performansı üzerindeki etkisini inceleyen Gatignon ve Xuereb (1997)'da bu etkiyi ispatlayabilmiştir.

Bu çalışmalardan hareketle çalışmamızda tedarikçilerle süreç entegrasyonu firma performansının yanında ürün performansı ile de ilişkilendirilmiştir ve hipotez şu şekilde kurulmuştur:

H2: Tedarikçiyle süreç entegrasyonunun ürün performansı üzerinde pozitif yönde anlamlı etkisi vardır.

2.2. Ürün Performansının Aracı Rolü ve Firma Performansı Üzerindeki Etkisi

Çalışmanın bir diğer önemli araştırma konusu olan süreç entegrasyonunun firma performansı üzerindeki etkisinde ürün performansının aracılık rolü ile ilgili bir çalışmaya literatürde rastlanılmamıştır. Ancak Langerak vd. (2007) çalışmasında pazar oryantasyonun firma performansına etkisinde ürün performansının düzenleyici rolünü tespit etmiştir. Tedarikçi entegrasyonu geriye doğru dikey entegrasyonken ve pazar oryantasyonu ileriye doğru dikey entegrasyon olarak görüldüğünden (Waters, 2003), pazar oryantasyonunun firma performansına etkisine aracılık eden ürün performansının tedarikçi entegrasyonu ile firma performansı arasındaki ilişkiye de aracı olarak etki edeceği düşünülmüştür. Yani süreçlerini tedarikçileriyle entegre edebilen firmaların daha yüksek performans gösterme sebebinin ürün performansı dolayısıyla olacağı düşünülmektedir.

Bu sebeple bir sonraki hipotez şu şekilde kurulmuştur:

H3: Süreç entegrasyonunun firma performansına etkisi ürün performansı tarafından aracılık edilmektedir.

Langerak vd. (2007) ayrıca ürün performansının firma performansı üzerinde etkisini de araştırmış ve pozitif yönde etki bulgulamıştır. Ürün performansının firma performansıyla ilişkili olan müşteri memnuniyetini de etkilediğini gösteren çalışmalar mevcuttur (Agustin ve Singh, 2005; Pan vd., 2012; Rafiq vd., 2013).

Bu sebeple dördüncü hipotez şu şekilde geliştirilmiştir:

H4: Ürün performansının firma performansı üzerinde pozitif yönde anlamlı etkisi vardır.

2.3. Piyasa Belirsizliğinin Düzenleyici Rolü

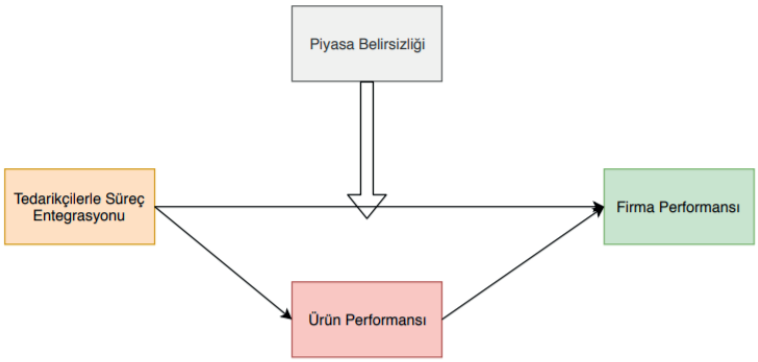
Piyasa belirsizliği bir diğer adıyla pazar belirsizliği talibin değişken olmasının yanında müşterilerin ve rakiplerinin tutumlarının tahmin edilemediği durumlar için kullanılır. Çalışmamızda olduğu gibi belirsizliği piyasa/pazar belirsizliği (Narasimhan ve Kim, 2002) olarak ele alan çalışmaların yanında, buna çok yakın olan talep belirsizliği (Boon-itt ve Wong 2011; Fynes vd.,2004) ve daha genel olan çevresel belirsizlik (Liao ve Tu, 2008; Stonebraker ve Liao, 2004) olarak ele alan çalışmalar olmuştur.

Tsai ve Hsu (2014) çalışmalarında departmanlar arasında entegrasyonun ürün performansına etkisinde pazar belirsizliğine yakın olan rekabet yoğunluğunun düzenleyici rolü olduğunu tespit etmiştir. Narasimhan ve Kim (2002), piyasa belirsizliğinin planlama entegrasyonu ile karlılık arasındaki ilişkide düzenleyici etkisini araştırmış ve belirsizliğin az olduğu pazarlarda karlılığın arttığını bulgulamıştır. O'Leary-Kelly ve Flores (2002), pazarlama-satış planlama kararı entegrasyonunun algılanan kârlılıkla üzerindeki etkisizinde talep belirsizliğinin düzenleyici etkisini tespit etmiştir. Boon-itt ve Wong (2011) talep belirsizliğinin tedarikçi entegrasyonu ile müşteri teslim performansı arasındaki ilişkiyi düzenlediğini bulmuştur. Benzer şekilde Liao ve Tu (2008)'de çevresel belirsizliğin yüksek olduğu koşullarda üretim süreçleri entegrasyonunun üretim performansı üzerindeki etkisinin daha fazla olduğunu bulgulamıştır. Buna göre çalışmanın son hipotezi şöyle geliştirilmiştir:

H5: Tedarikçiyle Süreç entegrasyonunun firma performansı üzerindeki etkisinde piyasa belirsizliğinin düzenleyici etkisi bulunmaktadır.

3. Araştırmanın Yöntemi

Kuramsal çalışma ve literatür taraması neticesinde kurulan araştırma modeli Şekil 1'de verilmiştir.



Şekil 1. Araştırmanın modeli

Araştırma İstanbul ve Gebze'de faaliyette bulunan KOBİ'ler üzerinde yapılmıştır. Araştırmanın örneklemini 156 sanayi firması oluşturmaktadır. Araştırmaya katılan firmaların 89'u gıda, 18'i tekstil, 11'i otomotiv ve yedek parça, 6'sı ambalaj, 6'sı makine, 5'i elektronik, 5'i elektrik, 4'ü kimya, 3'ü bilgisayar, 3'ü inşaat, 3'ü mobilya, 2'si enerji ve 1'i paketleme sektörlerinde faaliyet göstermektedir. Firmaların 80'i 6-15 yıl arası, 65'i 16 yıl ve üzeri, 11'i ise 0-5 yıl arası faaliyette bulunmaktadır. Firmaların 105'i 0-51 arası ve 51'i de 51-150 arası personel çalıştırmaktadır. Anketi cevaplandıran firma çalışanlarının 65'i satın alma, 53'ü pazarlama, 19'u üretim, 8'i dış ticaret departmanlarında görev yapmakta olup 11'i de yönetim kurulu üyesidir. Çalışanların 71'i 0-5 yıl arası, 64'ü 6-15 yıl arası ve 21'i de 16 yıl ve üzeri firmada görev yapmaktadır. Çalışanların 121'i üniversite, 33'ü lise ve 2'si de ilköğretim mezunudur.

Araştırmada öncelikle keşfedici faktör analizi (KFA), doğrulayıcı faktör analizi (DFA) ve güvenilirlik analizleri yapılarak ölçeklerin yapı geçerliği ve güvenilirliği test edilmiştir.

Tedarikçilerle süreç entegrasyonu ölçeğinin KFA ve güvenilirlik analizi sonuçları Tablo 1'de verilmiştir.

Tablo 1. Süreç entegrasyonu faktör yükleri ve güvenilirlik analizi

Maddeler	Faktör Yükü
TSE1: Ürün tasarım ve geliştirme aşamasında ana tedarikçileri işe dahil ederiz	,880
TSE2: Proje ekiplerimizde ana tedarikçi üyeliği / katılımı vardır	,884
TSE3: Şirketimiz, üretim planlama ve stok yönetimi konularında tedarikçileri işe dahil eder	,837
TSE4: Ortak sorunları çözme konusunda ana tedarikçileri işe dahil ederiz	,836
KMO: 0,809 Top. Açk. Varyans: %73,891 Alfa: 0,882 AVE: 0,737 CR: 0,919	

KFA sonucu süreç entegrasyonu ölçeğinin faktör yükleri 0,836 ile 0,880 aralığında elde edilmiştir. KMO değeri 0,809 olarak bulunmuştur ve $p<0,01$ olarak elde edilmiştir. Bu bulgu örneklem büyüklüğünün faktör analizi için uygun olduğunu göstermektedir. Ölçeğin toplam varyansın %73,891'ini açıkladığı tespit edilmiştir. Güvenilirlik analizi sonucu alfa katsayısı 0,882 olarak bulunmuştur. Bu bulgu ölçeğin güvenilir olduğunu göstermektedir. AVE değeri 0,50'nin üzerinde, CR değeri 0,70'in üzerinde ve CR değeri de AVE değerinden yüksek olarak elde edilmiştir. Bu bulgu da ölçeğin bileşen geçerliğini sağladığını göstermektedir.

Ürün performansı ölçeğinin KFA ve güvenilirlik analizi sonuçları Tablo 2'de verilmiştir.

Tablo 2. Ürün performansı faktör yükleri ve güvenilirlik analizi

Maddeler	Faktör Yükü
UP1: Ana ürünümüz, satış hedefimize ulaştı.	,946
UP2: Ana ürünümüz, kar hedefimize ulaştı.	,930
UP3: Ana ürünümüz, büyük karlılık getirdi.	,884
UP4: Müşteriler, ana ürünümüzün performansından çok memnunlar.	,888
KMO: 0,932 Top. Açk. Varyans: %83,263 Alfa: 0,932 AVE: 0,83 CR: 0,952	

KFA sonucu ürün performansı ölçeğinin faktör yükleri 0,884 ile 0,946 aralığında elde edilmiştir. KMO değeri 0,932 olarak bulunmuştur ve $p<0,01$ olarak elde edilmiştir. Bu bulgu örneklem büyüklüğünün faktör analizi için uygun olduğunu göstermektedir. Ölçeğin toplam varyansın %83,236'sını açıkladığı tespit edilmiştir. Güvenilirlik analizi sonucu alfa katsayısı 0,932 olarak bulunmuştur. Bu bulgu ölçeğin güvenilir olduğunu göstermektedir. AVE değeri 0,50'nin üzerinde, CR değeri 0,70'in üzerinde ve CR değeri de AVE değerinden yüksek olarak elde edilmiştir. Bu bulgu da ölçeğin bileşen geçerliğini sağladığını göstermektedir.

Firma performansı ölçeğinin KFA ve güvenilirlik analizi sonuçları Tablo 3'de verilmiştir.

Tablo 3. Firma performansı faktör ve güvenilirlik analizi

Maddeler	Faktör Yükü
FP1: Firmamız pazar payında bir artış sağlamıştır	,903
FP2: Firmamız satışlarda bir artış sağlamıştır	,897
FP3: Firmamız yatırımın geri dönüşünde bir artış sağlamıştır	,851
FP4: Firmamız satışların geri dönüşünde bir artış sağlamıştır	,856
FP5: Firmamız genel rekabetçi konumunda bir artışa ulaşmıştır	,638
KMO: 0,836 Top. Açk. Varyans: %69,712 Alfa: 0,890 AVE: 0,696 CR: 0,918	

KFA sonucu ürün performansı ölçeğinin faktör yükleri 0,638 ile 0,903 aralığında elde edilmiştir. KMO değeri 0,836 olarak bulunmuştur ve p<0,01 olarak elde edilmiştir. Bu bulgu örneklem büyüklüğünün faktör analizi için uygun olduğunu göstermektedir. Ölçeğin toplam varyansın %69,712'sini açıkladığı tespit edilmiştir. Güvenilirlik analizi sonucu alfa katsayısı 0,890 olarak bulunmuştur. Bu bulgu ölçeğin güvenilir olduğunu göstermektedir. AVE değeri 0,50'nin üzerinde, CR değeri 0,70'in üzerinde ve CR değeri de AVE değerinden yüksek olarak elde edilmiştir. Bu bulgu da ölçeğin bileşen geçerliğini sağladığını göstermektedir.

Piyasa Belirsizliği ölçeğinin KFA ve güvenilirlik analizi sonuçları Tablo 4'de verilmiştir.

Tablo 4. Piyasa belirsizliği faktör yükleri ve güvenilirlik analizi

Maddeler	**Faktör Yükü**
PB1: Rekabetçi piyasa koşullarının öngörülemezliği oldukça yüksektir.	,884
PB2: Piyasalardaki rakip faaliyetleri oldukça belirsizdir.	,889
PB3: Müşteri ürün talebi ve tercihleri oldukça belirsizdir.	,847
PB4: Müşteri gereksinimleri ve tercihlerindeki değişiklikleri öngörüp tahmin etmek zordur.	,859
PB5: Müşteri gereksinimlerindeki değişiklikler oldukça öngörülemez ve belirsizdir.	,849
KMO: 0,877 Top. Açk. Varyans: %74,957 Alfa: 0,916 AVE: 0,75 CR: 0,937	

KFA sonucu ürün performansı ölçeğinin faktör yükleri 0,847 ile 0,889 aralığında elde edilmiştir. KMO değeri 0,877 olarak bulunmuştur ve p<0,01 olarak elde edilmiştir. Bu bulgu örneklem büyüklüğünün faktör analizi için uygun olduğunu göstermektedir. Ölçeğin toplam varyansın %74,957'sini açıkladığı tespit edilmiştir. Güvenilirlik analizi sonucu alfa katsayısı 0,916 olarak bulunmuştur. Bu bulgu ölçeğin güvenilir olduğunu göstermektedir. AVE değeri 0,50'nin üzerinde, CR değeri 0,70'in üzerinde ve CR değeri de AVE değerinden yüksek olarak elde edilmiştir. Bu bulgu da ölçeğin bileşen geçerliğini sağladığını göstermektedir.

KFA ve güvenilirlik analizinden sonra DFA yapılmıştır. DFA sonucu ölçekler için elde edilen uyum iyiliği değerleri Tablo 5'de verilmiştir.

Tablo 5. DFA uyum iyiliği değerleri

Değişken	**CMIN**	**DF**	**CMIN/DF**	**GFI**	**CFI**	**TLI**	**RMSEA**
Tedarikçilerle Süreç Entegrasyonu	1,953	1	1,953	0,994	0,997	0,983	0,078
Ürün Performansı	0,288	1	0,288	0,999	1	1	0
Firma Performansı	3,695	4	0,924	0,990	1	1	0
Piyasa Belirsizliği	4,846	4	1,211	0,988	0,998	0,996	0,037

DFA neticesinde faktör yükleri tedarikçilerle süreç entegrasyonu ölçeği için 0,713 ile 0,884 aralığında; ürün performansı ölçeği için 0,802 ile 0,970 aralığında; firma performansı ölçeği için 0,545 ile 0,903 aralığında ve piyasa belirsizliği ölçeği için ise 0,786 ile 0,897 aralığında elde edilmiştir. CMIN/df değerlerinin 5'in altında bulunması, RMSEA değerlerinin 0,08'in altında elde edilmesi, GFI, CFI ve TLI değerlerinin de 0,95'in üzerinde elde edilmiş olması ölçeklerin kabul edilebilir uyum iyiliği kriterlerini sağladığını göstermektedir.

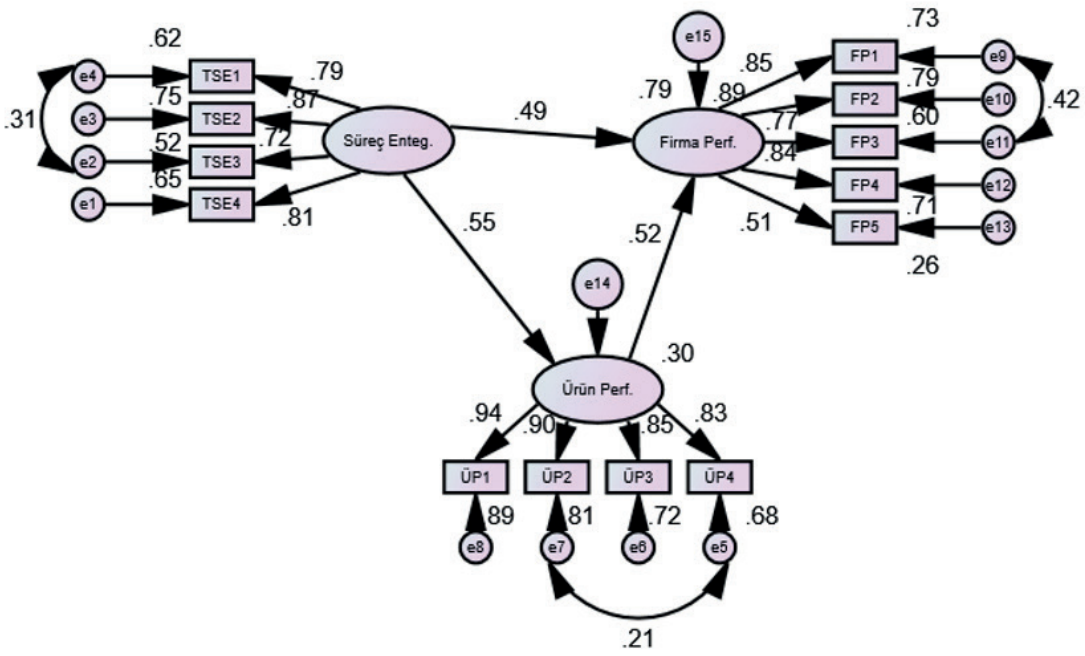
KFA, DFA ve güvenilirlik analizinden sonra değişkenler arasındaki ilişkiyi görebilmek için korelasyon analizi yapılmıştır. Korelasyon analizine ilişkin bulgular Tablo 6'da verilmiştir.

Tablo 6. Korelasyon analizi

	Ort.	Std. Sapma	Firma Performansı	Süreç Entegrasyonu	Ürün Performansı	Piyasa Belirsizliği
Firma Performansı	4,1064	,62853	1			
Süreç Entegrasyonu	3,9455	,72195	,682**	1		
Ürün Performansı	4,0962	,68830	,720**	,483**	1	
Piyasa Belirsizliği	3,8590	,74356	,455**	,621**	,337**	1

Korelasyon analizi sonucu değişkenler arasında 0,01 anlamlılık düzeyinde aynı yönde anlamlı bir ilişki olduğu bulgusuna ulaşılmıştır. Değişkenlerin ortalama değerlerine bakıldığında cevap ortalamalarının yüksek olduğu görülmektedir.

Araştırma hipotezlerini test etmek amacıyla öncelikli olarak yapısal eşitlik modeli kurularak analiz edilmiştir. Analiz edilen model Şekil 2'de, yapısal eşitlik modelinin analizi sonucu ulaşılan uyum iyiliği değerleri Tablo 7'de ve analiz sonuçları Tablo 8'de verilmiştir.



Şekil 2. Yapısal eşitlik modeli

Şekil 2'de görüleceği gibi araştırma kapsamında öncelikle tedarikçilerle süreç entegrasyonunun ürün performansı ve firma performansı üzerindeki etkisi ile ürün performansının firma performansı üzerindeki etkisi analiz edilmiştir. Uyum iyiliği değerlerini elde edebilmek için süreç entegrasyonu ölçeğinin 1. ve 3. maddeleri arasında, ürün performansı ölçeğinin 2. ve 4. maddeleri arasında, firma performansı ölçeğinin de 1. ve 2. maddeleri arasında modifikasyon yapılmıştır.

Tablo 7. Yapısal eşitlik modeli uyum iyiliği değerleri

Değişken	CMIN	DF	CMIN/DF	GFI	CFI	TLI	RMSEA
Yapısal Eşitlik Modeli	108,613	56	1,94	0,904	0,974	0,963	0,078

Yapısal eşitlik modelinin analizi sonucu CMIN/df değerlerinin 5'in altında bulunması, RMSEA değerlerinin 0,08'in altında elde edilmesi, CFI ve TLI değerlerinin de 0,95'in üzerinde elde edilmiş olması modelin kabul edilebilir uyum iyiliği kriterlerini sağladığını göstermektedir.

Tablo 8. Yapısal eşitlik modeli analiz sonuçları

Analiz Edilen Yol			Standardize Edilmemiş	Standardize Edilmiş	Std. Hata	Kritik Oran	P
Ürün Performansı	<---	Süreç Entegrasyonu	0,514	0,549	0,083	6,181	***
Firma Performansı	<---	Süreç Entegrasyonu	0,449	0,485	0,069	6,501	***
Firma Performansı	<---	Ürün Performansı	0,515	0,522	0,072	7,108	***

Yapısal eşitlik modelinin analizi sonucunda tedarikçilerle süreç entegrasyonunun ürün performansı ve firma performansını pozitif yönde anlamlı olarak etkilediği; ürün performansının da firma performansını pozitif yönde anlamlı olarak etkilediği tespit edilmiştir. Anlamlılık düzeyi her biri için sıfıra çok yakın olarak bulunmuştur. Tablo 8'de *** ifadesi sıfıra çok yakın bir değeri göstermektedir. Süreç entegrasyonunun ürün performansı üzerindeki etkisinde standardize edilmiş katsayı tahmin değeri 0,549 olarak bulunmuştur. Bu bulgu süreç entegrasyonunun 1 birim artması durumunda ürün performansının 0,549 birim artacağını göstermektedir. Süreç entegrasyonunun firma performansı üzerindeki etkisinde standardize edilmiş katsayı tahmin değerinin 0,485 olarak elde edilmiş olması süreç entegrasyonunun 1 birim artması durumunda firma performansının 0,485 birim artış göstereceği anlamlına gelmektedir. Ürün performansının firma performansı üzerindeki etkisinde tahmin değeri 0,522 olarak elde edilmiştir. Bu sonuç ürün performansının 1 birim artış göstermesi durumunda firma performansının 0,522 birim artış göstereceği anlamlına gelmektedir. Kritik oran değerlerinin de 1,96'nın üzerinde elde edilmiş olması aynı zamanda test edilen yolun istatistiksel olarak anlamlı olduğunu göstermektedir.

Tedarikçilerle süreç entegrasyonunun firma performansı üzerindeki etkisinde ürün performansının aracılık rolünü test edebilmek için Şekil 2'de verilmiş olan yapısal eşitlik modelinde bootstrap yöntemi kullanılmıştır. Ürün performansının aracılık rolünü test edebilmek için dolaylı etkilerin anlamlılığına bakılmış ve bunun için ise bootsrap yöntemi kullanılmıştır. 1000 örneklemden oluşan % 95 güven aralığında en yüksek olabilirlik yöntemi kullanılmış ve monte carlo parametrik bootsrap seçeneği seçilmiştir. Bootsrap güven aralığı alt değerleri (Lower Bounds) ve güven aralığı üst değerleri (Upper Bounds) ile Bootsrap standardize edilmiş dolaylı etkiler bulguları Tablo 9'da verilmiştir.

Tablo 9. Ürün performansı aracılık testi sonuçları

Standardize Edilmiş Toplam Etkiler	**Tedarikçilerle Süreç Entegrasyonu**
Ürün Performansı	0,549
Firma Performansı	0,772
Toplam Etkiler Anlamlılık	
Ürün Performansı	0,003
Firma Performansı	0,003
Toplam Etkiler Güven Aralığı Alt Değeri	0,669
Toplam Etkiler Güven Aralığı Üst Değeri	0,847
Standardize Edilmiş Doğrudan Etkiler	
Ürün Performansı	0,665
Firma Performansı	0,611
Doğrudan Etkiler Anlamlılık	
Ürün Performansı	0,003
Firma Performansı	0,002
Doğrudan Etkiler Güven Aralığı Alt Değeri	0,347
Doğrudan Etkiler Güven Aralığı Üst Değeri	0,611
Standardize Edilmiş Dolaylı Etkiler	
Firma Performansı	0,377
Dolaylı Etkiler Anlamlılık	
Firma Performansı	0,002
Dolaylı Etkiler Güven Aralığı Alt Değerleri	0,204
Dolaylı Etkiler Güven Aralığı Üst Değerleri	0,377

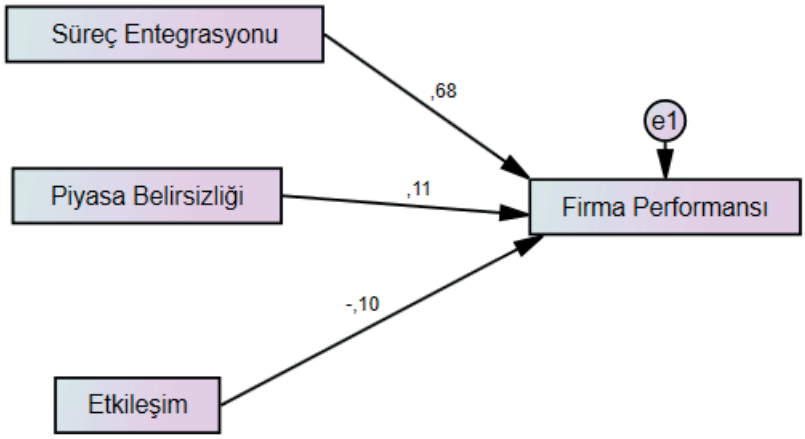
Tablo 9'da görüldüğü üzere standardize edilmiş dolaylı etkiler 0,377 olarak elde edilmiştir. Dolaylı etkiler güven aralığı alt değeri 0,204 ve güven aralığı üst değeri 0,377 olarak tespit edilmiştir. Dolaylı etkilerin anlamlılık düzeyinin de 0,01'in altında olduğu yani anlamlı olduğu bulgusuna ulaşılmıştır. Güven aralığı alt ve üst değer aralığının sıfır değerini kapsamaması ve anlamlı olması tedarikçilerle stratejik entegrasyonun firma performansı üzerindeki etkisinde ürün performansının aracılık rolü bulunduğunu göstermektedir.

Tedarikçilerle süreç entegrasyonunun firma performansı üzerindeki etkisinde piyasa belirsizliğinin düzenleyici rolünü analiz edebilmek için yol analizi yapılmıştır. Bu amaçla öncelikle süreç entegrasyonu ve piyasa belirsizliği değişkenlerinin çarpımından oluşan bir etkileşim değişkeni oluşturulmuştur. Analiz edilen düzenleyici etki modeli Şekil 3'de verilmiştir. Analiz sonuçları ise Tablo 10'da sunulmuştur.

Şekil 3'de görüleceği gibi süreç entegrasyonunun, piyasa belirsizliğinin ve bu iki değişkenin çarpımından oluşan etkileşim değişkeninin firma performansı üzerindeki etkisi analiz edilmektedir.

Tablo 10. Düzenleyici etki analizi

Analiz Edilen Yol			**Standardize Edilmemiş**	**Standardize Edilmiş**	**Std. Hata**	**Kritik Oran**	**P**
Firma Performansı	<---	Süreç Entegrasyonu	0,611	0,685	0,051	11,963	***
Firma Performansı	<---	Piyasa Belirsizliği	0,099	0,114	0,05	1,988	0,047
Firma Performansı	<---	Etkileşim	-0,014	-0,104	0,008	-1,818	0,069



Şekil 3. Düzenleyici etki modeli

Düzenleyici etki analizi sonucu süreç entegrasyonunun ve piyasa belirsizliğinin firma performansını pozitif yönde anlamlı olarak etkilediği görülmüştür. Fakat etkileşim değişkeni firma performansını anlamlı olarak etkilememiştir. Bu bulgu süreç entegrasyonunun firma performansı üzerindeki etkisinde piyasa belirsizliğinin düzenleyici rolü olduğu bulgusuna ulaşılamadığı bilgisini vermektedir. Zaten Tablo 10'da raporlandığı gibi etkileşim değişkeninin firma performansı üzerindeki etkisinin analizi sonucu kritik oran değeri de mutlak değer içerisinde 1,96'dan küçük bir değer olarak bulunmuştur. Bu bulguda etkinin anlamlı olmadığını göstermektedir. Anlamlılık düzeyi de 0,05'in üzerinde bulunduğundan dolayı da etki anlamsızdır.

4. Sonuç

Tedarikçi entegrasyonu uzun zamandır araştırılan ve firmaların performansını arttırabilecek bir yöntem olarak önerilen bir stratejidir. Firmaların tedarikçileriyle entegrasyonu literatürde farklı açılardan incelenmektedir. Bu çalışmada süreç entegrasyonu araştırılmış ve firma performansına direk ve ürün performansı aracılığıyla etkisi incelenmiştir.

Çalışmanın bulguları tedarikçileriyle süreçlerini entegre eden firmaların daha yüksek performans gösterdiği ve süreç entegrasyonun firma performansına etkisinde ürün performansının bu ilişkiye aracılık ettiği görülmüştür. Tedarikçilerini üretim planlama, ürün tasarımı, stok yönetimi ve bu konularda çıkacak problemlerin çözümlenmesine dahil eden firmalar tedarikçileriyle süreçlerini entegre etmiş olacak ve malzeme tedarikinde daha az sorun yaşayacağından daha yüksek performans gösterecektir. Süreçlerini tedarikçileriyle entegre etmiş olan firmalar onları ürün geliştirme süreçlerine dahil ederek ürün performansını arttırabileceği bunun da firma performansını arttıracağı ispatlanmıştır (H1-H2-H3). Bu çalışmanın ilk üç hipotezini doğrulamaktadır.

Ürün performansının firma performansına etkisi (H4) ile ilgili literatürde tatmin edici miktarda çalışmaya rastlanılmamıştır. Bir tane ürün performansının firma performansına etkisini araştıran çalışma (Langerak vd., 2007) ve birkaç tane ürün performansının müşteri memnuniyetine etkisini araştıran çalışmalara rastlanılmıştır (Pan vd., 2012; Rafiq vd., 2013). Bu çalışmalarla paralel sonuçlar bulunan çalışmamızda firmaların yüksek performans gösteren ürünlerine sahip olmasının firma performansını arttıracağı ispatlanmıştır (H4). Bu çalışmanın dördüncü hipotezini doğrulamaktadır.

Süreç entegrasyonunun firma performansını nasıl etkileyeceğinin yanında piyasa belirsizliğinin bu etkiyi nasıl düzenleyeceği de ayrıca merak konusu olmuş ve bu amaçla (H5) hipotez kurulmuştur. Ancak piyasa belirsizliğinin süreç entegrasyonu ile firma performansı arasındaki ilişkide düzenleyici rolü olmadığı bulgulamıştır. Bunun sebebinin piyasa belirsizliğinin daha pazar odaklı bir bakış açısı içerdiği ile ilgili olduğu düşünülmektedir. Bu bulguya göre pazarda oluşacak belirsizliklerin tedarik süreçleriyle ilgisinin olmadığını söylemek mümkün olacaktır.

Çalışmamız gösteriyor ki tedarikçileriyle süreçlerini entegre eden firmalar daha yüksek ürün performansı ve bunun aracılığıyla daha yüksek firma performansı göstermektedir. Bu sebeple firmalara tedarikçilerini süreçlerine dahil etmesi gerektiği önerilmektedir. Bu şekilde firmaların tedarikçileri ürün geliştirme, planlama gibi süreçlere dahil ederek daha yüksek performans gösteren ürünlere sahip olacakları ve bunun da firma performansının artmasına aracı olacağı konusunda firmalara öneriler yapılabilmektedir.

Çalışmamız literatüre tedarikçilerle süreç entegrasyonun firma performansına etki ettiği ve ürün performansının bu etkiye aracılık ettiği bulgusuyla katkı sağlamıştır. Pazar belirsizliğinin düzenleyici etkisi ispatlanamadığından gelecekte pazar odaklı bir belirsizlik yerine daha çok işletmenin genel çevresini veya üretim çevresini temel alan değişkenlerle bu etkiye tekrar bıkılması araştırmacılara önerilmektedir. Ayrıca literatürde süreç entegrasyonu dışında farklı entegrasyon boyutları kullanıldığı görülmüştür. Gelecekte bu boyutlarında firma performansına direkt etkisi ve ürün performansı üzerinden etkisinin incelenmesi literatüre daha fazla katkı sağlayacaktır.

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RESEARCH ARTICLE

Novel Indexes to Measure Competitiveness of Container Shipping Companies

Konteyner Taşımacılık Şirketlerinin Rekabet Düzeyini Ölçen Yeni İndeksler

Ahmet Selçuk Başarıcı[1], **Tanzer Satır**[2]

ABSTRACT

The purpose of this study is to propose novel and efficient competitiveness indexes to measure the level of competition among container shipping operators based on a specific region. These indexes should require only basic data, which is full container throughput on the basis of terminal/hinterland and ship operator. This study takes advantages of two methods to propose novel indexes as alternatives to *Herfindahl Hirschman Index* (HHI), which is very popular to measure level of competition. Originally named *Competition-based Overall Similarity Measurement Index* (COSMI) and *Entropy Competitiveness Index* (ECI) utilize overall similarity measure from clustering analysis and entropy methodologies, respectively. Both indexes have been proposed with two variants for each. COSMI200+ ignores the throughput of each SO having an amount less than 200 Twenty-foot Equivalent Units (TEUs), but COSMITOP5 takes into account only the top 5 SOs in terms of local throughput in a hinterland. ECI-JOINT includes a joint entropy coefficient which is constant for each hinterland, but ECI-VAR takes into account a variable entropy coefficient defined by the number of ship operators in each hinterland. Analyzing a dataset for the terminals located in Turkey, the Entropy Competitiveness Index (by means of ECI-JOINT variant) has been exhibited as a good alternative to HHI with a great correlation coefficient with it: 0.97. Theoretically, Competition-based Overall Similarity Measurement Index (by means of COSMITOP5 variant) seems a promising method, but it is highly affected by outliers and inconstant numbers of ship operators per route, indicating a moderate correlation coefficient with HHI: 0.45.

Keywords: Cluster analysis, Competitiveness index, Entropy, Maritime container transportation, Overall Similarity Measurement

ÖZ

Bu çalışmanın amacı, belli bir bölge bazlı olarak konteyner gemi operatörleri arasındaki rekabet seviyesini ölçmeye yarayan yeni ve etkin rekabet indeksleri oluşturmaktır. Bu indeksler terminal/bölge ve gemi operatörü bazlı olarak, sadece başlıca verilerden olan dolu konteyner sevkiyat verilerine ihtiyaç duymalıdır. Bu çalışma, rekabet seviyesi ölçümünde popüler olan *Herfindahl Hirschman İndeksine* (HHI) alternatif yeni indeksler oluşturabilmek için iki farklı yöntemden yararlanmaktadır. Özgün olarak *Rekabet Bazlı Toplam Benzerlik Ölçüsü İndeksi* (COSMI) ve *Entropi Rekabet İndeksi* (ECI) olarak adlandırılan bu indeksler, sırasıyla kümeleme analizi toplam benzerlik ölçüsü ve entropi yöntemlerinden yararlanmaktadırlar. Çalışmada her iki indeksin ikişer uyarlaması incelenmiştir. COSMI200+, bir lokal bölgedeki 200 TEU'dan daha az yükleme-tahliye performansı gösteren gemi operatörlerini gözardı ederken, COSMITOP5 sadece en yüksek performansa sahip 5 gemi operatörünü dikkate almaktadır. ECI-JOINT uyarlamasında sabit olan ortak bir entropi katsayısı kullanılırken, ECI-VAR uyarlamasında her bir lokal bölgedeki gemi operatörü sayısına göre değişen entropi katsayısı kullanılmaktadır. Türkiye'de mukim terminallere ait verilerin analizi, Entropi Rekabet İndeksi'nin (ECI-JOINT uyarlaması ile) HHI ile 0,97 değerinde korelasyon katsayısına sahip olduğunu ve bu indekse iyi bir alternatif olduğunu göstermektedir. Teorik olarak Rekabet Bazlı Toplam Rekabet Ölçüsü İndeksi (COSMITOP5 uyarlaması ile) umut veren bir yöntemi barındırsa da, dışadüşenler ve rota bazlı değişken gemi operatörü sayısı nedeniyle HHI ile 0,45 değerinde orta dereceli bir korelasyon katsayısına sahiptir.

Anahtar Kelimeler: Deniz konteyner taşımacılığı, Entropi, Kümeleme analizi, Rekabet indeksi, Toplam Benzerlik Ölçüsü

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1. Introduction

Container transportation provides advanced levels of punctuality, reliability, and security. Today, many types of cargo are transported in containers because of shorter transit times and less transfering costs (Karam & Eltawil, 2016, p.2). The size of the container traffic, approximately, corresponds to one third of global cargo traffic (Rathnayake & Wijeratne, 2012, p.363). At the global level, a large number of container shipping companies, i.e. ship operators (SOs), establish alliances in point of slot sharing on each other's ship, on the one hand, they make tough competition with each other to secure cargo for their containers.

Measuring the level of competition for terminals or hinterlands is important to determine both the local differences occurred in time and simultaneous changes in various regions. These findings are obligatory to obtain for taking measures primarily against cartelization and for making analysis about terminal investments, container operations, and so on. This study aims at proposing a reliable and meaningful index, which is compatible with the goals of the sectoral studies, for competition theory. One of the best ways to measure the level of competition is to focus on market shares or the amounts of throughput handled by each SO on the basis of a specific location. Today, the only well accepted index taking advantage of using basic data such as market shares is the *Herfindahl Hirschman Index* (HHI). It is benefited even by some prominent competition authorites widely (Miller, 1982, p.593); however, it does not consist of any satisfactory logic behind its methodology. Any beneficiary to calculate a competitiveness index by means of a simple set of data should be able to have alternative methods to achieve it. This paper aims at answering the question, "is there any simple, valid and, reliable alternative method to calculate a competitiveness index by means of a basic dataset?" Here, in this paper, two indexes have been proposed. The methods they rely on are known well, but they have never been adapted into competition theory till now. The first of these, which is named as *Competition-based Overall Similarity Measurement Index* (COSMI), examines the SOs by means of clustering analysis, assessing them based on similarities of their throughput in a hinterland. The other proposed competitiveness index adapted from Entropy theory, which is named as *Entropy Competitiveness Index* (ECI), takes the advantage of uncertainty concept.

Similarity concept has been widely used in many fields. Some of them are image identification, finding information (Khazaeli, 2013; Sicre, 2011; Vander Meer, 1997; Diplaros, 2007; Wilson, 2008; Fauquier & Boujema, February 2003), data mapping (BAE Systems, 2007; Lange, 2013; Vendrig, 2002), sorting (Ye et al., 2016), missing data estimation (Cai, 2016), harmony in music recording test (Robertson, 2013), determination of image quality (Galea et al., 2012), and metric index creation (Novak et al., 2012). These studies indicate that the methodology of cluster analysis includes several methods with several combinations. This study struggles to make the most appropriate combination for a competitiveness index to be utilized in container shipping.

The level of uncertainty in point of which SO secures a cargo in a specific region can give an idea on the level of competition in this region. In the literature, uncertainty is measured through the concept of entropy. Entropy originally had been related to physics, thermodynamics, but it was adapted into managerial uncertainty theory later on (Baray,

2003, p.7). Here, in this paper, entropy has been examined to understand if it is feasible to propose as a competitiveness index.

Both cluster analysis and entropy have been proven in different disciplines and fields by several researchers. This paper adapts them into maritime container transportation to test. This study examines them along with HHI by means of a local dataset. The papers relevant to competitiveness index have been discussed in Section 2, 'Literature review'. Section 3, 'Methodology', explains the concepts of cluster analysis and entropy. Section 4 discusses a case study in Turkish terminals, and then, a statistical dataset is analyzed in Section 5, 'Results and discussion'. Finally, the findings of the study, the implications, the limitation of the research, and the future research directions are presented in Section 6, 'Conclusions and recommendations'.

2. Literature Review

This section has been split into 4 sub-sections: 'Competitiveness index', 'Similarity in clustering theory', 'Entropy theory', and 'The gaps in the literature about competitiveness index'. The sub-section 'Competitiveness index' views the literature in general. The following two sub-sections examine to transfer the relevant content properly into COSMI and ECI. The sub-section 'The gaps in the literature about competitiveness index' discusses the reason why COSMI and ECI are proposed to analyze the dataset in this study as competitiveness indexes.

2.1. Competitiveness Index

Today, it is seen that there are very few options in terms of methodology measuring competition in liner shipping. The United Nations Conference on Trade and Development (UNCTAD) determines and publishes the Liner Shipping Connectivity Index (LSCI) values for the coast states since 2004. LSCI compares the commercial competitiveness of a country in terms of logistics and transportation. This index expresses the strength of connection of a country with the ports located in other countries by means of a few parameters (UNCTAD, 2015, p.39). LSCI does not involve in comparing the level of competition in different ports. Bartholdi et al. (2016) proposed Container Port Connectivity Index (CPCI) as an alternative to LSCI. CPCI uses the Hyperlink-induced Topic Search (HITS) algorithm to make the search engine ranking of websites on the internet. It provides to process both throughput of imports and exports simultaneously. The HITS algorithm inspires to combine both sides of foreign trade in a single system.

The studies released apart from container transportation can give an idea on how to examine the level of competition. Huggins (2003, p.91) aimed to assess relative economic competitiveness, scoring and sequencing the residential areas in the UK within a single index under measurable criteria. It relies on the data consisting of the number of companies per capita, knowledge-based business, activity rates, GDP per capita, full-time salaries, and unemployment rates.

Clark (2004, p.9) revealed a competitiveness index (Equation 1) to perceive the investment climate in transition economies. This index represents the level of competition based on sector, country, and company.

$$CI_{ijk} = \delta_1 T_{jk} + \partial_2 CP_j + \partial_3 IC_{jk} + \beta x_{ijk} + \gamma z_j + \lambda_j + \eta_k + \varepsilon_{ijk} \quad (1)$$

The competition index used in the analysis is an index representing the amount of competition that firm *i* in country *j,* and sector *k* faces. High values of the index refer to a highly competitive environment. The selected variables are the variables that define the investment climate. The main variables are the *customs tariff rates* (*T*) being controlled for trade policy, *the competition policy index* (*CP* - European Bank for Reconstruction and Development competition policy index), in which higher values represent fewer barriers to entry and better enforcement of stronger laws, and *the investment climate indexes* (*IC*). Several variables related to the investment climate may affect the level of competition. These variables are related to finance, soft budget constraints, infrastructure indexes, and burden of regulations. In addition to the main variables, dummy variables representing countries (λ_i and sectors (η_k) have been added into the regression. Some regressions might consist of country control dummy (z_j instead of country dummy. Moreover, the company-level control variables (x_{ijk} have been also taken into account in the regression. The symbols δ_1, ∂_2, ∂_3, β and γ represent the coefficients in the regression.

The Netherlands Competition Authority developed a unique competitiveness index particularly for the detection of cartel structures (Petit, 2012). After performing an extensive literature review, this model gathered 9 indicators under 4 categories constituting the competitiveness index: *the organization level* (the number of chambers), *the prices* in the Netherlands and in the European Union, *condensation* (condensation based on market share and symmetry measurement, the number of companies, and import rate), and *dynamics* (market growth, dissolution rate which means young and dissappearing players in the market, the survival rate which describes the ratio between the companies who are in the market in last 4 years, the average number of all companies in the market in the same period, and research and development rate). The absolute values of each indicator are converted to numbers between 0 and 1. By this way, a value is transformed to a comparative value. If the value approximates to 1, the competition level is accepted to decrease, and subsequently, it leads to a collusive oligopoly. Petit (2012) shared the results for several sectors.

HHI measures the level of competition in a market by considering the market shares of the competitors. It can be used to analyze the degree of market concentration in a certain sector. The index value is determined by summing the squares of market shares of each firm on a percentage basis. The highest index value is detected in a monopoly market. If a single company dominates the market with a 100% market share, the index value indicates the score 10,000 (Competition Authority – Turkey, 2018). When the level of competition increases, the index value decreases. When the number of competitors increases, the index value, which is inversely proportional, decreases. An increasing index value along with increasing competitiveness requires a transformation by taking the reciprocal of the HHI value or by subtracting it from 1. Since 1982, the United States Department of Justice Antitrust Department benefits from HHI (Miller, 1982, p.593). Because it is simple, effective and proven, leading and reputable institutions exploit it when developing new scientific methods. Kanagala et al. (2004, p.1277) illustrate the HHI method numerically (Equation 2 and 3).

$$\mathcal{P}_i = (ARi/D) * 100 \quad (2)$$

$$\text{HHI} = \sum_{i=1}^{n} \mathcal{P}_i^2 \quad (3)$$

The variables are symbolized by *n* for the number of participants in the market; $\mathcal{P}_i$ for the market share of the participant *i*; *D* for the total system demand; *ARi* for the amount of resources allocated to the participant *i*. Skilling & Zeckhauser (2002) proposed a political competition index (PCI) (Equation 4 and 5). It was set forth simply as an extension of the *political concentration index* released by Herfindahl. It is obtained by subtracting the HHI value from 1 (Skilling & Zeckhauser 2002, p.127).

$$\text{Where } \sum \propto_i = 1 \quad (4)$$

$$PCI = 1 - \sum \propto_i^2 \quad (5)$$

The symbol $\propto_i$ is the proportion of time in office for party (or coalition) *i*. Almeida & Fernandes (2011, p.11) examine the effect of total factor productivity of the developing economies in the long run, where the economic activities are gathered in certain areas (Equation 6, 7, 8).

$$Conc_{jrt} = L_{jrt}/L_{rt} \quad (6)$$

Sector diversity (*Div*) has been demonstrated by HHI.

$$Div_{jrt} = \sum_{k \neq j} \left(\frac{L_{krt}}{L_{rt}}\right)^2 \quad (7)$$

The high values of this index indicate a lower sector diversity. Based on this, the degree of competition in a sector is demonstrated by taking the inverse of the HHI value.

$$Comp_{jrt} = 1/\sum_{i \in Z} \left(\frac{L_{ijrt}}{L_{jrt}}\right)^2 \quad (8)$$

The variables are symbolized by *Z* for the set of integers; *i* for firm; *r* for region; *t* for time; *j* for sector; *L* for total employment and *Conc* for industry concentration.

The competitiveness indexes, which have been proposed in this paper are respectively based on clustering analysis and entropy. Herein below, the clustering and entropy theories are examined.

2.2. Similarity in Clustering Theory

Clustering analysis is one of the interdependent techniques such as factor analysis. Interdependent techniques focus on only the identification of the structure (Hair et al., 2009, p.553). This analysis investigates the similarity of observation values, which have multiple variables. It assorts some observation values, which have similar characteristics within a homogeneous structure, to a cluster and some others to another cluster. It benefits from the similarity theory while performing this operation. In many fields, it is used for taxonomy of similar observation values. Some of these fields are the personality types in psychology, the consumer behavious in product usage, and the chemical components in terms of performance characteristics (Dillon & Goldstein, 1984).

Clustering analysis utilizes various clustering procedures. They are commonly classified under two categories: hierarchical and non-hierarchical separation procedures. Hair et al. (2009, p.585) provide an overview in this context. Hierarchical separation procedure gathers the closest observation units under a single cluster, then it connects them each other within a rule. The most popular agglomerative algorithms are single-linkage, complete-linkage, average linkage, centeroid method, and Ward's method. The non-hierarchical procedures determine the number of clusters from the beginning, and chooses the starting (or seed) point for each cluster. The basic approach is to form a cluster including the closest observation units surrounding a seed point. Hierarchical clustering analysis is quite suitable for almost all kinds of research questions. However, one of the most prominent disadvantages of hierarchical methods is its sensitivity to outliers.

Picard & Franc (2003, p.181) examine the diversity of rainforest trees. They grouped the tree species. The paper proposes a new grouping method. This method compared Ward's method and Euclidean distance which uses hierarchical clustering analysis. Wei et al. (2006) proposes to assort documents on the basis of content. Thereby, the documents can automatically be assorted based on pre-determined categories. In addition to a hybrid document clustering technique, it utilizes similarity measurement improved from a method of vector distance measurement. Similar observations are assorted into the same clusters by the hierarchical clustering approach. Both these studies are good examples to demonstrate how to benefit hierarchical clustering analysis.

Basically, similarity is measured in two different ways: correlational measurement and distance measurement. *Correlational measurement* means that the value of the variable for each observation unit is compared pairwise with the value of the variable for another observation unit, and then a correlation matrix is formed. On the other hand, *distance measurement* takes into account the vector distance between the observation units. Rouhizadeh (2015, p.10-13) released a composing study about the methodology on vector-based similarity measurement. It scrutinises the use of language within disease of autism. The usage frequency of the words refers to a vectoral distance. In a vector space, if the vectors are close to each other, it refers to the assumption that the meaning of the words is semantically similar. The study expresses five different measurement methods, which are herein described briefly, in terms of the vector space similarity. They are the Jaccard similarity coefficient, Cosine similarity score, Relative frequency measure, BLEU score (Bilingual evaluation understudy), and Vector distance measurement. There are various options in determining the distance measurement: the Euclidean distance (Equation 9), Squared Euclidean distance, Manhattan distance (City-block), Chebychev distance, and Mahalanobis distance (Hair et al., 2009, p.575). Euclidean distance refers the distance between two points in a coordinate plane.

$$Euclidean\ distance = \sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2} \quad (9)$$

The variables are symbolized by X for variables on axis of abscissas and Y for variable on axis of ordinates. The Squared Euclidean distance takes advantage of the Centroid and Ward clustering methods.

Distance measurement does not truly describe similarity, but it represents condensation examined in the competition theory because similarity decreases as distance increases. It is possible to convert the distance measurement, i.e. condensation score, into similarity score. As Skilling & Zeckhauser (2002) and Almeida & Fernandes (2011) convert concentration index into competitiveness index, Turney et al. (2010, p.161) proposed two ways (Equation 10, 11) to convert it: inversion of the distance measurement and subtraction.

$$sim\ (x,y) = 1/dist\ (x,y) \quad (10)$$

$$sim\ (x,y) = 1 - dist(x,y) \quad (11)$$

The operators are symbolized by *sim* for similarity, *dist* for distance, and the variables are symbolized by x and y in the coordinate plane. Niemann et al. (2012, p.171-172) benefited these conversions in the context of the similarity theory. The study is about business process management supported by information technologies. It comprises a comparison of the process models and disclosure of their similarities. Regardless, the meaning of the word and phrase directories, L_1 and L_2, the similarities are calculated. The distance measurement is accepted as Levenshtein's distance, *lev* (L_1, L_2) The operation (Equation 12) substracts distance from 1 to reach a similarity measurement.

$$sim^{Lev}\ (L_1\ , L_2\ ) = 1 - lev\ (L_1\ , L_2\ ) \quad (12)$$

On the other hand, Niemann et al. (2012, p.171) also examine the semantic similarity between the words in itself and the sentences in itself. It has been defined as the *word distance* to access the semantic similarity. A word distance metric is based on WordNet (*WN*), which is a lexical database of semantic relations between words. The shortest path between two words, w_1 and w_2 as word-based network, is defined as Δ^{WN} (L_1, L_2). The similarity value (Equation 13) is expressed by the inverse of this distance, i.e. WordNet distance (*WND*).

$$sim^{WND}\ (L_1\ , L_2\ ) = 1/\Delta^{WN}\ (L_1\ , L_2\ ) \quad (13)$$

The proposal to convert distance measurement into the similarity measurement is extremely important because, in this way, the higher similarity score provides the higher index score.

2.3. Entropy Theory

The concept of entropy has been transferred into management science by Shannon (Baray, 2003, p.12). The weighting theory frequently has used entropy method. Some studies related to containerization have utilised it, too. Lee et al. (2012, p.5653) compare the financial statements of four Taiwanese and South Korean SOs. The study takes advantage of the entropy method and the gray relational analysis (GRA). The entropy method was exploited to weight the financial ratios whereas GRA ranked the performance of the SOs. Yang and Shen (2013, p.165) compared conventional and automated container terminals in terms of their operational performances. They implemented the identical methods as it had been released by Lee et al. (2012). Lee et al. (2014, p.246) compared the financial statements of container SOs. In this study, the weighting is implemented by two different ways. One of them is subjectively performed through questionnaires; the other one is

performed objectively, evaluating the financial statements, and then both are compared. Subjective weighting uses a fuzzy logic method: Consistent fuzzy preference relation. The other one benefits from entropy. The study concludes that an objective weighting cannot be performed through a subjective assessment. Su et al. (2016, p.25-27) compared some hub ports in the Far East: Hong Kong, Kaohsiung, and Xiamen, in the context of operational and managerial vulnerability. In the study, the indicators on vulnerability are weighted by the entropy method. The index scores are determined by GRA scores, and finally the ports are ranked by means of Analytic hierarchy process (AHP).

The literature review reveals that the entropy method has not been previously exploited to create an index to measure competitiveness. Entropy is utilized to measure the magnitude of uncertainty. One can discourse that the absence of competition in a market refers to a monopoly market. In such a market, one cannot alledge that it is uncertain. It is certain who will be selected by a customer as the shipping company for transportation. The concept of entropy, which was transferred from physics and information sciences to social sciences, contains characteristical information in the decision matrix (Ömürbek et al., 2016, p.238). Baray (2003) clearly illustrates the logic of the entropy concept.

> "Entropy can be explained and understood by the concepts of macro and micro circumstances. Macro circumstance represents a case in which a box is full of molecules which are equally or unequally distributed in both halves of it. On the other hand, micro ciscumstance represents the number of combinations of each molecule in a macro circumstance. If the molecules are evenly distributed into both halves of a box, the number of combinations in terms of replacement of the molecules becomes the highest. If the identical number of molecules are not evenly distributed into both halves, the number of combination decreases. In other words, if the number of combinations is low, entropy is low (i.e. uncertainty is low), if it is high, entropy is high (Baray, 2003, p.8-9)."

When one adapts this explanation to a competition environment in container shipping, it can be concluded that if there is a single SO in a market, it is certain who secures the cargo, but if there are numerous competing players, it will be relatively uncertain who secures it: it means entropy increases. In other words, the case of high uncertainty refers to increased competition, and on the other hand, the case of less uncertainty refers to a lower level of competition.

The literature about the competitiveness index in shipping contains some gaps to overcome. They are disscussed herein below.

2.4. The Gaps in the Literature About the Competitiveness Index

The well-known indexes in container shipping LSCI and CPCI are not related to the competitiveness index, but they just focus on the strength of the connection of a country with the rest of the ports in the World in terms of maritime container transportation. HITS algorithm benefited by CPCI seems inadequate in terms of pointing to the rivalry among SOs, but it inspires to combine both sides of foreign trade in a single system.

In the literature, some developed methods such as Huggins (2003) and Clarke (2004) about the competitiveness index keep several indicators in their models, therefore, they seem complicated and require various datasets. Generally, it is not easy and practical to get a wide series of data. The methods proposed by Huggins (2003) and Clarke (2004) apart from shipping aim at disclosing the fact of competitiveness in local production units, and they pursue the local indicators such as unemployment rates and the investment climate. On the other hand, the approch revealed by Petit (2012) seems very attractive as a preferable index in point of the competition among SOs, however, it is relatively complicated and is designed to detect cartelization. The abovementioned methods are doubtlessly precious, but their contents do not fit the aim of this study. Additionally, they require a dozen datasets from various resources, too.

This study struggles to find a simple but substantial way of measuring the level of competition. The practitioners and the academicians should be able to attain an index revealing the level of competition in a region by just having a dataset including the amounts of throughput of each player in a specific terminal, port, etc. Today, the only simple and proven way to measure competition in shipping this way is HHI. On the other hand, proven and well-known methods, which are entropy and a multivariate analysis technique: cluster analysis, have been adapted to this area in this study. The index arising from the cluster analysis is named COSMI, which is inspired by the HITS algorithm combining both sides of foreign trade, imports and exports, in a single system. The other index arising from the entropy method is named ECI.

3. Methodology

The section 'Methodology' explains the methodologies behind COSMI and ECI respectively. Introductions, the pros and cons of these indexes, their variants, and their implementation steps are elaborated in the following sub-sections.

3.1. COSMI

Overall similarity measure (OSM) is a term of the clustering analysis technique (Hair et al., 2009, p.565). It provides to measure the similarity level of observation values through multiple variables. Each distance between observation values formed by 2 different parameters on a coordinate plane is calculated by means of an appropriate technique, and then it is disclosed as a numerical value. This value is referred as OSM value. Consecutive and multiple calculations generate an OSM value for an observation group. The OSM value of an observation group can be compared with another group. In this way, one can detect which group's elements are more similar. Clustering analysis seems quite suitable to detect similarities of SOs in terms of their throughput per terminal or hinterland. This paper represents that the two parameters for each observation are the throughput for imports and exports. Hereby, OSM values are calculated based on route, such as Istanbul-Kocaeli hinterland – Far Eastern ports, for both inbound and outbound throughput simultaneously. If an OSM value is relatively small, it means that the similarity, i.e. competition, level in this group is high.

Clustering analysis includes different clustering procedures, different measurement types, and several consecutive methods to find out a valid OSM value. This paper struggles to form the best methods to acquire the most appropriate OSM values. This combination creates COSMI.

> "Hierarchical clustering analysis is quite suitable for almost all kinds of research questions. One can benefit the centroid method in hierarchical clustering procedure and can use the Squared Euclidean distance in distance measurement to attain the best results. However, one of the most prominent disadvantages of hierarchical methods is its sensitivity to the outliers. Additionally, the centroid method is sensitive to dissimilar scales and magnitudes (Hair et al., 2009, p.590)."

Therefore, OSM values must be calculated as standardized observation values. Furthermore, the measure of the Squared Euclidean distance can somewhat deal with the outliers and limited number of observation units (Hair et al., 2009, p.575).

The contribution of this paper to the competition literature is to propose an algorithm utilizing the clustering analysis. COSMI struggles to eliminate its weaknesses and adapts it into a competitiveness index. Herein below, the pros and cons of COSMI are discussed.

The advantageous parts of COSMI:

1. Since observation values are created simultaneously, weighting operation based on inbound and outbound throughput is fulfilled inherently.
2. Distant subsets in a coordinate plane reveal the fact that SOs compete within different segments in point of container throughput. When the distance between subsets increases, OSM value increases, therefore, competition level decreases; this is the expected result.
3. Since an OSM value is the sum of the distances between observation points, it is kept constant even if small and large observation values are replaced by axis of symmetry in a coordinate plane. Therefore, OSM is not sensitive to the magnitude of the observation value, and emphasizes the significance of competition even though subsets include a lower amount of throughput.
4. OSM is a well accepted method of the clustering theory.

The disadvantageous parts of COSMI:

1. OSM is sensitive to subsets and outliers even though observation values are standardized.
2. OSM is sensitive to the number of observation units. The more observation units are in a set, the more cumulative distance occurs, accordingly, the OSM value rises. Since the number of SOs differs per route, the OSM value may be dramatically affected.

One has to face a trade off between eliminating the disadvantages of COSMI as much as possible and keeping maximum amount of data in a set. Therefore, two approaches have been adopted: COSMI200+ and COSMITOP5. COSMI200+ ignores the throughput of each SO having an amount less than 200 TEUS for both inbound and outbound traffics

in total. On the other part, COSMITOP5 takes into account only the top 5 SOs in terms of local throughput in a terminal or in a hinterland. COSMI200+ keeps the data in a set as much as possible, whereas COSMITOP5 struggles to eliminate the disadvantages of OSM arising from the additive distance.

Implementation steps of COSMI:

Calculations are made through route-based datasets for each hinterland.

1. a. For COSMI200+: in case the sum of inbound and outbound throughput on the basis of route and SO in a dataset is below 200 TEUS, this part of data is subtracted from the original dataset.
   b. For COSMITOP5: all minor data in a dataset except the data reflecting top 5 SOs per route is subtracted from the original dataset.

2. The dataset per route is standardized (Z score). OSM values are calculated through the centroid method. Distant measurement is Squared Euclidean distance. First, the two closest elements of the cluster and then distance between them are determined. This transaction is repeated for the rest of elements similarly. Distances between clusters can be calculated through the centroids of subsets. The sum of the distances of each subset produces an OSM value per route.

3. Since the result is associated with distance measurement, one has to convert it into the similarity measure by inverting OSM value, obtaining similarity scores on route basis, i.e. COSMI per route. Since the OSM values are over 1, inverting operation is prefered instead of substracting OSM value from 1.

4. Similarity scores are multiplied by weighting scores of each route and then summed up to obtain COSMI scores on the basis of hinterland. Weighting operation takes into account the throughput of each route.

3.2. ECI

The entropy method takes in consideration the market shares of SOs in each route. The logarithm of market share represents the element of surprise (Baray, 2003, p.12). Normalized values are between 0 and 1. The logarithm of a value which approximates 1 is smaller than the logarithm of a value which approximates 0. It means that the more market share a SO has, the less surprise factor emerges to change this market share. In this context, uncertainty per SO is determined by multiplying the market share and the surprise factor for each SO. The sum of the uncertainties per SO is multiplied by the entropy coefficient to calculate the entropy value. Herein below, the pros and cons of ECI are discussed.

The advantageous parts of ECI:

1. The normalization step defines the market shares of each SO. This step, somewhat, simulates HHI.

2. The entropy method does not face an outlier problem because they become insignificant after calculating operations.

The disadvantageous parts of ECI:

1. Entropy cannot transact inbound and outbound data simultaneously as OSM can do. They must be calculated one by one to merge later on.

2. The number of SOs differs in each hinterland, and it may differ in time. Different numbers of SO granting service in each route create a coefficient problem to solve since the entropy coefficient is linked to the number of SO.

The entropy coefficient ensures the entropy value is kept between 0 and 1 (Yang & Shen, 2013, p.163). It depends on the number of SOs per hinterland. While calculating the entropy coefficient, the number of SOs in a matrix must be taken in consideration; however, the number of SOs servicing each hinterland differs. It means that the entropy coefficient of each matrix must be different. On the other hand, each matrix in an index has a relative relationship with one another. This approach causes different numbers of SOs and entropy coefficients per hinterland, emerging a risk of spoiling the entire anaysis. A solution is to add all the SOs servicing all hinterlands into the matrices of each hinterland wherein some of them do not have a service. There is another issue supporting this solution: an empirical analysis indicates that when the number of SOs decreases, the value of the entropy coefficient increases, leading to an increase in entropy. However, theoretically, when the number of SOs decreases, one expects that the entropy value, i.e. uncertainty, should decrease; therefore, the entropy coefficient must be kept constant in all matrices on a yearly basis. One should accept that the SOs which do not have a service for some hinterlands are potential competitors for the existing ones. Within the context of the above discussion, the opinion, a *constant entropy coefficient*, has been tested alongside an alternative opinion, a *variable entropy coefficient*. ECI-JOINT accepts a joint entropy coefficient, which is constant for each hinterland. It equals the number of SOs calling at all the hinterlands in the analysis per year. On the other hand, ECI-VAR takes into account a variable entropy coefficient defined by the number of SOs in each hinterland. The contribution of this paper to the literature on ECI is to propose the entropy method to the competition theory, adapting the entropy coefficient.

The implementation steps of the entropy method are detailed below (Yang & Shen, 2013, p.163).

1) The decision matrix is normalized (Equation 14).

$$p_{ij} = x_{ij} / \sum_{i=1}^{n} x_{ij} \quad (14)$$

The variables are symbolized by p_{ij} for normalized values, x_{ij} for original matrix values, i for alternatives, j for criteria, n for the number of alternatives.

2) The entropy values are calculated for each criterion (Equation 15, 16)

$$e_j = -k \sum_{i=1}^{n} p_{ij} \, ln \, p_{ij} \quad (15)$$

$$k = (ln(n))^{-1} \quad (16)$$

The variables are symbolized by k for entropy coefficient, e_j for entropy value, p_{ij} for normalized value. p_{ij} symbol refers to the market share of a SO in each route. The number of SOs in a market determines the value of the entropy coefficient, k. The number of alternatives, n, refers to the number of SOs. In this study, the alternatives are SOs and the criteria are routes.

The entropy values per route for each matrix must be merged to get only one entropy value per hinterland by implementing a weighting operation. Weight of each route respectively for inbound and outbound traffics is determined by dividing the route based throughput by the total throughput of a hinterland. The entropy value is a magnitude between 0 and 1.

Both indexes have been tested by means of a dataset including throughput of container terminals located in Turkey.

4. Case Study for Container Terminals in Turkey

The dataset used in this study is not publicly accessible in Turkey, but has been obtained from the local players. The tables in this study do not include the names of the SOs, intentionally. The local legislation prohibits disclosing corporate data. The dataset is on an annual basis, and it includes inbound and outbound throughput of SOs on route basis. Four-year data covers the period between 2013 and 2016, comprising twenty-foot and forty-foot containers, respectively. It provides to scrutinize Turkey in four hinterlands (Istanbul-Kocaeli hinterland including the terminals: Kumport, Mardas, Marport, Haydarpasa, Evyap port, Yilport, Limas, and Gemlik hinterland including the terminals: Borusan, Gemport, Rodaport, and Izmir-Aliaga hinterland including the terminals: Alsancak, Egegubre, Nemport, and Mersin hinterland including the terminals: Mersin MIP, Assan, Limak). Each hinterland includes 8 routes connecting Turkey to the rest of the world. They are the Far East, Northern Europe, the Mediterranean Sea, Africa, North America, South America, Australia New Zealand, and the Arabian Gulf. Minitab software has been utilized for the calculation of OSM values per route for COSMI.

The paper illustrates how the dataset has been processed for twenty-foot containers in Istanbul-Kocaeli hinterland, in the year 2016 for COSMI200+ (Table 1), COSMITOP5 (Table 2), ECI-VAR, and ECI-JOINT (Table 3, Table 4, Table 5, Table 6, Table 7). The results of these indexes in addition to HHI have then been compared (Table 8).

5. Results and Discussion

Since HHI is well accepted by several authorities worldwide, COSMI and ECI variants have been tested by HHI in terms of structural validation, correlating and corresponding them (Table 1). High value of correlation coefficient means high validity. This study has benefited the Pearson correlation coefficient. HHI correlates with ECI-JOINT highly: 0.97. HHI correlates with ECI-VAR highly, too: 0.86. On the other hand, the results for COSMI are quite far from satisfying the validation. They are - 0.08 for COSMI200+ and 0.45 for COSMITOP5.

COSMI200+ does not correlate with HHI. On the other hand, COSMITOP5 exhibits a better performance. Although the number of SOs competing in some routes is less than

5 in the data set, when almost equalizing the number of SOs in each route per hinterland, a moderate correlation coefficient (0.45) could be attained. Having a similar number of SOs for each hinterland allows to overcome one of the disadvantages of COSMI, which is sensitivity of OSM to the number of observation units. However, COSMI is still sensitive to subsets and outliers. This disadvantage of COSMI has surfaced dramatically. Apparently, it is not the best way to measure the level of competition. Nevertheless, in case of accepting a high degree of data loss, focusing on an equal number of SOs for each route and trivialising small numbers through some arithmetic steps as HHI implements, COSMI can be still promising.

ECI is much more attractive to create an index. As it is discussed in Section 3 'Methodology', different entropy coefficients per hinterland affected the correlation coefficients negatively in terms of validity. As a result, the correlation coefficient for ECI-JOINT is higher, therefore, ECI-JOINT can be evaluated as a good alternative for HHI. It is reliable, and has got a strong background of entropy theory. Besides, ECI-JOINT justifies the validity of HHI, which utilizes a simple method. Both ECI and HHI utilize market shares of the competitors but have entirely different operations in methodology. HHI benefits the power of squaring in maths to highlight the market shares of the dominant players. After the operation, the magnitude of difference between a pair of players gets greater. On the other hand, ECI concentrates on the surprise factor. The market leader secures a cargo with a minimal surprise factor. This operation approximates the possibility of securing cargo of any pair of players whose market shares are different. It means that after the operation, the magnitude of difference between a pair of players gets smaller. However, since the analysis focuses on the correlation of index scores of each matrix per hinterland, the coherence of the results acquired from both methods is great.

The relatively weaker performance of ECI-VAR must be discussed. ECI-VAR stresses that the number of SOs' services for each hinterland differs on a yearly basis. For example, there have been 25 SOs calling at the Istanbul – Kocaeli hinterland regularly since 2016, but there have been only 16 SOs for the Gemlik hinterland for this period. 25 players competing in a hinterland should provide a more competitive market than a market in which only 16 players compete. This parameter, the variable number of SOs, is expected to tune well the result of a competitiveness index in comparison to keeping the number of SOs constant. The entropy coefficient, which is linked to the number of SOs, could assist to manage it. However, one must keep in mind that the aim of the entropy coefficient is to keep the entropy value between 0 and 1 in a matrix. When it is kept constant, reflecting the maximum number of SOs in all hinterlands, i.e. in several matrices, it works well. If each matrix keeps its own entropy coefficient to interpret the level of competition further, it does not work because theoretical and practical results of the entropy coefficient are opposite while comparing different matrices (See Section 3, Methodology).

The higher scores for both COSMI and ECI reflect higher competition levels. With regard to ECI-JOINT, the Istanbul-Kocaeli hinterland is the most competitive market among all the hinterlands in Turkey in 2013 for both 20-foot and 40-foot full containers. However, the index results indicate that the level of competition in the Istanbul-Kocaeli hinterland

has gradually decreased in time. The Gemlik hinterland exhibits a similar sight. The level of competition for Mersin and Izmir-Aliaga displays an index moving up-and-down. The share of the Istanbul-Kocaeli hinterland throughput in containerized foreign trade of Turkey is 37% for twenty-foot container traffic and 44% for forty-foot container traffic. ECI-JOINT indicates a decreasing trend in the level of competition among SOs. This may arise from the effects of mergers and takeovers in liner shipping during the last decade. Another implication one can conclude is that the higher magnitude of throughput comes true, then the more severe competition is faced in a local region. Istanbul-Kocaeli and Mersin have a considerable part of container traffic in Turkey. Although the level of competition in the Istanbul-Kocaeli hinterland had decreased in time. In 2016, it was still higher than the levels they were in Gemlik and Izmir-Aliaga. Mersin is the toughest hinterland to compete then.

The section 'Conclusions and recommendations' addresses the necessity of a reliable competitiveness index, highlights ECI, explains the constraints of this study, and makes recommendations for future studies.

Table 1. COSMI200+ for 20' in the Istanbul-Kocaeli Hinterland, 2016

Ship Operator	Fareast		N. Europe		Intramed		Africa		N. America		S. America		Aus & N. Zea.		Arabian Gulf	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
SO 1	55.548	14.287	30.239	9.871	10.503	10.761	1.640	6.172	1.325	3.349	2.240	3.665	142	3.408	562	4.149
SO 2	23.264	19.266	4.450	1.528	2.763	1.600	535	9.112	668	662	115	2.305	52	912	579	3.372
SO 3	10.581	2.846	6.822	706	895	1.642	157	2.694	631	117	763	745	67	856	973	363
SO 4	8.044	4.962	301	59	112	911	1	665	213	215	13	261	48	374	920	4.728
SO 5	2.963	553	420	73	2.091	4.837	929	2.425	476	557	321	1.475			61	458
SO 6	7.310	2.703	223	305	705	303	5	198	1.301	1.244	0	238				
SO 7	8.042	7.870	2.443	1.663	0	1.604										
SO 8	5.285	2.923	64	239	9.462	16.977										
SO 9	6.893	1.459	1.290	3	161	626										
SO 10	13.186	1.275	462	64	62	362										
SO 11	1.227	1.041			3.458	3.651										
SO 12	1.125	951			2.429	682										
SO 13					376	0										
SO 14					1.207	2.169										
OSM Value per route	10,4527		19,0143		13,2735		4,7730		5,7778		9,2727		7,7368		5,3545	
COSMI per route	0,0957		0,0526		0,0753		0,2095		0,1731		0,1078		0,1293		0,1868	
Weighted COSMI	0,0469		0,0078		0,0146		0,0125		0,0045		0,0032		0,0019		0,0073	
COSMI for İstanbul	**0,0987**															

Table 2. COSMITOP5 for 20' in the Istanbul-Kocaeli Hinterland, 2016

Ship Operator	Fareast		N. Europe		Intramed		Africa		N. America		S. America		Aus & N. Zea.		Arabian Gulf	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
SO 1	55.548	14.287	30.239	9.871	10.503	10.761	1.640	6.172	1.325	3.349	2.240	3.665	142	3.408	562	4.149
SO 2	23.264	19.266	4.450	1.528	2.763	1.600	535	9.112	668	662	115	2.305	52	912	579	3.372
SO 3	10.581	2.846	6.822	706	3.458	3.651	157	2.694	631	117	763	745	67	856	973	363
SO 4	8.044	4.962	223	305	9.462	16.977	1	665	213	215	13	261	48	374	920	4.728
SO 5	8.042	7.870	2.443	1.663	2.091	4.837	929	2.425	1.301	1.244	321	1.475			61	458
OSM Value per route	5,1486		9,7000		6,0661		4,0555		5,0672		7,8601		7,7368		5,3545	
COSMI per route	0,1942		0,1031		0,1649		0,2466		0,1973		0,1272		0,1293		0,1868	
Weighted COSMI	0,0951		0,0152		0,0319		0,0148		0,0052		0,0037		0,0019		0,0073	
COSMI for İstanbul	**0,1751**															

Table 3. Throughput per SO, ECI for 20' in the Istanbul-Kocaeli Hinterland, 2016

Ship Operator	Fareast		N. Europe		Intramed		Africa		N. America		S. America		Aus & N. Zea.		Arabian Gulf	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
SO 1	55.548	14.287	30.239	9.871	10.503	10.761	1.640	6.172	1.325	3.349	2.240	3.665	142	3.408	562	4.149
SO 2	23.264	19.266	4.450	1.528	2.763	1.600	535	9.112	668	662	115	2.305	52	912	579	3.372
SO 3	10.581	2.846	6.822	706	895	1.642	157	2.694	631	117	763	745	67	856	973	363
SO 4	8.044	4.962	20	12	112	911	0,01	164	213	215	13	261	0,01	0,01	0,01	0,01
SO 5	0,01	0,01	420	73	2.091	4.837	0,01	0,01	476	557	0,01	0,01	0,01	0,01	0,01	0,01
SO 6	7.310	2.703	223	305	705	303	0,01	46	18	0,01	0,01	0,01	1	0,01	1	91
SO 7	8.042	7.870	0,01	0,01	0,01	0,01	1	665	20	9	15	6	5	1	920	4.728
SO 8	0,01	0,01	64	239	9.462	16.977	929	2.425	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
SO 9	6.893	1.459	1.290	3	161	626	5	198	1.301	1.244	321	1.475	48	374	61	458
SO 10	13.186	1.275	462	64	62	362	0,01	0,01	0,01	0,01	0,01	0,01	2	51	2	0,01
SO 11	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	9	47	0,01	0,01	0,01	0,01	0,01	32
SO 12	2.963	553	34	6	0,01	0,01	2	0,01	1	0,01	0,01	0,01	0,01	13	8	5
SO 13	0,01	0,01	2.443	1.663	0,01	0,01	0,01	0,01	0,01	0,01	0,01	238	0,01	0,01	0,01	0,01
SO 14	0,01	0,01	22	0,01	3.458	3.651	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
SO 15	0,01	0,01	17	16	2.429	682	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
SO 16	5.285	2.923	301	59	376	0,01	0,01	38	29	5	0,01	0,01	2	15	0,01	0,01
SO 17	0,01	0,01	0,01	0,01	1.207	2.169	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
SO 18	0,01	0,01	0,01	0,01	0,01	0,01	32	50	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
SO 19	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	5	116	1	0,01
SO 20	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	32	1	0,01
SO 21	1.227	1.041	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
SO 22	1.125	951	0,01	0,01	0,01	0,01	0,01	0,01	0,01	1	0,01	0,01	0,01	19	0,01	0,01
SO 23	0,01	0,01	0,01	0,01	0,01	1.604	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
SO 24	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	16	0,01	0,01	0,01	0,01	0,01	0,01
SO 25	0,01	0,01	0,01	0,01	0,01	0,01	0,01	14	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
Others	2.204	1.126	30	15	268	690	0,01	40	1	0,01	0,01	0,01	3	3	0,01	0,01
TOTAL	**145.672**	**61.262**	**46.837**	**14.560**	**34.492**	**46.815**	**3.301**	**21.618**	**4.692**	**6.222**	**3.467**	**8.695**	**327**	**5.800**	**3.108**	**13.198**

P.S.: If the throughput value of a SO for a route is zero, this value is accepted as 0,01 so that the calculating operation can be performed properly.

Table 4. Normalised Values, ECI for 20' in the Istanbul-Kocaeli Hinterland, 2016

Ship Operator	Fareast		N. Europe		Intramed		Africa		N. America		S. America		Aus & N. Zea.		Arabian Gulf	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
SO 1	0,387	0,238	0,646	0,679	0,307	0,233	0,497	0,286	0,282	0,538	0,646	0,421	0,438	0,588	0,181	0,314
SO 2	0,162	0,320	0,095	0,105	0,081	0,035	0,162	0,422	0,142	0,106	0,033	0,265	0,160	0,157	0,186	0,255
SO 3	0,074	0,047	0,146	0,049	0,026	0,036	0,048	0,125	0,135	0,019	0,220	0,086	0,207	0,148	0,313	0,028
SO 4	0,056	0,083	0,000	0,001	0,003	0,020	0,000	0,008	0,045	0,035	0,004	0,030	0,000	0,000	0,000	0,000
SO 5	0,000	0,000	0,009	0,005	0,061	0,105	0,000	0,000	0,101	0,090	0,000	0,000	0,000	0,000	0,000	0,000
SO 6	0,051	0,045	0,005	0,021	0,021	0,007	0,000	0,002	0,004	0,000	0,000	0,000	0,003	0,000	0,000	0,007
SO 7	0,056	0,131	0,000	0,000	0,000	0,000	0,000	0,031	0,004	0,001	0,004	0,001	0,015	0,000	0,296	0,358
SO 8	0,000	0,000	0,001	0,016	0,276	0,368	0,281	0,112	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SO 9	0,048	0,024	0,028	0,000	0,005	0,014	0,002	0,009	0,277	0,200	0,093	0,170	0,148	0,065	0,020	0,035
SO 10	0,092	0,021	0,010	0,004	0,002	0,008	0,000	0,000	0,000	0,000	0,000	0,000	0,006	0,009	0,001	0,000
SO 11	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,008	0,000	0,000	0,000	0,000	0,000	0,002
SO 12	0,021	0,009	0,001	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,003	0,000
SO 13	0,000	0,000	0,052	0,114	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,027	0,000	0,000	0,000	0,000
SO 14	0,000	0,000	0,000	0,000	0,101	0,079	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SO 15	0,000	0,000	0,000	0,001	0,071	0,015	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SO 16	0,037	0,049	0,006	0,004	0,011	0,000	0,000	0,002	0,006	0,001	0,000	0,000	0,006	0,003	0,000	0,000
SO 17	0,000	0,000	0,000	0,000	0,035	0,047	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SO 18	0,000	0,000	0,000	0,000	0,000	0,000	0,010	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SO 19	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,015	0,020	0,000	0,000
SO 20	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,006	0,000	0,000
SO 21	0,009	0,017	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SO 22	0,008	0,016	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	0,000	0,000
SO 23	0,000	0,000	0,000	0,000	0,000	0,035	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SO 24	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	0,000	0,000	0,000	0,000	0,000	0,000
SO 25	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
TOTAL	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**

Table 5. ECI-VAR and ECI-JOINT per route for 20' in the Istanbul-Kocaeli Hinterland, 2016

Ship Operator	Fareast		N. Europe		Intramed		Africa		N. America		S. America		Aus & N. Zea.		Arabian Gulf	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
SO 1	-0,367	-0,341	-0,282	-0,263	-0,363	-0,340	-0,348	-0,358	-0,357	-0,333	-0,282	-0,364	-0,362	-0,312	-0,309	-0,364
SO 2	-0,295	-0,365	-0,224	-0,237	-0,203	-0,117	-0,295	-0,364	-0,278	-0,238	-0,113	-0,352	-0,294	-0,291	-0,313	-0,349
SO 3	-0,192	-0,144	-0,281	-0,147	-0,095	-0,119	-0,145	-0,260	-0,270	-0,075	-0,333	-0,211	-0,326	-0,282	-0,364	-0,099
SO 4	-0,162	-0,206	-0,003	-0,006	-0,019	-0,078	0,000	-0,037	-0,140	-0,116	-0,021	-0,105	0,000	0,000	0,000	0,000
SO 5	0,000	0,000	-0,042	-0,027	-0,171	-0,236	0,000	0,000	-0,232	-0,216	0,000	0,000	0,000	0,000	0,000	0,000
SO 6	-0,152	-0,139	-0,025	-0,081	-0,080	-0,033	0,000	-0,013	-0,021	0,000	0,000	0,000	-0,018	0,000	-0,003	-0,034
SO 7	-0,162	-0,266	0,000	0,000	0,000	0,000	-0,002	-0,107	-0,023	-0,009	-0,024	-0,005	-0,064	-0,001	-0,360	-0,368
SO 8	0,000	0,000	-0,009	-0,068	-0,355	-0,368	-0,357	-0,246	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SO 9	-0,146	-0,090	-0,099	-0,002	-0,025	-0,058	-0,010	-0,043	-0,356	-0,322	-0,220	-0,301	-0,283	-0,177	-0,077	-0,117
SO 10	-0,219	-0,082	-0,046	-0,024	-0,011	-0,038	0,000	0,000	0,000	0,000	0,000	0,000	-0,031	-0,042	-0,005	0,000
SO 11	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-0,012	-0,037	0,000	0,000	0,000	0,000	0,000	-0,015
SO 12	-0,080	-0,043	-0,005	-0,003	0,000	0,000	-0,004	0,000	-0,002	0,000	0,000	0,000	0,000	-0,014	-0,015	-0,003
SO 13	0,000	0,000	-0,154	-0,248	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-0,098	0,000	0,000	0,000	0,000
SO 14	0,000	0,000	-0,004	0,000	-0,232	-0,201	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SO 15	0,000	0,000	-0,003	-0,007	-0,188	-0,062	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SO 16	-0,122	-0,147	-0,032	-0,022	-0,050	0,000	0,000	-0,011	-0,031	-0,006	0,000	0,000	-0,031	-0,015	0,000	0,000
SO 17	0,000	0,000	0,000	0,000	-0,118	-0,144	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SO 18	0,000	0,000	0,000	0,000	0,000	0,000	-0,045	-0,014	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SO 19	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-0,064	-0,078	-0,003	0,000
SO 20	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-0,029	-0,003	0,000
SO 21	-0,041	-0,070	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SO 22	-0,038	-0,066	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-0,001	0,000	0,000	0,000	-0,019	0,000	0,000
SO 23	0,000	0,000	0,000	0,000	0,000	-0,117	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SO 24	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-0,015	0,000	0,000	0,000	0,000	0,000	0,000
SO 25	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-0,005	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
TOTAL	**-1,98**	**-1,96**	**-1,21**	**-1,13**	**-1,91**	**-1,91**	**-1,21**	**-1,46**	**-1,72**	**-1,37**	**-0,99**	**-1,44**	**-1,48**	**-1,26**	**-1,45**	**-1,35**
ECI-VAR per route	**0,614**	**0,609**	**0,376**	**0,352**	**0,593**	**0,593**	**0,375**	**0,453**	**0,535**	**0,426**	**0,309**	**0,446**	**0,459**	**0,392**	**0,451**	**0,419**
ECI-JOINT per route	**0,581**	**0,576**	**0,356**	**0,334**	**0,561**	**0,562**	**0,355**	**0,429**	**0,507**	**0,403**	**0,292**	**0,422**	**0,435**	**0,371**	**0,427**	**0,396**

Table 6. ECI-JOINT for 20' in the Istanbul-Kocaeli Hinterland, 2016

	Fareast		N. Europe		Intramed		Africa		N. America		S. America		Aus & N. Zea.		Arabian Gulf		Total
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	
IST-KOC. 20› Volume	145.672	61.262	46.837	14.560	34.492	46.815	3.301	21.618	4.692	6.222	3.467	8.695	327	5.800	3.108	13.198	420.068
Weıght	0,3468	0,1458	0,1115	0,0347	0,0821	0,1114	0,0079	0,0515	0,0112	0,0148	0,0083	0,0207	0,0008	0,0138	0,0074	0,0314	1
ECI per route	0,5807	0,5762	0,3557	0,3335	0,5614	0,5615	0,3547	0,4287	0,5066	0,4027	0,2922	0,4224	0,4346	0,3707	0,4269	0,3962	
Regıon Score	0,2014	0,0840	0,0397	0,0116	0,0461	0,0626	0,0028	0,0221	0,0057	0,0060	0,0024	0,0087	0,0003	0,0051	0,0032	0,0124	**0,5140**
ECI-JOINT for Istanbul	**0,5140**																

Table 7. ECI-VAR for 20' in the Istanbul-Kocaeli Hinterland, 2016

	Fareast		N. Europe		Intramed		Africa		N. America		S. America		Aus & N. Zea.		Arabian Gulf		Total
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	
IST-KOC. 20› Volume	145.672	61.262	46.837	14.560	34.492	46.815	3.301	21.618	4.692	6.222	3.467	8.695	327	5.800	3.108	13.198	420.068
Weıght	0,3468	0,1458	0,1115	0,0347	0,0821	0,1114	0,0079	0,0515	0,0112	0,0148	0,0083	0,0207	0,0008	0,0138	0,0074	0,0314	1
ECI per route	0,6136	0,6088	0,3758	0,3524	0,5932	0,5933	0,3748	0,4530	0,5353	0,4256	0,3088	0,4463	0,4592	0,3917	0,4510	0,4187	
Regıon Score	0,2128	0,0888	0,0419	0,0122	0,0487	0,0661	0,0029	0,0233	0,0060	0,0063	0,0025	0,0092	0,0004	0,0054	0,0033	0,0132	**0,5431**
ECI-VAR for Istanbul	**0,5431**																

Table 8. Comparison of competitiveness index results

	Hinterlands	Container	HHI	ECI-VAR	ECI-JOINT	COSMI200+	COSMITOP5
2013	Istanbul-Kocaeli	20'	7.3156	0.6357	.6357	.0867	.1965
	Gemlik	20'	4.8355	0.5952	.5058	.0872	.1356
	Izmir-Aliaga	20'	4.7245	0.5456	.5164	.0780	.1321
	Mersin	20'	6.5132	0.6170	.5980	.1194	.1605
	Istanbul-Kocaeli	40'	6.7830	0.6070	.6010	.0753	.1461
	Gemlik	40'	4.0983	0.5250	.4546	.1205	.1729
	Izmir-Aliaga	40'	5.2368	0.5677	.5373	.1005	.1622
	Mersin	40'	6.8689	0.6267	.6074	.1064	.1580
2014	Istanbul-Kocaeli	20'	5.3922	0.5765	.5534	.0905	.1669
	Gemlik	20'	3.9433	0.5689	.4487	.0904	.1355
	Izmir-Aliaga	20'	4.5385	0.5328	.4931	.1016	.1479
	Mersin	20'	5.5101	0.5468	.5468	.1355	.1964
	Istanbul-Kocaeli	40'	5.1634	0.5529	.5365	.0699	.1388
	Gemlik	40'	3.5081	0.5057	.4173	.1214	.1616
	Izmir-Aliaga	40'	4.2246	0.5256	.4864	.0970	.1572
	Mersin	40'	5.5368	0.5512	.5513	.0812	.1440
2015	Istanbul-Kocaeli	20'	4.7807	0.5662	.5276	.0905	.1647
	Gemlik	20'	3.7601	0.5601	.4338	.0960	.1427
	Izmir-Aliaga	20'	4.3043	0.5144	.4794	.1169	.1709
	Mersin	20'	5.3828	0.5425	.5425	.1030	.1775
	Istanbul-Kocaeli	40'	4.7678	0.5478	.5164	.0759	.1379
	Gemlik	40'	3.2955	0.4795	.3964	.1258	.1538
	Izmir-Aliaga	40'	4.2518	0.5176	.4880	.0957	.1423
	Mersin	40'	5.5866	0.5543	.5494	.1085	.1876
2016	Istanbul-Kocaeli	20'	4.2806	0.5431	.5140	.0987	.1751
	Gemlik	20'	3.1674	0.5107	.4163	.0890	.1214
	Izmir-Aliaga	20'	4.4523	0.5352	.5001	.1150	.1601
	Mersin	20'	5.2584	0.5601	.5601	.0945	.1744
	Istanbul-Kocaeli	40'	4.4973	0.5260	.5039	.1020	.1677
	Gemlik	40'	3.1758	0.4636	.4014	.0868	.1294
	Izmir-Aliaga	40'	4.2342	0.5300	.4953	.1057	.1623
	Mersin	40'	5.7125	0.5739	.5740	.1344	.1936
	Correlation with HHI			**0.86**	**0.97**	**-0.08**	**0.45**

6. Conclusions and Recommendations

Container shipping has been exposed to consolidations in last 20 years, whereas it is still highly competitive. Many SOs disappeared or lost their independence by means of takeovers or mergers, and resulted in the existence of a lower number of independent SOs, especially, in intercontinental strings. Measuring the level of competition between terminals or hinterlands is important to determine both the local differences occurred in time and simultaneous changes in various regions. These findings are obligatory to take measures against cartelization and to make an analysis about terminal investments,

container operations, and so on. This study aims to propose a novel competitiveness index, which is reliable and harbours a meaningful method. Besides, this index must be compatible with the goals of the sectoral studies.

HHI is well accepted by the authorities worldwide to create a competitiveness index because it requires only the market shares of the players. Therefore, it is very simple to practise, but there is not any significant meaning behind it. It just squares the market shares of each player and sums them up to reach a conclusion about the competitiveness level in a market. It is practically useful but a novel index with a substantial background in terms of methodology enriches competitiveness theory. In this context, the clustering analysis, which is a multivariate analysis technique, and entropy have been adapted to create and to test novel indexes. The index based on clustering analysis is named COSMI, and the index based on entropy is named ECI. The magnitudes of inbound and outbound throughput of SOs for a hinterland are enough to create an index by means of these two approaches. Other methods in the literature are complicated and require a series of datasets which are practically quite difficult to collect. Two variants for each index have been tested by HHI, correlating and comparing the results.

In this study, ECI is proposed as a sound alternative to HHI. One of the variants for ECI, ECI-JOINT, correlates with HHI highly. The correlation coefficient is 0.97. It just needs identical datasets as HHI requires. Furthermore, it leans on a strong physics law: the second law of thermodynamics. The concept of entropy has benefited from several diciplines, but it has been adapted into a competition theory for the first time by this study. On the other hand, clustering analysis seems promising to create a competitiveness index at first sight, but COSMI is quite weak due to its sensitivities to the number of observation units and outliers. It requires further improvements to acquire better results; nevertheless, it is certain that a considerable part of dataset must be ignored to overcome its vulnerabilities.

The dataset in this study includes inbound and outbound throughput of SOs at container terminals located in Turkey, and it is based on four hinterlands. One should emphasize the below constraints relating to the dataset. It includes some distant terminals such as Marport/Istanbul and Evyap/Kocaeli in the same hinterland. Infact, benefiting from a data set on the basis of the hinterland instead of on the basis of the terminal is quite logical because neighbouring terminals may serve for the same hinterland, whereas in time, SOs may change their ports of call. Additionally, it must be underlined that the reefer containers and other special types of equipment could not be distinguished and were accepted as standard ones. Nevertheless, this study focuses on the methodologies for a novel index, therefore, these constraints might be ignored.

In liner shipping, especially for container transportation, ECI-JOINT can be considered as a substantial index as an alternative to HHI. For future studies, ECI-JOINT must be tested further alongside HHI by various datasets particularly including more matrices so that it can be well accepted in the literature.

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RESEARCH ARTICLE

Using Data Envelopment Analysis for Measuring the Efficiency of Water Bottling Distributors

Veri Zarflama Analizini Yöntemi Kullanarak Su Distribütörlerinin Etkinliğinin Ölçümlenmesi

Uğur Arcagök[1]

ABSTRACT

The purpose of this research is to assess the efficiency and productivity of 51 water bottling distributors based on DEA (Data Envelopment Analysis) approaches that were evaluated between 2012 and 2013, as per 5 variables, these being sales, staff, distance, size, and capex. We got different results from the initial assumptions after the analysis. Big cities distributors' efficiencies are better than the small cities and town distributors. The time period was selected because of the global conflict, war in Syria, Turkish government policies, accepting the war refugees and the other reasons, natural and environmental. According to the research results, some suggestions have been made for the managers of the distributors.

Keywords: Data envelopment analysis, Productivity analysis, Malmquist index, Efficiency change, Total factor productivity

ÖZ

Bu araştırmanın amacı, bir su fabrikasının 51 tane dağıtıcısının 2012 ve 2013 yılları arasındaki verilerini 5 farklı değişken (satışlar, personel sayısı, firma ile dağıtıcı arasındaki uzaklık, depo büyüklüğü ve diğer kuruluş maliyetleri) yardımıyla Veri Zarflama Analizi yöntemi (VZA) kullanarak dağıtıcıların etkinliğini ve verimliliği değerlendirmektir. Analizden sonra ilk varsayımlardan farklı sonuçlar aldık. Büyük şehirlerin distribütörlerinin verimliliği küçük şehirlerden ve kasaba distribütörlerinden daha iyi olduğu sonucuna varıldı. Küresel çatışma, Suriye'deki savaş, Türk hükümeti politikaları, savaş mültecilerini kabul etme ve diğer doğal ve çevresel nedenlerden dolayı 2012 ve 2013 yılları seçildi. Analiz sonuçlarına göre dağıtıcıların yöneticilerine etkinliklerini ve verimliliklerini artırıcı bazı önerilerde bulunuldu.

Anahtar Kelimeler: Data envelopment analysis, Productivity analysis, Malmquist index, Efficiency change, Total factor productivity

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1. Introduction

In the research, the efficiency of 51 distributors was assessed based on Data Envelopment Analysis (DEA) approaches that had been evaluated between 2012 and 2013, as per 5 variables, these being sales, staff, distance, size, and capex.

The most important and reasonable step in the DEA analysis is to figure out variables, inputs and outputs. Then, the variables are explained through specific statistical analyses (descriptive statistical analysis, correlation analysis, and box Plot graph analysis). The second step is the analysis of the Data Envelopment Analysis (DEA). Furthermore, the most convenient orientation model is arranged. In other words, the main objective is to focus on the orientation model of inputs or outputs. Then, scale efficiency (CRS or VRS) is defined through explanations. The scale efficiency gives specific information relevant to the distributors. Moreover, the allocative efficiency of the distributors is explained as the cost function. Also, the Malmquist Index of the distributors is examined. Consequently, some assumptions are made such as the output of total factor productivity analysis according to the data collected in the recent two years such as the Malmquist index (MI), the efficiency change (EC), and the technological change (TC) for every decision-making unit (DMU).

Briefly, it would be better to explain the most appropriate conceptual model before the analysis. For this reason, the inputs and outputs, the orientation model, and returns to scale (VRS or CRS) should be identified before the analysis. After stating the result of the analysis, they are studied on Pim-Dea, Stata, Spss and Microsoft Excel computer programs.

1.2. Background Information About the Establishment

The establishment is a natural spring water factory that had been founded in Turkey in 2006, and it has 51 distributors in Turkey. The product line of the company covers the following products: natural spring water bottles of 0.5 L, 1.5 L, 5 L, and 19 L. All the products are bottled in a zero-touch environment. The natural spring waters have a high reputation in Turkey, and thus, this might have created a positive effect on sales and advertisement.

The distributors' main role and objective is to make distinction between the packages as per shops, restaurants, hospitals, universities, schools etc.; and this helps to cover a variety of customers, and thus, keeps the business steadily profitable. The most important responsibilities are implementing a strong stock control system, and "just in time" delivery to the customers. Although a few distributors are big such as the ones in the Diyarbakir, Batman, Gaziantep, Şanlıurfa and Mardin Provinces, most of the distributors are relatively small. With the use of the data obtained from the distributors in between 2012 and 2013, the research examined their relative efficiency, and simultaneously tested the distributors by the efficiency evaluation methods through returns to scale considering a sample of 51 distributors of the water factory.

The supply chain of the company begins with the suppliers of raw materials of components such as caps, plastic bottles and labels. The procurement department is responsible for the suppliers. Then, the raw materials are sent to the manufacturing process. The

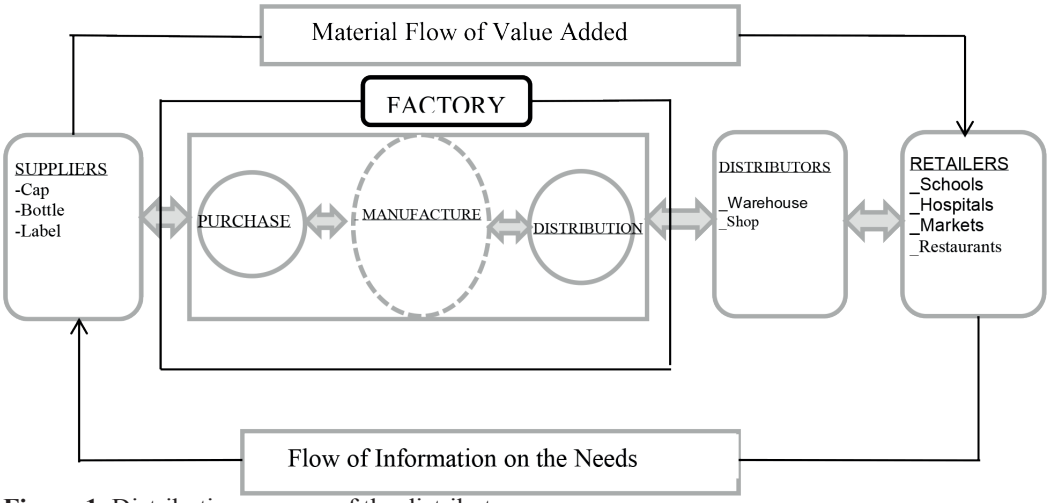


Figure 1. Distribution process of the distributors

company delivers the manufactured products to the distributors. The distributors stock the products in their warehouses and shops. Afterwards, they distribute the products for meeting the needs of the retailers such as supermarkets and restaurants which are responsible for satisfying the needs of the final consumer. For this reason, the chain may be symbolized by a group of companies in various sectors (suppliers, carriers, factories, distributors, retailers, customers) which allow the flow of raw materials, products, money and information in a better way, and thus all the logistics operations improve, and the operating costs decrease (Santos, Marins, Alves & Moellmann, 2010).

The distribution of the products has two processes, these are physical distribution and the distributors' process. Physical distribution is the delivery of finished products from the factory to the distributors. Physical distribution intends to provide a high level of service in order to establish a smooth flow along the distribution network, and thus, to enable a successful distribution of the products to the right place according to the time set, and at a low cost. The main objective of the distributors is to actualize the procedure in a quality, fast and reliable manner with a lower total cost by satisfying the requirements of the retailers. Distribution covers the operational affairs and controls that allow the transfer of the products from point of manufacture to the points of delivery to the retailers. The main objective of the distribution channel is to deliver the correct products to the right places in a timely manner, and at the lowest cost. As it is mentioned earlier, delivery costs have the highest rate among Operating Costs.

The bottling company (factory) is responsible for assuring the receipt of the products by the distributors. In other words, the factory has to deliver products at the right time, and to the right place with high quality standards. After that point, the company's responsibilities come to an end. For example, if the distributors are not able to sell the products, they cannot send the products back to the company. In addition, the delivery cost belongs to the distributors. When the distributors make a request for the products, the company has to send the products to the distributors within three days. So, it can be said that the distributors are just responsible for distributing the products to retailers, and for the delivery cost (from distributors to retailers).

Distribution of the distributors is characterized by transportation to various retailers of the required amount of products via pickup trucks conforming to the size of the demand**.** Some of the distributors operate in large cities, and they have many customers (retailers). Their demands are more than the other customers. As the size of the demand increases, most of the distributors located in big cities have more than one pickup truck to deliver products in a quality manner, and of right size. Other factors considered by the distributors are the customer visits' frequency, delivery amount, sharing the delivery of products, the distance to be handled, time of completing the delivery, and returning the required instruments to office. These factors are very important for the distributors. Because there is no contract between distributors and retailers, so the retailers do not have to sell the distributors' products. They may sell other bottled water companies' products. If the distributors don't have the required features, they may lose the retailers because the bottled water market is subject to competitive market conditions in Turkey. There are many bottled water brands, and the prices of the brands are very close to each other.

1.3. Factors That Affect The Costs And Revenues Of The Distributors

Delivery Cost: It covers shipping of the products from the factory to the distributors, and from the distributors to the retailers. The cost depends on some variables such as the distance and quantity. As regards to the distance, some of the distributors have higher delivery costs than the others.

Warehouse and Shop Costs: The costs arise from various elements such as the rents of the shop and warehouse. The distributors have different rental costs due to market conditions, location and size of the warehouse and shop, and some of the distributors have multiple rental costs.

Stock Costs: It covers some costs such as costs for overstocking, keeping stock or keeping less stock, and opportunity cost, cost of capital (which is related to the capital stock, the optimal stock, and the level of investment in stock), cost of the warehouse space (which is related to various costs such as costs for reorganizing stock places in the warehouse, and heating-cooling costs), stock risk costs (deterioration and damage risks), and loading, unloading and returning costs.

Bill Costs: It covers various costs that vary in proportion to goods and services that the business uses such as electric, water, phone, ventilation, heating-cooling, fuel (arising from the distributors' delivery to the retailers) bills.

Staff Wages: All the workers are blue-collar. The distributors pay the workers' wages based on the subsistence wage. The subsistence wage is arranged every year by the government. In addition, it does not cover the wages of the distributor's managers since the managers are actually the owners at all the distributors.

In addition, there are some factors such as regional factors and environmental factors which affect distributors negatively in reaching their goals. These negative factors have a direct effect on costs. Regional and environmental factors cover the location of the distributors. The location of the distributors has a significant effect on rental costs and

delivery costs. Moreover, all the distributors have at least a warehouse and a shop. As mentioned above, some of the distributors are located in big cities such as Diyarbakır, Batman, Gaziantep, Şanlıurfa and Mardin, while others are located in small cities and towns. It is known that rents in big cities are higher compared to small cities and towns. For this reason, some of the distributors have higher rental costs. The location of the distributors directly affects the delivery costs. If the distributor is located distant from the factory, then it has higher delivery costs than a distributor which is closer to the factory.

The distributors arrange the price of the products. There is no constant price of the products. It plays a significant role in terms of the distributors' revenue (they trade cash or checks with retailers). The distributors obtain revenue in two different ways. The first one is making money from the sales. Secondly, all the factories want the highest sales rate from their distributors. In order to promote the distributors, the company gives them a part of the profit. According to the annual sales of the distributors, the company gives them a part of the profit each year.

Regional and environmental factors such as purchasing power of consumers, demands of the customers, number of customers, and climate of the region can have indirect effects on the revenue of the distributors. As mentioned earlier, some of the distributors are located in big cities, so they can reach more customers than the other distributors. Moreover, it is known that the big cities' inhabitants have higher purchasing power and demands. However, it is not always an advantage. Sometimes the big cities have a cutthroat competition. In addition, the climate of the city has an indirect effect on sales. If the summer season is long in a city, the inhabitants consume more water. And this explains why distributors in the Diyarbakır, Batman, Gaziantep, Şanlıurfa and Mardin Provinces have the highest sales rate, as they are cities with long summer seasons.

1.4. Additional Information about the Business Distribution

The common consensus on costs is that the rent (shop and warehouse costs) and delivery costs have a high rate among the total costs. When the size of the distributor enlarges, its rental cost will also increase. In addition, the same relevance exists between the distance and delivery costs. So, if a distributor's place is close to the factory, it has a cost advantage over the distant distributors. The lowest bank guarantee has to be equal to or more than 10,000 TRY. Moreover, all the distributors have to have at least 1 forklift, 1 pallet truck, 1 pickup truck, 2 staff (without manager), 1 warehouse, and 1 store in order to maintain their business. According to the work load of the distributors, the numbers can increase, but they cannot decrease.

2. Literature Review

2.1. Data Envelopment Analysis (DEA)

Data envelopment analysis (DEA) emerged from the Ph.D. dissertation research of Edwardo Rhodes prepared at Carnegie Mellon University. He evaluated the Project Follow Through by the supervision of W.W. Cooper, and the project was an educational program applied at U.S. public schools aimed at disadvantaged students such as black or Hispanic students. The

research covered the comparison of the outputs of a set of school districts that were taking part in the project. Copper & Rhodes (1978)published their first paper, which introduced DEA, in the European Journal of Operational Research. They used DEA to generalize to the multiple-input/multiple-output case the Farrell's (1957) single-input/single-output technical efficiency measure by forming a relative efficiency score as the ratio of a single virtual output to a single virtual input (Farrell, 1957). As a result of the paper, DEA started to be used as a new instrument of management science for technical-efficiency analysis of decision making units (DMUs) in the public sector (Cooper, W.W. 2000).

There are two scale assumptions that are usually evaluated in DEA which are constant returns to scale (CRS), and variable returns to scale (VRS). They cover both increasing and decreasing returns to scale. The assumption of the CRS is that outputs will vary at the same rate as inputs. On the other hand, VRS assumes that production technology can show decreasing, constant and increasing returns to scale (Seiford & Thrall 1990)

Two different orientation models, which are input-oriented and output-oriented models, can be used for DEA. Input-oriented model can be utilized for evaluating how efficient the input of a firm is used for obtaining the same output level. Determining the reduction in the variable inputs based on fixed outputs and based on a desired output level is possible. In contrast, in output-oriented DEA, the efficient operation of linear programming enables the determination of a firm's potential output that gives its inputs. As Fare had referred for output-oriented models as that "...very much in the spirit of neo-classical production functions defined as the maximum achievable output given input quantities" (Fare, Grosskopf, & Lovell, 1993).

As reported by Cooper, Seiford and Tone (2007), DEA has also been utilized to provide a new comprehension regarding activities (and entities) for which other methods were used for their assessment. For example, the use of DEA for analyzing the benchmarking applications has identified many sources of inefficiency in some firms with high profitability; and this has provided a means for identifying better benchmarks in many applied studies. Because of these facilities, DEA studies of different organization forms' efficiency have demonstrated that previous research was insufficient in appraising the potentials of such organizations (Cooper, Seiford and Tone 2007).

According to Cooper, Seiford and Zhu (2011), data envelopment analysis (DEA) is a data oriented approach for assessing the performance of a set of decision making units (DMUs). It transforms multiple inputs into multiple outputs. The explanation of a DMU is generic and flexible. We have seen many applications in which DEA was being used to assess the performances of many different kinds of entities engaged in different activities in different contexts in different countries. In addition, DEA applications of these kinds used different forms of DMUs for evaluating the performance of entities, like universities, regions, hospitals, establishments etc. (Cooper, Seiford and Zhu, 2011).

2.2. Data Envelopment Analysis (DEA) Applications

Ross & Droge (2002) utilized 102 distribution centers in order to evaluate distribution centers' performance by the use of the data envelopment model. The aim of the research

was an integrated benchmarking framework demonstrated in the context of a large supply chain system. The research evaluated distribution centers in a large context, and measured and explained the distribution centers consistently showing best performance by the use of facet analysis, and revealed the performance trends by the use of window analysis on 4 years' data. They used size of workforce, experience, man-hours required (or dollar cost), vehicles (fleet size or capacity), equipment (size or capacity), capital (net present value), and information (demand requirements, machine availability) as the inputs. The inputs represent the major components of a typical distribution center's distribution plan, and the aims of the distribution plan regarding efficient uses of direct labor and distribution vehicles. Also, they utilized the sales volume of four different products as the outputs. They used variable returns to scale DEA model. Their approach developed a new possible direction for appraising distribution center (Ross & Droge, 2002).

Bigne and Blesa (2003) examined the relation among the market orientation behaviors of manufacturers, and the distributors' trust in the relationship, and their satisfaction. In addition, they studied how the distributors' trust affects their satisfaction. They analyzed three models in which the relation between trust and satisfaction were correlated. They used the Spanish ceramic industry for the application. The results illustrate that trust develops the satisfaction of distributors regarding the relation (Bigne and Blesa, 2003).

Chen (2005) analyzed two models which were joint stock replenishment and temporal shipment consolidation decisions for business distribution, and compared their relative cost effectiveness. According to the shipment release schemes, time based or quantity based models were different from each other. Stock replenishment was creating a lump sum cost to seller. (From suppliers, or shipment to customers). The time-based scheme should had been more efficient, as every cost is time-based, but the quantitative examples demonstrated that the quantity-based scheme always performs at least as well as the time-based scheme. A possible identification would be that the time-based scheme is creating higher waiting costs regarding customers. The results showed that the quantity-based scheme can excel the time-based one while the opposite never occurs (Chen Wang & Xu, 2005).

Balteiro and Herruzo (2006) analyzed the relation between productive efficiency and innovation activity in Spain's wood-based industry. They used two different methodologies which were a non-parametric technique (data envelopment analysis, DEA), and a logistic regression model. Several inputs and outputs associated with economic and financial data wereused in a non-parametric technique. The logistic regression model was used in order to explore the relation between the property of efficiency, and indicators of innovation activity. The results showed that there was no significant relation between the firm's efficiency and innovation activities (Balteiro, Herruzo, Martinez and Pachón, 2006).

Souza, Macedo and Sales (2010) used data envelopment analysis (DEA) in order to evaluate the relative performance of the 100 supermarket companies being the smallest ones in the list of the 300 largest ones. The results demonstrated that single store companies had performance issues due to economies of scale, while chain stores had issues due to poor technical efficiency. According to the results, the ten largest supermarket companies had better performances than the others (De Souza, April-June 2010).

3. Methodology

The objectives of the DEA are to measure the relative efficiency of the homogeneous decision-making units (DMUs). The efficiency is usually expressed in a ratio form. In the DEA, many inputs' and many outputs' efficiency scores are defined as follows:

Efficiency: Weighted Total Output / Weighted Total Input

DEA is a combination of the many variables, and the relationship of the variables evaluated. It also uses mathematical programming to assess a combination of a large number of inputs and outputs. If we compare DEA with the other approaches, DEA is easier for the user. Furthermore, there are two efficiency orientation models: input and output orientation models. The aim of the input orientation is to minimize inputs for specified output. The purpose of the output orientation is to maximize output for given inputs. In the DEA, the returns to scale are related to how the productivity of an efficient producer changes with the scale size. If inputs increase by a rate, then outputs will increase by that rate. If inputs increase by a greater rate, then outputs will increase by a greater rate, and it increases returns scale. If inputs increase by a rate, then outputs will increase by a lesser rate, and it decreases returns scale. If the rate of increase of the inputs and outputs are the same, then it is constant returns to scale (in the conceptual model part DEA is explained extensively).

3.1. Conceptual Model of the Research

Measurement of Efficiency

Technical efficiency is related to the production of outputs as a result of given inputs. Production plans of the technical efficiency can be applied in two ways. First, if there is no chance to produce more outputs using the same inputs. Secondly, technical efficiency can be applied to produce same outputs by using less inputs. The DMUs (measured technical efficiency) are derived from the frontier. "*The measurement of some distance between the observed inputs - outputs combination for a specific DMU and the frontier"*. Afterwards, the scale efficiency analyzes the shape of the frontier (Favero and Papi, 1995). For these reasons, in this application, technological, scale, pure and efficiency change of the 51 distributors were analyzed by a non-parametric method known as data envelopment analysis (DEA).

Return to scale is related to the way the productivity of an efficient producer changes according to scale size. Also, it is known that it is a feature of the frontier that describes how productivity changes alternatively by scale. It is clear that all the distributors have different cost profiles, and some of them are larger than the others. Also, some of them are distributors at mega cities, and the others at small cities or towns. Therefore, it could be said that the VRS model would be more appropriate for the analysis due to the reasons which proved that VRS is more preferable than CRS.

In addition, the research needs to be controlled in terms of whether there is adequate observation or not before the analysis chapter. There are two general rules of thumb to know the minimum amount of required observation. The below assumptions prove that

we can accurately assume the VRS-output orientation model for the research analysis. Banker (1989) had suggested a rough rule of thumb (Emrouznejad, 2012).

(In the research) …OBSERVATIONS = 51, INPUTS = 1 and OUTPUTS = 4.

1Observations > 3* (INPUTS + OUTPUTS) 1 51 >= 3* (1+4) = 51 >= 15

2Observations > INPUTS * OUTPUT 251 > 1*4 = 51 > 4

The Orientation Model

At this point, the type of the orientation model has to be arranged. It means that the objectives of the model, which are input or output orientation, should be organized. Walden and Kirkley had stated that an input-oriented technical efficiency model evaluates the vector of inputs used in any output bundle's production, and measures whether a firm is making use of the minimum inputs necessary to produce a specific bundle of outputs. Efficiency is measured by the maximum decrease in inputs which will still allow a specific bundle of outputs to be produced. The output-oriented model demonstrates how much each DMU should increase the output production when the inputs are kept constant (Walden & Kirkley, 2000).

In the application, if the input variables are considered, it can be seen how highly they are fixed, and how difficult it is to decrease them. Number of the staff can be decreased by the discharge of employees. However, the idea can give the result that the distributors might have to pay extra cost to employees (termination compensation). The distributors cannot reduce the distance easily, because it will deeply change the capital and operating costs. It would be required for the owners of the distributors to rebuild the establishment. So, there is no way to change the distance input. Additionally, size represents the usage of space (warehouse and store). If distributors want to change their warehouse or store, the may pay contract penalties. The distributors cannot change the size variable, and they cannot either change the operational cost, because the operational costs such as utility costs, rent costs and delivering costs are out of the distributors' control, so it would be hard to reduce it as a company. Capital indicates the bank guarantee, and machine and equipment costs. If the capital is changed, selling second hand equipment would be required. This would not be sensible, because the distributors would lose money. In consequence, the input variables are out of the distributors' control. The distributors cannot decrease the input variables. As explained, the input variables are kept constant, then the DMUs analysis is made as output orientation; and the output orientation model shows how much each DMU should increase output production. In other words, in order to maximize the sales, the DEA output orientation model is assigned.

Table 1. Basic DEA model

$\boldsymbol{max\ h_0(u,v)}: \frac{\sum_r u_r y_{ro}}{\sum_i v_i x_{io}}$	$\boldsymbol{min\ h_0(v,u)}: \frac{\sum_i v_i x_{io}}{\sum_r u_r y_{ro}}$
$\boldsymbol{subject\ to}: \frac{\sum_r u_r y_{rj}}{\sum_i v_i x_{ij}} \leq 1 \quad j = 1, 2, \dots, n$	$\boldsymbol{subject\ to}: \frac{\sum_i v_i x_{ij}}{\sum_i u_r y_{rj}} \geq 1 \quad j = 1, 2, \dots, n$
$\boldsymbol{u_i, v_j \geq 0} \qquad \boldsymbol{for\ all\ i\ and\ r}$	$u_i, v_j \geq \in > 0 \qquad for\ all\ i\ and\ r$

We suppose that there are n DMUs to be assessed. Each DMU, in order to Each DMU consumes varying amounts of m different inputs to produce s different outputs, consumes varying amounts of m different inputs. Especially, DMU_J consumes x_{ij} amount of input I, and produces y_{rj} amount of output r. We assume that $x_{ij} \geq 0$, and that at least one positive input and one positive output value are being obtained by each DMU. CCR construction can be interpreted as the decrease of the multiple-output / multiple-input case (for each DMU) to a single "virtual"-output and "virtual"-input. For a particular DMU, the ratio of this single virtual-output to single virtual-input gives a measure of efficiency that is a function of the multipliers. In mathematical programming, this ratio, which is required to be maximized, forms the objective function for the particular DMU under evaluation, and it should be noted that the variables u_r, s and the vis and the y_{ros} and x_{ios} are respectively the observed output and input values of DMU_o being evaluated. Of course, without further additional constraints, the above equation is unbounded (William W. Cooper, 2005).

The Inputs and Outputs

Sales: it represents, in terms of the quantity, how many products each distributor sold to the retailers. There is not another way to earn money for the distributors. Selling other products or providing other services is forbidden. All the distributors want to maximize their sales number in order to make money. Because of these reasons, it is obvious that the sales variable is a potential output.

Staff: The data index part defines the amount of labor used in a store and warehouse of the distributors. All the distributors have different workloads, so the number of the staff is different for most of the distributors. It can be said that the higher number of the staff shows that more men are needed to perform the operations required by the distributors. It should be minimized because it is a potential input.

Distance: it shows the distance between the factory and the distributors' final location. If a distributor has a higher distance number, it means that the distributor has to pay a higher delivery cost. It is obvious what a high distance number means for the distributors cost. So, it is an input for the distributor.

Size: it indicates that this variable 'size' facilitates the calculation of the usage of space and its relation to the process of distribution. It is known that large size usage will increase the rent costs. The distributors demand is lower rent costs. So, it is an input.

Capex: it is the monetary value of the bank warranty (license) and machine and equipment (e.g. forklıfts, pallet trucks and truck) costs. It is an investment cost of the distributors. The objective of the distributors is to minimize the investment, so it is clear that the variable is a potential input.

Data Collecting Procedures

The data were obtained directly from the factory; they have a yearly database about all the distributors. The factory sent all the information about the distributors by email. There were some problematic issues with the data. They were complex and huge. The company has many domestic and overseas distributors. To utilize the data for the research, the

first step was determining the distributors which are domestic distributors. The number of the domestic distributors is more than the overseas distributors. Then, the years were arranged. It is better to use the last two years' data to make the best estimation about the distributors. Then the data were cleaned on excel for a reasonable use in the analysis. The last step was about what the distributors are doing, what is the most important factor on revenue and cost, what is the most important factor of their business, etc. Thanks to the questions, the background information, the data and business distribution were identified. The questions were asked to the distributors directly on the phone and by email. Finally, the data collecting part had three steps, first of all, the data were fixed. Secondly, the data were cleaned. The last step was to clearly understand the business distribution. It is clear that the primary data were used in the research.

4. Analyses and Results

4.1. Basic Statistical Analyses

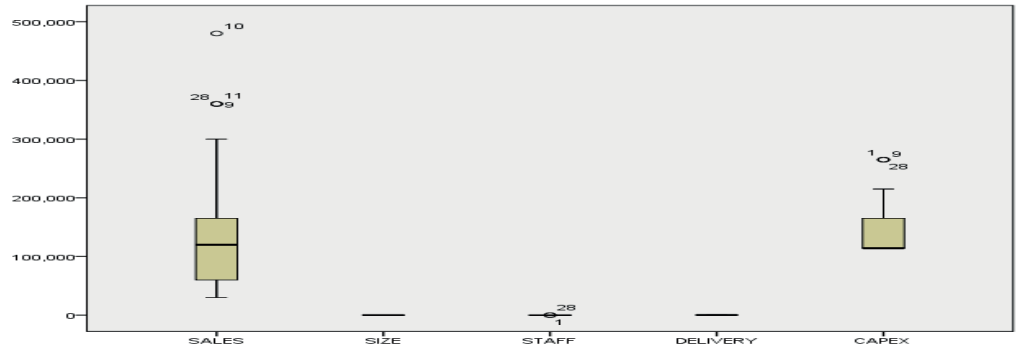
The summary (descriptive) statistics illustrate that there is a large dispersal in the values of variables between different activities. In other words, descriptive statistics explains how the variables spread between maximum and minimum values. Also, there is a significant gap between the maximum value and the minimum value of the variables. The minimum values are markedly less than the maximum values. In addition, it is known that if the observation values are close to the mean, the standard deviation value is becoming low and close to the mean without the Capex variable. The table shows that the mean values and standard deviation values are close to each other. So, the standard deviation values are slightly less than the mean values. It means that the observation value of the variables is concentrated around the average.

Table 2. Descriptive Statistics (2012)

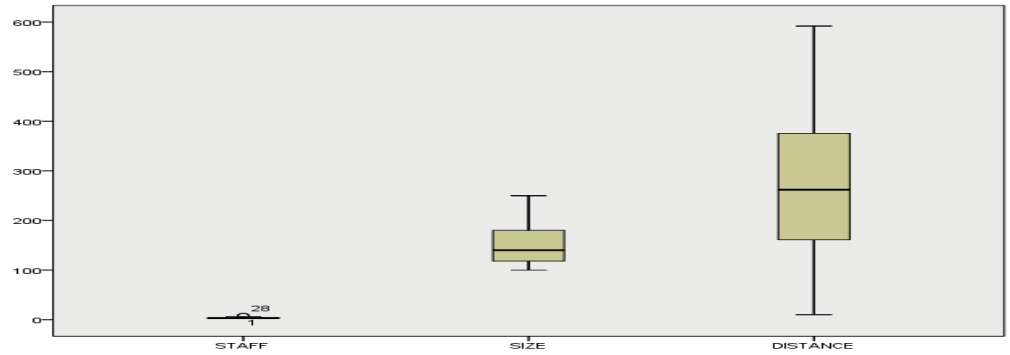
Variable	Obs	Mean	Std. Dev.	Min	Max
SALES	51	132117.6	101678.2	30000	480000
SIZE	51	154.2353	46.57492	100	250
STAFF	51	3.156863	1.405312	2	8
DISTANCE	51	274.8627	150.202	10	592
CAPEX	51	145627.5	44966.19	114000	265000

By looking at box plots (they are shown in the Appendix part), box plot 1 illustrates that the median of the Sales and Capex are about 120.000 and 114.000 respectively. In terms of the sales, the distributors 10, 28, 11, and 9, which are the Nusaybin, Kiziltepe, Mardin and Gaziantep distributors, have the highest sales quantities. For the Capital Expenditures, the distributors 9, 28 and 1, which are the Mardin, Gaziantep and Diyarbakir distributors, have the highest Capital expenditures. Also, box plots 2 and 3 demonstrate that the median of the distance, size, and staff are 262, 140 and 3 respectively. The DMU 28 and 1 have 8 staff which is the highest number in all the distributors. (All the reasons are discussed in the Discussion Chapter.)

The pairwise correlation Table 3 shows the relationship between the five variables, which are the sales, staff, distance, size, and capex. It is known that the objective of pairwise



Box plot 1. All The Variables



Box plot 2. Delivery Size And Staff Variables

correlation analysis is to assess the closeness of the linear relationship among defined variables. The most important point in a correlation analysis is that we desire a low correlation among inputs variables, while we want a high correlation of input variables with output variables.

Table 3. Pairwise Correlation

	SALES	SIZE	STAFF	DISTANCE	CAPEX
SALES	1				
SIZE	0.9194	1			
STAFF	0.8170	0.8061	1		
DISTANCE	-0.3018	-0.2961	-0.2276	1	
CAPEX	0.8642	0.8749	0.7817	-0.1614	1

The distributors determined the number of the staff, size of the warehouse and store, as the sales quantity. Also, the distributors' capex value is in direct proportion to the sales quantity. The reasons explained why most of the inputs and outputs are significantly and positive correlated with each other (without distance variable). In addition to that, before the analysis chapter, it was predicted that most of the variables obviously have a high relation with each other. However, the distance variable seems to be problematic. It has not correlated with other variables. It is obvious that the distance variable is negligible. Because the distance has a negative and low correlation with all the variables. So, the distance variable is excluded from the main model.

4.2. Data Envelopment Analysis (DEA)

Two years of data of the distributors were used in the DEA analysis. First of all, the main model which is the VRS output orientation model was run in order to find the least and the highest efficient distributors. Secondly, the least efficient distributor's peers were investigated and their lambda values were commented on as well. Thirdly, the CRS output orientation model was run to search for the least and the highest efficient distributors on the CRS and MPSS as well. Fourthly, the allocative efficiency of the distributors under cost efficiency was studied. Lastly, the productivity change (Malmquist Index) of the least efficient distributors (VRS and CRS) and productivity change of the all the distributors was investigated.

Variable Returns to Scale (VRS)

The Vrs-Output oriented model was run in order to investigate the least efficient distributor. As is mentioned before, the inputs are not under the distributors' control and the distributors desire is to maximize their sales quantity which is an output variable in this research. Besides, 13 distributors are 100 % efficient under the VRS. They are the Silvan, Mardin, Nusaybin, Midyat, Siirt, Sirnak, Cizre, Kars, Siverek, Akcakale, Sahinbeyi, Elbistan and Kilis distributors respectively. On the other hand, the Hani distributor is the least efficient distributor within the 51 distributors. (All the distributors efficient results over the two years are shown in the appendix part). It is 33.33 % efficient. In other words, it is 66.66 % inefficient. To comment on the distributor, it is better to search for the actual value, gain value, target value and slack value of the distributor.

Some formulations about Table 4:

***Achieved* = (Actual Value / Target) * 100**

***Sales Achieved Value* = (30000 / 90000) * 100 = 33.3**

< *for output variables* > Target = Actual value * (1+GAIN/100)

90000 = 30000 * (1+ 200 / 100)

< *For input variables* > Target Value = Actual Value -Slack Value

114 = 114 –0 (Size *Target Value)*

Table 4. Target and slack values for Hani distributor, output orientation

Variables	Type	Actual Value	Target	Gain (%)	Slack	Achieved (%)
SALES	OUTPUT	30000	90000	200	0	33.33
STAFF	INPUT	2	2	0	0	100
SIZE	INPUT	120	120	0	0	100
CAPEX	INPUT	114000	114000	0	0	100

The target values demonstrate the input and output levels that the Hani distributor should use to achieve Pareto efficiency. Besides, it can be said that the increase value for sales is 200 % and it does not have any slack value. The sales can increase to 90000. Also, the

model is an output orientated model, the output of which is sales, and should be able to increase at least by:

100 –Eff (%) = 100 –33.33 = 66.66 %

The minimum increase that outputs should achieve to make the unit 100% efficient is:

(100 –Eff %) / Eff = 100 –33.33 / 33.33 = % 200

From the information, it is obvious that sales should increase by 200 % to become Pareto efficient. In addition, the variable does not have any slack value. If the variable has slack value, the variable can increase by the slack value. The situation is not valid inputs and output variables. Therefore, the variables do not have any slack value in this circumstance.

Peers of the Least Efficient Distributor

It is known that the Hani distributor is the least efficient within all the distributors. So, the Hani distributor could develop its efficiency by adopting the practices used by its more efficient peers. The efficient peers are the 100% efficient DMUs with the most similar input mix in an output-oriented model (or most similar output mix in an input oriented one) to the assessed DMUs. It means that they are benchmarks. From the data, it is clear that the Sahinbeyi distributor is an efficient peer with the Hani distributor (The values are represented in Table 6).

Table 5 shows that the Sahinbeyi distributors used the same inputs number but their efficiency is 200 % more than the Hani distributor. In other words, the peers value represents that the Hani distributor can increase sales 200 % with exactly the same inputs. It is an attainable target. The lambda values are the raw weights assigned to the peer unit when solving the DEA model. These λ values are the weights that relate to each efficient peer variable value to investigate the ideal benchmark for the Hani distributors. For instance, it is calculated as below (Vrs -Output Size input variable):

$$Sizetarget, Hani = \lambda Sahinbeyi, IN{*}SIZESahinbeyi$$

Table 5. Hani distributor's efficient peers input and output values

Variables	Sahinbeyi
SALES (output)	90000
STAFF (input)	2
SIZE (input)	120
CAPEX (input)	114000

Table 6. Lambda values for Hani efficient Peers (input and output orientation)

Lamda	Sahinbeyi
λ (output)	1
λ (input)	1

Returns to Scale (CRS- Output)

Under the CRS-output oriented model, the Mardin and Nusaybin distributors have the highest efficient value, however, the Araban Distributor has the least efficient within 51 distributors. The efficiency value of Araban is 15. In other words, it is 85% inefficient. It operates under increasing returns to scale and its scale efficiency is:

Scale Eff (out-put) = VRS Eff / CRS Eff (out-put)
15 / 100 = 15 % (Araban)
VRS < CRS
Scale efficiency always <= 1

Variable Returns to Scale (VRS) hold when the CRS do not hold for all scales of operation. In addition, the explanation of the MPSS is that MPSS corresponds to the maximum productivity attainable in the single input -single output case, it corresponds to the maximum output to input ratio.

Allocative Efficiency

Allocative efficiency contends with minimizing the cost of production with a proper combination of inputs to a specified level of outputs and a set of input costs. To produce minimum outputs, we need an optimal input combination. Because of this reason, all the distributors have to use the correct ratio of the combined inputs and be technically efficient at low prices in order to produce output with a minimum cost. Thanks to the results, the distributors will have profit maximization. To sum up, allocative efficiency assesses the DMU capability to minimize cost so that output is produced at a minimal cost (Allocative Efficiency = Cost Efficiency * Efficiency).

In the allocative analysis, the new model, which is allocative efficiency, is run with VRS-output oriented model and for the allocative type cost efficient chosen. Then, the inputs values are written for all the distributors. The six distributors which are Nusaybin, Cizre, Kars, Siverek, Sahinbeyi, and Elbistan are 100 % efficient based on the cost allocative efficiency analysis (The values are calculated, and all the distributors cost and allocative efficiencies are demonstrated in the Appendix chapter).

Staff: 1 Staff salary is 886 TL the first year, and 978 the second year for all the distributors. As is mentioned before the distributors pay subsistence wages for all the staff.

Size (rent / m2): (Each of the distributors' rent cost / Each of the distributors' size). We obtained one square meter payment of the distributors.

Capex: the capex variable indicated the distributors' capital expenditure differently. So, we wrote just one for all the distributors.

Productivity Change (Malmquist Index)

The Malmquist analysis measures the productivity changes for distributors from 2012 to 2013. Besides, the Malmquist index measures productivity change top-down. Also, if the pure efficiency, scale efficiency change and technological change are calculated,

the productivity change (%) over the time of the distributors can be obtained for each distributor. In this research, data of the distributors were used between 2012 and 2013, and the Malmquist analysis output of the 2012 and 2013 data (VRS-output oriented model) gave the Malmquist Index (MI), the efficiency change (EC) and the technological change (TC) for all distributors. First of all, the CRS-output oriented model and the FGNZ Index (CRS) were chosen, then the model was run to obtain the results. In addition, the Malmquist Index value of Hani is -1.13%. It means that the distributor's productivity decreased in the second year (TC (2.96%) < EC (-4.08)). The productivity of the distributor was stable in the second year. The Araban distributor's Malmquist Index is 2.96% (EC(2.96) > TC(0)). In other words, the distributor's productivity increased in the second year (MI = TC * EC).

Pure Efficiency Change

The Hani and Araban distributors' pure efficiency values are 1.10% and 109.87% respectively. Both distributors became much more close to the VRS frontier in the second year. Pure efficiency change measures how much the evaluated distributors in the period are closer to (or further away from) the VRS frontier in period t+1. So, the distributors are further away from the VRS frontier in the second year (PEC: VRS Y2 / Y1).

Efficiency Change

Efficiency change demonstrates whether a distributor shifted or not (closer to or further from) the CRS frontier. In other words, it indicates the distributors' changed efficiency. It decomposed from pure efficiency (PEC) and scale efficiency change (SEC). The formulation of the efficiency change is shown below, and all the distributors' efficiency change is demonstrated in the Appendix chapter.

EC = Pure Efficiency change * Scale Efficiency Change

The Araban distributor is the least efficient within the 51 distributors, under the CRS (all the distributors' results are illustrated in the Appendix chapter). Under the VRS, the efficiency of the Hani distributor decreased by -4.08% from the first year to the second year. Also, the Araban distributor is the least efficient distributor under the CRS, the distributor increased efficiency by 2.96, but the frontier is stable in the frontier (the virtual benchmark of the Suruc distributor has become – 1.01 % less efficient). Regarding the efficiency change, the pure efficiency of the Hani distributor is 1%, and the scale efficiency change of the distributor is -5.19%. Because of this reason, the efficiency change is -4.08%, and it has a negative impact on the overall productivity.

Scale Efficiency Change

Scale efficiency change indicates how much more (or less) scale efficient the evaluated distributors are in period t+1. Also, the Araban and Hani Distributors' scale efficiency results are -106.92 % and -5.19 % respectively. It is obvious that the scale efficiency of the Araban distributor decreased significantly in the second year, and the Hani distributor decreased in the second year. It means that both distributors moved away from their most productive scale size in the second year. The scale efficiency change is given by the combination of these two components: SEC: Scale Efficiency Y2 / Scale Efficiency Y1.

Technological Change (Frontier Shift)

Technological change (frontier shift) measures the same interpretation as before by how much the productivity of the benchmark of the evaluated distributors improved or deteriorated. Furthermore, the Hani and Araban distributors' technological change values are 2.96% and 0% respectively. In other words, the productivity of the benchmark of the Araban distributor is stable in the second year, whereas the Hani distributor's assessed benchmark (peers) distributor increased (TC (Frontier Shift): Malmquist index / Efficiency Change)).

General Change in The Productivity for All the Distributors

Overall, if the productivity change components for all the distributors are taken into account, it can draw some important results about the distributors' performance evolution. From Table 8, it is obvious that most of the evaluated distributors could not manage to improve their productivity during the two years, because the average of the distributors is less than 1. It is known that some of the distributors' productivity increased, and some of them decreased. The productivity of the distributors takes a value between 14.84 and -14.93(%). However, the average of the technological change increased by 0.85%. It means that the benchmarks of the distributors increased, but the efficiency change decrease is more than the technological change decrease. It also explains why the distributors MI average is negative. Furthermore, the scale efficiency change average of the distributors is negative, which means that the distributors moved away from their most productive scale size. However, the pure efficiency change average of the distributors is 1.53. The average of the distributors becomes closer to the VRS frontier in the second year.

Table 7. Actual and Most Productive Scale Size for Hani Distributor

Variables	Target Value	MPSS
SALES(output)	90000	200304.88
STAFF(input)	2	4.45
SIZE(input)	120	267.07
CAPEX(input)	114000	253719.51

Table 8. General Change In The Productivity For All The Distributors

	TC(%)	MI(%)	EC(%)	SEC(%)	PEC (%)
AVG	0.85	-0.27	-1.12	-2.65	1.53
MIN	-13.93	-14.93	-18.63	-106.92	-15.27
MAX	9.53	14.84	14.84	15.27	109.87
STD DEV	4.59	6.01	7.18	16.01	17.27

5. Discussion and Conclusion

It is known that the civil conflict started in Syria in 2011, and it is still continuing. Besides, the Republic of Turkey has 13 border gates with Syria. They are in Mardin (2), Sanliurfa (3), Gaziantep (2), Hatay (4), Kilis (1), Sirnak (1). After the civil war started,

Turkey accepted all the refugees from Syria. They are more than 4 million. The Turkish government built tent cities in Mardin, Sanliurfa and Gaziantep. So, the extraordinary situation affected the research results directly, since water is a kind of indispensable product. All people have to drink water every day. Furthermore, in these tent cities, refugees are drinking bottled water. This circumstance affects the results of the Mardin distributor and Mardin town's distributors (Nusaybin, Kiziltepe and Midyat), Gaziantep distributors and Gaziantep town's distributors (Sahinbeyi, Sehitkamil), Sirnak distributor and Sirnak town's distributor (Cizre) sales directly. According to the box plot (appendix box plot 1) results, the Mardin distributor and its town distributors which are Nusaybin and Kiziltepe have the highest sales quantity within all the distributors. Also, the Gaziantep distributor is another distributor that has the highest sales value. Besides, Gaziantep is a big city. It is the most developed city, and it is the most qualified industrial city of Turkey's south east region. It has a population of about two million people. So, the situation of the Gaziantep is negotiable. We cannot say that the sales number of Gaziantep is just due to the refugees from Syria. Also, it is important to figure out that Mardin city and its towns water quality is too low. There are two dams in Mardin. The city 's water is supplied from these dams. Their dam water base level is low. The dams were built in 1985, so they are old dams. Thus, the tap water quality is low. Because of that, Mardin city and its town citizens cannot drink tap water. It can be another factor to explain why Mardin and its town have a high sales quantity number.

In terms of the Capex and Staff variables, the Diyarbakir, Gaziantep and Mardin distributors have the greatest value because these distributors are located in big cities. They have to have more machines (trucks and other machines) and equipment to reach retailers just in time. Also, we know that the rent costs of the big cities are more than in small cities and the towns. So, they have to pay for more rent costs than the other distributors. The situation supports both assumptions. Nusaybin, Kiziltepe, Midyat are towns of Mardin city, and the population of Mardin is greater than theirs, but they have more sales quantity than Mardin. It can be concluded that the town of Mardin cities distributors is affected by the refugees from Syria. As the analysis results show, it is clear that the Mardin, Diyarbakir, Gaziantep, and Sanliurfa distributors and their town distributors have the highest sales quantity numbers. Also, it can be explained by the weather conditions of the cities. The cities are located in the south east of Turkey. The region is the warmest region of Turkey. The average temperature of the region is more than 35 C in spring and summer time. Also, the yearly average temperature of the region is more than 25 C. It is known that there is positive correlation between water consumption and temperature. It means that if thetemperature rises, the water demands will increase. According to the weather average of the region, these cities are very hot. It can be another important reason why the distributors sales quantity is higher than the other distributors.

In the analysis the DEA, results of the distributors are obtained. As a result of the DEA analysis, all the big cities could not be 100% efficient without Mardin city. It is interesting that most of the big cities' town distributors are 100 % efficient such as Nusaybin, Midyat, Sahinbeyli, etc. The situation is valid for the two years' efficiency of the distributors. As well, the same situation continues in allocative efficiency results. The town distributors are

again 100% efficient as Nusaybin, Sahinbeyli distributors. Rent costs of the distributors can be the main results, because the distributors have to store and warehouse, and the cost of the rent is more in big cities than in the small cities and towns. However, all the distributors pay subsistence wages to their staff, but the big city's distributors have to have more staff. So, these reasons explain why the town distributors are more efficient than the city distributors in allocative efficiency.

To sum up, in this research, we used real data of a water bottling factory's 51 distributors over two years. The distributors' efficiency and productivities analyses were obtained via Data Envelopment Analysis (DEA) results with four parameters: Sales, Staff, Size and Capex (the delivery variable is excluded from the model in the correlation analysis). The productivity of the distributors is also analyzed over the two years in these results. In addition to that, it is important to discuss the result of the analysis after the analyses and results since, before the analysis, we got different results from the assumptions (big cities distributors' efficiencies are better than the small cities and town distributors). This is because of the global conflict (war in Syria), Turkish government policies (accepting the war refugees) and the other reasons (natural and environmental). Furthermore, as the productivity analyses of the DEA approaches, the big cities distributor's productivities are less than the small cities and towns distributors. Because of these reasons, the small cities and towns distributor's efficiency and productivities are better than the big cities distributors (the reasons are explained in depth in the discussion).

5.1. Recommendations

In the DEA analysis results, some of the distributors' efficiencies are low, for instance, the Hani, Araban, Suruc, Hakkari, and Adiyaman distributors are the least efficient distributors (the Araban distributor is 100% efficient in the second year). The efficiency of the distributors is less than %50. The first step should be to check the distributors' benchmarks (peers), because the manager can see their capacity. In other words, the manager can figure out how much we can increase our sales with specified inputs. The Hani and Araban distributors analysis is done in the analysis chapter (Hani was the least efficient distributor over the two years under the VRS-output oriented model, and the Araban distributor is the least efficient distributor under the CRS-output oriented model over the two years).

Another important point is the productivity of the distributors. In the results, the productivity of the Cizre distributors decreased significantly in the second year. Cizre is a town of Sirnak city. Besides, the Sirnak distributor's efficiency decreased by -5 %. It clear that the Cizre distributor's sales quantity decreased in the second year (by 2000), and the number of the Capex increased. So, the investment decreased the efficiency of the Distributor.

According to the total number of the parameters, the number of the sales and capex change in the second year. There is small increase in the number of the sales variable (about 6000), however, the capex variable increased significantly. Also, the staff wages increased in the second year. These reasons explain also why most of the distributors' efficiency

decreased in the second year. It is obvious that the number of the inputs increased more than the number of the outputs. Because of these reasons, we can suggest to the manager of the distributors that they should be careful about their internal resources. These kinds of spending decrease their efficiency. They should not increase their inputs more than their outputs.

5.3. Research Limitations (Constraints)

It is better to start with the parameters, because some of the variables are dropped from the model before the main analysis (DEA). First, the distance (delivery) variables are excluded from the model in the correlation analysis. It measures the distance between the factory and the distributors' final location (warehouse or store). But the parameter can develop, and it may be suitable to analyze for other researchers. For example, the distance from a distributor to its retailers. Tthe rent cost and transportation costs are the main expenditure of the distributors. It is better to have more parameters in the analysis. In addition to that, the Capex variable measured the second hand price of their machines and equipment. It is not easy to find the real value of the distributors' machines and equipment because some of the distributors bought them many years ago, and some of them bought second hand. It is a constraint (limitation) of the research. Another limitation of the research is the market structure of the distributors, and where they are located. Maybe there is a competitive market in their cities or towns. For example, maybe there are many water bottling factories or companies in the distributor's city or there is not any water bottling company or companies. It is another limitation of the research. So, if we know about these kinds of the constraints, the research can be a more in-depth analysis, and the results can be more reliable.

5.4. Future Research

The efficiency of the distributors is evaluated as their sales quantities and the inputs. Also, the research can apply to the sales price of the distributors because there is no fixed price. Besides, the sales price can show the market structure, and the efficiency of the distributors assessed with new parameters. In addition to that, the variables can change as one output and two inputs. The output can be sales quantities or sales price of the distributors. In terms of the inputs, one of them can be the operational expenditures: utility costs, delivery costs, staff costs, etc. Another input can be the capital expenditures: bank warranty to obtain sales license for the factory and machines and equipment. Besides, some also have overseas distributors (Iraq distributors). The model can be more general with a larger number of DMUs.

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Ek 1.

Distributors	Efficiency (VRS-Output)
HANI	33.33
ARABAN	33.33
SURUC	37.04
HAKKARI	38.89
ADIYAMAN	42.11
ANTAKYA	45.16
BISMIL	50
KOZLUK	50
BULANIK	50
MERSIN	52.63
ISKENDERUN	58.26
MALATYA	59.32
REYHANLI	60.54
DIYARBAKIR	62.5
VAN	62.57
ELAZIG	63.08
ADANA	65.22
AGRI	66.67
AFSIN	66.67
BINGOL	66.67
KAHTA	66.67
SIVAS	66.67
BIRECIK	68.97
ERZURUM	68.97
BITLIS	71.43
SEHITKAMIL	73.31
K.MARAS	74.43
BATMAN	74.89
GAZIANTEP	75
PATNOS	80
MUS	80
URFA	81.81
CERMIK	82.35
NIZIP	87.08
KURTALAN	87.39
HILVAN	89.04
KIZILTEPE	89.7
ERGANI	92.2
SILVAN	100
MARDIN	100
NUSAYBIN	100
MIDYAT	100
SIIRT	100
SIRNAK	100
CIZRE	100
KARS	100
SIVEREK	100
AKCAKALE	100
SAHINBEYI	100
ELBISTAN	100
KILIS	100

Distributors	Efficiency (CRS-Output)
ARABAN	15
HANI	17.25
SURUC	17.25
BISMIL	17.76
KOZLUK	17.76
BULANIK	17.76
HAKKARI	24.55
AGRI	34.5
BIRECIK	34.5
AFSIN	34.5
BITLIS	34.5
BINGOL	34.5
KAHTA	34.5
ERZURUM	34.5
SIVAS	34.5
PATNOS	34.62
MUS	34.62
KARS	35.53
ELBISTAN	35.53
ADIYAMAN	36.68
ANTAKYA	37.09
SEHITKAMIL	37.17
K.MARAS	37.17
CERMIK	38.14
KILIS	45
MERSIN	45.85
ISKENDERUN	46.41
REYHANLI	46.55
MALATYA	46.75
VAN	47.04
ERGANI	49.56
HILVAN	49.56
AKCAKALE	49.56
SIRNAK	51.75
SAHINBEYI	51.75
ELAZIG	55.03
ADANA	55.18
SILVAN	58.94
SIVEREK	59.47
DIYARBAKIR	62.5
SIIRT	66.67
NIZIP	69.52
KURTALAN	69.61
CIZRE	70.11
BATMAN	72.91
GAZIANTEP	75
URFA	76.84
KIZILTEPE	87.43
MIDYAT	88.89
MARDIN	100
NUSAYBIN	100

Distributors	COST Efficiency (VRS-Output)	Allocative Efficiency (VRS-Output)
HANI	99.89	299.68
ARABAN	99.25	297.74
SURUC	99.95	269.86
HAKKARI	69.51	178.74
ADIYAMAN	69.12	164.17
ANTAKYA	69.59	154.09
BISMIL	100	200
KOZLUK	100	200
BULANIK	100	200
MERSIN	69.74	132.5
ISKENDERUN	69.92	120.01
MALATYA	69.75	117.58
REYHANLI	69.99	115.62
DIYARBAKIR	58.65	93.84
VAN	69.98	111.85
ELAZIG	71.12	112.76
ADANA	70.59	108.23
AGRI	99.8	149.7
AFSIN	99.86	149.79
BINGOL	99.86	149.79
KAHTA	99.8	149.7
SIVAS	99.84	149.76
BIRECIK	99.87	144.81
ERZURUM	99.87	144.81
BITLIS	99.92	139.88
SEHITKAMIL	99.12	135.21
K.MARAS	99.18	133.26
BATMAN	72.93	97.39
GAZIANTEP	66.24	88.31
PATNOS	99.92	124.9
MUS	99.92	124.9
URFA	67.32	82.29
CERMIK	99.26	120.53
NIZIP	70.92	81.45
KURTALAN	71.24	81.51
HILVAN	99.63	111.89
KIZILTEPE	81.88	91.29
ERGANI	99.69	108.13
SILVAN	98.6	98.6
MARDIN	66.97	66.97
NUSAYBIN	100	100
MIDYAT	64.22	64.22
SIIRT	70.29	70.29
SIRNAK	99.88	99.88
CIZRE	100	100
KARS	100	100
SIVEREK	100	100
AKCAKALE	99.83	99.83
SAHINBEYI	100	100
ELBISTAN	100	100
KILIS	99.5	99.5

Distributors	Fırst Efficıency (VRS-Output)	Second Efficıency (VRS-Output)
ADANA	65.22	59.44
ADIYAMAN	42.11	46.04
AFSIN	66.67	67.39
AGRI	66.67	63.46
AKCAKALE	100	100
ANTAKYA	45.16	44.54
ARABAN	33.33	100
BATMAN	74.89	82.26
BINGOL	66.67	64.13
BIRECIK	68.97	67.98
BISMIL	50	48.79
BITLIS	71.43	72.09
BULANIK	50	46.77
CERMIK	82.35	78.39
CIZRE	100	100
DIYARBAKIR	62.5	71.73
ELAZIG	63.08	67.22
ELBISTAN	100	98.39
ERGANI	92.2	79.14
ERZURUM	68.97	66.29
GAZIANTEP	75	87.32
HAKKARI	38.89	37.2
HANI	33.33	33.7
HILVAN	89.04	80.45
ISKENDERUN	58.26	52.29
K.MARAS	74.43	68.28
KAHTA	66.67	63.46
KARS	100	100
KILIS	100	100
KIZILTEPE	89.7	95.85
KOZLUK	50	51.61
KURTALAN	87.39	79.32
MALATYA	59.32	64.91
MARDIN	100	100
MERSIN	52.63	48.83
MIDYAT	100	96.51
MUS	80	79.22
NIZIP	87.08	88.36
NUSAYBIN	100	100
PATNOS	80	76.62
REYHANLI	60.54	58.89
SAHINBEYI	100	100
SEHITKAMIL	73.31	100
SIIRT	100	100
SILVAN	100	95.54
SIRNAK	100	92.59
SIVAS	66.67	61.25
SIVEREK	100	94.84
SURUC	37.04	38.55
URFA	81.81	87.93
VAN	62.57	61.63

Distributors	PEC	SEC	EC	TC
ADANA	0.91	1.03	0.94	0.96
ADIYAMAN	1.09	1.04	1.13	0.94
AFSIN	1.01	0.96	0.97	1.02
AGRI	0.95	1.02	0.97	1
AKCAKALE	1	1.1	1.10	0.95
ANTAKYA	0.99	1.04	1.03	0.96
ARABAN	3	1.02	**3.06**	0.34
BATMAN	1.1	1.03	1.13	0.97
BINGOL	0.96	0.96	0.92	1.02
BIRECIK	0.99	1.18	1.17	0.84
BISMIL	0.98	1.44	1.41	0.72
BITLIS	1.01	1.16	1.17	0.86
BULANIK	0.94	1.44	1.35	0.72
CERMIK	0.95	1.2	1.14	0.87
CIZRE	1	0.89	0.89	0.97
DIYARBAKIR	1.15	1	1.15	1
ELAZIG	1.07	1.08	1.16	0.92
ELBISTAN	0.98	1.02	1.00	1.01
ERGANI	0.86	1.22	1.05	0.91
ERZURUM	0.96	1.18	1.13	0.84
GAZIANTEP	1.16	1	1.16	1
HAKKARI	0.96	1	0.96	1.01
HANI	1.01	0.96	**0.97**	1.02
HILVAN	0.9	1.21	1.09	0.89
ISKENDERUN	0.9	1.04	0.94	1.02
K.MARAS	0.92	1.27	1.17	0.83
KAHTA	0.95	1.02	0.97	1
KARS	1	1.03	1.03	1
KILIS	1	1.01	1.01	1
KIZILTEPE	1.07	1.02	1.09	0.98
KOZLUK	1.03	1.44	1.48	0.72
KURTALAN	0.91	1.04	0.95	1.01
MALATYA	1.09	1.04	1.13	0.97
MARDIN	1	1	1.00	1
MERSIN	0.93	1.04	0.97	0.94
MIDYAT	0.97	1	0.97	1.03
MUS	0.99	1.11	1.10	0.91
NIZIP	1.01	1	1.01	0.99
NUSAYBIN	1	1	1.00	1
PATNOS	0.96	1.11	1.07	0.91
REYHANLI	0.97	0.98	0.95	1.03
SAHINBEYI	1	1.02	1.02	1
SEHITKAMIL	1.36	1.01	1.37	0.76
SIIRT	1	0.92	0.92	1
SILVAN	0.96	1.15	1.10	0.87
SIRNAK	0.93	1.04	0.97	0.99
SIVAS	0.92	1	0.92	1.01
SIVEREK	0.95	1.05	1.00	0.95
SURUC	1.04	1.62	1.68	0.62
URFA	1.07	1.04	1.11	0.99
VAN	0.99	0.99	0.98	1.02

Distributors	MI	TC (%)	MI (%)	EC (%)	SEC (%)
ADANA	0.90	-4.08	-10.56	-6.48	2.96
ADIYAMAN	1.07	-6.19	6.35	12.54	3.92
AFSIN	0.99	1.98	-1.11	-3.09	-4.08
AGRI	0.97	0.00	-3.15	-3.15	1.98
AKCAKALE	1.05	-5.13	4.40	9.53	9.53
ANTAKYA	0.99	-4.08	-1.17	2.92	3.92
ARABAN	1.04	**-107.88**	**3.96**	**111.84**	**1.98**
BATMAN	1.10	-3.05	9.44	12.49	2.96
BINGOL	0.94	1.98	-6.18	-8.16	-4.08
BIRECIK	0.98	-17.44	-1.89	15.55	16.55
BISMIL	1.02	-32.85	1.59	34.44	36.46
BITLIS	1.01	-15.08	0.75	15.84	14.84
BULANIK	0.97	-32.85	-2.57	30.28	36.46
CERMIK	0.99	-13.93	-0.82	13.10	18.23
CIZRE	0.86	-3.05	-14.70	-11.65	-11.65
DIYARBAKIR	1.15	0.00	13.98	13.98	0.00
ELAZIG	1.06	-8.34	6.12	14.46	7.70
ELBISTAN	1.01	1.00	0.96	-0.04	1.98
ERGANI	0.95	-9.43	-4.63	4.80	19.89
ERZURUM	0.95	-17.44	-4.97	12.47	16.55
GAZIANTEP	1.16	0.00	14.84	14.84	0.00
HAKKARI	0.97	1.00	-3.09	-4.08	0.00
HANI	0.99	**1.98**	**-1.11**	**-3.09**	**-4.08**
HILVAN	0.97	-11.65	-3.13	8.53	19.06
ISKENDERUN	0.95	1.98	-4.63	-6.61	3.92
K.MARAS	0.97	-18.63	-3.07	15.56	23.90
KAHTA	0.97	0.00	-3.15	-3.15	1.98
KARS	1.03	0.00	2.96	2.96	2.96
KILIS	1.01	0.00	1.00	1.00	1.00
KIZILTEPE	1.07	-2.02	6.73	8.75	1.98
KOZLUK	1.07	-32.85	6.57	39.42	36.46
KURTALAN	0.96	1.00	-4.51	-5.51	3.92
MALATYA	1.10	-3.05	9.49	12.54	3.92
MARDIN	1.00	0.00	0.00	0.00	0.00
MERSIN	0.91	-6.19	-9.52	-3.33	3.92
MIDYAT	1.00	2.96	-0.09	-3.05	0.00
MUS	1.00	-9.43	-0.00	9.43	10.44
NIZIP	1.00	-1.01	-0.01	1.00	0.00
NUSAYBIN	1.00	0.00	0.00	0.00	0.00
PATNOS	0.97	-9.43	-3.08	6.35	10.44
REYHANLI	0.98	2.96	-2.11	-5.07	-2.02
SAHINBEYI	1.02	0.00	1.98	1.98	1.98
SEHITKAMIL	1.04	-27.44	4.30	31.74	1.00
SIIRT	0.92	0.00	-8.34	-8.34	-8.34
SILVAN	0.96	-13.93	-4.03	9.89	13.98
SIRNAK	0.96	-1.01	-4.34	-3.33	3.92
SIVAS	0.93	1.00	-7.34	-8.34	0.00
SIVEREK	0.95	-5.13	-5.38	-0.25	4.88
SURUC	1.04	-47.80	4.36	52.16	48.24
URFA	1.10	-1.01	9.68	10.69	3.92
VAN	1.00	1.98	-0.03	-2.01	-1.01

AMAÇ VE KAPSAM

Ulaştırma ve Lojistik Dergisi (JTL), İstanbul Üniversitesi Ulaştırma ve Lojistik Fakültesi'nin çok disiplinli ve altı aylık resmi bir dergisidir. Derginin amacı, taşımacılık ve lojistik endüstrisinin küresel ekonomi için geri döndürülemez hale gelen sorunları hakkında yeni fikirleri yayınlamaktır. JTL, akademisyenlere ve saha uygulayıcılarına ulaştırma ve lojistik için yeni konuları tartışmak ve analiz etmek için dinamik bir platform sunmaktadır. JTL Dünya çapında iş yöneticileri ve araştırmacılar arasında lojistik ve tedarik zinciri yönetimi ile ilgili bilgi alışverişinin yanı sıra, lojistik ve tedarik zinciri yönetim sorunları ve teknikleri hakkında yeni bir düşünce platformunda bağımsız, özgün ve özenli bir analiz olanağı sunar. Dergimize akademisyenler ve saha uygulayıcıları tarafından yapılan ulaştırma, lojistik ve tedarik zinciri yönetimi ve uygulamalarını geliştiren makaleler, araştırma çalışmaları, örnek olay analizleri ve inceleme makaleleri davet edilmektedir. Ulaştırma, lojistik veya tedarik zinciri yönetiminin herhangi bir alanındaki makaleler dergimize kabul edilmektedir. Dergimiz editörleri gelen çalışmalar ile ilgili eserlerin teorik ve yöntemsel süreçlerin uygulamalar ile ne derecede örtüştüğünü test etmektedirler. Yayınlanmak üzere gönderilen makalelerin tedarik zincirinde ulaştırma ve lojistik süreci perspektifinden uygulamalarının yapılması ve yorumlanması kabul için öncelikli tercih nedeni olmaktadır. Bu nedenle, dergimize işletmecilik, girişimcilik, yönetim, muhasebe, kurumsal yönetim müşteri ilişkileri yönetimi (CRM), pazarlama, insan kaynakları yönetimi, ekonomi, finans, işletme, imalat sanayi, lojistik, tedarik zinciri yönetimi, ulaşım endüstrileri, yeşil lojistik, ters lojistik, insani lojistik, sürdürülebilirlik, şehir lojistiği sektörleri ile ilgili çalışmalar kabul edilmektedir. Tüm makaleler, hakemler tarafından yayınlanmak üzere olarak incelenmektedir.

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- Araştırmanın tasarlanması, tasarımın gözden geçirilmesi ve araştırmanın yürütülmesinde, bütünlük, kalite ve şeffaflık ilkeleri sağlanmalıdır.
- Araştırma ekibi ve katılımcılar, araştırmanın amacı, yöntemleri ve öngörülen olası kullanımları; araştırmaya katılımın gerektirdikleri ve varsa riskleri hakkında tam olarak bilgilendirilmelidir.
- Araştırma katılımcılarının sağladığı bilgilerin gizliliği ve yanıt verenlerin gizliliği sağlanmalıdır. Araştırma katılımcıların özerkliğini ve saygınlığını koruyacak şekilde tasarlanmalıdır.
- Araştırma katılımcıları gönüllü olarak araştırmada yer almalı, herhangi bir zorlama altında olmamalıdırlar.
- Katılımcıların zarar görmesinden kaçınılmalıdır. Araştırma, katılımcıları riske sokmayacak şekilde planlanmalıdır.
- Araştırma bağımsızlığıyla ilgili açık ve net olunmalı; çıkar çatışması varsa belirtilmelidir.
- Deneysel çalışmalarda, araştırmaya katılmaya karar veren katılımcıların yazılı bilgilendirilmiş onayı alınmalıdır. Çocukların ve vesayet altındakilerin veya tasdiklenmiş akıl hastalığı bulunanların yasal vasisinin onayı alınmalıdır.
- Çalışma herhangi bir kurum ya da kuruluşta gerçekleştirilecekse bu kurum ya da kuruluştan çalışma yapılacağına dair onay alınmalıdır.
- İnsan öğesi bulunan çalışmalarda, "yöntem" bölümünde katılımcılardan "bilgilendirilmiş onam" alındığının ve çalışmanın yapıldığı kurumdan etik kurul onayı alındığı belirtilmesi gerekir.

Yazarların Sorumluluğu

Makalelerin bilimsel ve etik kurallara uygunluğu yazarların sorumluluğundadır. Yazar makalenin orijinal olduğu, daha önce başka bir yerde yayınlanmadığı ve başka bir yerde, başka bir dilde yayınlanmak üzere değerlendirmede olmadığı konusunda teminat sağlamalıdır. Uygulamadaki telif kanunları ve anlaşmaları gözetilmelidir. Telife bağlı materyaller (örneğin tablolar, şekiller veya büyük alıntılar) gerekli izin ve teşekkürle kullanılmalıdır. Başka yazarların, katkıda bulunanların çalışmaları ya da yararlanılan kaynaklar uygun biçimde kullanılmalı ve referanslarda belirtilmelidir.

Gönderilen makalede tüm yazarların akademik ve bilimsel olarak doğrudan katkısı olmalıdır, bu bağlamda "yazar" yayınlanan bir araştırmanın kavramsallaştırılmasına ve dizaynına, verilerin elde edilmesine, analizine ya da yorumlanmasına belirgin katkı yapan, yazının yazılması ya da bunun içerik açısından

eleştirel biçimde gözden geçirilmesinde görev yapan birisi olarak görülür. Yazar olabilmenin diğer koşulları ise, makaledeki çalışmayı planlamak veya icra etmek ve / veya revize etmektir. Fon sağlanması, veri toplanması ya da araştırma grubunun genel süpervizyonu tek başına yazarlık hakkı kazandırmaz. Yazar olarak gösterilen tüm bireyler sayılan tüm ölçütleri karşılamalıdır ve yukarıdaki ölçütleri karşılayan her birey yazar olarak gösterilebilir. Yazarların isim sıralaması ortak verilen bir karar olmalıdır. Tüm yazarlar yazar sıralamasını Telif Hakkı Formunda imzalı olarak belirtmek zorundadırlar.

Yazarlık için yeterli ölçütleri karşılamayan ancak çalışmaya katkısı olan tüm bireyler "teşekkür / bilgiler" kısmında sıralanmalıdır. Bunlara örnek olarak ise sadece teknik destek sağlayan, yazıma yardımcı olan ya da sadece genel bir destek sağlayan, finansal ve materyal desteği sunan kişiler verilebilir.

Bütün yazarlar, araştırmanın sonuçlarını ya da bilimsel değerlendirmeyi etkileyebilme potansiyeli olan finansal ilişkiler, çıkar çatışması ve çıkar rekabetini beyan etmelidirler. Bir yazar kendi yayınlanmış yazısında belirgin bir hata ya da yanlışlık tespit ederse, bu yanlışlıklara ilişkin düzeltme ya da geri çekme için editör ile hemen temasa geçme ve işbirliği yapma sorumluluğunu taşır.

Editör, Hakem Sorumlulukları ve Değerlendirme Süreci

Baş editör, makaleleri, yazarların etnik kökeninden, cinsiyetinden, uyruğundan, dini inancından ve siyasi felsefesinden bağımsız olarak değerlendirir. Yayına gönderilen makalelerin adil bir şekilde çift taraflı kör hakem değerlendirmesinden geçmelerini sağlar. Gönderilen makalelere ilişkin tüm bilginin, makale yayınlanana kadar gizli kalacağını garanti eder. Baş editör içerik ve yayının toplam kalitesinden sorumludur. Gereğinde hata sayfası yayınlamalı ya da düzeltme yapmalıdır.

Baş editör; yazarlar, editörler ve hakemler arasında çıkar çatışmasına izin vermez. Hakem atama konusunda tam yetkiye sahiptir ve dergide yayınlanacak makalelerle ilgili nihai kararı vermekle yükümlüdür.

Hakemlerin araştırmayla ilgili, yazarlarla ve/veya araştırmanın finansal destekçileriyle çıkar çatışmaları olmamalıdır. Değerlendirmelerinin sonucunda tarafsız bir yargıya varmalıdırlar. Gönderilmiş yazılara ilişkin tüm bilginin gizli tutulmasını sağlamalı ve yazar tarafında herhangi bir telif hakkı ihlali ve intihal fark ederlerse editöre raporlamalıdırlar.

Hakem, makale konusu hakkında kendini vasıflı hissetmiyor ya da zamanında geri dönüş sağlaması mümkün görünmüyorsa, editöre bu durumu bildirmeli ve hakem sürecine kendisini dahil etmemesini istemelidir.

Değerlendirme sürecinde editör hakemlere gözden geçirme için gönderilen makalelerin, yazarların özel mülkü olduğunu ve bunun imtiyazlı bir iletişim olduğunu açıkça belirtir. Hakemler ve yayın kurulu üyeleri başka kişilerle makaleleri tartışamazlar. Hakemlerin kimliğinin gizli kalmasına özen gösterilmelidir. Bazı durumlarda editörün kararıyla, ilgili hakemlerin makaleye ait yorumları aynı makaleyi yorumlayan diğer hakemlere gönderilerek hakemlerin bu süreçte aydınlatılması sağlanabilir.

Hakem Süreci

Daha önce yayınlanmamış ya da yayınlanmak üzere başka bir dergide halen değerlendirmede olmayan ve her bir yazar tarafından onaylanan makaleler değerlendirilmek üzere kabul edilir. Gönderilen ve ön kontrolü geçen makaleler iThenticate yazılımı kullanılarak intihal için taranır. İntihal kontrolünden sonra, uygun olan makaleler baş editör tarafından orijinallik, metodoloji, işlenen konunun önemi ve dergi kapsamı ile uyumluluğu açısından değerlendirilir. Baş editör, makaleleri, yazarların etnik kökeninden, cinsiyetinden, uyruğundan, dini inancından ve siyasi felsefesinden bağımsız olarak değerlendirir. Yayına gönderilen makalelerin adil bir şekilde çift taraflı kör hakem değerlendirmesinden geçmelerini sağlar.

Seçilen makaleler en az iki ulusal/uluslararası hakeme değerlendirmeye gönderilir; yayın kararı, hakemlerin talepleri doğrultusunda yazarların gerçekleştirdiği düzenlemelerin ve hakem sürecinin sonrasında baş editör tarafından verilir.

Hakemlerin değerlendirmeleri objektif olmalıdır. Hakem süreci sırasında hakemlerin aşağıdaki hususları dikkate alarak değerlendirmelerini yapmaları beklenir.

- Makale yeni ve önemli bir bilgi içeriyor mu?
- Öz, makalenin içeriğini net ve düzgün bir şekilde tanımlıyor mu?
- Yöntem bütünlüklü ve anlaşılır şekilde tanımlanmış mı?

- Yapılan yorum ve varılan sonuçlar bulgularla kanıtlanıyor mu?
- Alandaki diğer çalışmalara yeterli referans verilmiş mi?
- Dil kalitesi yeterli mi?

Hakemler, gönderilen makalelere ilişkin tüm bilginin, makale yayınlanana kadar gizli kalmasını sağlamalı ve yazar tarafında herhangi bir telif hakkı ihlali ve intihal fark ederlerse editöre raporlamalıdırlar. Hakem, makale konusu hakkında kendini vasıflı hissetmiyor ya da zamanında geri dönüş sağlaması mümkün görünmüyorsa, editöre bu durumu bildirmeli ve hakem sürecine kendisini dahil etmemesini istemelidir.

Değerlendirme sürecinde editör hakemlere gözden geçirme için gönderilen makalelerin, yazarların özel mülkü olduğunu ve bunun imtiyazlı bir iletişim olduğunu açıkça belirtir. Hakemler ve yayın kurulu üyeleri başka kişilerle makaleleri tartışamazlar. Hakemlerin kimliğinin gizli kalmasına özen gösterilmelidir.

YAZILARIN HAZIRLANMASI

Dil

Dergide Türkçe ve İngilizce makaleler yayınlanır. Gönderilen makalelerde makale dilinde öz, İngilizce öz ve İngilizce geniş özet olmalıdır. Ancak makale İngilizce ise, İngilizce geniş özet istenmez.

Yazıların Hazırlanması ve Yazım Kuralları

Aksi belirtilmedikçe gönderilen yazılarla ilgili tüm yazışmalar ilk yazarla yapılacaktır. Makale gönderimi online olarak https://jtl.istanbul.edu.tr/en/_ sayfasından erişilen https://mc04.manuscriptcentral.com/jtl üzerinden yapılmalıdır. Gönderilen yazılar, makale türünü belirten ve makaleyle ilgili detayları içeren (bkz: Son Kontrol Listesi) Kapak Sayfası; yazının elektronik formunu içeren Microsoft Word 2003 ve üzerindeki versiyonları ile yazılmış elektronik dosya ve tüm yazarların imzaladığı Telif Hakkı Anlaşması Formu eklenerek gönderilmelidir.

1. Yazılar Makale Şablonu kullanılarak hazırlanmalıdır. Makale ana metninde, çift taraflı kör hakemlik süreci gereği, yazarın / yazarların kimlik bilgileri yer almamalıdır.
2. Yayınlanmak üzere gönderilen makale ile birlikte yazar bilgilerini içeren Kapak Sayfası gönderilmelidir. Kapak Sayfasında, makalenin başlığı, yazar veya yazarların bağlı bulundukları kurum ve unvanları, kendilerine ulaşılabilecek adresler, cep, iş ve faks numaraları, ORCID ve e-posta adresleri yer almalıdır (bkz. Son Kontrol Listesi).
3. Giriş bölümünden önce 180-200 kelimelik çalışmanın kapsamını, amacını, ulaşılan sonuçları ve kullanılan yöntemi kaydeden makale dilinde öz ve İngilizce öz ile 600-800 kelimelik İngilizce genişletilmiş özet yer almalıdır. Makale İngilizce ise İngilizce geniş özet istenmez. Özlerin altında çalışmanın içeriğini temsil eden, 3'er adet anahtar kelime yer almalıdır.
4. Çalışmaların başlıca şu unsurları içermesi gerekmektedir: Makale dilinde başlık, öz ve anahtar kelimeler; İngilizce başlık, öz ve anahtar kelimeler; geniş özet, ana metin bölümleri, kaynaklar, tablolar ve şekiller.
5. **Makale Türleri:**

   Araştırma Makaleleri: Orijinal araştırma makaleleri derginin kapsamına uygun konularda önemli, özgün bilimsel sonuçlar sunan araştırmaları raporlayan yazılardır. Orijinal araştırma makaleleri, Öz, Anahtar Kelimeler, İngilizce Geniş Özet, Giriş, Yöntem, Bulgular, Tartışma, Sonuçlar, Kaynaklar bölümlerinden ve Tablo, Grafik ve Şekillerden oluşur.

   Öz: Makale dilinde başlık ve İngilizce başlık öz'lerin üzerinde yer almalıdır. Araştırma yazılarında Türkçe ve İngilizce özler 180-200 kelime arasında olmalı ve çalışmanın amacı, yöntemi, ana bulguları ve sonuçlarını ifade etmelidir. Ayrıca Türkçe, Almanca, Fransızca ya da İtalyanca makaleler için özlerden sonra 600-800 kelimelik İngilizce geniş özet de yer almalıdır.

   Giriş: Giriş bölümünde konunun önemi, tarihçe ve bugüne kadar yapılmış çalışmalar, hipotez ve çalışmanın amacından söz edilmelidir. Hem ana hem de ikincil amaçlar açıkça belirtilmelidir. Sadece gerçekten ilişkili kaynaklar gösterilmeli ve çalışmaya ait veri ya da sonuçlardan söz edilmemelidir. Giriş bölümünün sonunda çalışmanın amacı, araştırma soruları veya hipotezler yazılmalıdır.

   Yöntem: Yöntem bölümünde, veri kaynakları, çalışmaya katılanlar, ölçekler, görüşme/değerlendirmeler ve temel ölçümler, yapılan işlemler ve istatistiksel yöntemler yer almalıdır. Yöntem bölümü, sadece çalışmanın planı ya da protokolü yazılırken bilinen bilgileri içermelidir; çalışma sırasında elde edilen tüm bilgiler bulgular kısmında verilmelidir.

   Bulgular: Ana bulgular istatistiksel verilerle desteklenmiş olarak eksiksiz verilmeli ve bu bulgular

uygun tablo, grafik ve şekillerle görsel olarak da belirtilmelidir. Bulgular yazıda, tablolarda ve şekillerde mantıklı bir sırayla önce en önemli sonuçlar olacak şekilde verilmelidir. Tablo ve şekillerdeki tüm veriyi yazıda vermemeli, sadece önemli noktaları vurgulanmalıdır.

Tartışma: Tartışma bölümünde o çalışmadan elde edilen veriler, kurulan hipotez doğrultusunda hipotezi destekleyen ve desteklemeyen bulgular ve sonuçlar irdelenmeli ve bu bulgu ve sonuçlar literatürde bulunan benzeri çalışmalarla kıyaslanmalı, farklılıklar varsa açıklanmalıdır. Çalışmanın yeni ve önemli yanları ve bunlardan çıkan sonuçları vurgulanmalıdır. Giriş ya da sonuçlar kısmında verilen bilgi ve veriler tekrarlanmamalıdır.

Sonuçlar: Çalışmadan elde edilen sonuçlar belirtilmelidir. Sonuçlar, çalışmanın amaçları ile bağlantılı olmalıdır, ancak veriler tarafından yeterince desteklenmeyen niteliksiz ifadeler ve sonuçlardan kaçınılmalıdır. Yeni hipotezler gerektiğinde belirtilmeli, ancak açıkça tanımlanmalıdır.

Şekil, Resim, Tablo ve Grafikler:. Metin içinde kullanılan fotoğraf, plân, harita vb. materyallerin ".jpg / .tiff" uzantılı kayıtları gönderilecek dokümanlara eklenmelidir. Bu tür belgelerin baskı tekniğine uygun çözünürlükte (en az 300 piksel) ve sayfa alanını aşmayacak büyüklükte olmasına dikkat edilmelidir. Fotoğraf ve levhaların 10 sayfayı aşmamasına dikkat edilmeli ve metin içinde parantezle atıfta bulunulan resim, harita veya diğer ekler makalenin sonuna eklenmelidir.

Derleme: Yazının konusunda birikimi olan ve bu birikimleri uluslararası literatüre yayın ve atıf sayısı olarak yansımış uzmanlar tarafından hazırlanmış yazılar değerlendirmeye alınır. Yazarları dergi tarafından da davet edilebilir. Derleme yazısı, başlık, öz, anahtar kelimeler, İngilizce geniş özet (Türkçe, Almanca, Fransızca ve İtalyanca makaleler için), ana metin bölümleri ve kaynaklardan oluşmalıdır.

6. Referanslar derginin benimsediği American Psychological Association (APA) 6 stiline uygun olarak hazırlanmalıdır.
7. Kurallar dâhilinde dergimize yayınlanmak üzere gönderilen çalışmaların her türlü sorumluluğu yazar/ yazarlarına aittir.

KAYNAKLAR

Referans Stili ve Formatı

Journal of Transportation and Logistics, metin içi alıntılama ve kaynak gösterme için APA (American Psychological Association) kaynak sitilinin 6. edisyonunu benimser. APA 6.Edisyon hakkında bilgi için:

- American Psychological Association. (2010). Publication manual of the American Psychological

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- http://www.apastyle.org/

Kaynakların doğruluğundan yazar(lar) sorumludur. Tüm kaynaklar metinde belirtilmelidir. Kaynaklar aşağıdaki örneklerdeki gibi gösterilmelidir.

Metin İçinde Kaynak Gösterme

Kaynaklar metinde parantez içinde yazarların soyadı ve yayın tarihi yazılarak belirtilmelidir.

Birden fazla kaynak gösterilecekse kaynaklar arasında (;) işareti kullanılmalıdır. Kaynaklar alfabetik olarak sıralanmalıdır.

Örnekler:

Birden fazla kaynak;
(Esin ve ark., 2002; Karasar 1995)
Tek yazarlı kaynak;
(Akyolcu, 2007)
İki yazarlı kaynak;
(Sayıner ve Demirci, 2007, s. 72)
Üç, dört ve beş yazarlı kaynak;
Metin içinde ilk kullanımda: (Ailen, Ciambrune ve Welch, 2000, s. 12–13) Metin içinde tekrarlayan kullanımlarda: (Ailen ve ark., 2000)
Altı ve daha çok yazarlı kaynak;
(Çavdar ve ark., 2003)

Kaynaklar Bölümünde Kaynak Gösterme

Kullanılan tüm kaynaklar metnin sonunda ayrı bir bölüm halinde yazar soyadlarına göre alfabetik olarak numaralandırılmadan verilmelidir.

Kaynak yazımı ile ilgili örnekler aşağıda verilmiştir.

Kitap

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h) Düzenli Olarak Online Yayımlanan Bildiriler

Herculano-Houzel, S., Collins, C. E., Wong, P., Kaas, J. H., & Lent, R. (2008). The basic nonuniformity of the cerebral cortex. *Proceedings of the National Academy of Sciences, 105,* 12593–12598. http://dx.doi.org/10.1073/pnas.0805417105

i) Kitap Şeklinde Yayımlanan Bildiriler

Schneider, R. (2013). Research data literacy. S. Kurbanoğlu ve ark. (Ed.), Communications in Computer and Information Science: Vol. 397. *Worldwide Communalities and Challenges in Information Literacy Research and Practice* içinde (s. 134–140). Cham, İsviçre: Springer. http://dx.doi.org/10.1007/978-3-319-03919-0

j) Kongre Bildirisi

Çepni, S., Bacanak A. ve Özsevgeç T. (2001, Haziran). *Fen bilgisi öğretmen adaylarının fen branşlarına karşı tutumları ile fen branşlarındaki başarılarının ilişkisi.* X. Ulusal Eğitim Bilimleri Kongresi'nde sunulan bildiri, Abant İzzet Baysal Üniversitesi, Bolu

Diğer Kaynaklar

a) Gazete Yazısı

Toker, Ç. (2015, 26 Haziran). 'Unutma' notları. *Cumhuriyet,* s. 13.

b) Online Gazete Yazısı

Tamer, M. (2015, 26 Haziran). E-ticaret hamle yapmak için tüketiciyi bekliyor. *Milliyet.* Erişim adresi: http://www.milliyet

c) Web Page/Blog Post

Bordwell, D. (2013, June 18). David Koepp: Making the world movie-sized [Web log post]. Retrieved from http://www.davidbordwell.net/blog/page/27/

d) Online Ansiklopedi/Sözlük

Bilgi mimarisi. (2014, 20 Aralık). Vikipedi içinde. Erişim adresi: http://tr.wikipedia.org/wiki/Bilgi_mimarisi

Marcoux, A. (2008). Business ethics. In E. N. Zalta (Ed.), *The Stanford encyclopedia of philosophy*. Retrieved from http://plato.stanford.edu/entries/ethics-business/

e) Podcast

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f) Bir Televizyon Dizisinden Tek Bir Bölüm

Shore, D. (Senarist), Jackson, M. (Senarist) ve Bookstaver, S. (Yönetmen). (2012). Runaways [Televizyon dizisi bölümü]. D. Shore (Baş yapımcı), *House M.D.* içinde. New York, NY: Fox Broadcasting.

g) Müzik Kaydı

Say, F. (2009). Galata Kulesi. *İstanbul senfonisi* [CD] içinde. İstanbul: Ak Müzik.

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a) Turkish Book
Karasar, N. (1995). *Araştırmalarda rapor hazırlama* (8th ed.) [Preparing research reports]. Ankara, Turkey: 3A Eğitim Danışmanlık Ltd.
b) Book Translated into Turkish
Mucchielli, A. (1991). *Zihniyetler* [Mindsets] (A. Kotil, Trans.). İstanbul, Turkey: İletişim Yayınları.
c) Edited Book
Ören, T., Üney, T., & Çölkesen, R. (Eds.). (2006). *Türkiye bilişim ansiklopedisi* [Turkish Encyclopedia of Informatics]. İstanbul, Turkey: Papatya Yayıncılık.
d) Turkish Book with Multiple Authors
Tonta, Y., Bitirim, Y., & Sever, H. (2002). T*ürkçe arama motorlarında performans değerlendirme* [Performance evaluation in Turkish search engines]. Ankara, Turkey: Total Bilişim.
e) Book in English
Kamien R., & Kamien A. (2014). *Music: An appreciation.* New York, NY: McGraw-Hill Education.
f) Chapter in an Edited Book
Bassett, C. (2006). Cultural studies and new media. In G. Hall & C. Birchall (Eds.), *New cultural studies: Adventures in theory* (pp. 220–237). Edinburgh, UK: Edinburgh University Press.
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Erkmen, T. (2012). Örgüt kültürü: Fonksiyonları, öğeleri, işletme yönetimi ve liderlikteki önemi [Organization culture: Its functions, elements and importance in leadership and business management]. In M. Zencirkıran (Ed.), *Örgüt sosyolojisi* [Organization sociology] (pp. 233–263). Bursa, Turkey: Dora Basım Yayın.
h) Book with the same organization as author and publisher
American Psychological Association. (2009). *Publication manual of the American psychological association* (6th ed.). Washington, DC: Author.

Article

a) Turkish Article
Mutlu, B., & Savaşer, S. (2007). Çocuğu ameliyat sonrası yoğun bakımda olan ebeveynlerde stres nedenleri ve azaltma girişimleri [Source and intervention reduction of stress for parents whose children are in intensive care unit after surgery]. *Istanbul University Florence Nightingale Journal of Nursing, 15*(60), 179–182.

b) English Article

de Cillia, R., Reisigl, M., & Wodak, R. (1999). The discursive construction of national identity. *Discourse and Society, 10*(2), 149–173. http://dx.doi.org/10.1177/0957926599010002002

c) Journal Article with DOI and More Than Seven Authors

Lal, H., Cunningham, A. L., Godeaux, O., Chlibek, R., Diez-Domingo, J., Hwang, S.-J. ... Heineman, T. C. (2015). Efficacy of an adjuvanted herpes zoster subunit vaccine in older adults. *New England Journal of Medicine, 372,* 2087–2096. http://dx.doi.org/10.1056/NEJMoa1501184

d) Journal Article from Web, without DOI

Sidani, S. (2003). Enhancing the evaluation of nursing care effectiveness. *Canadian Journal of Nursing Research, 35*(3), 26–38. Retrieved from http://cjnr.mcgill.ca

e) Journal Article wih DOI

Turner, S. J. (2010). Website statistics 2.0: Using Google Analytics to measure library website effectiveness. *Technical Services Quarterly, 27,* 261–278. http://dx.doi.org/10.1080/07317131003765910

f) Advance Online Publication

Smith, J. A. (2010). Citing advance online publication: A review. *Journal of Psychology.* Advance online publication. http://dx.doi.org/10.1037/a45d7867

g) Article in a Magazine

Henry, W. A., III. (1990, April 9). Making the grade in today's schools. *Time, 135,* 28–31.

Doctoral Dissertation, Master's Thesis, Presentation, Proceeding

a) Dissertation/Thesis from a Commercial Database

Van Brunt, D. (1997). *Networked consumer health information systems* (Doctoral dissertation). Available from ProQuest Dissertations and Theses database. (UMI No. 9943436)

b) Dissertation/Thesis from an Institutional Database

Yaylalı-Yıldız, B. (2014). *University campuses as places of potential publicness: Exploring the politicals, social and cultural practices in Ege University* (Doctoral dissertation). Retrieved from Retrieved from: http://library.iyte.edu.tr/tr/hizli-erisim/iyte-tez-portali

c) Dissertation/Thesis from Web

Tonta, Y. A. (1992). *An analysis of search failures in online library catalogs* (Doctoral dissertation, University of California, Berkeley). Retrieved from http://yunus.hacettepe.edu.tr/~tonta/yayinlar /phd/ickapak.html

d) Dissertation/Thesis abstracted in Dissertations Abstracts International

Appelbaum, L. G. (2005). Three studies of human information processing: Texture amplification, motion representation, and figure-ground segregation. *Dissertation Abstracts International: Section B. Sciences and Engineering, 65*(10), 5428.

e) Symposium Contribution

Krinsky-McHale, S. J., Zigman, W. B., & Silverman, W. (2012, August). Are neuropsychiatric symptoms markers of prodromal Alzheimer's disease in adults with Down syndrome? In W. B. Zigman (Chair), *Predictors of mild cognitive impairment, dementia, and mortality in adults with Down syndrome.* Symposium conducted at the meeting of the American Psychological Association, Orlando, FL.

f) Conference Paper Abstract Retrieved Online

Liu, S. (2005, May). *Defending against business crises with the help of intelligent agent based early warning solutions.* Paper presented at the Seventh International Conference on Enterprise Information Systems, Miami, FL. Abstract retrieved from http://www.iceis.org/iceis2005/abstracts_2005.htm

g) Conference Paper - In Regularly Published Proceedings and Retrieved Online

Herculano-Houzel, S., Collins, C. E., Wong, P., Kaas, J. H., & Lent, R. (2008). The basic nonuniformity of the cerebral cortex. *Proceedings of the National Academy of Sciences, 105,* 12593–12598. http://dx.doi.org/10.1073/pnas.0805417105

h) Proceeding in Book Form

Parsons, O. A., Pryzwansky, W. B., Weinstein, D. J., & Wiens, A. N. (1995). Taxonomy for psychology. In J. N. Reich, H. Sands, & A. N. Wiens (Eds.), *Education and training beyond the doctoral degree: Proceedings of the American Psychological Association National Conference on Postdoctoral Education and Training in Psychology* (pp. 45–50). Washington, DC: American Psychological Association.

i) Paper Presentation

Nguyen, C. A. (2012, August). *Humor and deception in advertising: When laughter may not be the best medicine.* Paper presented at the meeting of the American Psychological Association, Orlando, FL.

Other Sources

a) Newspaper Article

Browne, R. (2010, March 21). This brainless patient is no dummy. *Sydney Morning Herald, 45.*

b) Newspaper Article with no Author

New drug appears to sharply cut risk of death from heart failure. (1993, July 15). *The Washington Post,* p. A12.

c) Web Page/Blog Post

Bordwell, D. (2013, June 18). David Koepp: Making the world movie-sized [Web log post]. Retrieved from http://www.davidbordwell.net/blog/page/27/

d) Online Encyclopedia/Dictionary

Ignition. (1989). In *Oxford English online dictionary* (2nd ed.). Retrieved from http://dictionary.oed.com

Marcoux, A. (2008). Business ethics. In E. N. Zalta (Ed.). *The Stanford encyclopedia of philosophy.* Retrieved fromhttp://plato.stanford.edu/entries/ethics-business/

e) Podcast

Dunning, B. (Producer). (2011, January 12). *in Fact: Conspiracy theories* [Video podcast]. Retrieved from http://itunes.apple.com/

f) Single Episode in a Television Series

Egan, D. (Writer), & Alexander, J. (Director). (2005). Failure to communicate. [Television series episode]. In D. Shore (Executive producer), *House;* New York, NY: Fox Broadcasting.

g) Music

Fuchs, G. (2004). Light the menorah. On *Eight nights of Hanukkah* [CD]. Brick, NJ: Kid Kosher.

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