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PRIMARY RESEARCH

Examining service innovation competencies of Turkish deposit banks with fuzzy ANP, fuzzy TOPSIS and fuzzy VIKOR methods

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Abstract

This study aimed to rank the service innovation issues of deposit banks in Turkey. In this context, 26 deposit banks of Turkey are analyzed by considering 16 different balanced scorecard-based criteria. Regarding the methodology, the fuzzy ANP method is used to measure the significance of dimensions and criteria. It is defined that the most significant dimension is performance. It is also seen that organizational compliance (D3) is in the last rank. Additionally, return on investment (C1), profitability (C2), and customer expectations (C5) have the highest significance. These alternatives are ranked by considering fuzzy TOPSIS and fuzzy VIKOR methods. The results of both these methods are very similar. It is concluded that there is not a comparative advantage among the banks regarding the ownership type. For example, the best bank (F15) is a foreign bank, whereas the worst bank (F13) is another foreign bank. Similar to this situation, some private banks (P1, P7, P8) have successful performance while others (P4, P5) have weak performance. The new service development concept will probably become more important in the future. Hence, this study has significant results by focusing on a very important topic for the banking sector.

INTRODUCTION

Service innovation is a very significant issue for almost all companies. The main reason is that globalization led to high competition between the companies in all industries (Ayuningrat, Noermijati., & Hadiwidjojo, 2016; Lamberth-Cocca & Meiren, 2017). Because of this situation, it can be said that in order to increase competitive power, companies should take some actions, such as service innovation (Ryu & Lee, 2018). Otherwise, these companies cannot be preferred by the customers. Hence, it will not possible for these companies to survive in the market (Bernik, Azis, Kartini, & Harsanto, 2015; Yuksel, 2016).

While considering this situation emphasized below, it is understood that evaluating the performance of the companies regarding service innovation is crucial. Most of the methods to achieve the performance consider only financial aspects. However, it can be said that these kinds of methods are not sufficient to achieve this objective. Within this framework, the popularity of balanced scorecard method increases since non-financial issues are also considered in this process (Dinçer, Hacıoğlu, & Yüksel, 2017; Jingnan, Yunus, & Kamal, 2018).

This study aims to analyze Turkish banking sector for service innovation. For this purpose, 16 different criteria considering balanced scorecard dimensions are determined. Additionally, fuzzy ANP, TOPSIS and VIKOR methods are used. The criteria are assessed by using fuzzy ANP. Moreover, fuzzy TOPSIS and VIKOR approaches are considered for ranking different banking groups (state, foreign and private) regarding service innovation.

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This study has six different parts. After the introduction part, balanced scorecard approach will be detailed. In this part, four different balanced scorecard dimensions are explained. In the third part, literature is reviewed. The fourth part fuzzy ANP, TOPSIS and VIKOR methods are identified. Moreover, in the fifth part, the details of analysis results are explained. In the conclusion part, suggestions are shared based on these results.

Balanced Scorecard Approach

Especially in the last decades, competition among the companies increased very much due to the globalization. Therefore, measuring the performance of the companies play a more significant role to recognize any deficiency before it causes bigger problems. Within this framework, it is understood that classical performance measurement methods are not sufficient to satisfy this condition. The main is that these classical methods mainly focus on the financial situation of the companies while measuring the performance.

The significant difference between the balanced scorecard method from the others is that it also includes non-financial issues in addition to the financial factors. The term "balanced" refers to the condition that this method gives balanced importance to financial and non-financial aspects. This method mainly includes following four different dimensions (Sánchez-Márquez, Guillem, Vicens-Salort, & Vivas, 2018; Tangpornpaiboon & Puttanapong, 2016).

• Finance: The financial performance is analyzed. It helps to learn whether there is a problem in the company regarding financial aspect (Yüksel, 2016).

• Customer: It analyzes the quality of the image of the companies. Within this framework, it concentrates on the expectations of the customers to increase customer satisfaction (Dincer, Yüksel, & Martinez, 2019; Kuo & Chen, 2015).

• Internal Process: In this dimension, employee participation plays an important role. This situation contributes both the performance of the employees and the companies. When employee participate any aspects in the company, it increases the motivation of them. On the other side, by considering different ideas of the companies, company can reach its objectives more easily (Dinçer & Yüksel, 2018; Kozina, 2017).

• Learning and Growth: This dimension defines qualification of the employees and adaption of the companies to any changes in the market (Alahoul, Azizan, & Alwi, 2016; Dincer, Yuksel, & Cetiner, 2019).

LITERATURE REVIEW

Service innovation concept is considered for many different aspects. Griffin and Page (1996) identified new services as investments. Therefore, they analyzed the returns of these investments. Y. Liu and Yang (2009) emphasized the aspect that successful service innovation contributes the profitability of the companies. Moreover, Tajeddini (2011) underlined that service innovation provided cost efficiencies. Furthermore, Griffin (1997) also determined the same conclusions.

Furthermore, some other studies emphasized the effect of new service development on customer relationship. De Brentani (1995) identified that if new service development process could performed successfully, it helps to meet customer demands. Furthermore, Wu, Tzeng, and Chen (2009) determined that effective service innovation process increases customer satisfaction. Similarly, Y. Liu and Yang (2009), Wu et al. (2009) showed that service innovation provides long term effective relationship with the customers.

Additionally, the influence of service innovation on organizational compliance is also emphasized in many different studies. For example, Homburg and Kuehnl (2014), Y. Liu and Yang (2009) and Perks and Riihela (2004) underlined that it has a positive effect on personnel motivation. Schilling and Hill (1998) defined that with service innovation, employees understand the goals of organization. Edvardsson, Meiren, Schäfer, and Witell (2013) stated that employees should be considered in this aspect. Similar to these studies, Melton and Hartline (2010) and Stevens and Dimitriadis (2004) also underlined that employee participation in this process improves the quality of this process.

Also, some researchers also considered the importance of technological improvement in new service development. Brown and Eisenhardt (1995) determined that in service innovation projects, market-based databases should be considered and that underlined that for this purpose, technological improvement is crucial. Similar to these studies, S. Liu (2012), Van Riel and Lievens (2004), Van Den Ende (2003) and Ittner and Larcker (1997) identified that with the help of technological improvement, data flow in new service development process can be provided effectively. On the other side, Kuczmarski (1992) focused on the importance of professional training activities for the employees.

Consequently, it is identified that many different studies focus on new service development concept in different aspects. For instance, some of them underline the importance of financial situation while some others concentrate on the customer relationship in this process. In addition to these

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subjects, organizational compliance and the importance of training are also taken into the consideration. Therefore, a new study which analyzes all these concepts together in service innovation process. Within this context, it is obvious that balanced scorecard approach helps to achieve this objective since it has all these concepts. Table 1 gives information about key performance indicators of service innovation competencies.

TABLE 1. Key performance indicators of service innovation competencies

Perspective	Service Innovation Competencies	Indicators	Studies
Financial	Performance	Return on Investment	Griffin and Page (1996), Oktar and Yüksel (2015), Yüksel (2017)
		Profitability	Y. Liu and Yang (2009), C. Storey and Kelly (2001), Zengin and Yüksel (2016)
		Competitive Advantage	Dinçer and Yüksel (2018), Tajeddini (2011), Tajeddini (2011), Kitsios, Doumpos, Grigoroudis, and Zopounidis (2009), C. Storey and Kelly (2001), Yüksel, Mukhtarov, Mammadov, and Özsarı (2018)
		Cost Effectiveness	Kuester, Schuhmacher, Gast, and Worgul (2013), Y. Liu and Yang (2009), Tajeddini (2011), Yuksel and Zengin (2017)
Customer	Market issues	Customer Expectation	Alam and Perry (2002), De Brentani (1995), Edvardsson et al. (2013), Emir, Dincer, Hacioglu, and Yuksel (2015)
		Satisfaction	Cheng, Chen, and Tai Tsou (2012), Dincer (2018), Y. Liu and Yang (2009), Sigala (2012),Wu et al. (2009)
		Practice	Edvardsson et al. (2013), Griffin (1997), Jaw, Lo, and Lin (2010), Makkonen and Komulainen (2014), C. D. Storey and Easingwood (1996), Tunay and Yüksel (2017)
		Commitment	Edvardsson et al. (2013), Heskett, Sasser, and Hart (1990), Y. Liu and Yang (2009)
Internal Factors	Organizational Issues	Compatibility	De Brentani (1995), Homburg and Kuehnl (2014), LY. Liu and Yang (2009), Perks and Riihela (2004)
		Clearity	Homburg and Kuehnl (2014), Limpibunterng and Johri (2009), Schilling and Hill (1998), Smith, Fischbacher, and Wilson (2007)
		Contribution	Edvardsson et al. (2013), De Brentani (1995), Melton and Hartline (2010), Page (1993), C. Storey and Hughes (2013), Stevens and Dimitriadis (2004)
		Encouragement	Denison and Mishra (1995), De Brentani (1995), Melton and Hartline (2010), Page (1993), Stevens and Dimitriadis (2004)
Learning	IT Competency	Communication	Edvardsson et al. (2013), S. Liu (2012), Stevens and Dimitriadis (2004)
		Data	Edvardsson et al. (2013), S. Liu (2012), Kitsios et al. (2009)
		Training	Alam (2012), Kuczmarski (1992), Wu et al. (2009)
		Technologic Development	Ittner and Larcker (1997), S. Liu (2012), Van Riel and Lievens (2004), Van Den Ende (2003), YUKSEL and Özsarı (2017)

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RESEARCH METHODOLOGY

Fuzzy ANP Method

People face many difficulties in order to make decision. The main reason is that they have to consider lots of difficult situation at the same time in this process. ANP aims to make decisions in complex conditions. In addition to this situation, clusters can also affect each other in ANP method (Saaty, 1990). The details of ANP system are given below (Chang, Kuo, Wu, & Tzeng, 2015). First of all, the problem should be explained in detail. Within this scope, the purpose, criteria and sub criteria related to this problem should be identified. Moreover, interaction between the elements is taken into the consideration. As a result, a supermatrix can be created. After that, a weighted matrix is developed by using the importance of the elements. These matrixes are illustrated below. In these matrixes, "a" represent criteria whereas "w" shows the weights (Dincer, Hacioglu, & Yuksel, 2016).

$$A = (a_{ij})_{nxn} \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix}$$

$$A = (a_{ij})_{nxn} \begin{bmatrix} w_1 a_{11} & \cdots & w_1 a_{1n} \\ \vdots & \ddots & \vdots \\ w_n a_{n1} & \cdots & w_n a_{nn} \end{bmatrix}$$

In this process, Chang's fuzzy extent analysis is considered which is also detailed below (Chang et al., 2015).

a- "Fuzzy Synthetic Extent" (Si) is identified. The calculation is shown below.

$S_i = \left(\sum_{j=1}^{m} a_{ij}\right) \times \left(\sum_{p=1}^{n} \sum_{j=1}^{m} a_{pj}\right)^{-1}$

$\sum_{j=1}^{m} a_{pj} = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j\right)$

$\sum_{p=1}^{n} \sum_{j=1}^{m} a_{pj} = \left(\sum_{j=1}^{n} l_j, \sum_{j=1}^{n} m_j, \sum_{j=1}^{n} u_j\right)$

$\left(\sum_{p=1}^{n} \sum_{j=1}^{m} a_{pj}\right)^{-1} =$

$\left(1/\sum_{j=1}^{n} l_j, 1/\sum_{j=1}^{n} m_j, 1/\sum_{j=1}^{n} u_j\right)$

b- The details of the degree of possibility is illustrated below.

$$(M_1 \geq M_2) = \begin{cases} 1, & m_1 \geq m_2 \\ \frac{l_2 - u_1}{m_1 - u_1 - m_2 - l_2}, & m_1 < m_2, u_1 \geq l_2 \\ 0, & \text{otherwise,} \end{cases}$$

c- It is calculated as following

$$V(M \geq M_1, M_2, \ldots M_k) = V[(M \geq M_1) \text{ and } (M \geq M_2) \text{ and } \ldots (M \geq M_k)] = \min V(M \geq M_i)$$

d- The normalization of these vectors can be provided as below.

$w = (d(A_1), d(A_2)_{2\ldots}, d(A_n))^T$

Fuzzy TOPSIS Method

This approach is used to make decisions in complex environment. Hwang and Yoon developed this method in 1981. It refers to the first letters of "technique for order of preference by similarity to ideal solution". The main advantage of this method is to use and make comments to the about results easily. In the analysis process, both positive and negative ideal solutions are generated (Dincer et al., 2016). In the equation below, $\widetilde{X}_{ij}$ shows the value for criterion "*j*" and alternative "*i*". Additionally, it can be said that there are K decision makers.

$\widetilde{X}_{ij} = \frac{1}{K} + \left(\widetilde{X}_{ij}^1 + \widetilde{X}_{ij}^2 + \widetilde{X}_{ij}^3 + \cdots + \widetilde{X}_{ij}^K\right)$ Where $i = 1, 2, 3, ..m$ and $j = 1, 2, 3..n$

$\widetilde{W}_j = \frac{1}{K} + \left(\widetilde{W}_j^1 + \widetilde{W}_j^2 + \widetilde{W}_j^3 + \cdots + \widetilde{W}_j^K\right)$

While using these fuzzy weights, fuzzy decision matrix can be generated. The details are shown below. In this equation, "C" represents criteria while "A" gives information about the alternatives.

$$\widetilde{D} = \begin{array}{c} \\ A_1 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{ccc} C_1 & \cdots & C_n \end{array} \\ \begin{bmatrix} \widetilde{X}_{11} & \cdots & \widetilde{X}_{1n} \\ \vdots & \ddots & \vdots \\ \widetilde{X}_{m1} & \cdots & \widetilde{X}_{mn} \end{bmatrix} \end{array}$$

In the following step, fuzzy decision matrix is normalized by using the following equations.

$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_{ij}^*} + \frac{b_{ij}}{c_{ij}^*} + \frac{c_{ij}}{c_{ij}^*}\right)$

$c_{ij}^* = \sqrt{\sum_{i=1}^{m} c_{ij}^2}$

Just then, positive and negative solutions are calculated with the formulas below.

$A^+ = \left(\widetilde{V}_1^+, \widetilde{V}_2^+, \widetilde{V}_3^+, \ldots, \widetilde{V}_n^+\right)$ and

$A^- = \left(\widetilde{V}_1^-, \widetilde{V}_2^-, \widetilde{V}_3^-, \ldots, \widetilde{V}_n^-\right)$

where $\tilde{V}_j^+ = (1, 1, 1)$ and $\tilde{V}_j^- = (0, 0, 0)$

$D_i^* = \sum_{j=1}^{n} d\left(\widetilde{V}_{ij}, \widetilde{V}_j^*\right)$

$D_i^- = \sum_{j=1}^{n} d\left(\widetilde{V}_{ij}, \widetilde{V}_j^-\right)$

In this context, "A+" demonstrates the fuzzy positive ideal solution whereas "A-" shows the fuzzy negative ideal solution. Furthermore, "Di-" refers to the distance from negative ideal solution. Moreover, "Di+" shows the distance from positive ideal solution. Hence, the closeness coefficient can be calculated by using following equations.

$CC_i = \frac{D_i^-}{D_i^+ + D_i^-}$

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Fuzzy VIKOR Method

VIKOR method was developed to make decision in complex situations. Because decision making is not an easy aspect, people face many difficulties when they try to select the best alternative. In VIKOR method, C refers to the criteria whereas A shows the alternatives. The different steps of this method are detailed below (Dincer et al., 2016). In the first step, the criteria are identified as following.

$f_i^* = \max f_{ij}$ and $f_i^- = \min f_{ij}$

On the other side, for the cost issue, the following equations are considered.

$f_i^* = \min f_{ij}$ and $f_i^- = \max f_{ij}$

In the second step, Sj and Rj values are calculated as below. In these equations, w represents weights of the criteria.

$S_j = \sum_{i=1}^{n} w_i \frac{(f_i^* - f_{ij})}{(f_i^* - f_i^-)}$

$R_j = \max \frac{w_i(f_i^* - f_{ij})}{(f_i^* - f_i^-)}$

In the third step, the index value (Qj) is calculated as below.

$Q_j = \frac{v(S-S^*)}{S^- - S^*} + \frac{(1-v)(R_j - R^*)}{R^- - R^*}$

$S^* = \min_j S_j$ and $S^- = \max_j S_j$

$R^* = \min_j R_j$ and $R^- = \max_j R_j$

In the fourth step, the values are ranked.

RESULTS AND DISCUSSION

The first phase of the analysis includes the fuzzy ANP methodology to measure the relative importance of dimensions and criteria. The project team has been also been defined as a decision-maker group to appoint the linguistic terms. The summary results can be seen in Table 2.

TABLE 2. The weights of criteria

Dimensions	Weights	Criteria	Local Weights	Global Weights
Financial	0,34	Return on Investment	0,33	0,11
		Profitability	0,28	0,10
		Competitive Advantage	0,23	0,08
		Cost Effectiveness	0,15	0,05
Customer	0,27	Customer Expectation	0,44	0,12
		Satisfaction	0,32	0,08
		Practice	0,18	0,05
		Commitment	0,07	0,02
Internal Factors	0,18	Compatibility	0,44	0,08
		Clearity	0,23	0,04
		Contribution	0,19	0,03
		Encouragement	0,14	0,03
Learning	0,21	Communication	0,29	0,06
		Data	0,29	0,06
		Training	0,22	0,05
		Technologic Development	0,20	0,04

Table 2 shows that performance dimension (D1) has the highest importance in the balanced scorecard perspectives while the organizational compliance (D3) has the weakest weight of new service development competencies. Accordingly, the return on investment (C5) and customer expectation (C8) are the most importance criteria as the commitment (C8) has the weakest criterion with 0.02.

Following phase continues with the ranking the alternatives by using the fuzzy TOPSIS and fuzzy VIKOR methods comparatively. Both methods used the linguistic terms provided from the group decision. The following steps of the fuzzy TOPSIS have been applied to rank alternatives by calculating the negative D_1^- and positive D_1^* ideal solution as well as the closeness coefficient CC_1 .

TABLE 3. The values of D_1^*, D_1^-, CC_1 and ranking the alternatives

Alternatives	Ownership	D_1^*	D_1^-	CC_1	Ranking
A1	S1	15,84	0,17	0,01053	4
A2	S2	15,84	0,16	0,01030	6
A3	S3	15,86	0,14	0,00897	11

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Table 3. Continue.

Alternatives	Ownership	D_1^*	D_1^-	CC_1	Ranking
A4	P1	15,83	0,18	0,01096	3
A5	P2	15,91	0,10	0,00649	20
A6	P3	15,89	0,12	0,00738	15
A7	P4	15,91	0,10	0,00618	22
A8	P5	15,92	0,09	0,00572	24
A9	P6	15,84	0,16	0,01019	7
A10	P7	15,83	0,18	0,01128	2
A11	P8	15,84	0,17	0,01048	5
A12	F1	15,90	0,11	0,00695	16
A13	F2	15,92	0,09	0,00569	25
A14	F3	15,90	0,11	0,00693	17
A15	F4	15,90	0,11	0,00683	18
A16	F5	15,88	0,13	0,00824	13
A17	F6	15,86	0,15	0,00924	9
A18	F7	15,88	0,13	0,00837	12
A19	F8	15,86	0,15	0,00919	10
A20	F9	15,89	0,12	0,00757	14
A21	F10	15,91	0,10	0,00648	21
A22	F11	15,86	0,15	0,00946	8
A23	F12	15,90	0,11	0,00680	19
A24	F13	15,93	0,08	0,00516	26
A25	F14	15,92	0,09	0,00578	23
A26	F15	15,82	0,18	0,01130	1

In Table 3, "A" shows the alternatives. With respect to the ownership, "S" demonstrates state banks, "P" refers to the private banks and "F" focuses on the foreign banks. A26 is the best bank in service innovation competencies, and A24 has the worst degree of the service innovation performance. The fuzzy VIKOR is used to provide the comparative results of the banks' new service development competencies as well. The results are demonnstrated in Table 4.

TABLE 4. The values of S_i, R_i and Q_i and ranking the alternatives

Alternatives	Ownership	S_i	R_i	Q_i	Ranking
A1	S1	0,274	0,064	0,250	6
A2	S2	0,304	0,064	0,270	7
A3	S3	0,444	0,082	0,478	11
A4	P1	0,170	0,061	0,161	3
A5	P2	0,729	0,083	0,673	19
A6	P3	0,624	0,083	0,604	14
A7	P4	0,776	0,097	0,793	20
A8	P5	0,837	0,117	0,968	24
A9	P6	0,289	0,061	0,240	5
A10	P7	0,238	0,041	0,072	2
A11	P8	0,252	0,061	0,215	4
A12	F1	0,675	0,082	0,628	16
A13	F2	0,847	0,117	0,974	25
A14	F3	0,675	0,083	0,637	17
A15	F4	0,708	0,117	0,882	21

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Table 4. Continue..

Alternatives	Ownership	S_i	R_i	Q_i	Ranking
A16	F5	0,513	0,083	0,530	13
A17	F6	0,385	0,061	0,302	9
A18	F7	0,474	0,083	0,504	12
A19	F8	0,399	0,061	0,312	10
A20	F9	0,640	0,084	0,622	15
A21	F10	0,749	0,117	0,910	22
A22	F11	0,355	0,061	0,282	8
A23	F12	0,697	0,083	0,651	18
A24	F13	0,885	0,117	1,000	26
A25	F14	0,796	0,115	0,923	23
A26	F15	0,127	0,041	0,000	1

TABLE 5. Comparative results of service innovation competencies with the fuzzy TOPSIS and fuzzy VIKOR

Alternatives	Ownership	Ranking with FTOPSIS	Ranking with FVIKOR
A1	S1	4	6
A2	S2	6	7
A3	S3	11	11
A4	P1	3	3
A5	P2	20	19
A6	P3	15	14
A7	P4	22	20
A8	P5	24	24
A9	P6	7	5
A10	P7	2	2
A11	P8	5	4
A12	F1	16	16
A13	F2	25	25
A14	F3	17	17
A15	F4	18	21
A16	F5	13	13
A17	F6	9	9
A18	F7	12	12
A19	F8	10	10
A20	F9	14	15
A21	F10	21	22
A22	F11	8	8
A23	F12	19	18
A24	F13	26	26
A25	F14	23	23
A26	F15	1	1

In Table 4, A26 is the best in the new service development competencies while A24 has the weakest performance in the banking sector.

Table 5 presents the comparative results of two integrated decision making approaches under the fuzzy environment. FANP-FTOPSIS and FANP-FVIKOR models give the same re-

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sults for selecting the best and the worst bank in the performance measurement. Thus, both approaches could provide the coherent results for ranking the banks in the performance of service innovation competencies.

CONCLUSION

Nowadays, banks all around the world have to give very much importance to service innovation concept to increase the competitive advantage. Otherwise, they cannot find a chance to survive in such a severe competition. This study aimed to assess the service innovation performance. In the analysis process, 26 Turkish deposit banks are examined. Also, 16 different criteria are identified by considering 4 different dimensions of balanced scorecard approach. Moreover, fuzzy ANP, fuzzy TOPSIS and fuzzy VIKOR are considered to achieve this purpose.

It is concluded that performance (D1) has the highest importance (0.34). Furthermore, it is also determined that internal factors have the lowest weight (0.18). Furthermore, it is also identified that return on investment (C1), profitability (C2) and customer expectations (C5) are the most important criteria. However, commitment (C8), contribution (C11) and encouragement (C12) are accepted as the least important criteria. It is also defined that the results of fuzzy TOPSIS and fuzzy VIKOR are very similar. In other words, both of these two methods give similar ranking results for the banks with respect to new service development competencies. In spite of this situation, by analyzing the performance of the banks according to the ownership type, it is identified there is not a comparative advantage of one type to another. For instance, the best bank in both methods is a foreign bank (F15). However, another foreign bank (F13) is also determined as the worst bank. Similarly, a private bank (P7) has the second highest performance while another private bank (P5) has a very bad performance.

IMPLICATIONS

The concept of service innovation has a high popularity in banking sector. Banks have to consider this situation to increase power. Additionally, it can also be said that new service development concept will probably become more important in the future. Hence, this study has significant results by focusing on a very important topic for banking sector.

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