

EVALUATION OF THE NEW BALANCED SCORECARD STRUCTURE VIA DESIGN OF EXPERIMENT: A CASE STUDY IN IT DEPARTMENTS OF BANKS

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Keywords	Abstract
Balanced Scorecard (BSC), Design of Experiment, full factorial design, IT	Balanced Scorecard (BSC) has emerged as one of the most widely used performance appraisal tools. The BSC includes both financial and non-financial factors to assess performance of businesses. Although the BSC is a useful tool for businesses, it is not dynamic or sensitive to fluctuation. This fragility of the BSC can be eliminated by incorporating risk and agile perspectives to the existing BSC structure. Thus, BSC includes six perspectives as Financial, Customer, Internal Business Processes, Learning and Growth, Risk, Agile. Aim of this study is to investigate impacts of risk and agile perspectives and their interaction with current four BSC perspectives (Financial, Customer, Internal Business Processes, Learning and Growth). For this aim, Design of Experiment (DOE) methodology is used. Design of Experiment examines relationship between criteria. Since financial perspective is the most important indicator of the business performance, it is determined as output variable. Other five perspectives are determined as input variables. Single impacts of five perspectives and impacts of their interactions on financial perspectives are investigated. An illustrative example in IT departments of the banks is presented in this study, and IT personnel are preferred as decision makers for Design of Experiment (DoE) application. Findings present that agile and risk perspectives influences financial perspective, their two-way and three-way interactions with other perspectives have significant impact on financial perspective.

YENİ DENGELİ SKORKART YAPISININ DENEY TASARIMI İLE DEĞERLENDİRİLMESİ: BANKALARIN BT BÖLÜMLERİNDE BİR VAKA ÇALIŞMASI

Anahtar Kelimeler	Öz		
Dengeli puan kartı, Deney tasarımı, Tam faktöryel tasarım, BT	Dengeli Puan Kartı (DPK), en yaygın kullanılan performans değerlendirme araçlarından biri olarak ortaya çıkmıştır. BSC, işletmelerin performansını değerlendirmek için hem finansal hem de finansal olmayan faktörleri içerir. BSC, işletmeler için faydalı bir araç olmasına rağmen, dinamik değildir veya dalgalanmalara duyarlı değildir. Yöntemin bu zayıflığı, mevcut DPK yapısına risk ve çevik bakış açıları eklenerek giderilebilir. Böylece DPK, (Finansal, Müşteri, Dahili İş Süreçleri, Öğrenme ve Büyüme, Risk, Çevik) olmak üzere altı perspektif içerir. Bu çalışmanın amacı, risk ve çevik perspektiflerin etkilerini ve bunların mevcut dört BSC perspektifiyle (Finansal, Müşteri, İç İş Süreçleri, Öğrenme ve Büyüme) olan etkileşimlerini incelemektir. Bu amaçla Deney Tasarımı (DT) metodolojisi kullanılmıştır. DT kriterler arasındaki ilişkiyi inceler. Finansal perspektif iş performansının en önemli göstergesi olduğu için çıktı değişkeni olarak, diğer beş perspektif girdi değişkeni olarak belirlenmiştir. Beş perspektifin tekil etkileri ve etkileşimlerinin finansal perspektif üzerindeki etkileri incelenmiştir. Bu çalışmada bankaların BT departmanlarında açıklayıcı bir örnek sunulmakta ve DOE uygulaması için karar verici olarak BT personeli tercih edilmektedir. Bulgular, çevik ve risk perspektiflerinin finansal perspektifi anlamlı bir şekilde etkilediğini göstermektedir. Ayrıca, bu iki perspektifin diğer perspektiflerle ikili ve üçlü etkileşimleri de finansal perspektif üzerinde önemli bir etkiye sahiptir.		
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1. Introduction

The Balanced Scorecard (BSC) was developed and presented in 1996 by Robert Kaplan and David Norton. It is a performance measurement and management system. BSC is a tool used to define, implement and manage strategies at all levels of the business. Launched as one of the most important developments in management accounting, BSC fulfills the three basic functions of businesses as a measurement system, a strategic management system and a communication tool (Striteska and Spickova, 2012).

BSC contains four perspectives as customer, financial, internal business processes, and learning and growth. While measuring and evaluating performance in BSC, answers are sought for the following questions regarding these four perspectives (Yaşar, 2016).

- How do customers see the business? (Customer perspective)
- How do the shareholders see the business? (Financial perspective)
- What are the processes that the business should develop, where should the business be superior? (Internal business processes perspective)
- How can the continuity of value creation and improvement be ensured? (Learning and growth perspective)

Because needs for agility and risk management in current BSC structure, Akman and Turan (2021) proposed a new BSC structure. They suggested that two new dimensions, agile and risk perspectives, should be added to the basic BSC structure that includes four perspectives as separate perspectives. Thus, BSC includes six perspectives. Then, they examined the single effects of these two new dimensions on other dimensions of BSC with the DEMATEL method. Thus, they determine pairwise causal relationships between six perspectives of the new BSC structure. Akman and Turan (2021) divided six perspectives into two groups as cause-and-effect groups. Risk and Agile perspectives were included in the cause factors, and both perspectives are defined as influencing factors. Both perspectives are related to current perspectives of BSC. DEMATEL results showed single influence of Risk and Agile factors on other perspectives. Akman and Turan's study doesn't provide us interactions of Risk and Agile perspectives with other perspectives. We want to

see interactions of Risk and Agile perspectives with other BSC perspectives. For this aim, DOE is very appropriate method, because with DOE method allows to see the interactions of two or more perspectives, and effects of these interactions on perspectives, and we can analyze how these two dimensions, Risk and agile, interact with the existing BSC dimensions and how they affect other dimensions together. With the DOE method, it is possible to make separate analyzes for each perspective. By considering one perspective as an output variable, and others as input variables, it is possible to see the single, double and triple effects/interactions of input perspectives together on output variable, and to make more detailed comments. Therefore, in this study, the DOE method is used to investigate impacts of risk and agile perspectives' interaction impacts with one and more other perspectives together, and the DOE method provide the opportunity to examine in detail the causal relationships between other perspectives, especially the risk and speed perspectives. Thus, aim of this study is used to reinforce and support the results of Akman and Turan (2021)'s study.

The rest of this study is arranged as follows; In Section 2, the related studies using BSC to measure IT performance have been reviewed. Section 3 contains methodology of the study. Section 4 presents a DOE application to evaluate singular, two-way and three-way interactions' influences of BSC perspectives via a case study in IT departments. Section 5 provides the Results and Discussions.

2. Theoretical Background

Many criticisms of the BSC's inadequacy have been found in the literature (Rillo, 2004; Salem, Hasnan and Osman, 2012; Awadallah and Allam, 2015). One of the most important criticisms is that BSC method establishes its approach to analysis around only four perspectives (financial, customer, internal business processes, and learning and growth). Many suggestions which contain adding new perspectives to the existing four BSC perspectives have been made because the current perspectives do not meet the needs of the businesses (Akman and Turan, 2021).

Current BSC perspectives cover the internal environment, but not the external environment, competitive performance, or stakeholder

perspectives (Kannan, Jafarian, Khamene and Olfat, 2013). BSC is insufficient for businesses because it does not account for external factors. While BSC is useful for internal issues, it is ineffective when it comes to external variables (Steele, Branson and Sung, 2013; Nezhad, Modiri and Yazdi, 2011). Current BSC structure with 4 perspectives don't support long-term strategies and don't take a proactive approach to dangers and possibilities in the external environment (Akman and Turan, 2021).

In most cases, a typical BSC does not cover in essential aspects relating to the business risks that the organization faces. Many authors suggested that risk management and risk related factors should be added to the BSC structure. As seen in Table 1, while some authors argue that risk factors should be characterized as a distinct perspective (Chang, Wu and Lin, 2007; Chen, Chen and Peng, 2008; Beasley, Chen, Nunez and Wright, 2006;

Chlistalla ve Schaper, 2009; Liang, 2013) in BSC, others proposed that argue that risk factors should be included in each of the current BSC perspectives (Oliviera, 2014; Asosheh, Nachigar and Jamporazmey, 2010; Siepermann, 2012; Spano, Sart0, Caldarelli and Vigano, 2016; Chang and Tsai, 2016).

Companies must adjust quickly and aggressively to unforeseen and unpredicted environmental changes in order to survive and compete (Kidd, 1994). In a fast-changing environment, companies must behave agile to cope with environmental and business risks, and to be competitive (Ahn, 2001; Rdiouat, Bahsani, Lakhdissi and Semma, 2015). Therefore, some authors suggested that that agility factors have been integrated to current perspectives of the BSC structure (Rdiouat et al., 2015; Tizroo, Esmaeili, Khaksar and Saparauskas, 2017).

Table 1
Needs for Agile and Risk perspectives

Suggestion of the study	Authors
Suggestions for RISK	
Incorporating the fifth perspective, which includes operational risks called as internal risks, into the traditional BSC approach.	Tangen (2003)
Risk management should be added to the BSC for financial organizations especially for banks	Beasley, Chen, Nunez and Wright (2006)
the 'Risk Dimension must be added alongside the original four BSC dimensions as a fifth dimension,	Chang et al. (2007)
Risk management should be included to the BSC	Chen et al. (2008)
Enterprise Risk Management (ERM) can be integrated to BSC	Wu and Olson (2008)
Risk management metrics can undoubtedly play a role in the financial BSC.	Kaplan and Norton (2010)
Since one of the main activities of clearing houses is risk management, risk management should be included in the BSC as a completely separate perspective.	Chlistalla ve Schaper (2009)
Risk management should be added as a third pillar for financial performance, and potentially a completely new set of risk management processes should be incorporated in the internal processes perspective.	Kaplan (2009)
Ambiguity risks (process, human resource, and technological risks) should be incorporated into the BSC's four existing perspectives.	Asosheh et al. (2010)
performing risk management in an integrated manner with the BSC will have a positive effect on shareholder value.	Raşid, Golshan, İsmail and Ahmad (2012)
risk indicators should be simply integrated into one or all of the traditional BSC dimensions,	Siepermann (2012)
In order to create the performance measurement system, BSC should contains five by adding the risk dimension to the generic four dimensions of the BSC.	Liang, 2013
The most critical risk factors should be identified according to the selected BSC perspectives and their indicators.	Oliviera (2014)

Companies should have an agile mindset in order to avoid losing or even increasing market share.

Rdiouat et al. (2015).

Since the strategy development process focuses on the external environment as well as internal competencies, adding risk to BSC will increase the effectiveness of the processes by ensuring that internal and external risk factors are taken into account.

Kotze, Vermaak and Kirshen (2015)

Risk control factor (service, performance, professionalism, risk control, and consumers' confidence) should be included to financial performance evaluation criteria in wealth management banks.

Chang and Tsai (2016)

Risk component should be included to internal business process perspective

Spano, Sarto, Caldarelli and Vigano (2016)

Suggestions for AGILITY

The agility factors should be adopted within the four perspectives of the BSC.

Tizroo et al (2017)

BSC is not concerned in extreme competition or rapid change. The existing BSC should be changed to accommodate the change by adding agility to BSC

Ahn (2001)

Agility factors should be included into four perspectives of BSC.

Rdiouat et al. (2015)

Agile and Risk factors should be added separately to current BSC structure

Akman and Turan, (2021)

The new BSC structure proposed by Akman and Turan (2021) includes six perspectives as seen in Figure 1; Financial, Customer, Internal Business Processes, Learning and Growth, Agile, Risk. You

can find detailed explanation about needs for agile and risk perspectives in the study of Akman and Turan (2021)



Figure 1. The BSC structure proposed by Akman and Turan (2021)

Financial perspective. The financial perspective includes traditional measures that reflect the success of other BSC perspectives in achieving organizational strategic goals. The financial

perspective is usually based on accounting data. It is at the top of the BSC perspectives hierarchy, as the decisions taken regarding other perspectives will ultimately lead to financial results (Bento, White and Lourdes., 2013)

Customer perspective. It measures the value propositions determined by the organizational strategy for the target customer groups (Bento et al., 2013). The main output criteria of this perspective are; customer satisfaction, customer retention, customer loyalty, new customer acquisition, customer profitability and market share (Kaplan and Norton, 1996).

The internal business processes perspective covers the basic and critical business processes that organizations have to perform well in order to deliver customer value (Bento et al., 2013). These processes are the internal processes that will affect the customer satisfaction of the business at the highest level and enable an organization to reach its financial goals (Kaplan and Norton, 1996).

Learning and growth perspective refers to the infrastructure that the business has to create for long-term growth and development (Kaplan and Norton, 1996)

Agile perspective. Although agile perspective includes the fact that the whole process of the product or service to be produced is fast, from the supply to the sale, it mainly covers the speed of the existing system in terms of new products and services to be created apart from the product and service, and the agility in terms of developments outside the company (Akman and Turan, 2021).

Risk perspective. Risk perspective covers the risks of the products and services to be offered, as well as the risks that may occur in terms of developments outside the company, together with the risks of the entire process from the supply of the product or service to be produced to the sale (Akman and Turan, 2021).

2.2. Literature Review

Literature review includes studies performed in evaluation of IT performance via BSC as presented in below

Birkhölzer, Dickmann, Vaupel and Dantas (2005) developed a model by using elements from the Capability Maturity Model Integration (CMMI) and balanced scorecards. Thus, the BSC eliminated the lack of information with regards to the Capability Maturity Model Integration (CMMI) managed IT processes, and the CMMI is consisted of fifteen processes that convert to the BSC's six perspectives (financial, customer, innovation, quality, product process and learning and growth) contains 27 Key

performance indicators (Birkhölzer et al., 2005). Grembergen and De Haes (2005) developed the relationship between the business BSC (BU BSC) and a general IT BSC is developed, and they demonstrated how a cascade of balanced scorecards can aid in the IT governance and business/IT alignment processes. Also, they explored the development and execution of an IT BSC, as well as an IT BSC Maturity Model.

Klubeck and Langthome (2008) proposed a report card allows an IT department to assess its progress and overall performance, as well as convey its efficacy to university leadership, IT personnel, and customers, and make any necessary improvements. A report card won't tell organizations how well IT department runs, but it will give the information organization need to make improvements. The report card simplifies the way an IT department looks at its data by taking the balanced scorecard technique a step further (by doing less).

Shang and Lin (2010) report multi-case study on three service-based companies. They highlighted the difficulties that customer service centers of these companies had in their attempt to implement IT infrastructure library to improve organizational efficiency. They collected data related to barriers to IT infrastructure library across service and process by means of BSC framework. Herath, Terath and Bremser (2010) developed a conceptual framework for strategic implementation of IT security using a balanced scorecard (BSC) approach. Asosheh et al. (2010) proposed a novel methodology for IT project selection by combining the balanced scorecard (BSC) and data envelopment analysis (DEA). BSC is used as a complete framework for setting IT project evaluation criteria, while DEA is used as a nonparametric tool for ranking IT projects in this approach.

Using the Balanced Scorecard (BSC) framework, Leckson-Leckey, Osei and Harvey (2011) determined and documented the extent to which banks' IT investments can affect their profitability in Ghana. The research draws on a large panel dataset of 15 banks drawn from Ghana's banking industry over a ten-year period (1998-2007). They proposed that banks maintain high levels of IT investment have a higher return on investment. Chen and Liang (2011) were carried out a survey to see how different tactics affected organizational performance as evaluated by the balanced

scorecard (BSC). The findings reveal that knowledge crossover and mutation have an impact on various dimensions of organizational performance (BSC dimensions). Furthermore, they found that organizational characteristics such as IT competency and culture of sharing have moderating impacts on performance.

Zeng and Luo (2013) stated that for a successful BSC implementation, a competent IT system is required. In order to construct the information systems strategy based on the outcomes of the systems performance, Ebrahimi, Hassanzadeh, Elahi and Ebrahimi (2013) explored the information systems strategic management based on systems performance, and they used BSC maturity model to assess the strategic management of information systems. Maria, Wijaya and Fibriani (2013) assessed the deployment of information and communication technology (ICT) at a using the IT Balanced Scorecard, particularly from the user's perspective (User Orientation).

Wijayanti, Setiawan and Sukamto (2017) defined the performance assessment indicators for IT governance, calculated the scores based on the indicators, and used UPI to analyze IT governance's performance. The methodology for establishing evaluation indicators in questionnaire form in this study is a combination of the Balanced Score Card (BSC) and COBIT 4.1. The final scores of IT governance's performance will represent UPI's business aims and objectives in all areas by integrating both methodologies.

Yoshikuni and Albertin (2017) used partial least squares path modeling to analyze the causal relationship between the balanced scorecard's performance perspectives. They undertook quantitative empirical research of firms during an economic crisis using data from 845 Brazilian companies and find the following noteworthy outcomes. Dynamic capability afforded by operational and analytical IT had a favorable impact on business process improvement and company performance. The results of mediation (endogenous variables) and moderation (control variables) help to define IT's role and advantages for business performance.

Christianto, Loisa and Andry (2020) conducted performance appraisal research to assess the manager level to manage existing business processes using BSC and integrated with COBIT 4.1,

3. Design of Experiment (DOE)

DOE is a method used to determine the values of variables that will influence the process performance by systematically changing the values of the controllable variables that influence the quality characteristic of the process (Montgomery, 2005). DOE is important in terms of statistically evaluating each factor and determining the highest level of results from each experiment (Albak and Belibağlı, 2010).

Many different methods are used in statistical DOE such as full factorial design, partial factorial, Taguchi method, response surface methodology, Shainin method, etc. If there is more than one factor in an experiment, factorial designs are used. Factorial design is the inclusion of all possible combinations of each factor level in the experiment. In other words, a full factorial experimental design is a combination of at least two or more levels multiplied by each other (Lazic, 2004).

The DOE conceptual approach is explained for two and three factors, as well as a generic 2^k factorial design, where k denotes the number of factors and 2 denotes the number of levels (Duraković, 2017).

When full factorial experimental design is combined with statistical methods, it provides great convenience to researchers in the analysis phase. Analysis of Variance (ANOVA) and regression analysis are used in the analysis of full factorial experiments. These methods allow to see the effect of a criterion. The ANOVA statistically explains which factors are important for which process. ANOVA technique reflects the statistical reliability and variability of the effects of the parameters according to different levels (Savaşkan, Taptık and Urgen, 2004). Regression analysis is used to detect the existence of a clear mathematical relationship between cause (independent input variable) and result (dependent output variable) (Hamzaçebi and Kutay, 2003). With the help of these methods, it is possible to calculate the effect of a factor on the experiment. These methods help to identify the source of the differences without making any changes during the processes (Breyfogle, 2003).

In this study, the full factorial DOE is utilized. Methodology for DOE is presented in Figure 3.

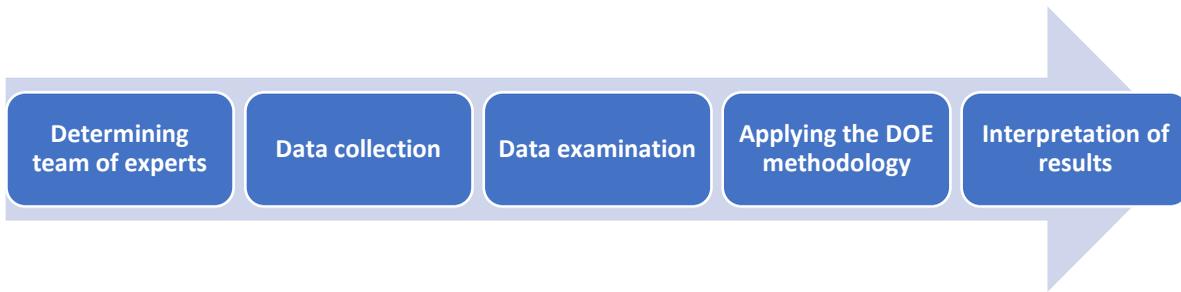


Figure 3. Methodology for DOE application

Research and publication ethics were complied with in this study.

4. Implementing the Design of Experiment for the Proposed BSC Approach in IT departments of banks

Akman and Turan (2021) used fuzzy DEMATEL method to present relationships between six perspectives of the proposed BSC approach. Fuzzy DEMATEL illustrates the cause-effect relationship for only one cause perspective on the other perspective, while the DOE represents the cause-effect relationship for one or more cause perspectives. Upon this, the DOE was implemented for six perspectives on behalf of all interactions. In this study, the full factorial design which has five factors with two levels for six perspective is performed. The Minitab 16 software was utilized

for DOE application. Values are entered for the perspective which are determined as effect.

Step 1. Determining team of experts for the DOE study

A survey was applied to the experts working in IT departments of banks. Qualified personnel are preferred (Industrial Engineering, Computer Engineering, Management Engineering and Management Information Systems). The survey was sent to 256 IT personnel, and 142 respondents answered the survey. The characteristics of participants are seen in Table 2. %78,9 of respondents is male, %38,7 of them have been working for 5-10 years in the company. %37,3 of them are working as expert. %69,7 of them have bachelor’s degree.

Table 2
Some characteristics of experts

Gender	Number	%	Working position	Number	%
Male	112	78,9	Assistant Expert	18	12,7
Female	30	21,1	Expert	53	37,3
Total	142	100	Senior Expert	14	9,9
Experience	Number	%	Project Leader	38	26,8
0-1 year	2	1,4	Vice manager	19	13,4
1-3 year	27	19,0	Total	142	100
3-5 years	22	15,5	Occupation		
5-10 years	55	38,7	Industrial Engineering	38	26,8
More than 10 years	36	25,4	Computer Engineering	54	38,0
Total	142	100	Management Engineering	22	15,5
Graduation Degree	Number	%	Management Information Systems	28	19,7
Bachelor’s degree	99	69,7	Total	142	100
Master degree	41	28,9			
PhD	2	1,4			
Total	142	100			

Step 2. Data collection

Data was collected via a questionnaire survey. In order to evaluate perspectives of the BSC structure

proposed by Akman and Turan (2021), target ratios for indicators of six perspectives were asked for next year. An example is given below

In your opinion, what should be the annual target number of the following indicators of this BSC perspective in the R&D company?
 1st Indicator: %75. 2nd Indicator: %5. 3rd Indicator: %20

According to the DOE, interactions of six perspectives were examined on the acquired answers. Hence, the DOE was performed towards the given targets.

Since the values for 6 perspectives will be examined, a two-level full factorial design method with 5 factors has been adopted as a methodology. Therefore, 25=32 experiments were conducted for each perspective. Points were given for each perspective in the survey questions of 142 participants. These scores are divided into percentage ranges. Accordingly, low and high levels were determined as two levels in the experiment, and while the level values were determined, 0% and 50% were selected for the low level and 50% and 100% for the high level, but no value was reached for ANOVA since there was no intersection. Therefore, 0% to 75% of all values given for each perspective are taken as low levels. Likewise, 25% to 100% of all values given for each perspective are taken as high levels. Thus, as the intersection point, it covers 25% to 75% of the

values as in the box diagrams. This intersection point consists of numbers in the center, similar to the normal distribution. It was %0 to %25 that made the low level different, while the numbers between %75 and %100 that made the high level different.

Step 2. Data examination before DOE application

Before applying DOE, the Matrix Plot of all perspectives are investigated in order to present the relationship between each of the perspectives. For this, the data of the questionnaire applied to 142 people were used. This matrix diagram is shown in Figure 4. The line in the pairwise comparison is the regression line that reflects the relationship of the two perspectives. Desired situation is that points are close to the regression line. As seen in Figure 4, clusters which are very close to the line indicate that there is a significant relationship between the two perspectives and each criterion is related to each other in general.

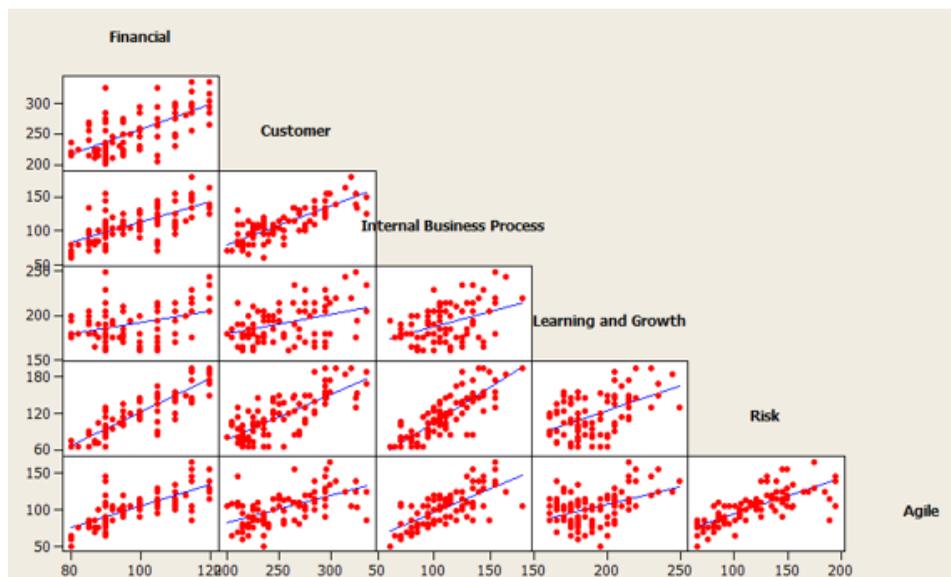


Figure 4. The Matrix Plot of BSC Perspectives

Step 3. Determining the DoE methodology

The Full Factorial design was conducted. It has five input factors with two levels for six perspectives. Low and high values were specified. According to this, it is accepted that the values between %0 and %75 are low, and values between %25 and %100 are high because of being intersection set (Intersection is set between 25% and %75 like the box plot). While “1” refers “low”, “2” refers “high”. The average of acquired results for each perspective was computed as low and high values.

Finally, the DOE was implemented in six perspectives for these values. Since there are six perspective, $2^5=32$ experiments are performed for each perspective. Experiment pattern and the $L_{32}(2^5)$ orthogonal array (with 5 parameters and 2 levels), and experimental results which is used in this study, are shown in Table 3. While A, B, C, D and E represent the parameters, Customer, Internal business process, Learning & Growth, Risk and Agile respectively, the numbers in each line represent the levels of the parameters.

Table 3
Experimental results

Exp. No.	Customer	Internal Business Process	Learning & Growth	Risk	Agile	Financial
	A	B	C	D	E	Y
1	1	1	1	1	1	89,90
2	1	1	1	1	2	93,50
3	1	1	1	2	1	94,90
4	1	1	1	2	2	95,80
5	1	1	2	1	1	91,60
6	1	1	2	1	2	93,90
7	1	1	2	2	2	96,30
8	1	1	2	2	1	95,10
9	1	2	1	1	1	94,30
10	1	2	1	1	2	94,70
11	1	2	1	2	2	95,80
12	1	2	1	2	1	95,10
13	1	2	2	1	1	93,60
14	1	2	2	1	2	94,70
15	1	2	2	2	1	95,10
16	1	2	2	2	2	96,20
17	2	1	1	1	1	93,00
18	2	1	1	1	2	94,70
19	2	1	1	2	1	96,20
20	2	1	1	2	2	98,00
21	2	1	2	1	1	92,70
22	2	1	2	1	2	94,70
23	2	1	2	2	1	96,40
24	2	1	2	2	2	98,50
25	2	2	1	1	1	94,80
26	2	2	1	1	2	95,50
27	2	2	1	2	1	97,00
28	2	2	1	2	2	99,00
29	2	2	2	1	1	94,20
30	2	2	2	1	2	95,40
31	2	2	2	2	1	97,40
32	2	2	2	2	2	100,10

When all way interactions and two ways interactions were performed, changes of results are examined.

Step 4. Interpretation of results

Afterwards, ANOVA was applied for 6 perspectives. Pareto analysis was applied to see whether the effect of the other 5 perspectives and the interaction between them was high for the relevant perspective. Re-interaction was examined according to the interaction number of the values exceeding the threshold value. For example, since it affects one and two interactions, it is also examined as one-way interaction and two-way interaction. By examining it in parts, it was determined whether the residual numbers showed a uniform distribution. The Normal Diagram of Effects shows the important results of the Pareto Chart in bold. The Main Effect Diagram, on the other hand, visually shows the level of influence of the relevant perspective by other perspectives. It shows that the closer or parallel to the horizontal line, the less effect it has, and the higher the slope, the greater the effect. The Interaction Diagram gives the interaction in terms of low and high degrees of other perspectives for the relevant perspective. It is desired that there is a linear relationship between them. If the line of low and high values is crossed, there is no interaction. The Residual Diagram consists of 4 graphs showing the distribution of residual values. The Normal Probability Diagram shows the distribution of residual values. Being above or very close to the

desired line, In the histogram, the distribution is typical for the normal distribution, specific to the bell shape, dense in the center, and decreasing equally on both sides as it moves away from the center, Equal or close in both areas separated by the horizontal axis in Versus Fits number distribution, in Versus Order, it is required to distribute in zigzags on both sides.

Since Kaplan and Norton (1996, 2009) stated that the main purpose of BSC's other perspectives is to influence the financial perspective, financial perspective results are detailed. Conversely, other perspective results are also interpreted.

5. Results and Discussion

For the financial perspective, a pareto chart showing the effects of other perspectives and their interactions is presented in Table 5. According to Figure 5, perspective that most influences the financial perspective is Risk, followed by Customer, Agile, Internal Processes and Customer*Risk interaction because their values are above threshold value. Interaction of Internal Processes*Risk and interaction of Customer*Internal Processes*Risk, is slightly below the threshold value, but they have implications on the financial perspective. The impact of the Learning and Development perspective on the Financial Perspective is not great.

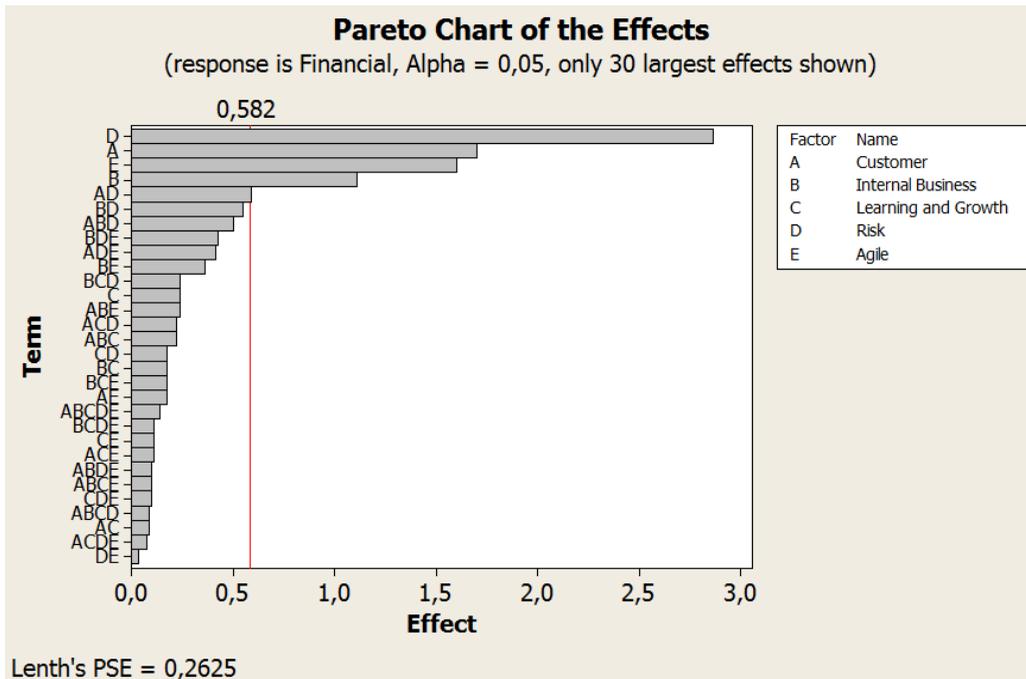


Figure 5. Pareto Chart of the Effects in terms of Financial Perspective

Figure 6 shows the Normal Diagram of Effects for the Financial perspective. If perspectives are significant for the financial perspective, their color are red, otherwise their color is black. Risk has the highest importance in terms of percentage and

impact. Consistent with the Pareto results, most important perspective for financial perspective is Risk. In order of importance, it is followed by Customer, Speed, Internal Processes and Risk*Customer, respectively.

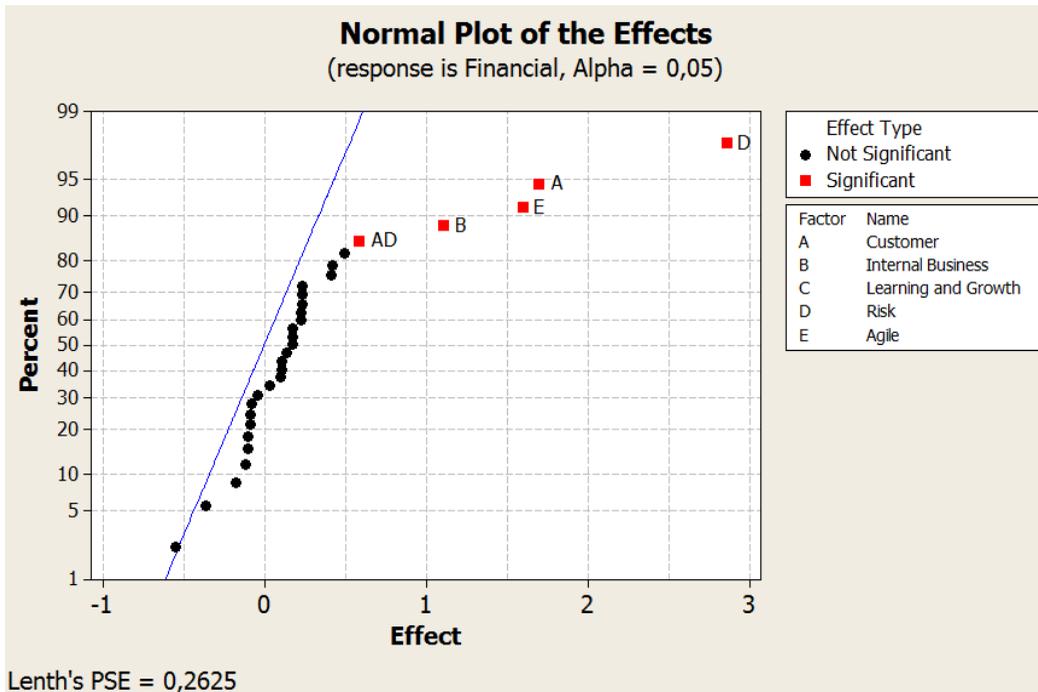


Figure 6. Normal Plot of the Effects in terms of Financial Perspective

Figure 7 shows the main effects plot for the financial perspective. The risk is the most important as its slope is the highest. Since Learning

and Development is in a parallel position close to the horizontal line and its slope is negligible, it has little impact on the financial perspective.

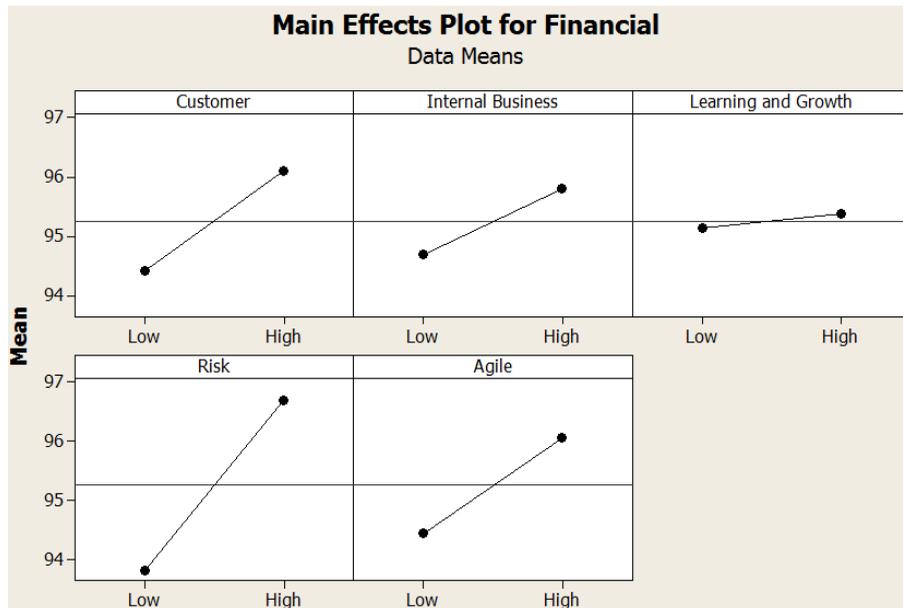


Figure 7. The Main effects Plot for the Financial Perspective

Figure 8 shows the Interaction Plot for the Financial perspective. The Interaction Plot illustrates relationship between both perspectives for low and high values. The power of these relationship represents a linear of both perspectives. A collateral relationship between the low and high values is wanted. It reveals that there

is not a relationship between two perspectives, when the lines cut each other. In Figure 8, perspectives are connected with each other, since they are collateral each other. It seems that there is an interaction between other perspectives for financial perspective. As already stated, that in the BSC, other criteria serve financial criteria.

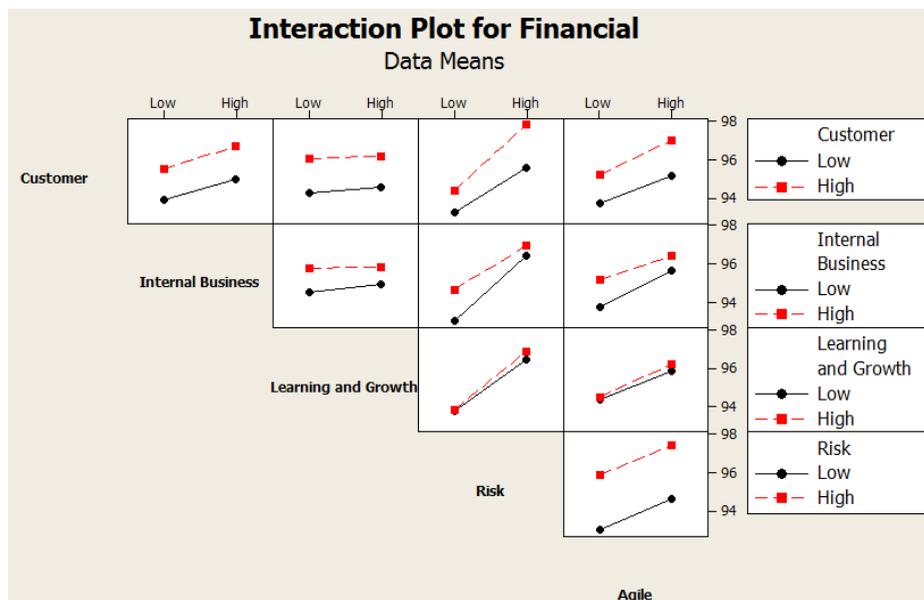


Figure 8. The Interaction Plot for the Financial Perspective

Figure 9 shows the Residual Plots graphs. These graphs are meaningful. Since, dispersion in Normal Probability Plot is close and symmetric to the line, the graph is meaningful. Versus Fits graph points

should disperse for both areas. In Histogram, the outcomes are consistent, as the normal distribution are seen as a bell curve. In Versus Order, the outcomes are meaningful, since the line weave symmetrically.

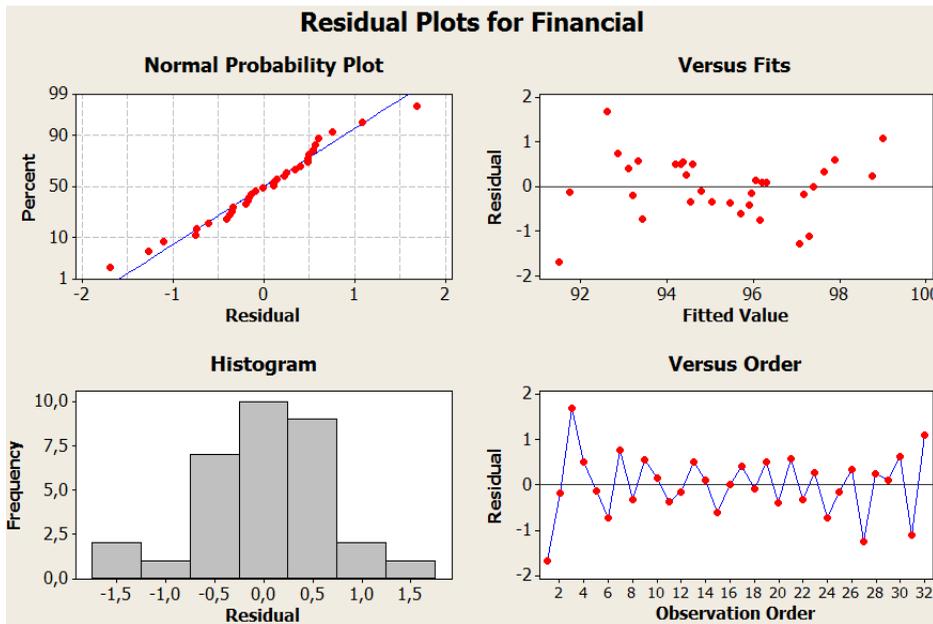


Figure 9. The Residual Plots for the Financial Perspective

Since Kaplan and Norton (1996) stated that the main purpose of BSC's other perspectives is to influence the financial perspective, regression analysis (coefficients and significance levels) and ANOVA test for the financial perspective were examined

Table 4 shows the results of the regression analysis for the financial perspective. In this table singular

impacts of perspectives, and pairwise interactions impact of them, triple interactions impact of them on financial perspectives are presented. According to these results, the selected five perspectives including their bilateral and triple interactions explains %92,47 variance of the financial perspective. This ratio is considerable high.

Table 4
Regression Analysis Results For Financial Perspective

Term	Effect	β Coeff	t	P
Constant		95,3250	4884,55	0,000
Customer (A)	1,7188	0,8594	44,04	0,000
Internal Business Process (B)	1,1312	0,5656	28,98	0,000
Learning and Growth (C)	0,3000	0,1500	7,69	0,000
Risk (D)	2,8937	1,4469	74,14	0,000
Agile (E)	1,6250	0,8125	41,63	0,000
Customer*Internal Business Process (A*B)	0,0250	0,0125	0,64	0,526
Customer*Learning and Growth (A*C)	-0,0969	-0,0484	-0,68	0,303
Customer*Risk (A*D)	0,5500	0,2750	14,09	0,000
Customer*Agile (A*E)	0,2312	0,1156	5,92	0,000
Internal Business Process* Learning and Growth (B*C)	0,1719	-0,0859	-1,01	0,167
Internal Business Process*Risk (B*D)	-0,5500	-0,2750	-14,09	0,000
Internal Business Process*Agile (B*E)	-0,3062	-0,1531	-7,85	0,000
Learning and Growth*Risk (C*D)	0,1563	0,0781	4,00	0,000
Learning and Growth*Agile (C*E)	0,1625	0,0813	4,16	0,000
Risk*Agile (D*E)	-0,0062	-0,0031	-0,16	0,874
Customer*Internal Business Process*Learning and Growth (A*B*C)	0,2125	0,1062	5,44	0,000
Customer*Internal Business Process*Risk (A*B*D)	0,4813	0,2406	12,33	0,000
Customer*Internal Business Process*Agile (A*B*E)	0,2250	0,1125	5,76	0,000
Customer*Learning and Growth*Risk (A*C*D)	0,2250	0,1125	5,76	0,000
Customer*Learning and Growth*Agile (A*C*E)	0,1562	0,0781	4,00	0,000
Customer*Risk*Agile (A*D*E)	0,4125	0,2062	10,57	0,000
Internal Business Process*Learning and Growth*Risk (B*C*D)	0,2375	0,1188	6,08	0,000
Internal Business Process*Learning and Growth*Agile (B*C*E)	0,2062	0,1031	5,28	0,000
Internal Business Process*Risk*Agile(B*D*E)	0,4125	0,2063	10,57	0,000
Learning and Growth*Risk*Agile (C*D*E)	0,1437	0,0719	3,68	0,001

S = 0,573685 PRESS = 28,0844

R-Sq = 94,26% R-Sq(pred) = 89,80% R-Sq(adj) = 92,47%

Regression Equation is written as following

$$Y = 95,3250 + 0,8594*A + 0,5656*B + 0,15*C + 1,4469*D + 0,8125*E + 0,0125*A*B - 0,0484*A*C + 0,2750*A*D + 0,1156*A*E - 0,0859*B*C - 2750*B*D - 0,1531*B*E + 0,0781*C*D + 0,0813*C*E - 0,031*D*E + 0,1062*A*B*C + 0,2406*A*B*D + 0,1125*A*B*E + 0,1125*A*C*D* + 0,0781*A*C*E + 0,2062*A*D*E + 0,1188*B*C*D + 0,1031*B*C*E + 0,206*B*D*E + 0,0719*C*D*E$$

Impact of Customer, Internal Business Process, Learning and Growth, Risk, Agile on Financial perspective are meaningful and statistically significant since their p values are smaller than 0,05. When two-way interactions are investigated,

Customer*Risk, Customer *Agile, Learning & Growth *Risk, Learning & Growth*Agile interactions have positive and significant impact on financial perspective. Internal Business Process*Risk interaction and Internal Business

Process*Agile interaction have meaningful, but negative impact on Financial Perspective.

All three-way interactions of perspectives have positive and significant impact on financial perspective ($p < 0,05$).

Table 5 presents variance analysis results for financial perspective. In Table 5, it is seen that the Risk perspective has the highest value in Seq Sum of Squares (SS), Adj SS, Adj Mean Square (MS) and F values.

Table 5
Variance Analysis for Financial perspective

Source	do	Seq SS	Adj SS	Adj MS	F	P
Main Effects	5	245,412	245,412	49,082	2013,64	0,000
Customer	1	47,266	47,266	47,266	1939,10	0,000
Internal Business Process	1	20,476	20,476	20,476	840,03	0,000
Learning and Growth	1	1,44	1,44	1,440	59,08	0,000
Risk	1	133,981	133,981	133,981	5496,64	0,000
Agile	1	42,250	42,250	42,250	1733,33	0,000
2-Way Interactions	10	13,456	13,456	1,346	55,21	0,000
Customer*Internal Business Process	1	0,010	0,010	0,010	0,41	0,526
Customer*Learning and Growth	1	0,141	0,141	0,141	1,77	0,122
Customer*Risk	1	4,840	4,840	4,840	198,56	0,000
Customer*Agile	1	0,856	0,856	0,856	35,10	0,000
Internal Business Process*Learning and Growth	1	0,456	0,456	0,456	4,23	0,078
Internal Business Process*Risk	1	4,840	4,840	4,840	198,56	0,000
Internal Business Process*Agile	1	1,501	1,501	1,501	61,56	0,000
Learning and Growth*Risk	1	0,391	0,391	0,391	16,03	0,000
Learning and Growth*Agile	1	0,423	0,423	0,423	17,33	0,000
Risk*Agile	1	0,001	0,001	0,001	0,03	0,874
3-way interactions	10	13,797	13,797	1,380	56,61	0,000
Customer*Internal bProcesses*Learning and Growth	1	0,722	0,722	0,722	29,64	0,000
Customer*Internal Processes*Risk	1	3,706	3,706	3,706	152,03	0,000
Customer*Internal Processes*Agile	1	0,810	0,810	0,810	33,23	0,000
Customer*Learning and Growth*Risk	1	0,810	0,810	0,810	33,23	0,000
Customer*Learning and Growth*Agile	1	0,391	0,391	0,391	16,03	0,000
Customer*Risk*Agile	1	2,722	2,722	2,722	111,69	0,000
İnternal Processes*Learning and Development*Risk	1	0,903	0,903	0,903	37,03	0,000
İnternal Processes*Learning and Development*Agile	1	0,681	0,681	0,681	27,92	0,000
İnternal Processes*Risk*Agile	1	2,723	2,723	2,723	111,69	0,000
Learning and Growth*Risk*Agile	1	0,331	0,331	0,331	13,56	0,001
Residual Error	48	15,797	15,797	0,329		
Lack of Fit	16	15,022	15,022	0,939	38,770	0,000
Pure Error	32	0,775	0,775	0,024		
Total	63	275,435				

For all 5 perspectives the p significance level is also below 0.05. This means the five perspectives have significant impact on the Finance perspective. Similar to Table 3, it is seen that the two-way interactions (Customer*Risk, Customer*Agile, Internal Business Process*Risk, Internal Business Process*Agile, Learning and Growth*Risk, Learning and Growth*Agile) are also significant. All three-way interactions are significant ($p < 0.05$).

6. Conclusions

When we examine the current BSC structure, it is seen that it is extremely inadequate especially for banks. Although the BSC is a highly effective tool in ensuring internal efficiency in that it includes not only financial but also non-financial performance indicators, it is insensitive to external change. Therefore, BSC is extremely inadequate for banks. Although different disciplines and different perspectives have been added regarding this, it has been seen that it is not effective in solving these problems. Success in companies requires showing the same ability outside the company as well as managing the company effectively. Today, a company that enters the market fast is far ahead of its competitors. Despite being more efficient than the competitors, not being able to enter the market quickly will leave the company face to face with big problems in the long run. Now that the product-oriented approach has been shifted to a customer-oriented approach, the companies that respond to the demands of the customers in the fastest way and even offer new products and services beyond the customer's demands will also manage the market. Therefore, it is necessary to be fast and configure the structure to adapt to this speed. Agility is also a point that triggers risk. Some bold steps will also bring uncertainty.

In this new structure to be created for the purpose, it is necessary to consider the risk within the existing structure in order to balance the agility and therefore the system. For this, risk and agile perspectives should be used in addition to existing perspectives. Thus, under a single structure, the deficiency of the model will be eliminated.

To support findings of Akman and Turan (2021), this paper investigates whether the risk and agile perspectives are necessary for the BSC via DOE method. The relationships amongst perspectives are examined by the DOE method. This study proves that the DOE can be utilized with respect to

expressing the causal relationship like the DEMATEL. But DOE and DEMATEL are different. The difference of the DOE from DEMATEL is that the DOE allows to study one-way, two way and three-way interactions of perspectives while DEMATEL allows to investigate single effects of perspectives. The DOE indicates that if a perspective which is affected by one or more perspectives is also affected by these perspectives' interactions. Consequently, the DOE deepens results of Akman and Turan (2021)'s study

But fuzzy DEMATEL interprets the results by considering the sum of all perspectives like fuzzy and it produces a single result for interaction of six dimensions. Design of experiment (DOE) method evaluated each perspective separately, and obtained six independent results for each perspective. One perspective was determined as output variable, and other six perspectives as input variables. Then DOE and statistical analyses were performed, and six independent results were provided. In this study, we presented only financial perspective' results as an example. By adapting and applying DOE, we saw whether single, two-way and three-way interactions of input perspectives have an effect on the output perspective. Thus, results of this study support findings of Akman and Turan (2021).

The DOE results illustrate that the risk is the most significant perspective in six perspectives, since it is the most effective perspective for each perspective. The customer is the most effective perspective for risk.

To sum up, six perspectives are used, the DOE expresses the causal relationship with all way interactions. The DOE displays two-way and three-way interactions which exceeds the threshold value.

This study shows that two-way interactions of risk and agile perspectives with other perspectives influence financial perspective positively and significantly. All three-way interactions of risk and agile perspectives have positive and significant impacts on financial perspective. Thus, this study proves that risk and agile factors are related with other perspectives and their interactions with other perspectives influence financial perspective which is defined as output variable.

Future studies can also put the new BSC paradigm to the test in other fields. Six perspectives can be

used in a variety of fields. In future studies, sub criteria of perspectives can be weighted. When weighting the perspectives, alternative Multiple Criteria Decision Making (MCDM) methods such as the ANP, AHP, CRITIC, SWARA, TOPSIS can be used.

Contributions of Authors

In this study, Hakan TURAN, to Conception and design of study, Questionnaire design, acquisition of data, analysis and interpretation of data, preparing draft of the manuscript. Gülşen AKMAN, contributed to Conception and design of study, Organizing the study, Literature review, Drafting the manuscript, Editing and revising the manuscript critically for important intellectual content. Zerrin ALADAĞ contributed to the Editing and Reviewing of the paper

Conflict of Interest

The authors declare no conflict of interest.

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