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MEASURING ERROR MANAGEMENT CULTURE: SCALE DEVELOPMENT AND VALIDATION

Hata Yönetimi Kültürü Ölçeğinin Geliştirilmesi: Geçerlik ve Güvenirlik Çalışmaları

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ABSTRACT

In this study, the error management culture scale (EMC-S) was developed. The sample of the research consists of 636 teachers in the city center of Elazığ. Lawshe technique was used by taking expert opinions to ensure the scope and face validity and exploratory and confirmatory factor analyzes were performed to ensure construct validity. In the first stage, a draft version of the scale was developed by employing the Lawshe technique. In the second stage, exploratory factor analysis (EFA) was performed with the participation of three hundred twelve teachers. Before the analysis, the data was screened to determine whether the data were appropriate for factor analysis. The results of the EFA confirmed that the scale has sixteen items with four factors. The factors were entitled as error sharing (five items), error competence (five items), error avoidance (three items), and response to error (three items). In the third stage, confirmatory factor analysis (CFA) was conducted with three hundred twenty four different participants. The results revealed proof of recommended agreement (CFI=.945, NFI=.958, GFI=.927, SRMR=.051, RMSEA=.058). In addition, reliability of the scale was calculated. The reliability coefficient values for factors and the scale was over .782, which proved that the scale is highly reliable.

Anahtar Kelimeler
Hata Yönetimi Kültürü, Ölçek Geliştirme, Ölçek Doğrulama

ÖZ

Bu çalışmada hata yönetimi kültür ölçeği (HYK-Ö) geliştirilmiştir. Araştırmanın örneklemini, Elazığ il merkezindeki 636 öğretmen oluşturmaktadır. Kapsam ve görünüş geçerliğinin sağlanması için uzman görüşleri alınarak Lawshe tekniği kullanılmış, yapı geçerliği sağlanması için de açımlayıcı ve doğrulayıcı faktör analizleri yapılmıştır. İlk aşamada ölçeğin taslak versiyonu, Lawshe tekniği kullanılarak geliştirilmiştir. İkinci aşamada üç yüz on iki öğretmenin katılımıyla açımlayıcı faktör analizi (AFA) yapılmıştır. Analizden önce verilerin faktör analizi için uygun olup olmadığının belirlenmesi için veriler taranmıştır. AFA sonuçları, ölçeğin dört faktörlü on altı maddeden oluştuğunu doğrulamıştır. Faktörler, hata paylaşımı (beş madde), hata yetkinliği (beş madde), hatadan kaçınma (üç madde) ve hataya tepki (üç madde) olarak adlandırılmıştır. Üçüncü aşamada, üç yüz yirmi dört farklı katılımcı ile doğrulayıcı faktör analizi (DFA) yapılmıştır. Sonuçlar kabul edilebilir düzeydedir (CFI = .945, NFI = .958, GFI = .927, SRMR = .051, RMSEA = .058). Ayrıca ölçeğin güvenirliği hesaplanmıştır. Faktörler ve ölçeğin güvenirlik katsayı değerleri .782'nin üzerinde olması ölçeğin oldukça güvenilir olduğunu kanıtlamıştır.

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1. Introduction

In today's world, societies implement a continuous development policy in line with their interest in order to have a voice and compete with other societies, which requires training of employees in this direction. This brings up an issue related to work atmosphere. One of the primary issues for the development of societies is to provide the work atmosphere in which error management is of great importance. Error is defined as an act that through unintentionally ignorance which cause failing to achieve what should be done (TDK, 2020). Considering that information is becoming more complex every day, it is critical to be aware of errors that cannot be prevented in organizations. For the achievement of an organization, negative consequences of errors must be reduced and turned into a positive consequences (Frese, 1991), which is related to error management. Error management is the earliest diagnosis and analysis of errors, reducing and overcoming the undesirable situations due to the error, and learning from the error (Cigularoy et al., 2010). Every organization has its own culture and it includes error management, which is the form of communication used by members of an organization about the error that may occur while performing transactions. Error management expresses all the practices and official procedures related to how an error is detected, what tools and methods are used to fix the error, and how members deal with that error (Van Dyck et al., 2005). In other words, error management culture is to concentrate on the causes of errors by taking the necessary steps and changing the rules in order to prevent repetition of them and to minimize their negative consequences (Helmreich, 1998). Organizations with poor error management are concerned with only the negative consequences of errors rather than supporting their employees to overcome those errors (Reason, 1990). These organizations with traditional culture support the idea that the employee who make a mistake should be punished, which results in less communication. Accordingly, employees tend to conceal the error in order to prevent themselves from being accused (Carmeli & Gittell, 2009). Indeed, communication has a critical feature in error management in terms of facilitating the solutions and creating an opportunity to learn from errors (Keith & Freze, 2011) and provides members of an organization with the ability to predict possible errors (Leenders et al., 2003). Organizations with a strong organizational culture can manage their errors. These organizations provide their employees with opportunities to learn from errors, raise awareness about errors, analyze them in accordance with the system, share experiences related to errors, and ensure that employees learn from them by taking responsibility (Guchait et al., 2015).

There are two approaches related to the error management culture: prevention approach and resilience approach. The prevention approach focuses on situation before an error occurs. The rationale of this approach is that if critical works and processes are detected before the error that may occur, it can be prevented. On the other hand, the resilience approach focuses on the processes after the occurrence of the error. This approach accepts the philosophy assuming that errors cannot be prevented before they occur and taking any cautions before the error only hinder innovations. This approach advocates that zero error policy is not a case to be applied in organizations. In short, organizations supporting the resilience approach intervene the error as soon as it occurs (Van Dyck et al., 2005; Goodman et al., 2011).

In order to deal with errors and learn from them, employees have a number of duties in all institutions. Specifically, employees should ensure that members of organizations are willing to fulfill their duties, loyal to their profession, and not afraid to make mistakes. However, employees' efforts are not sufficient since the others' feelings and thoughts have a great importance. While feeling that they are a stakeholder of the organization, employers should not be afraid of mistakes and share them with the other stakeholders in order to intervene in them in a timely manner and not repeat the same mistake. Although the concept of error management culture is a concept that attracts researchers' attention (Hales & Pronovost, 2006; Cigularov et al., 2010; Serger, 2017; Yiğital, 2018; Özerden, 2019) there is a limited number of studies in this topic in Turkish literature. In addition, any domestic questionnaire developed on the error management culture was not encountered. In order to fill this gap with proof of validity and reliability, this study aims to develop an error management culture scale (EMC-S).

2. The Study

This study consists of three stages. In the first stage, the EMC-S was constructed based on the Lawshe technique. While the second stage focused on determination of the construct validity of the scale, the third stage focused on verification of the structure that created in the second stage, the fourth stage focused on verification reliability.

2.1. Stage 1: Scale Development

In order to ensure scale's content validity, the Lawshe (1975) technique was used. The Lawshe technique consists of six steps. In the first step, a group of experts is identified. This technique requires five to 40 experts for its effective usage. For this step, twelve faculty members from the different Department of Education Faculty were chosen to form the expert group. The second step is about the determination of possible items for the scale. Firstly, a comprehensive literature review was conducted in order to identify studies related to the error management in organizations (Edmondson, 2004; Van Dyck et al., 2005; Goodman et al., 2011; Keith & Freze, 2011). Based on the literature review, a pool of 41 items sampling was developed. These items were related to competence against errors, sharing of errors within the institution, avoidance of errors, and reaction shown after occurrence of an error. The third step of the Lawshe technique is to obtain expert views. The experts evaluated each item in terms of the following criteria: a) item measures the targeted structure, b) item is related to the structure but unnecessary, and c) item does not measure the targeted structure. The next step is to calculate content validity ratio (CVR) based on the expert views. CVR is calculated by dividing up the total number of experts who state the item is necessary by the total number of experts who review the item and subtracting it from one (1). If CVR is equal to or below zero, then, the item is dropped out from the pool. Then, the obtained CVRs were compared with the content validity criteria provided in the literature (Veneziano & Hooper, 1997) by considering significance level (p value) as 0.05. In this study, CVR was calculated for each item and 10 items were removed from the draft version of the scale since they were below the statistical criteria determined through twelve experts' opinions. The following step is to calculate the content validity index (CVI) of the remaining items. CVI is calculated through the average of CVR of the items in the pool, which identifies the items that will be included in the final draft of the scale. The overall CVI was calculated as 0.74. The last step is to decide the items that will be included in the scale through CVR/CVI criterion. After this step, the content validity of the scale consisting of 31 items were completed. In addition to content validity, the items were reviewed in terms of its language and grammar issues by two experts in the field of Turkish education. After the revisions, the scale was ready for use. Then, the necessary permissions were obtained from the institutions in order to administer the scale.

2.2. Stage 2: Construct Validity of the EMC-S

2.2.1. Participants

Education constitutes the basis of the society; therefore, educational processes should be carried out effectively (Ertürk, 1992). The most important actors of this process are teachers due to their responsibilities (Köse, 2015). Those responsibilities include guiding students, dealing with social problems, and protecting environment (McNeil, 1996). Considering that errors are inevitable, error management culture need to be discussed for educational institutions as well. Therefore, the sample of this study was chosen from the teachers.

A stratified sampling method was used in determination of the participants. This method meets the purpose of the research because there are important stratified for the sample to be used in the study universe. In this method, some substrates are found in the universe and studied within the framework of the specified universe (Büyüköztürk et al., 2012; Yıldırım & Şimşek, 2013). In the city where the data were collected was divided into five educational zone. Therefore, participants were stratified on educational zone. There are different approaches to participant selection in scale development studies, especially for validity and reliability. While Tavşancıl (2014) argues that the number of samples should be at least five times more than the number of items in the scale, Büyüköztürk (2010) states that it should be five to ten times more than the item numbers. It was also emphasized that the number of samples of 500 and above was good for scale development (Comrey & Lee, 1992). According to these information, the sample size of the study was at the desired level. The total sample was made up 354 for the stage 2. Before data collection, the researches met the participants and introduced the study to them. All participants agreed to fill out the scale. After obtaining their consent, the scale was distributed to the participants. Data screening and extraction process resulted in the exclusion of 42 cases from the data set due to missing values in their responses, which left 312 cases for analysis. Demographic information about the participants are provided in Table 1.

Table 1. Demographic information about the participants for EFA

Gender	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Total
Male	40	28	21	29	43	161
Female	38	26	25	24	38	151
Total	78	54	46	53	81	312

2.2.2. Data Analysis

EFA was performed to determine the construct validity of the scale. EFA enables researchers to determine the associations among items and also the factors in the scale. First of all, in order to determine whether the data was suitable for factor analysis, Kaiser-Meyer-Olkin (KMO) value was calculated and Bartlett Sphericity test was performed. In order to conduct EFA, the KMO value must be higher than .60 and Bartlett Sphericity test needs to be significant at $p < 0.01$ (Büyüköztürk, 2010). According to the results, the KMO value was 0.848 and Bartlett Sphericity Test was significant at $p < 0.000$. These results proves that the data was suitable for EFA. For the factor analysis, IBM SPSS Version 22 was used.
EFA was performed using principle component analysis and varimax rotation (25) and the factor loading of less than 0.30 was removed from the analysis (Field, 2009; Büyüköztürk, 2010). In addition, for the cross loaded items, the difference between the item loadings were checked out. Those items were removed from the scale if the difference was below 0.1 (Costello & Osborne, 2005).

2.2.3. Findings

According to the EFA results, item 23, 28, and 30 were removed since their item loadings were less than .03. In addition, item 1 and 5 were cross loaded items and the difference between the item loadings were less than .01. Thus, those two items were also removed from the analysis. After the removal, the analysis was repeated two more times. Items 10, 14, and 27 in the second round and items 2, 8, and 15 in the third round were removed from the analysis due to their item loadings. The fourth round resulted in removal of item 24 due to its item loading less than .30 and item 20 and 22 due to cross loading with the factor loading difference lower than 0.1. Thus , the scale consisted of 16 items with four factors. The item loadings with factors are provided in Table 2 and the eigenvalue line graph is shown in Figure 1.

Table 2. Item loadings and factors

Item number*		**Factor 1**	**Factor 1**	**Factor 3**	**Factor 4**
After EFA	**Before EFA**				
9	18	**,773**			
8	17	**,766**			
10	19	**,751**			
6	16	**,717**			
7	21	**,563**			
3	11		**.811**		
4	12		**.751**		
5	13		**.740**		
1	6		**.603**		
2	7		**.577**		
11	3			**.809**	
12	9			**.750**	
13	4			**.742**	
14	26				**.861**
15	29				**.795**
16	31				**.677**
Eigenvalue		5.288	2.861	1.196	1.052
Variance (%)		30.05	50.93	58.40	64.89
Total (%)		64.89			

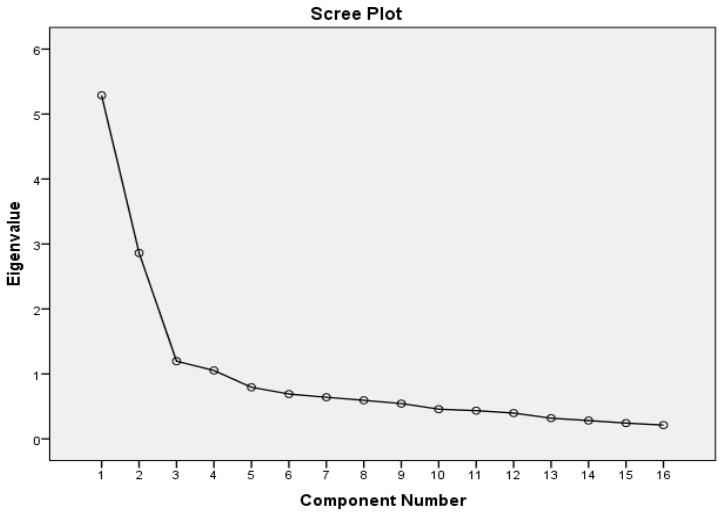

Figure 1. The eigenvalue line graph

As seen in Table 2, the lowest item loading is .56, which implies that the items had desired item loadings. After the analysis, the literature was reviewed to name the factors and expert views were obtained. As a result, the factors were named as Error Sharing (Factor 1), Error Competence (Factor 2), Error Avoidance (Factor 3), and Response to Error (Factor 4). The error sharing factor consisted of five items with factor loadings ranging between .563 and .773 and explains 30.05 % of the total variance; the error competence factor consisted of five items with factor loadings ranging between .577 and .811 and explains 50.93 % of the total variance; the error avoidance factor consisted of three items with factor loadings ranging between .742 and .809 and explains 58.40 % of the total variance; and the response to error factor consisted of three items with factor loadings ranging between .677 and .861 and explains 64.69 % of the total variance. Overall, four factors explain 64.89% of the total variance.

2.3. Stage 3: Construct Validity of the EMC-S

2.3.1 Participants

A stratified sampling method was used in determination of the participants. Total of 382 teachers agreed to voluntarily participate. These participants were not included in the EFA stage. After the introduction of the study and obtaining their consent, the final draft of the scale was administered to the participants. Data screening and extraction process resulted in the exclusion of 58 cases due to missing values in their responses, which left 324 cases for analysis. Since the scale consists of 16 items, the number of participants was considered as acceptable (Büyüköztürk, 2010). Table 3 provides demographic information about the participants. The values are given in Table 3.

Table 3. Demographic information about the participants for CFA

Gender	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Total
Male	43	29	23	24	53	172
Female	39	20	29	18	46	152
Total	82	49	52	42	99	324

2.3.2. Data Analysis

In the previous stage, EFA was performed to determine the construct validity of the scale. In this stage, confirmatory factor analysis (CFA) was performed to confirm the structure created with EFA. CFA allows researchers to statistically test this structure, which is revealed through the relationships between variables (Büyüköztürk,2010)

2.3.3. Findings

In order to confirm the structure, CFA was performed. According to the results, the chi-square to degrees of freedom ratio (220.678/97) was found to be 1.999 Jöreskog & Sörbom (1993) stated that $\chi 2/df$, is a determining ratio for the compliance indicator and the coherence increases as this value approaches zero (0). Other values obtained from the analysis were proof of perfect agreement (CFI=.945, NFI=.905, GFI=.927, SRMR=.051, RMSEA=.058). The results and the reference values are given in Table 4.

Table 4. Fit index information for CFA (Bentler, 1980; Bentler & Bonett, 1980; Baumgartner & Homburg, 1996; Schermelleh-Engel & Moosbrugger, 2003; Brown, 2006; Marsh, Hau, Artelt, Tabachnick & Fidell, Baumert & Peschar, 2006; Çokluk ve diğerleri, 2010)

Notation	Perfect fit values	Recommended value	Calculated value	Result
X^2/sd	$0 \leq X^2/sd \leq 2$	$2 \leq X^2/sd \leq 3$	1.999	Perfect fit
GFI	$.95 \leq GFI \leq 1.00$	$.90 \leq GFI \leq 95$	.927	Recommended fit
AGFI	$.90 \leq AGFI \leq 1.00$	$.85 \leq AGFI \leq .90$	.912	Recommended fit
CFI	$.97 \leq CFI \leq 1.00$	$.95 \leq CFI \leq .97$	.945	Recommended fit
NFI	$.95 \leq NFI \leq 1.00$	$.90 \leq NFI \leq .95$	.905	Recommended fit
IFI	$.95 \leq IFI \leq 1.00$	$.90 \leq IFI \leq .95$	.946	Recommended fit
RMSEA	$.00 \leq RMSEA \leq .05$	$.05 \leq RMSEA \leq .08$	.058	Recommended fit
SRMR	$.00 \leq SRMR \leq .05$	$.05 \leq SRMR \leq .10$	.051	Recommended fit

According to the CFA results, the factor loadings of the items under the error sharing factor were . 760, .750, .679, .565 and .543; the factor loadings of the items under the error competence factor were . 823,.709, .706, .657, .567; the factor loadings of the items under the error avoidance factor were . .763, .723 and .709; and the factor loadings of the items under the response to error factor were . 843, .778 and .634. Only one covariance path between items 4 and 5 under the error competence factor was added. The final model is presented in Figure 2.

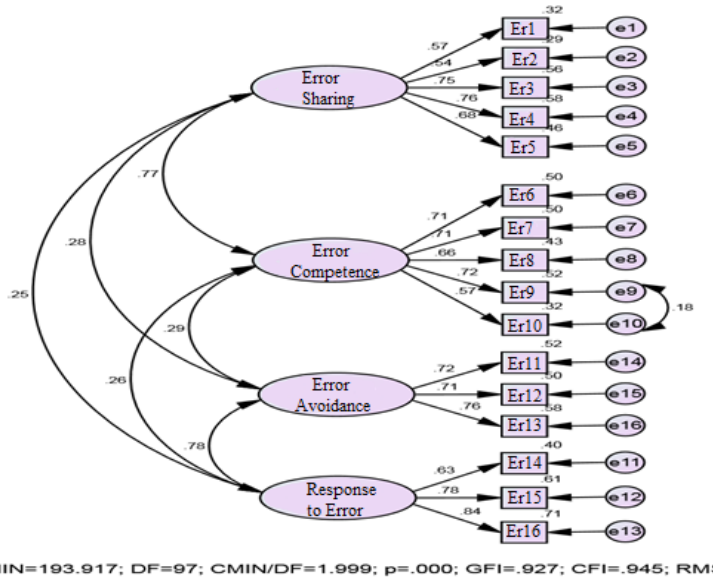

Figure 2. The final model and values

2.4. Stage 4: Scale Reliability

In order to ensure about the reliability of EMC-S, Cronbach's alpha reliability coefficient was calculated. Tavşancıl (2014) stated that a scale is considered as reliable if the reliability coefficient value is over .70. There are other studies accepting values higher than .50 for reliability (Kember et al., 2004; Kayış, 2009). In this study, the Cronbach's alpha values were higher than .745 for both EFA and CFA analysıs, which reveals that the scale is highly reliable. The values are given in Table 5.

Table 5. The reliability information of EMC-S

	Factors	Cronbach's Alpha
EFA	Error sharing	.813
	Error competence	.844
	Error avoidance	.745
	Response to error	.751
	EMC-S	.844
CFA	Error sharing	.786
	Error competence	.809
	Error avoidance	.773
	Response to error	.792
	EMC-S	.856

3. Conclusion

In today's developing and changing world, the complexity of information makes errors inevitable. Considering that errors cannot be prevented, errors and its effects on people's lives should be investigated. Specifically, reasons of errors, inference with errors, sharing them with colleagues, reactions to them, competence of employees against errors have been subject of curiosity. Although there exist some studies related to those topics, there is no Turkish scale related to error management culture in the literature. In order to fill this gap, the error management culture scale was developed. This study developed a 16-item instrument to evaluate error management culture in institutions. The EMC-S has demonstrated evidence of content and construct validity. The internal consistency reliability results also proved that the scale is highly reliable. Therefore, the EMC-S can be used in all institutions to measure their culture in terms of error management. The study by PORTO et al. (2020) supports our study. The factor loadings ranged from 0.35 to 0.82 and Cronbach's reliability coefficient was 0.94, which is consistent with the original study and with other studies using the scale. The scale is valid and reliable.

4. Limitations and recommendations

The EMC-S was tested by participation of teachers in data collection process. Although there exist various institutions, this study chose particularly educational institutions. Therefore, more research is needed to examine a variety of participants from different institutions to test the psychometric properties of EMC-S. Also, the sample size in the study is limited to 636 teacher participants, so the results may not represent the overall teacher population in Turkey. More research is required by increasing the sample size for further testing the EMC-S.

5. The scale developed in the research

The "final version of the scale" containing the items of the scale developed by the researchers for the error management culture are given below. The values are given in Table 6.

Table 5. Error Management Culture Scale

In this section, 16 items are provided in regard to the error management culture in your school. Please answer each item by reading it carefully. Answers for each item are limited to five options: Completely disagree (1), Disagree (2), Moderately agree (3), Agree (4), and Completely agree (5). Please answer the most appropriate option for you by placing an X mark. It is critical not to leave blank items as much as possible.	Completely disagree	Disagree	Moderately agree	Agree	Completely agree
1. Employees attempt to control the possible damage of errors by making an effort.	**1**	**2**	**3**	**4**	**5**
2. Employees take responsibility to reduce the situations that cause errors.	**1**	**2**	**3**	**4**	**5**
3. Employees have the necessary knowledge to fix errors.	**1**	**2**	**3**	**4**	**5**
4. Employees tend to intervene with an error in a timely manner.	**1**	**2**	**3**	**4**	**5**

5. Employees do not consider errors as an obstacle to achieving goals.	**1**	**2**	**3**	**4**	**5**
6. If there is insufficiency in coping with an error, help is sought from other employees	**1**	**2**	**3**	**4**	**5**
7. In order to prevent re-occurring of the same error, the content of an emerging error is shared with other employees.	**1**	**2**	**3**	**4**	**5**
8. All employees act together to reduce the effect of an error.	**1**	**2**	**3**	**4**	**5**
9. An error that occurs is discussed openly with all employees.	**1**	**2**	**3**	**4**	**5**
10. Opportunities are provided for employees to learn from errors.	**1**	**2**	**3**	**4**	**5**
11. Employees ignore the error to get out of a difficult situation.	**1**	**2**	**3**	**4**	**5**
12. Employees blame others because of an error that occurs.	**1**	**2**	**3**	**4**	**5**
13. Employees avoid compensation for an error that occurs.	**1**	**2**	**3**	**4**	**5**
14. Employees tend to hide their mistakes, worrying that they will be blamed about it.	**1**	**2**	**3**	**4**	**5**
15. The employee who makes a mistake is exposed to degrading behaviors within the organization.	**1**	**2**	**3**	**4**	**5**
16. Error is seen as a means of punishment, not as a learning opportunity.	**1**	**2**	**3**	**4**	**5**

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Etik, Beyan ve Açıklamalar

1. Etik Kurul izni ile ilgili;

☑ Bu çalışmanın yazar/yazarları, Fırat Üniversitesi Sosyal Bilimler Araştırmaları Etik Kurulu'nun 24/05/2019 tarih 330285 sayı ve 9 numaralı kararı ile etik kurul izin belgesi almış olduklarını beyan etmektedir.

2. Bu çalışmanın yazar/yazarları, araştırma ve yayın etiği ilkelerine uyduklarını kabul etmektedir.

3. Bu çalışmanın yazar/yazarları kullanmış oldukları resim, şekil, fotoğraf ve benzeri belgelerin kullanımında tüm sorumlulukları kabul etmektedir.

4. Bu çalışmanın benzerlik raporu bulunmaktadır.