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Adaptation of the Engineering Professional Responsibility Assessment Tool (EPRA) to Turkish Engineering Students

Mühendislik Mesleki Sorumluluk Değerlendirme Aracının (MSDA) Türk Kültürüne Uyarlanması

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Abstract

There has been a significant shift in engineering education due to societal transformation, evolving industry expectations, and sustainability concerns. Consequently, new competencies have been incorporated into engineering curricula, with ethics education emphasizing social responsibility as a core competency for students. This paper aims to adapt the "Engineering Professional Responsibility Assessment (EPRA)" to Turkish culture. Data were obtained from two different groups. The participants in the 1st group consisted of 490 students from the faculty of engineering and the second group consisted of 747 students. The original scale consists of 51 items and 8 factors. Explanatory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were performed to examine the construct validity of the scale. As a result of EFA, some items were removed from the scale, and a three-factor structure with 25 items was obtained. The adapted scale is a reliable measurement tool that can be used by engineering educators and researchers to make inferences about students' social responsibility levels. The adapted scale proves to be a reliable measurement tool, offering insights into students' levels of social responsibility for engineering educators and researchers. The reliability values within CTT and IRT also support each other. The marginal reliability coefficient from the IRT was 0.98, while the Cronbach Alpha within the CTT was 0.97 and the Omega was 0.97.

Keywords: Higher Education, Engineering Curriculum, Social Responsibility, Professional Responsibility, Scale Adaptation

Özet

Toplumsal dönüşüm, gelişen endüstri beklentileri ve sürdürülebilirlik endişeleri nedeniyle mühendislik eğitiminde önemli bir değişim yaşanmıştır. Sonuç olarak, öğrenciler için temel bir yeterlilik olarak sosyal sorumluluğu vurgulayan etik eğitimiyle birlikte mühendislik eğitim programında yeni yeterlilikler dahil edilmiştir. Bu makale "Mühendislik Mesleki Sorumluluk Değerlendirmesi (EPRA)"nın Türk kültürüne uyarlanmasını amaçlamaktadır. Veriler iki farklı gruptan elde edilmiştir. 1. gruptaki katılımcılar 490 mühendislik fakültesi öğrencisinden, ikinci gruptaki katılımcılar ise 747 öğrenciden oluşmaktadır. Orijinal ölçek 51 madde ve 8 faktörden oluşmaktadır. Ölçeğin yapı geçerliğini incelemek amacıyla Açımlayıcı Faktör Analizi (AFA) ve Doğrulayıcı Faktör Analizi (DFA) yapılmıştır. AFA sonucunda bazı maddeler ölçekten çıkarılarak 25 maddelik üç faktörlü bir yapı elde edilmiştir. Uyarlanan ölçek, mühendislik eğitimcileri ve araştırmacılar tarafından öğrencilerin sosyal sorumluluk düzeylerine ilişkin çıkarımlarda bulunmak amacıyla kullanılabilecek güvenilir bir ölçme aracıdır. Uyarlanan ölçeğin, mühendislik eğitimcileri ve araştırmacılar için öğrencilerin sosyal sorumluluk düzeylerine ilişkin bilgiler sunan güvenilir bir ölçüm aracı olduğu kanıtlanmıştır. CTT ve IRT içerisindeki güvenilirlik değerleri de birbirini desteklemektedir. IRT'den elde edilen marjinal güvenirlik katsayısı 0,98, CTT içindeki Cronbach Alpha 0,97 ve Omega 0,97 olarak bulunmuştur.

Anahtar Kelimeler: Yükseköğretim, Mühendislik Eğitim Programı, Sosyal Sorumluluk, Mesleki Sorumluluk, Ölçek Uyarlama

"Responsibility" can be defined as being in charge of one's actions or obligations within a given or expected task or duty. Demirören (2019) describes the concept of responsibility as the ability to accept the consequences of one's behaviour or situation where they do not interfere with the events that may have negative consequences on something. This definition seems to be within the scope of personal responsibility. However, considering that an individual is a bio-psycho-social being (Tretter & Löffler-Stastka, 2019), it is inevitable to consider that every responsibility concerning the individual has a social dimension. For example, Zandvoort (2008) described

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the concept of social responsibility as a sense of commitment to a socially just, equal, and sustainable world. Therefore, instead of defining the concept of social responsibility only as a "feeling" about the individual and society, it would be better to state that it is an ethical theory describing the behaviours that individuals and collective groups are expected to perform to better serve the society and the environment (Bielefeldt & Canney, 2016) and create a more sustainable world (Conlon, 2008; Kealy, 2020; Weber, Diaz, & Schwegler, 2014).

When the concepts in the above-mentioned definitions are considered together, individuals in today's world need to be responsible not only to themselves, the society, and the environment they live in, but also to all human beings around the globe. With the globalization of the term "social responsibility" and considering it in a broader context, this term has turned into a concept in which people should also be responsible for the solution of global problems in addition to social problems (Başer & Kılınç, 2015; Orgev & Demir, 2020). In this respect, social responsibility is about being responsible to all living things, nature, and the world, which creates a whole (Ewest, 2015; Park, Meglio, & Schriber, 2019; Starrett, 1996). Preventing major problems that may threaten the earth and humanity, such as environmental pollution, global warming, wars, injustice, and negative social habits, can be possible only if people feel responsible for society and this becomes a part of their personality by putting this feeling into action (Başer & Kılınç, 2015). On the other hand, social responsibility is important not only for individuals but also for universities, one of the main roles of which is to serve society. Therefore, higher education institutions should adopt social responsibility as a core value in their strategic plans, curriculum, and practices, and should try to educate their students in line with the principles of social responsibility. In addition, considering that university education is the last step before starting a profession, the concept of social responsibility should also be addressed in the professional context (Berg & Lee, 2016; Canney, 2013; Conlon, 2008; Narain, 2015; Rapoport, 2012; Shulman, 2005).

The concept of social responsibility in engineering education has gained importance due to sustainability problems related to society, economy and environment, university-industry collaborations, workplaces, and societal expectations. In this context, the curricula implemented in engineering faculties should focus not only on developing students' technical competencies but also professional competencies such as social responsibility, which made ethics one of the most important issues in engineering education (Bombaerts, 2020; Christie & de Graaff, 2017; Johnson, Smith, Smythe & Varon, 2009; Schipper & van der Stappen, 2018; Tordai & Holik, 2018). In addition, due to the increasing importance of social responsibility in the field of engineering, the terms sustainability, education for sustainable development (ESD), and engineering for sustainability have also gained popularity (Biswas, 2012; Byrne et al., 2010; Duarte et al., 2019; Guerra, 2012; Kamp, 2006; Kastenhofer et al., 2010; Mathebula, 2018). With the introduction of these concepts into the literature and the importance of university-industry cooperation, industrial companies have adopted the aim of rapidly implementing their corporate social responsibilities or have started to work under the name of philanthropy to suppress the social reaction due to their corporate social responsibilities that they have not implemented before. The fact that more studies have been carried out under the name of corporate social responsibility than the concept of social responsibility in the literature can be a result of this situation.

This study focuses on "Social Responsibility", not "Corporate Social Responsibility". From a critical point of view, the concept of corporate responsibility is considered a marketing strategy or an advertising tool due to the increasing competition among institutions in the industry. The aim is to be accepted by the society, and the countries with which they cooperate, and to maintain their existence. Similarly, Bakan (2012) stated that the concept of social responsibility is a mask that companies use to hide their wrong practices. This situation may be more common, especially in underdeveloped countries where individuals and societies are not conscious enough. Therefore, it is a good idea that the concept of social responsibility, which is attributed both to individuals and societies, is also demanded by educational institutions and other organizations. However, it is unrealistic to think that such goals will be achieved, and practices will be sustainable without educating the individuals with the competence of social responsibility. A transformative action is required for individual, social, institutional, and global social responsibility (Freire, 1993, p. 107). Transformative action here means "changing the present to create a better future" (Hickling-Hudson, 1988) and thus challenging the status quo (Hudson, 2016, p. 255). In this context, it is expected that students from the faculty of engineering, like all students in higher education institutions, will be educated in a way to gain social responsibility competencies so that they feel responsible for themselves and society first, and find solutions to sustainability problems to achieve societal development. This paper aims to adapt the "Engineering Professional Responsibility Assessment (EPRA) Tool" to Turkish Culture.

Materials and Methods

This study adopts descriptive research methodology aiming to determine the adaptability of the "Engineering Professional Responsibility Assessment (EPRA)" tool, developed in the USA by Canney ve Bielefeldt (2016), into Turkish culture and to determine its psychometric properties.

Participants

This research was approved by the Ethics Committee on 25.03.2021 under reference number 06/40, and the data collection process was conducted by the standards of the Helsinki Declaration (World Medical Association, 2013). The authors have no financial or non-financial competing interests in this Research. All the participants were informed about the purpose of the study, the confidentiality of their voluntary participation, the assurance of keeping their responses confidential, and the collective scientific use of the data. Data were obtained from two different groups of participants for the research.

Participant Group 1

The data for Participant Group 1 were obtained to determine whether the original structure of the EPRA was confirmed in Turkish culture after the translation and linguistic equivalence of the scale were achieved. The translation process involved a thorough forward and backward translation method, with the involvement of bilingual experts to ensure accuracy and cultural relevance. Linguistic equivalence was verified through a pilot study with a smaller sample, ensuring the translated version retained the same meaning and relevance as the original.

Participants consisted of 490 students studying in different departments at the Faculty of Engineering, Çanakkale Onsekiz Mart University. The participants were selected using stratified random sampling to ensure a representative sample across different departments and academic years. Demographic information, including age, gender, and academic background, was collected to understand the sample characteristics better.

The data collected were used for two main purposes. Firstly, the data were utilized to confirm the original structure of the EPRA within the Turkish cultural context. This involved conducting a Confirmatory Factor Analysis (CFA) to see if the original factor structure could be replicated with the Turkish sample. Fit indices such as RMSEA, CFI, and TLI were used to assess the model fit.

Secondly, the data were also used to confirm the structure discovered as a result of Exploratory Factor Analysis (EFA) conducted by using the information obtained through Item Response Theory (IRT). The EFA was carried out to explore the underlying factor structure without preconceived notions, while IRT provided detailed item-level information, assessing item difficulty and discrimination parameters. This combined approach helped ensure a robust validation of the EPRA in the Turkish context.

Participant Group 2

As stated also in the Findings section, the original structure of EPRA could not be confirmed from the Turkish culture application. For this reason, to obtain more information about the EPRA items and the structure it has for Turkish Culture, the group consisted of 747 students studying in different departments at the Faculty of Engineering, Çanakkale Onsekiz Mart University were included. Demographic information of the participants in the participant groups (1 and 2) is indicated in Table 1.

Data Collection Tool (EPRA-Original Form)

The tool adapted to Turkish Culture within the scope of the research is the “Engineering Professional Responsibility Assessment (EPRA)” which was developed by Canney & Bielefeldt (2016). The tool aims to measure the social responsibility attitudes of engineering faculty students. In this way, an opportunity will be created to make changes in the Engineering curricula by collecting information about the thoughts of engineering students about social responsibility. To develop this tool, Canney & Bielefeldt (2016) collected data from a total of 1000 students from civil engineering (n=262), environmental engineering (n=474), mechanical engineering (n=182), and other engineering departments (n=60) fields. The structure obtained as a result of the CFA analysis is shown in Figure 1.

The authors defined the structure in Figure 1 as follows: Personal Social Awareness (PSA), Professional Development (PD), and Professional Connectedness (PC) are “Realms”. Awareness (AW), Ability (AB), Connectedness (CO), Base Skills (BA), Professional Ability (PA), Analysis (AN), Personal Connectedness (PC), and Cost Benefits (CB) are “Dimensions”. Finally, the items that are indicators of these dimensions were included in the measurement tool. The authors who developed the measurement tool (Canney & Bielefeldt, 2016) reported that there was no covariance between PSA and PD in CFA, and between PSA and PC. A covariance of 0.27 was determined between PD and PC. This situation was found to be correlated with the “Professional Social Responsibility Development Model (PSRDM)”, which was followed theoretically by Canney & Bielefeldt (2016). In addition, the contribution of the professional ability dimension to professional development (loading=0.08) was found to be low in the tried CFA models, and it was emphasized that this dimension may be removed from the measurement tool in future studies. Furthermore, the evidence of IRT validity and reliability was determined in the measurement tool items.

EPRA, in its English form, is a 7-point Likert scale. However, considering the use of adverbs of frequency in Turkish and informing the authors who developed the measurement tool, the items in the Turkish adaptation form were applied as a five-point scale (“Strongly Disagree”, “Disagree”, “Partially Agree”, “Agree” And “Strongly Agree”). EPRA items AW1, AW3, AB4, CO1, PA2, PA3, AN3, PC4, PC6, PC8, PC11 and PC16 are reverse coded.

Data Analysis

To ensure data reliability, data analysis started with the examination of whether there were any missing values in the data set. No missing data were found in the data file. The papers of the participants who did not respond to most of the items in the measurement tool were not included in the data file. The maximum Likelihood (ML) method was chosen to analyze the structure in EFA. To clarify the factors, the Direct Oblimin (DO) method was chosen as the rotation method. In cases where sub-dimensions may be related, oblique rotation methods are preferred. Similarly, in the original version of EPRA, the relations between sub-dimensions were also revealed. Validity and reliability analyses were performed using IRT for Likert-type scale items. Item calibrations were determined with the Generalized Partial Credit Model (GPCM). IRT calibrations were determined using "Mirt v.1.30" (Chalmers, 2012) package software included in the R v.4.0.5.

Results

This section includes the steps the authors used during the adaptation process. Each step is explained in detail under separate subheadings.

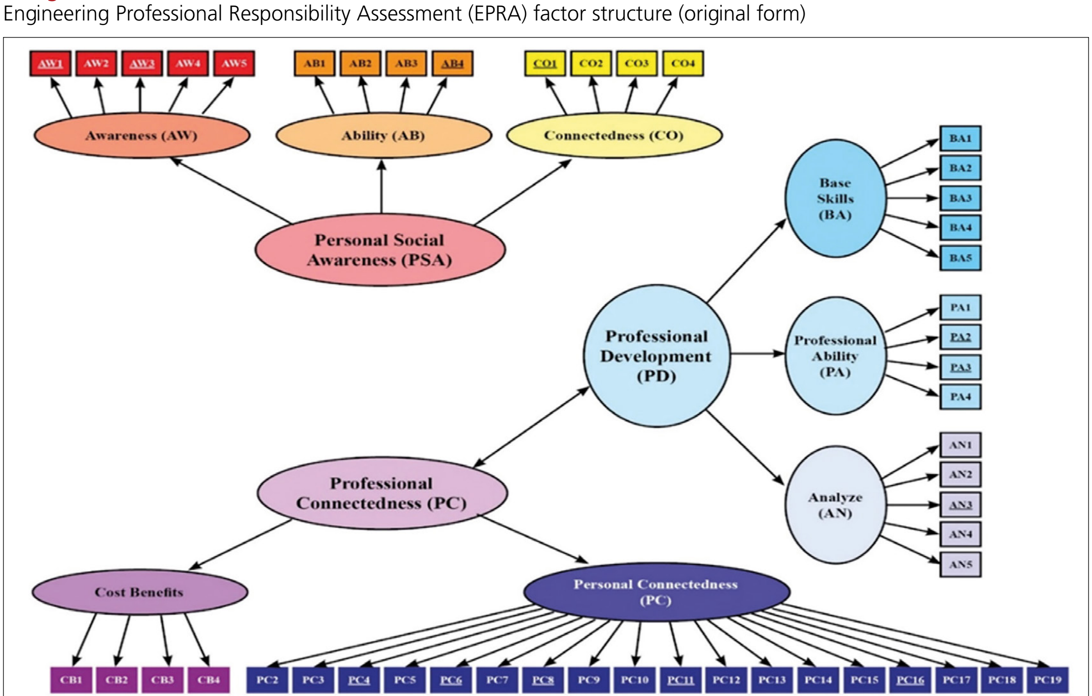
Step 1: Linguistic Equivalence

In the first step, items in the scale were translated into Turkish, and then those items were translated back into English. The original items (in English), the items translated into Turkish, and the items translated back to English were sent to the authors who developed the scale via e-mail. In line with the opinions of the authors, the items were revised, and the authors sent the revised version to an expert group (four English language experts, two educational scientists who work on social responsibility in educational sciences, and one expert in the field of measurement and evaluation). The experts stated their opinions about the items as "appropriate", "partially appropriate" and "not appropriate". In addition, further suggestions were received, as well. Consistency between expert opinions was examined through Krippendorff Alpha. The coefficient of consistency between raters was determined as 0.89, which shows that there is consistency between the rates (Krippendorff, 2004).

Step 2: Confirmation of EPRA's Original Structure

In the second step, the measurement tool was applied to 490 students studying in different departments at the Faculty of Engineering, and the original structure of the measurement tool was tested with CFA. Before CFA, a multivariate normal distribution examination was performed on the data set. Multivariate normal distribution could not be obtained. However, KMO and Bartlett test results showed that the data set was not a unit matrix and that sample adequacy was achieved. Therefore, analysis was started. All estimations while performing CPR were performed with the maximum likelihood method. As seen in Figure 1, the measurement tool in its original structure, PSA, itself is a scale consisting of the sub-dimensions "awareness (AW), ability (AB) and connectedness (CO)". It was also stated that PSA did not show covariance with PD and PC dimensions. Based on

Figure 1
Engineering Professional Responsibility Assessment (EPRA) factor structure (original form)



this information, the PSA was tested in an independent scale structure. First, the Omega reliability coefficient of the three-factor structure was determined (0.97). The three dimensions under PSA and the multivariate normal distribution of 13 items under these three dimensions were tested with the Henze-Zirkler's multivariate normality test using R package software and there was no multivariate normal distribution found among the items (HZ Test=35.305, p<.05). A confirmatory factor analysis (CFA) model was established for PSA and model fit indices were calculated (Table 2).

Model fit indices indicate that the model cannot be confirmed (Hooper, Coughlan & Mullen, 2008; Hu & Bentler, 1999; Kline, 2005; Tabachnick & Fidell, 2013).

As seen in Figure 1, in EPRA's original structure, PD is a scale that consists of the sub-dimensions "base skills (BA)", "professional ability (PA)" and "analyze (AN)". Canney & Bielefeldt (2016) also stated that BA has little contribution to PD in the factor structure and this situation should be considered in further studies. Similarly, in Figure 1, Professional Connectedness (PC) is a scale that consists of the sub-dimensions "cost benefits (CO)" and "personal connectedness (PC)" in EPRA's original structure. Finally, covariance was found between PD and PC. In summary, the structure of the original scale has two main realms and five sub-dimensions. The Omega reliability coefficient of the five-factor structure was found to be 0.98.

A total of five dimensions under PD and PC realms and the multivariate normal distribution of 36 items under these five dimensions were tested with the Henze-Zirkler multivariate normal distribution test in the R package software and no multivariate normal distribution was found among the items (HZ Test= 13.595, p<.05). A confirmatory factor analysis (CFA) model was established for PD and PC covariate and model fit indices were calculated (Table 3).

Model fit indices reveal that the model cannot be confirmed (Hooper, Coughlan & Mullen, 2008; Hu & Bentler, 1999; Kline, 2005; Tabachnick & Fidell, 2013). Therefore, it was concluded that the original structure of the EPRA was not confirmed in the Turkish application.

Step 3: Creating a New Structure for EPRA in Türkiye (EFA-CFA)

In the third step, exploratory factor analysis (EFA) was applied to the same data obtained from 490 engineering faculty students considering the possibility that "the measurement tool may show a different factor structure in the Turkish application". In the EFA, Maximum Likelihood (ML) was used to determine the factors, and Direct Oblimin was chosen as the rotation method. The analysis results revealed that KMO was 0.973 and Bartlett's Test of Sphericity was 23165.167 (p<.05). The items AB3, CB2, PA1, PC10, PC4 could not show the factor loadings suggested by the literature. Therefore, these items were omitted from the measurement tool. The factors that emerged after the rotation process are presented in Table 4.

To determine whether this three-factor structure was confirmed, a new application was made to different engineering departments. In this application, EPRA was applied to 747 students studying at different departments, and the new EFA results for EPRA were tested using CFA (Table 5).

Model fit indices show that the model cannot be confirmed (Hooper, Coughlan & Mullen, 2008; Hu & Bentler, 1999; Kline, 2005; Tabachnick & Fidell, 2013). Therefore, it was decided that the new EPRA structure in the new application (n=747) was not confirmed in the Turkish application.

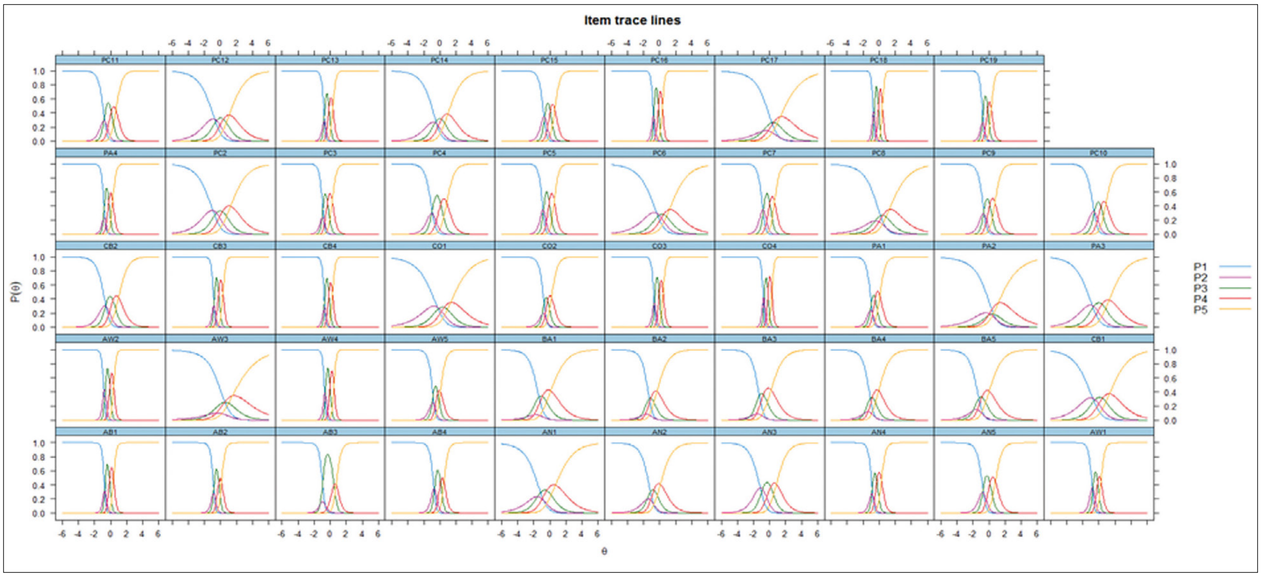
Step 4: Item Analysis with IRT Item Characteristic Curves and Item Information Functions

In the fourth step, item analyses were performed based on IRT using the data obtained from 747 engineering students. Item calibrations in IRT were performed with the Generalized Partial Credit Model (GPCM). $S\_\chi2$, (degree of freedom), RMSEA, and level of significance statistics of the items according to GPCM. The results are presented in Table 6.

The boundary value for RMSEA, which is one of the important fit indices in IRT, is 0.08, and item agreement is achieved if it is below this value (Stout, 1990). According to the item fit statistics in Table 6, the RMSEA values of all the items are lower than 0.08. Based on this result, it was determined that 49 items of EPRA provided model fit according to GPCM. In the next step, the "a" (item discrimination) and "b" (item difficulty) parameters and standard errors of the items whose model fit was determined according to the GPCM were estimated separately for each item and the results are presented in Table 7.

In item response theory (IRT), the discrimination value of an ideal scale item (i.e., parameter "a") should be between 0.5 and 2. The related literature suggests that if the range of this parameter is between 0.75 and 2.50, it is acceptable (Flannery, Reise & Widaman, 1995). Table 7 indicates that the discrimination values of the following items AN1, AN2, AN3, AN5, BA1, BA2, BA3, BA4, BA5, CB2, CO2, PA3, PC2, PC4, PC6, PC8, PC9, PC10, PC11, PC12 and PC14 are at the desired level. The ideal (medium difficulty level) limits for item difficulty levels (i.e., "b" parameter) are considered to be between -1.00 and 1.00 (Hambleton, 1994). The items with a difficulty level less than -1.00 are considered easy, and the items above 1.00 are considered difficult. The estimations according to the GPCM (LogLikelihood, p<.05) show that the items in the measurement tool are consistent. Item characteristic curves are shown in Figure 2.

Figure 2
Item Characteristic curves of the items in EPRA



According to the item characteristic curves in Figure 2, the items in the measurement tool function differently for different levels of the relevant characteristics and are distinctive at different levels. Item information functions are shown in Figure 3.

The item information function is a graphical representation that depicts the range of characteristics (the characteristic to be measured on the scale) by which the item best distinguishes the individuals who take the measurement tool (Edelen & Reeve, 2007). In the item information function, the higher the peak of the curve, the more information the item gives. When the item information functions of the items in EPRA are analyzed, the most informative items are AB1, AB2, AN4, AW1, AW2, AW4, CB3, CB4, CO3, CO4, PA4, PC3, PC13, PC16, PC18 and PC19. The test information function is shown in Figure 4.

The test information function depicts the level of information about the items of the measurement tool as a whole (Hambleton, Swaminathan & Rogers, 1991). According to the analysis, EPRA is a measurement tool that gives information about the characteristics it aims to measure. The level at which the measurement tool gives the best information is between -1.5 and 1.5. The marginal reliability coefficient of EPRA was calculated as 0.98.

Figure 3
Item information functions of EPRA

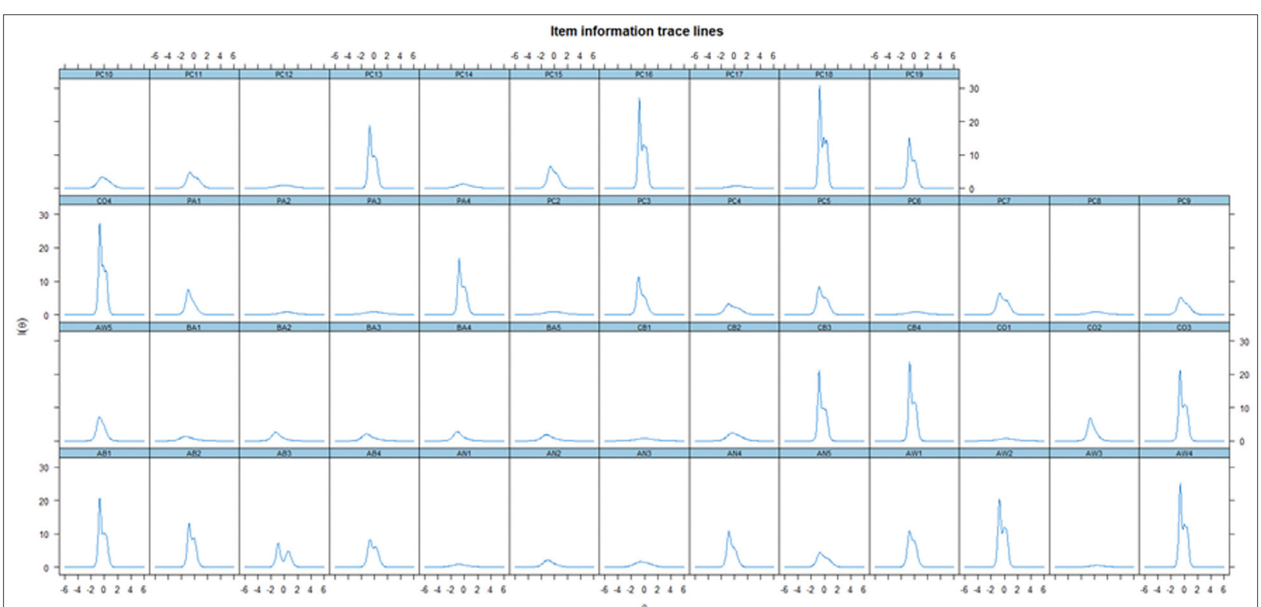
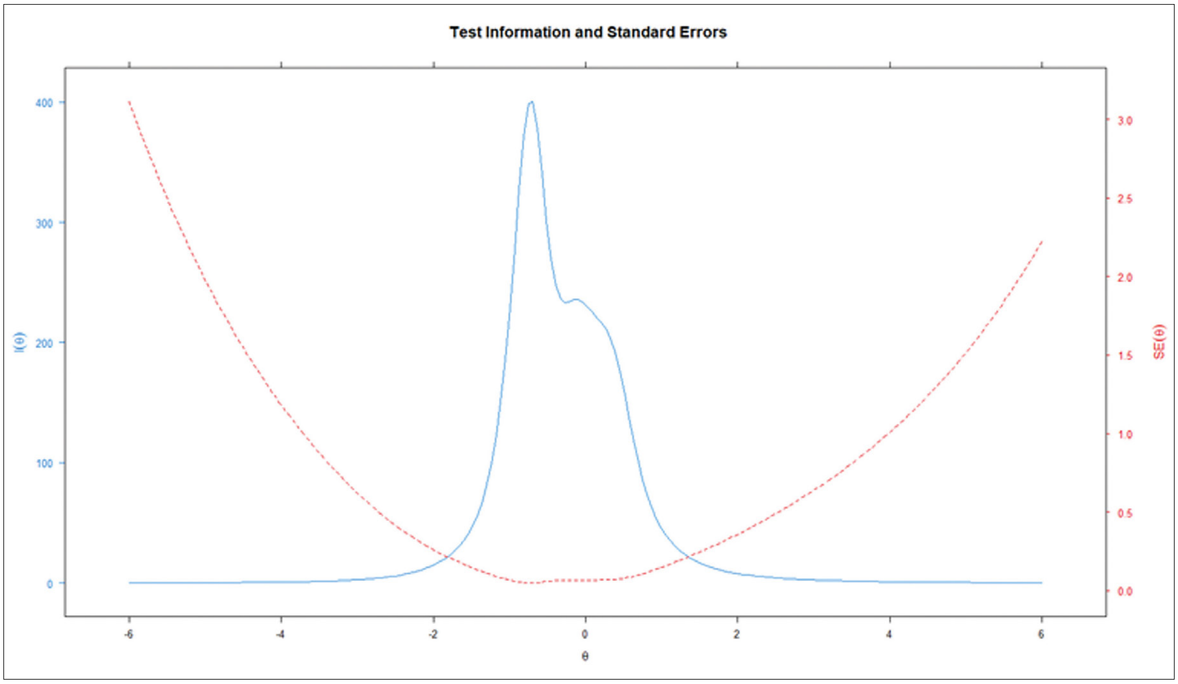


Figure 4
Item functions of EPRA

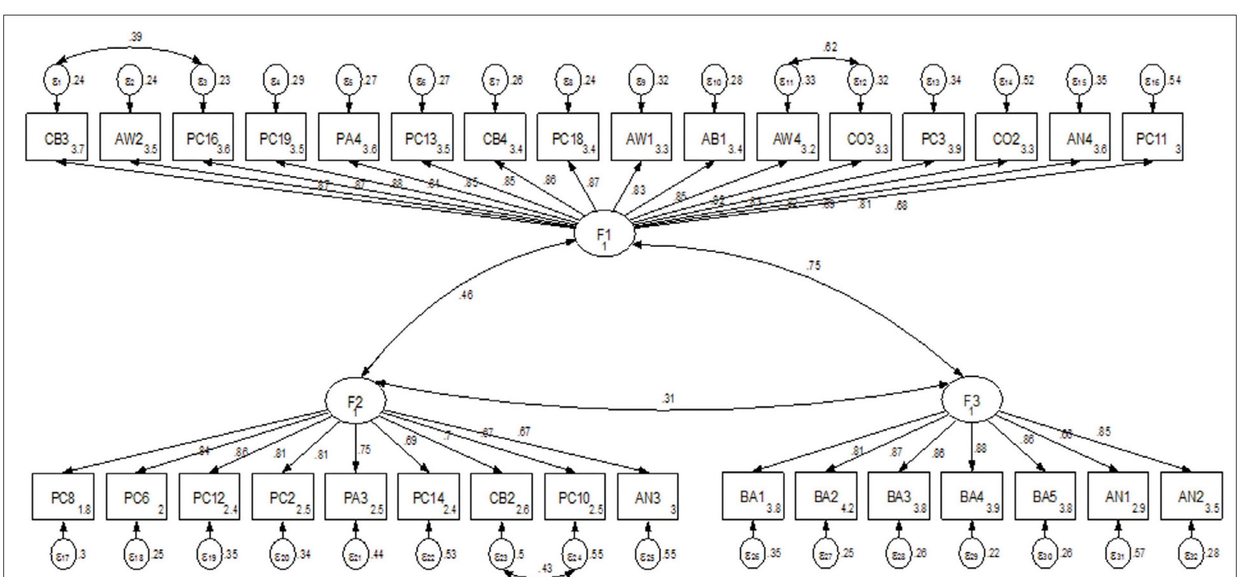


Step 5: EFA and CFA Based on IRT Results

In the fifth step, the EFA was carried out by selecting the items in line with the results obtained from the item analyses made based on IRT with the data obtained from 747 engineering students. In the EFA, Maximum Likelihood (ML) was used as the factor determination method and Direct Oblimin was used as the rotation method. As a result of the analysis, KMO was found as 0.968 and Bartlett's Test of Sphericity was 16216.378 (p<.05). The factors resulting from the rotation process are presented in Table 7.

The Cronbach Alpha reliability value of this three-factor structure was calculated as 0.97 and the Omega reliability value was found as 0.97. To determine whether this three-factor structure was confirmed or not, the CFA test was conducted using the data from the first application to the students studying in different departments of the faculty of engineering (Table 4). CFA at this stage was performed using the same CFA data (n=490) as performed in step 2. The model tested in CFA is represented in Figure 5.

Figure 5
CFA model of EPRA in line with IRT results



In the model shown in Figure 5, fit indices within acceptable limits were achieved through three modifications. The scale items with modification relationships established between the error terms are items that are close to each other in meaning. Therefore, the model was verified by establishing a covariance relationship between the error terms (residues) of these items. Accordingly, higher covariance was detected from the errors of CB3 and PC16, AW4 and CO3, CB2 and PC10. It can be noted that these items are highly correlated with each other. The fit indices of the model are summarized in Table 9.

Model fit indices reveal that the model is confirmed (Hooper, Coughlan & Mullen, 2008; Hu & Bentler, 1999; Kline, 2005; Tabachnick & Fidell, 2013).

Discussion

This study aimed to adapt the "Engineering Professional Responsibility Assessment (EPRA) Tool" to Turkish culture. To do this, a five-step systematic process was followed. In the first step, the linguistic equivalence was ensured through translation and revision after the expert group's suggestions. The second step was to confirm EPRA's original structure by applying the scale to 490 students studying in different departments at the Faculty of Engineering and testing it with CFA. Model fit indices revealed that the model cannot be confirmed in its original structure in Turkish culture. Therefore, as a third step, exploratory factor analysis (EFA) was applied to the same data obtained from 490 engineering faculty students considering the possibility that the measurement tool may show a different factor structure in the Turkish application. As the tool was not confirmed with the data collected from these students, another group of 747 students who study at different departments from the faculty of engineering were included in the study. The last structure confirmed in Turkish Culture regarding EPRA revealed that three different realms emerged, but no dimensions emerged under these realms. In addition, the three realms have emerged in a covariate structure with each other in Turkish Culture. The analyses performed within the scope of CTT and IRT support each other. In the analyses carried out within the scope of CTT regarding the confirmation of the original structure in Turkish Culture, we had an unconfirmed structure, which effected the loadings of the items under the factors, led to the low level of item information function in the analyses performed within the scope of IRT, and some options could not be applied in the item characteristic curves. The reliability values in the analyses within CTT and IRT also support each other. The marginal reliability coefficient from the IRT was 0.98, while the Cronbach Alpha within the CTT was 0.97 and the Omega was 0.97.

The reason why the original structure of EPRA could not be confirmed in Turkish may have resulted from several factors related to Turkish culture. When the items that were not confirmed in the analyses (26 items) are examined, it can be stated that the engineering students in Turkish culture do not have enough awareness of the help people need within an international context as they may not think that they as future engineers will have any positive effects on the community by doing voluntary work. In addition, they do not think that engineering skills are useful in making the community a better place. Therefore, we can conclude that the engineering students in our sample are not interested in the societal context of the Engineering profession. Similarly, most of the items under the realm of professional connectedness (except for PC13, PC16, PC18, and PC19) in the original EPRA form were not confirmed in the analysis. Because these items were mostly related to volunteerism and community service, we can conclude that the engineering students in the sample do not have professional connectedness. This reveals the fact that engineering education should focus more on social responsibility competency in line with professional competencies. To do this, ethics education can be integrated into current engineering curricula at universities, or a core curriculum approach can be applied to engineering education.

While the current study utilized a robust methodological approach involving EFA, CFA, and IRT, there are areas for future methodological enhancements. For instance, expanding the sample size to include students from multiple universities across Türkiye would increase the generalizability of the results. Additionally, incorporating qualitative methods such as focus groups or interviews could provide richer contextual understanding of how social responsibility is interpreted within Turkish culture. Finally, employing multi-group Confirmatory Factor Analysis (MG-CFA) could help assess the measurement invariance of the scale across different demographic groups, further validating the adapted EPRA tool in diverse contexts.

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Table 1
Demographic Information of the Participant Groups

Variables		N	%
Participant Group 1			
Gender	Male	274	55.9
	Female	216	44.1
Years	Preparatory Class	26	5.3
	Year 1	71	14.5
	Year 2	112	22.9
	Year 3	154	31.4
	Year 4	127	25.9
Department	Civil Engineering	117	23.9
	Computer Engineering	183	37.3
	Mining Engineering	14	2.9
	Geology Engineering	13	2.7
	The Food Engineering	124	25.3
	Environmental Engineering	39	8
Total		**490**	**100**
Participant Group 2			
Gender	Male	418	56
	Female	329	44
Years	Preparatory Class	40	5.4
	Year 1	149	19.9
	Year 2	167	22.4
	Year 3	194	26
	Year 4	197	26.4
Department	Civil Engineering	212	28.4
	Computer Engineering	251	33.6
	Mining Engineering	18	2.4
	Geology Engineering	19	2.5
	The Food Engineering	172	23
	Environmental Engineering	75	10
Total		**747**	**100**

Table 2
CFA Model Fit-Indices for Original EPRA-PSA Sub-Dimensions

Fit Indices	X^2/df	CFI	TLI	RMSEA	SRMR
Standard Estimated	22.201	0.782	0.726	0.208	0.112
Robust Estimated	11.021	0.790	0.735	0.143	

Table 3
Model Fit- Indices for Original EPRA-PD, CFA, and PC Covariate

Fit Indices	X^2/df	CFI	TLI	RMSEA	SRMR
Standard Estimated	11.225	0.655	0.630	0.144	0.150
Robust Estimated	6.923	0.668	0.644	0.110	0.150

Table 4
EPRA Turkish Version EFA Oblimin Rotation Results EPRA

	Factors		
	1	2	3
CO4	0.895		
PC13	0.864		
PC16	0.864		
PC19	0.863		
CB3	0.856		
PC18	0.852		
CO3	0.848		
AB2	0.843		
CB4	0.828		
AB1	0.823		
AW2	0.819		
PA4	0.813		
AW4	0.810		
AB4	0.763		
AW5	0.757		
AW1	0.756		
PC15	0.697		
AN4	0.644		
PC5	0.608		
CO2	0.607		
PC11	0.598		
PC3	0.589		
PC7	0.557		
PC9	0.553		
AN5	0.479		
CO1		0.900	
PC6		0.860	
CB1		0.857	
PA2		0.834	
PC17		0.831	
PA3		0.822	
PC2		0.819	
AW3		0.817	
PC8		0.808	
PC12		0.784	
PC14		0.574	
AN3		0.515	
BA3			0.881
BA2			0.851
BA5			0.840
BA4			0.819
BA1			0.785
AN2			0.776
AN1			0.701

Table 5
CFA Model Fit-Indices for the New EPRA Structure

Fit Indices	X2/df	CFI	TLI	RMSEA	SRMR
Standard Estimated	6.305	0.863	0.856	0.084	0.093
Robust Estimated	3.725	0.879	0.872	0.079	0.093

Table 6
Item Fit-Indices for EPRA according to IRT

Items	GPCM			Items	GPCM		
	$S\chi^2$	df	RMSEA		$S\chi^2$	df	RMSEA
AB1	241.357	68	0.058	CO3	218.382	70	0.053
AB2	464.664	87	0.076	CO4	366.765	66	0.078
AB3	195.894	67	0.051	PA1	368.495	95	0.062
AB4	219.778	98	0.041	PA2	642.767	162	0.063
AN1	348.988	144	0.044	PA3	504.694	149	0.057
AN2	334.164	144	0.044	PA4	374.673	77	0.072
AN3	292.210	127	0.042	PC2	461.860	149	0.053
AN4	353.536	88	0.064	PC3	298.073	91	0.055
AN5	160.714	101	0.028	PC4	164.145	101	0.029
AW1	321.053	87	0.060	PC5	171.660	85	0.037
AW2	235.236	68	0.057	PC6	601.934	166	0.059
AW3	677.438	131	0.075	PC7	156.095	93	0.030
AW4	187.453	69	0.048	PC8	570.808	162	0.058
AW5	427.263	94	0.069	PC9	212.855	108	0.036
BA1	362.048	116	0.053	PC10	296.567	129	0.042
BA2	376.449	97	0.062	PC11	198.902	105	0.035
BA3	350.387	112	0.053	PC12	531.013	153	0.058
BA4	350.077	101	0.057	PC13	298.558	73	0.064
BA5	381.897	107	0.059	PC14	360.034	97	0.060
CB1	508.670	153	0.056	PC15	175.188	100	0.032
CB2	336.539	136	0.044	PC16	259.510	64	0.064
CB3	355.565	70	0.074	PC17	551.234	150	0.060
CB4	317.221	70	0.069	PC18	221.283	57	0.062
CO1	588.534	167	0.058	PC19	397.488	79	0.074
CO2	326.348	112	0.051				

Table 7
Item Parameters and Standard Error Values According to GPCM for EPRA

Items	a(SE)	b1(SE)	b2(SE)	b3(SE)	b4(SE)
AB1	5.333(0.379)	-0.713(0.070)	-0.738(0.046)	-0.136(0.022)	0.364(0.06)
AB2	4.069(0.304)	-0.776(0.098)	-0.881(0.066)	-0.198(0.028)	0.143(0.027)
AB3	2.900(0.252)	-0.627(0.124)	-1.269(0.115)	0.472(0.051)	0.730(0.071)
AB4	3.386(0.258)	-0.747(0.078)	-0.695(0.053)	0.064(0.031)	0.484(0.043)
AN1	0.783(0.072)	-0.761(0.248)	-1.538(0.226)	-0.388(0.129)	0.711(0.134)
AN2	1.233(0.116)	-0.759(0.245)	-1.540(0.212)	-0.703(0.104)	0.090(0.074)
AN3	1.332(0.107)	-1.146(0.154)	-0.846(0.105)	0.161(0.073)	0.875(0.104)
AN4	3.585(0.278)	-0.822(0.116)	-0.947(0.078)	-0.298(0.032)	0.178(0.031)
AN5	2.263(0.178)	-0.694(0.097)	-0.802(0.075)	0.106(0.043)	0.793(0.074)
AW1	3.937(0.292)	-0.833(0.088)	-0.734(0.053)	-0.149(0.028)	0.264(0.030)
AW2	5.925(0.417)	-0.828(0.071)	-0.684(0.039)	-0.095(0.020)	0.382(0.026)
AW3	0.552(0.055)	2.727(0.387)	-1.576(0.312)	0.538(0.222)	1.497(0.266)
AW4	6.355(0.448)	-0.681(0.052)	-0.596(0.032)	-0.030(0.019)	0.460(0.028)
AW5	2.684(0.215)	-0.743(0.127)	-0.996(0.094)	-0.277(0.043)	0.039(0.038)
BA1	0.932(0.090)	0.327(0.435)	-3.022(0.443)	-0.927(0.140)	0.123(0.094)
BA2	1.229(0.128)	-0.136(0.431)	-2.452(0.410)	-1.089(0.143)	-0.338(0.081)
BA3	1.186(0.112)	-0.050(0.349)	-2.471(0.346)	-0.750(0.107)	0.212(0.076)
BA4	1.321(0.130)	-0.316(0.299)	-1.910(0.280)	-0.852(0.113)	-0.070(0.068)
BA5	1.105(0.107)	-0.531(0.314)	-2.011(0.290)	-0.891(0.126)	0.017(0.080)
CB1	0.744(0.066)	-0.755(0.175)	-0.487(0.148)	0.448(0.146)	1.339(0.189)
CB2	1.565(0.123)	-0.575(0.099)	-0.620(0.083)	0.298(0.067)	0.990(0.105)
CB3	5.365(0.384)	-0.786(0.085)	-0.829(0.055)	-0.312(0.022)	0.319(0.024)
CB4	5.576(0.399)	-0.679(0.068)	-0.741(0.047)	-0.159(0.022)	0.286(0.023)
CO1	0.689(0.062)	-0.320(0.164)	-0.134(0.157)	0.520(0.170)	1.347(0.211)
CO2	2.380(0.194)	-0.473(0.112)	-0.957(0.096)	-0.265(0.046)	0.203(0.043)
CO3	5.580(0.395)	-0.682(0.059)	-0.657(0.039)	-0.057(0.021)	0.433(0.029)
CO4	6.695(0.468)	-0.768(0.062)	-0.659(0.036)	-0.185(0.020)	0.304(0.021)
PA1	2.654(0.223)	-0.871(0.168)	-1.132(0.119)	-0.512(0.051)	0.076(0.036)
PA2	0.636(0.061)	0.979(0.208)	0.197(0.207)	-0.125(0.204)	1.157(0.219)
PA3	0.816(0.070)	-0.815(0.171)	-0.642(0.141)	0.387(0.129)	1.292(0.172)
PA4	4.477(0.333)	-0.704(0.093)	-0.904(0.068)	-0.218(0.026)	0.257(0.026)
PC2	0.862(0.073)	-0.917(0.165)	-0.486(0.130)	0.255(0.121)	1.289(0.163)
PC3	3.529(0.276)	-0.796(0.128)	-1.035(0.090)	-0.339(0.033)	0.247(0.031)
PC4	1.954(0.157)	-0.926(0.136)	-1.044(0.100)	0.082(0.048)	0.844(0.081)
PC5	3.404(0.259)	-0.855(0.097)	-0.797(0.060)	-0.071(0.029)	0.555(0.045)
PC6	0.758(0.067)	-0.341(0.149)	-0.065(0.143)	0.485(0.157)	1.221(0.193)

PC7	2.954(0.229)	-0.827(0.092)	-0.747(0.060)	0.043(0.033)	0.637(0.055)
PC8	0.715(0.065)	0.835(0.190)	-0.507(0.177)	0.442(0.169)	1.263(0.205)
PC9	2.417(0.188)	-0.606(0.083)	-0.695(0.066)	0.080(0.041)	0.731(0.067)
PC10	1.923(0.151)	-0.599(0.085)	-0.551(0.068)	0.245(0.055)	0.880(0.089)
PC11	2.367(0.188)	-0.722(0.100)	-0.843(0.077)	0.083(0.041)	0.663(0.064)
PC12	0.871(0.075)	-0.684(0.152)	-0.464(0.129)	0.386(0.125)	1.111(0.160)
PC13	5.009(0.361)	-0.707(0.074)	-0.763(0.050)	-0.150(0.023)	0.333(0.026)
PC14	0.959(0.081)	-0.409(0.142)	-0.598(0.128)	0.173(0.109)	0.987(0.139)
PC15	2.909(0.225)	-0.726(0.079)	-0.637(0.055)	0.054(0.034)	0.620(0.055)
PC16	6.462(0.447)	-0.787(0.070)	-0.737(0.043)	-0.152(0.019)	0.341(0.023)
PC17	0.647(0.061)	1.462(0.248)	-0.856(0.217)	0.518(0.188)	1.356(0.228)
PC18	7.174(0.496)	-0.747(0.058)	-0.648(0.034)	-0.096(0.018)	0.394(0.024)
PC19	4.333(0.321)	-0.729(0.088)	-0.847(0.061)	-0.174(0.026)	0.265(0.027)
Iteration=456	Log Likelihood: - 38944.933	p<.05			

Table 8
New EFA Structure Based on IRT Results for EPRA

Items Code	Items	Factors		
		1	2	3
CB3	I believe that the volunteer work I've done will have a positive impact on my life.	0.899		
AB2	I can be effective in solving the problems encountered by the society.	0.895		
PC16	I don't think engineering is important to serve more people in society.	0.887		
PC19	It is important for me to have a sense of contributing and helping the community by participating in community service.	0.884		
PA4	Engineers can have a positive impact on the society.	0.874		
PC13	Engineers must use certain skills to solve social problems.	0.857		
CB4	I believe the extra time spent on community service is highly valuable.	0.854		
PC18	I believe it takes more than time, money, and social effort to solve social problems; therefore, we also have to work for societal transformation at the national or global level.	0.848		
AW2	Society needs engineers.	0.838		
AW1	In Türkiye, there are not many people who need help.	0.806		
AB1	As an engineer, I can make a difference in the society.	0.798		
AW4	There are people in society who cannot even meet their basic needs.	0.788		
CO3	I feel responsible for contributing to the society.	0.775		
PC3	Having a career which aims at helping people is important to me.	0.683		
CO2	It is my responsibility to take some measures to help people in need.	0.681		
AN4	While seeking technical solutions to problems, engineers should also need to consider the potential impact of these solutions in a broader sense.	0.609		
PC11	I think that volunteer work will not have an impact on my career.	0.565		
PC8	The needs of society have no bearing on my choice to pursue my engineering career.		0.944	
PC6	I see engineering and community service as two separate missions.		0.884	
PC12	For me, it's important to be an engineer to serve others.		0.774	
PC2	My experience as a volunteer has changed the way I think about spending money.		0.763	
PA3	Technology does not have a key role in solving the problems of society.		0.721	
PC14	It is important to use engineering skills to benefit society.		0.669	
CB2	I feel that participation in community service events strengthens my engineering skills.		0.638	
PC10	Engineering companies should also do some voluntary work for which they do not charge (Pro bono) a fee for serving society.		0.580	
AN3	Even if the feedback from society is negative, I do not make any changes in a project I am running.		0.518	
BA3	Business Skills (i.e., Management Skills, Professionalism)			0.866
BA2	Technical Skills (i.e., Experimenting, Data Analysis, Design, Problem Solving)			0.846
BA5	Ethics (i.e., all your work complies with the professional code of conduct)			0.834
BA4	Professional Skills (i.e., Communication, Current Issues, Creativity, Leadership, Lifelong Learning, Teamwork)			0.827
BA1	Basic Skills (i.e., Mathematics, science-related skills)			0.779
AN2	Societal Context (i.e., the relationship between your profession and society)			0.768
AN1	Cultural Awareness (i.e., your culture and other cultures)			0.698

Table 9
CFA Model Fit-Indices for the New EPRA Structure

Fit Indices	X^2/df	CFI	TLI	RMSEA
Standard Estimated	4.311	0.881	0.875	0.078