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Sustainability Communication in Higher Education Institutions: Scale Development and Validation Study*

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Abstract

This article aims to develop and validate the Sustainability Communication Scale in higher education institutions. An eight-step process proposed by DeVellis (2022) was applied to develop the scale, which consists of 32 items capable of measuring the level of sustainability communication in Turkish universities. A total of 1291 participants, comprising 109 academics and 1182 students, participated in the study. Expert opinion analysis, KMO and Barlett tests, exploratory and confirmatory factor analyses, Cronbach's alpha, composite reliability, and partial correlation analyses were all used to check the scale's validity and reliability. According to the results of the exploratory factor analysis using the principal components method, the scale consists of 4 factors: environmental sustainability communication, social sustainability communication, economic sustainability communication, and sustainability of communication. The general structure and measurement of the scale have been validated by confirmatory factor analysis. The internal consistency coefficient found using Cronbach's alpha was .769; internal consistency coefficients found using composite reliability were .875(F1), .888 (F2), .866(F3), .882(F4). The findings indicate that the scale is a valid and reliable measurement tool.

Keywords: *Sustainability, Sustainable Development, Sustainability Communication, Scale Development, Sustainability in Higher Education Institutions.*

Öz

Bu makalede Yükseköğretim Kurumlarında Sürdürülebilirlik İletişimi Ölçeğinin geliştirilmesi ve doğrulanması amaçlanmıştır. Ölçek geliştirmek için DeVellis (2022) tarafından ortaya konulan sekiz aşamalı süreç uygulanmıştır. Ölçek Türk üniversitelerinin sürdürülebilirlik iletişiminin düzeyini ölçebilecek 32 maddeden oluşmaktadır. 109 akademisyen ve 1182 öğrenciden oluşan toplam 1291 kişi araştırmaya katılmıştır. Ölçeğin geçerliği ve güvenirliği; uzman görüşü analizi, KMO ve Barlett testleri, açımlayıcı ve doğrulayıcı faktör analizleri, Cronbach Alpha, birleşik güvenirlik, kısmi korelasyon analizleri kullanılarak test edilmiştir. Temel bileşenler (principal components) yöntemi ile ortaya çıkan açımlayıcı faktör analizi sonuçlarına göre ölçeğin 4 faktörden oluştuğu belirlenmiştir: Çevresel sürdürülebilirlik iletişimi, sosyal sürdürülebilirlik iletişimi, ekonomik sürdürülebilirlik iletişimi ve iletişimin sürdürülebilirliği. Ölçeğin genel yapısı ve ölçümü doğrulayıcı faktör analizi ile doğrulanmıştır. Cronbach Alpha analizi kullanılarak bulunan iç tutarlılık katsayısı .769; birleşik güvenirlik kullanılarak bulunan iç tutarlılık katsayıları .875(F1), .888 (F2), .866(F3), .882(F4) olarak ölçülmüştür. Bulgular ölçeğin geçerli ve güvenilir bir ölçüm aracı olduğunu göstermektedir.

Anahtar Kelimeler: *Sürdürülebilirlik, Sürdürülebilir Kalkınma, Sürdürülebilirlik İletişimi, Ölçek Geliştirme, Yükseköğretim Kurumlarında Sürdürülebilirlik..*

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Introduction

Nowadays, sustainability practices have become a necessity for institutions and businesses to operate while protecting natural resources for future generations and maintaining ecological balance. Sustainability requires the development of actionable strategies rather than remaining theoretical. The success of these strategies is directly linked to sustainability communication. Sustainability communication ensures that sustainability goals are conveyed clearly and effectively to all stakeholders.

The United Nations (UN) Sustainable Development Goals (SDGs), developed under the leadership of the UN, guide sustainability efforts. In this context, the importance of sustainability and sustainable development is addressed, encompassing both past developments and future planning.

The process that began with the Club of Rome's "Limits to Growth" report in 1972 highlighted the environmental damage caused by the industrialization of G-7 countries, marking a turning point for global sustainability movements (Zink et al., 2008, p.5). The 1987 Bruntland Report by the UN defined the framework of sustainability, presenting a three-pronged approach combining economic growth, environmental improvement, and social justice (Mebratu, 1998, pp.496-501). This report defined sustainable development as meeting the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). Significant meetings such as the 1992 Earth Summit and the 2000 Millennium Summit led to a broad consensus on sustainable development, resulting in action plans involving the private sector and other stakeholders. The UN SDGs established at the 2015 UN Sustainable Development Conference shape the sustainability agenda, with 17 goals and 169 targets to be achieved by 2030, forming the foundation of related communication activities (Akdemir, 2023, p.2).

Sustainability is addressed in three main dimensions in UN activities and literature: economic, environmental, and social. The importance of balanced development in these three dimensions is emphasized (Purvis, 2019). Institutions and businesses that are environmentally respectful, socially valued, and economically sustainable are the primary targets of sustainability efforts. Sustainability and sustainable development concern all segments of society and hold universal importance that needs to be supported by effective communication. Universities hold a crucial responsibility in educating the public and promoting active engagement. Through effective communication and collective collaboration, steps toward a sustainable future can be taken more consciously and effectively.

Universities play a crucial role in addressing societal issues and improving environmental, economic, and social impacts. These institutions should pioneer in the field of sustainability by developing and implementing innovative strategies. Sustainability communication is critical to ensuring that these strategies are understood and adopted by the public, encouraging widespread participation. Incorporating sustainability activities into universities' academic work and communicating them to society can establish these institutions as knowledge and practice centers, accelerating sustainable change. In this context, measuring sustainability communication for organizations is essential. This study aims to develop and validate a scale for sustainability communication. While developing a measurement tool to assess the quality and strength of sustainability communication, a scale was designed to be developed in higher education institutions, which are presumed to have more knowledge and interest in the concept.

Existing research on measuring sustainability communication has provided various perspectives that aid in the development of sustainability communication scales (Djordjevic & Cotton, 2011; Siano et al., 2015; Lertpratchya et al., 2017; Atmaca et al., 2019; Filippo et al., 2020; Sezen Gültekin & Argon, 2020; Arief et al., 2022), focusing on different industries (Baviera-Puig et al., 2015, Hamani, 2019), communication channels (Katiliute et al., 2014; Siano et al., 2016; Amey et al., 2020; Wut et al., 2021; Amabile et al., 2022; Tanç et al., 2022), and specific areas related to the topic such as

organizational, environmental sustainability, and corporate social responsibility (Kassing et al., 2010; Parguel et al., 2011; Ferraz & Gallardo-Vazquez, 2016; Baghoor et al., 2017; Lock & Seele, 2017; Lock & Schulz-Knappe, 2018; Tetrevova et al., 2021). However, these studies are generally narrow in scope and do not offer a comprehensive solution that covers all aspects of sustainability communication. Therefore, a comprehensive sustainability communication scale encompassing all dimensions needs to be developed. This new scale could be a more effective and reliable tool to support institutions and companies in achieving their sustainability goals.

This study aims to fill the existing gap in the literature and develop a new scale that can evaluate sustainability communication more broadly. The research began with a literature review, examining the conceptual foundations of sustainability, sustainable development, and sustainability communication. A mixed-method approach, evaluating both qualitative and quantitative data, was adopted methodologically. A draft scale was prepared based on findings from the literature review and improved with contributions from field experts. As a result, a valid and reliable scale was obtained through validity and reliability analyses, which can be used to measure sustainability communication. This scale has the potential to be an important tool for enabling higher education institutions to assess their sustainability communication strategies and make strategic decisions in this area. This study adhered to "Research and Publication Ethics."

Sustainability and Sustainable Development

Environmental movements have urged people to address environmental issues to make the world a livable place. However, abandoning the achievements of civilization, such as technology, industry, economy, corporations, and state structures, to protect the environment could result in significant costs. Therefore, a balanced development model that is not detrimental to both the environment and human achievements has been needed, leading to the development of the concept of sustainable development. This concept gained prominence with the Bruntland Report by the UN World Commission on Environment and Development (Akdemir, 2023, p.17). Efforts to achieve sustainability and sustainable development aim to balance the environment, economy, and society.

In terms of its definition, sustainability means "the ability to continue at a certain rate or level"; in a second sense, it refers to "avoiding the depletion of natural resources to maintain an ecological balance" (Oxford English Dictionary, 02.03.2024, oed.com); from an academic perspective, sustainability is defined as "economic, social, and environmental systems that create and sustain human welfare" (Markandya et al., 2003, p.171). Sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs," while sustainability refers to the same principle of balancing current needs with future needs (WCED, 1987).

Sustainability and sustainable development are categorized into three main dimensions: social, economic, and environmental. Dalal-Clayton & Bass (2000) defined the three main dimensions of sustainability as follows: economic sustainability is defined as the creation of wealth and livelihoods; social sustainability as the elimination of poverty and improvement of quality of life; and environmental sustainability as the conservation and enhancement of natural resources for future generations.

The UN and all its stakeholders have proposed the concept as a "prescription" to address the world's current outcomes. The agenda, scope, and roadmap for sustainable development efforts are determined by the UN. The current plan for sustainable development efforts is the UN SDGs, which cover the years 2015–2030. The UN SDGs, which shape the agenda for sustainability efforts for 2015–2030 and consist of 17 goals and 169 targets, also have three main categories. Of the 17 goals, 7 are related to economic, 5 to environmental, and 5 to social sustainability (Barbier & Burgess, 2017, p.6).

Sustainability Communication

The concept of sustainability represents a communication approach aimed at encouraging changes, improving conditions, and increasing participation in decision-making processes. Efforts by experts and political leaders alone are insufficient in this area (Aversano-Dearborn et al., 2018, p.6). Sustainability communication has significant potential to overcome these challenges.

Sustainability communication is a strategy used to manage stakeholder relationships by considering environmental, social, and economic factors, as well as to instill awareness and behavioral change for a future in harmony with nature. The focus of this strategy is to enhance societal welfare while protecting nature and to ensure that people adopt a sustainable lifestyle, thereby enabling future generations to benefit from these resources (Özgen, 2022, p.3).

Sustainability communication is approached from two different perspectives: one is to communicate sustainability itself, and the other is to communicate through sustainable methods. The first approach addresses social and environmental issues to drive behavior and attitude change, while the second approach aims to communicate the impacts of research on the environment. The concept of sustainability communication is evolving over time, and it lacks a precise definition (Doğru, 2023, p.323).

Sustainability communication, in alignment with the principles of sustainable development, focuses on economic, environmental, social, and cultural values. This approach aims to help various stakeholders better understand the relationship between humans and the environment, thereby gaining broad support and acceptance. The main goal is to develop methods that support individuals in adopting a sustainable lifestyle and enhance social interactions (Lähtinen et al., 2017, p.2).

When conceptualizing sustainability communication, various definitions and literature from different disciplines are examined. The three main dimensions of sustainability and sustainable development and the current 2015-2030 SDGs defined under these dimensions come to the forefront (Adomßent & Godemann, 2011; Fischer et al., 2016; Özgen, 2022; Doğru, 2023; Akbayır, 2019; McDonagh, 1998; Godemann & Michelsen, 2011b; Gutterman, 2020; Lähtinen et al., 2017; Signitzer & Prexl, 2008; Purvis et al., 2019; Weder et al., 2021; Cahyandito, 2010; Servaes & Lie, 2015; Ziemann, 2011; Demirci, 2022; Newig et al., 2013; Genç, 2017; Oçak, 2018, Kuşay, 2020, Heinrichs, 2011; Özdemir, 2023). In addition to the sustainable development literature, a sub-dimension has been identified: sustainability of communication, which is defined in various ways in the literature (sustainable communication, communication sustainability, etc.) (Arın Saydam, 2014; Kilbourne, 2004; McDonagh, 1998; Kuşku Özdemir, 2019; Ural, 2013; Özgen, 2022; Kaya et al., 2014). In this context, Figure 1 presents the four dimensions of sustainability communication.

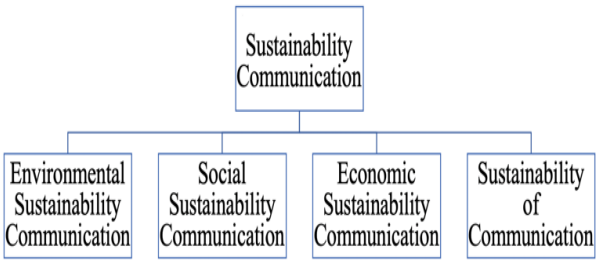

Figure 1. Dimensions of Sustainability Communication (Source: Akdemir, 2023, p.52)

Sustainability communication is a dynamic process aimed at fostering mutual understanding to promote a sustainable future for society. It emphasizes justice, norms, and the need to analyze the root causes of issues, transforming knowledge into action on both individual and societal levels. This process spans various domains, including individuals, institutions, education, media, politics, and business (Godemann & Michelsen, 2011, p.6). Measuring sustainability communication and evolving it based on findings is critical to ensuring the effectiveness of sustainability initiatives. Therefore, the development of a reliable scale is deemed essential.

Method

In the study, the eight-step scale development hierarchy of DeVellis (2022) was followed. DeVellis (2022) was selected due to its systematic approach to scale development, enhancing both the reliability and validity of measurement tools.

This method is recognized in psychometric research for its scientific rigor. The eight steps in DeVellis's process are: (1) determining the construct, (2) generating an item pool, (3) determining the format of measurement, (4) expert review, (5) including validation items, (6) pilot testing, (7) factor analysis, and (8) finalizing the scale (DeVellis, 2022). The research adhered to all stages of scale development within the exploratory sequential mixed-method design, addressing the process through two fundamental phases: the qualitative research phase and the quantitative research phase (Creswell, 2014; Toraman, 2021). The implementation of this study was carried out within the framework of the decision of the Social and Human Sciences Ethics Committee of Kahramanmaraş Sütçü İmam University dated April 6, 2023, and numbered 11.

The problem and Purpose of the Research

The problem of the research is the need to develop a scale that can identify the deficiencies and shortcomings in the communication processes related to the sustainable development activities of higher education institutions and measure the quality and strength of sustainability communication. In this context, the aim of the research is to develop a 'Sustainability Communication Scale' specific to higher education institutions and to conduct validity and reliability analyses of this scale.

Population and Sample of the Study

The research population consists of academicians and students from 81 Turkish universities that are ranked in the top 1000 according to the GREENMETRIC 2022 index and exposed to sustainability messages. The sample of the research includes 109 academicians and 1182 students from the Faculty of Economics and Administrative Sciences (FEAS) and Business Faculties of the top 5 non-profit public universities listed in the 2022 GREENMETRIC Sustainability Index (GREENMETRIC, 2022), who directly contribute to education and training and are assumed to be directly exposed to sustainability messages. The sample was limited to the FEAS and Business Faculties, as these are the most prevalent departments in the Turkish universities included in the GreenMetric 2022 rankings. This focus enables a targeted examination of sustainability communication in key academic fields, though it may limit broader generalizability across other disciplines. The study was conducted on a total sample of 1291 individuals. A total of 540 academicians from five public universities were reached via email, and through these academicians, students were also contacted. An "Online Form" application (https://surdurulebilirlik-iletisimi.vercel.app) was developed and used to conduct the data collection process effectively and efficiently. Using the homogeneous sampling method, a type of purposive sampling (Patton, 2001; Büyüköztürk et al., 2012:91), a group likely to be conscious of sustainability issues was targeted (Etikan et al., 2016:2). Within this framework, the research was particularly focused on FEAS and business faculties, with participation from 109 academicians and 1182 students. This sample structure reflects the general demographic structure of students and academicians in Turkey (YÖK, 2023). The statistical status of the sample is presented in Table 1.

Table 1. Sample Size of the Study

Student Type	Total Sample	Pilot Study	EFA	CFA
Undergraduate	928	180	376	372
Associate degree	224	42	92	90
Master's degree	25	5	11	9
Doctorate	5	1	2	2
Total Students	**1182**	**228**	**481**	**473**
Academic Staff Type	**Total Sample**	**Pilot Study**	**EFA**	**CFA**
Professor	19	4	8	7
Associate Professor	12	2	5	5
Assistant Professor	23	5	9	9
Research Assistant	20	4	8	8
Lecturer	26	5	11	10
Instructor	9	2	4	3
Total Academicians	**109**	**22**	**45**	**42**
Grand Total	**1291**	**250**	**526**	**515**

Qualitative Research

Before creating the item pool, a theoretical framework that would form the basis of the scale was determined. This framework was created by

utilizing existing theories, concepts, and literature related to sustainability communication. The current conceptual framework (Barbier & Burgess, 2017:6) is based on the three main factors (Economic, Social, and Environmental Sustainability) determined by the UN (Dyllick & Hockerts, 2002, p.132) and the 17 SDGs, which form the sub-dimensions of these three factors. An additional dimension, "sustainability of communication," was envisioned since the measurement of the concept of sustainability communication was involved (Arın Saydam, 2014; Kilbourne, 2004; McDonagh, 1998; Kuşku Özdemir, 2019; Ural, 2013; Özgen, 2022; Kaya et al., 2014).

The items in the item pool were written using a hybrid method involving inductive (Hinkin, 1998) and deductive methods (Gürbüz & Şahin, 2018:30). The most comprehensive reporting and measurement tool (GRI) (Bayhantopçu & Özuyar, 2021:399), which was considered to form the items of the scale from the theoretical framework, and the SDGs, which determine the main framework and agenda of the concept (Oçak, 2018:1), were reached. Subsequently, items were written because of detailed research within the SDGs and GRI (Global Reporting Initiative) documents. A large item pool was created because having a large item pool positively impacts the validity and reliability of the scale (DeVellis, 2022: 80), and initially, 77 items were written.

The dimensions in the field of sustainability and the item pool were revealed through a detailed and comprehensive examination of the relevant literature. The prepared items were first applied to a group of 11 people (3 academicians and 8 students) as part of a pilot application, and they were asked to indicate the items' understandability and any ambiguous points (Yalçın, 2021:3). Additionally, feedback was received regarding the overall structure of the scale and the experience of completing it. The items were reviewed based on participant feedback, and the scale's face validity was ensured.

For content validity, expert opinions in the field were obtained to determine the items and dimensions of the scale more accurately. To ensure content validity, the Modified Lawshe (1975) Method proposed by Ayre & Scally (2014) was used. Expert opinions on the scale items were obtained via email from 19 experts selected through purposive sampling (Yurdugül, 2005:2). The opinions received were analyzed using the Modified Lawshe Method, and the scale was revised accordingly (Ayre & Scally, 2014). Table 2 displays the status of the participants.

Table 2. Table of Sample Sizes Participating in the Research

	Title/Profession							
	Prof. Dr.	**Dr.**	**Phd.(c)**	**UN Expert**	**Multinational Relations Expert**	**Turkish Instructor**	**Statistics Expert**	**Total**
Gender								
Female	1	1	0	3	1	2	0	8
Male	1	6	1	1	0	0	2	11
Total	2	7	1	4	1	2	2	19

Qualitative Research Findings

The Content Validity Index (CVI) value of the 19 experts who participated in the study was determined to be 0.474 (Ayre & Scally, 2014). In the analysis, 25 items were excluded for not meeting the CVI threshold of 0.474 (Lawshe, 1975; Ayre & Scally, 2014). Following expert evaluations, an additional 6 items were removed. As a result, 31 items were excluded overall, leaving 46 items remaining in the scale. After the removal of the 31 items, the CVI value was calculated to be 0.731. This indicates that the remaining items on the scale possess content validity. The obtained CVI value (0.731), which is greater than the CVI criterion (0.474), indicates that the content validity of the remaining 46 items is statistically significant (Lawshe, 1975; Karagöz & Bardakçı, 2020:18). Furthermore, expert opinions support the four predicted factors (environmental sustainability communication, social sustainability communication, economic sustainability communication, and sustainability of communication) identified after the literature review. The analysis table was prepared using the Office 365 Excel program.

Quantitative Research

The scale was designed based on expert opinions and applied to a predetermined sample group of 250 individuals (Baş, 2003, p.185) representing the target audience within the scope of a pilot study to evaluate the scale's structural characteristics, assess its measurement validity, and provide basic information for possible improvements before factor analysis (Karakoç & Dönmez, 2014, p.42). The pilot study involved a total of 228 students and 22 academicians. The student sample comprised undergraduate students (180), associate degree students (42), master's degree students (5), and one doctorate student. Among the academic participants, there were 4 professors, 3 associate professors, 5 assistant professors, 4 research assistants, 5 lecturers, and 2 instructors, providing a diverse academic representation. The collected data were analyzed using SPSS 25 software. Following the pilot study, minor adjustments were made based on the second round of expert opinions, without removing any items, taking into account survey methodologies, Turkish language rules, and literature information.

During the pilot study stage, the remaining 46 items in the item pool were identified with factor codes. For example, the term "F1Q1" denotes the first item in the first factor. According to this arrangement, "F1" represents environmental sustainability communication, "F2" represents social sustainability communication, "F3" represents economic sustainability communication, and "F4" represents sustainability of communication factors.

During the pilot application process, partial correlations between factors were analyzed. Although analyzing these correlations before conducting confirmatory factor analysis (CFA) is not generally appropriate, the clear distinction between the factors has been supported both in the literature and by expert opinions. Therefore, Pearson correlation analysis was conducted for the four factors, namely F1, F2, F3, and F4.

The construct validity of the scale was ensured using a two-phase strategy, including Exploratory Factor Analysis (EFA) and CFA (Karagöz and Bardakçı, 2020, p.15; Büyüköztürk et al., 2012, p.119). In the first phase of this approach, EFA techniques were applied to determine the fundamental factor structure of the scale. In the second phase, the factor structure determined by EFA was confirmed using CFA (Yaşlıoğlu, 2017:75). In the structural validity analyses, SPSS 25 software was used for dataset preparation, reliability analyses, and determining suitability for factor analysis, while AMOS 24 software was employed to confirm the factor structure.

The EFA phase of this study involved participants from five different universities. Data collected from 526 participants was analyzed using a 36-item scale. During the EFA process, three analyses were conducted, and two items were removed from the scale. The reliability of the scale was tested using Cronbach's alpha and composite reliability analysis methods, and it was concluded that the scale was reliable. In the CFA phase, data collected from 515 participants from 5 different universities, different from the EFA participants, was analyzed to confirm the scale structure.

Quantitative Research Findings

In the pilot study, based on the item-total correlation analysis results, some items showed low correlation values. Specifically, in Factor 1, items 3 (-.233), 7 (.043), and 12 (-.019); in Factor 2, items 8 (-.014), 10 (-.193), and 11 (-.080); in Factor 3, items 4 (-.255) and 5 (-.247); and in Factor 4, items 2 (-.144) and 4 (.069) had item-total correlations below the generally accepted .30 threshold. These items were removed from the scale due to their low overall contribution to it (Field, 2005). After item analysis, the scale was reduced from 46 to 36.

The Cronbach's alpha reliability coefficient of the initial 46-item scale was calculated as 0.826. After removing the low-correlation items, the internal consistency coefficient was calculated as 0.860. Generally, a Cronbach's alpha value above 0.70 indicates sufficient internal consistency for the scale (Nunnally, 1978).

Post-pilot study partial correlation analysis results between factors showed no statistically significant relationships, with $p > .05$ for F1 and F2 ($r = 0.031$, $p = .628$), F1 and F3 ($r = 0.033$, $p = .609$), F1 and F4 ($r = 0.017$, $p = .793$), F2 and F3 ($r = -0.058$, $p = .359$), F2 and F4 ($r = -0.018$, $p = .778$), and F3 and F4 ($r = -0.062$, $p = .328$). The results show no significant

correlations between the factor pairs, indicating that the four factors are independent constructs. This suggests the scale measures distinct dimensions, with no correlations exceeding 0.70, preserving the uniqueness of each factor (Brown, 2006). After item removal, .943 (F1), .954 (F2), .957 (F3), .926 (F4). When the Cronbach's alpha value for all factors is above 0.70, the scale is considered to have sufficient internal consistency (Nunnally, 1978).

Based on the second expert evaluation conducted after the pilot study, the current 36-item form was deemed appropriate. Minor adjustments were made to the items without compromising their conceptual integrity, based on survey methodologies, Turkish language rules, and literature information.

To assess sample adequacy before EFA, the Kaiser-Meyer-Olkin (KMO) test was used (Karagöz & Bardakçı, 2020:35). The KMO measure was 0.922, indicating that the sample was highly suitable for factor analysis. The Bartlett's Test of Sphericity was used to test the applicability of factor analysis. The Chi-Square value was 11859.301, with degrees of freedom (df) of 561. The p-value was .000, which is less than 0.05 (Field, 2005). These findings demonstrate the applicability of EFA for determining the structure of factors and relationships in the data (Karagöz & Bardakçı, 2020). The detailed results are presented in Table 3.

Table 3. EFA KMO and Bartlett's Test

Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy		.922
Bartlett's Test	Chi-square Value	11859.301
	Sd	561
	p(p<0,05)	.000

During EFA, oblique rotation methods (direct oblimin and promax) were used, given their capacity to account for correlations between factors, a common practice in social sciences where factors need not be orthogonal (Hair et al., 2010). Additionally, the principal components method, widely applied for its simplicity and effectiveness, was employed in the analysis (Fabrigar et al., 1999).

The initial EFA revealed a five-factor structure in the 36-item scale. The study aimed to create a four-factor structure. However, a five-factor structure with 36 items (Table 4) was formed.

Table 4. Explained Total Variance Amounts (1st Analysis)

Factor	Initial Eigenvalues			Total Factor Loadings			Transformed Total Factor Loadings
	Total	Variance %	Cumulative %	Total	Variance %	Cumulative %	Total
1	6.713	18.647	18.647	6.713	18.647	18.647	6.695
2	4.411	12.254	30.901	4.411	12.254	30.901	4.354
3	4.227	11.743	42.643	4.227	11.743	42.643	4.234
4	3.477	9.659	52.302	3.477	9.659	52.302	3.599
5	1.067	2.964	55.266	1.067	2.964	55.266	1.073

Extraction Method: Principal Component Analysis

In the pattern matrix analysis, a specific item (F3Q10) in the 36-item scale study does not load on any factor (Table 5). This indicates that the item F3Q10 does not fit the intended factor structure, and as Castello and Osborne (2005) suggest, at least three items should load on a factor. Therefore, this item was removed from the scale.

Table 5. Pattern Matrix (1st Analysis)

Factor									
1		2		3		4		5	
F3Q3	.977	F4Q1	.727	F2Q1	.757	F1Q8	.761	**F3Q10**	**.914**
F3Q9	.975	F4Q5	.721	F2Q4	.753	F1Q10	.681		
F3Q7	.975	F4Q6	.706	F2Q7	.703	F1Q9	.653		
F3Q6	.974	F4Q10	.693	F2Q3	.694	F1Q6	.618		
F3Q1	.973	F4Q9	.685	F2Q9	.668	F1Q11	.607		
F3Q8	.971	F4Q8	.682	F2Q13	.610	F1Q4	.593		
F3Q2	.971	F4Q3	.682	F2Q6	.588	F1Q5	.584		
		F4Q11	.667	F2Q12	.563	F1Q1	.570		
		F4Q7	.663	F2Q5	.559	F1Q2	.556		
				F2Q2	.539				

Extraction Method: Principal Component Analysis
Rotation Method: Oblimin with Kaiser Normalization
a. Rotation converged in 3 iterations.

A new EFA was conducted on the 35-item scale. The analysis's goal was for the scale to have a four-factor structure, and this was achieved. However, upon examining the commonalities table (Table 6), it was observed that the commonality value for item F2Q2 was below the minimum acceptable threshold of 0.32 for an item to be retained in the

scale (Tabachnick & Fidell, 2001). The commonality for item F2Q2 was far below the values of 0.5 (strong), 0.4 (adequate), and the minimum accepted threshold of 0.32 in the literature (Castello & Osborne, 2005). Therefore, this item was removed from the scale. Following the second EFA, the analysis proceeded with the 34-item scale.

Table 6. Communalities Table (2nd Analysis)

Item	Initial	Extraction	Item	Initial	Extraction
F1Q1	1.000	.337	F3Q1	1.000	.947
F1Q2	1.000	.315	F3Q2	1.000	.943
F1Q4	1.000	.354	F3Q3	1.000	.956
F1Q5	1.000	.341	F3Q6	1.000	.948
F1Q6	1.000	.382	F3Q7	1.000	.951
F1Q8	1.000	.575	F3Q8	1.000	.942
F1Q9	1.000	.426	F3Q9	1.000	.950
F1Q10	1.000	.466	F4Q1	1.000	.532
F1Q11	1.000	.382	F4Q3	1.000	.470
F2Q1	1.000	.581	F4Q5	1.000	.520
F2Q2	**1.000**	**.294**	F4Q6	1.000	.505
F2Q3	1.000	.488	F4Q7	1.000	.439
F2Q4	1.000	.578	F4Q8	1.000	.470
F2Q5	1.000	.312	F4Q9	1.000	.485
F2Q6	1.000	.353	F4Q10	1.000	.480
F2Q7	1.000	.498	F4Q11	1.000	.451
F2Q9	1.000	.453			
F2Q12	1.000	.325			
F2Q13	1.000	.369			

Extraction Method: Principal Component Analysis

The third exploratory factor analysis (EFA) revealed a four-factor structure for the scale, with factors labeled F1, F2, F3, and F4. The factor loading values ranged from .576 to .759 for F1, .565 to .766 for F2, .971 to .977 for F3, and .662 to .726 for F4, indicating strong relationships between the factors and their corresponding items (Table 7). This demonstrates that the scale effectively measures sustainability communication across multiple dimensions. The scale maintained item loadings above .30, with no cross-loadings, ensuring clarity in the factor structure. Measures were taken to avoid overlapping items with similar load values across factors, and at least three items were included per factor (Castello & Osborne, 2005). This resulted in a coherent four-factor structure comprising 34 items, which is detailed in the pattern matrix presented in Table 8.

Table 7. Item Factor Distributions and Factor Loading Values (3rd Analysis)

Item	Env. Sus. Comm.	Item	Soc. Sus. Comm.	Md.	Eco. Sus. Comm.	Md.	Sus. of Comm.
F1Q1	.576	F2Q1	.766	F3Q1	.973	F4Q1	.726
F1Q2	.559	F2Q3	.697	F3Q2	.971	F4Q3	.682
F1Q4	.595	F2Q4	.763	F3Q3	.977	F4Q5	.720
F1Q5	.581	F2Q5	.565	F3Q6	.974	F4Q6	.706
F1Q6	.616	F2Q6	.589	F3Q7	.975	F4Q7	.662
F1Q8	.759	F2Q7	.708	F3Q8	.971	F4Q8	.683
F1Q9	.652	F2Q9	.676	F3Q9	.975	F4Q9	.687
F1Q10	.680	F2Q12	.570			F4Q10	.694
F1Q11	.608	F2Q13	.605			F4Q11	.667

Table 8. Pattern Matrix (3rd Analysis)

Factor							
1		2		3		4	
F3Q3	.977	F4Q1	.726	F2Q1	.766	F1Q8	.759
F3Q9	.975	F4Q5	.720	F2Q4	.763	F1Q10	.680
F3Q7	.975	F4Q6	.706	F2Q7	.708	F1Q9	.652
F3Q6	.974	F4Q10	.694	F2Q3	.697	F1Q6	.616
F3Q1	.973	F4Q9	.687	F2Q9	.676	F1Q11	.608
F3Q8	.971	F4Q8	.683	F2Q13	.605	F1Q4	.595
F3Q2	.971	F4Q3	.682	F2Q6	.589	F1Q5	.581
		F4Q11	.667	F2Q12	.570	F1Q1	.576
		F4Q7	.662	F2Q5	.565	F1Q2	.559

According to the EFA results, the scale consists of 34 items across four sub-dimensions, explaining 54.647% of the total variance, confirming its validity as a measurement tool (Streiner, 1994:140). The optimal number of factors is determined when each additional factor contributes less than 5% to the total variance (Yaşlıoğlu, 2017:77).

Table 9. Amounts of Total Variance Explained (3rd Analysis)

Factor	Initial Eigenvalues			Total Factor Loadings			Transformed Total Factor Loadings
	Total	Variance %	Cumulative %	Total	Variance %	Cumulative%	Total
1	6.713	19.744	19.744	6.713	19.744	19.744	6.695
2	4.409	12.967	32.711	4.409	12.967	32.711	4.350
3	3.986	11.724	44.434	3.986	11.724	44.434	4.003
4	3.472	10.213	54.647	3.472	10.213	**54.647**	3.598
5	.904	2.659	57.307				

Extraction Method: Principal Component Analysis

The fourth factor accounts for 10.2% of the variance, with the closest following percentage being 2.6%. The detailed variance percentages are listed in Table 9.

The Scree Plot in Figure 2 illustrates the variance explained by each factor in the four-factor model. The first factor accounts for the largest variance, while the last explains the least (Streiner, 1994:138). The optimal number of factors is determined by observing where the plot levels off, using the breakpoints and shape of the graph as guides (Cattell, 1978).

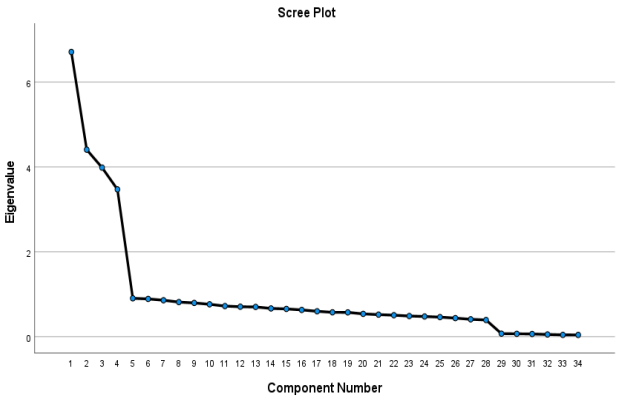

Figure 2. Scree Plot Graph

To determine the reliability of the scale, Cronbach's alpha reliability analysis was conducted, and the scale was found to have an α of 0.779. Since the Alpha value is greater than 0.7, the scale, including its sub-dimensions, is considered a reliable measurement tool. Cronbach's alpha values for the four factors were .804 for "F1", .836 for "F2" .991 for "F3", and .864 for "F4", indicating strong reliability. (Cronbach & Meehl, 1955; Karagöz & Bardakçı, 2020:62).

Considering that Cronbach's alpha does not provide sufficient reliability for multidimensional scales (Karagöz & Bardakçı, 2020), composite reliability (CR) coefficients were used to assess the internal consistencies of the factors. The calculations conducted using Microsoft Office 365 Excel and AMOS 24 software determined the CR as 0.8077 for F1, 0.8409 for F2, 0.9911 for F3, and 0.8646 for F4. Since these values are above 0.70, they provide strong evidence of the reliability of the four factors (Raykov, 1997).

For the CFA, path diagrams were created in AMOS 24 for the four-factor, 34-item scale derived from the EFA, with 9 items in the first factor, 9 in the second, 7 in the third, and 9 in the fourth. The analysis confirmed the requirement of at least three items per factor (Castello & Osborne, 2005:3), and item F4Q10 was removed due to non-conformance. Item F1Q9 was removed post-CFA due to a factor loading of 0.61, while item F2Q6 was retained as its factor loading was close to the range of 0.65 to 0.70 (Stevens, 2002). Consequently, a 32-item four-factor scale was developed and validated. The path analysis diagram is presented in Figure 3, and the model fit indices are shown in Table 10.

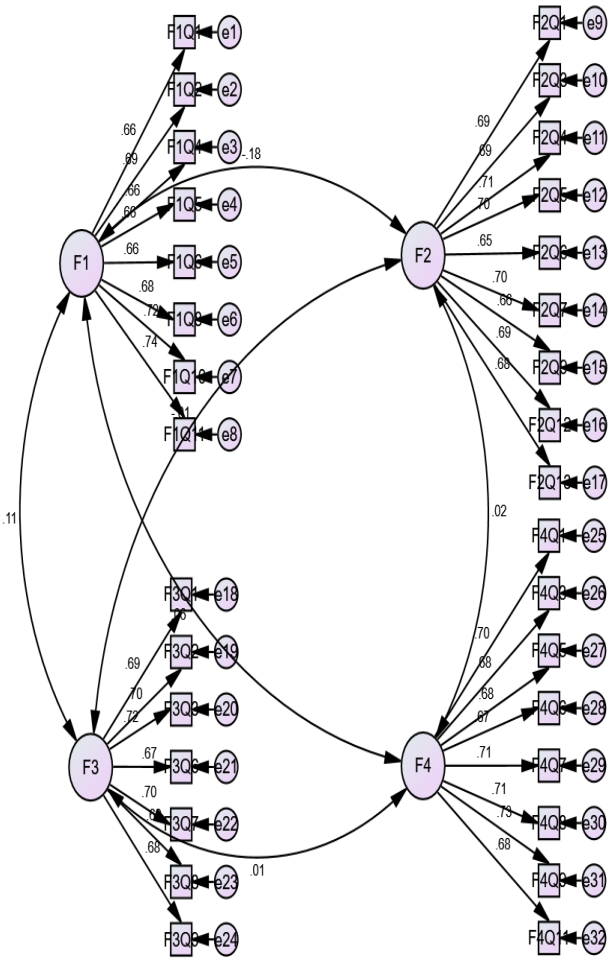

Figure 3. CFA Path Diagram

Table 10. CFA Fit Indices Table

Fit Index	CMIN/df	RMSEA	AGFI	GFI	NFI	CFI	IFI	TLI
Scale Values	1,03	0,008	0,93	0,94	0,93	0,99	0,99	0,99

When examining the fit indices of the model, it was found that the x2/df ratio of 1.03 shows excellent fit; the AGFI value of 0.939 provides a

high data fit; other fit indices such as GFI, NFI, CFI, IFI, and TLI with values above 0.90 indicate excellent levels; and the RMSEA value of 0.008 achieves ideal results.

Composite reliability coefficients were calculated to measure the internal consistency of the factors. As a result of these calculations, the CR values were found to be 0.8751 for F1, 0.8885 for F2, 0.8666 for F3, and 0.8820 for F4. These coefficients indicate the measurement reliability of each factor, and generally, values of 0.70 and above suggest that the factors are reliable (Raykov, 1997). Therefore, it can be said that all four factors are reliable.

Before the application of CFA, the Cronbach's alpha reliability coefficient of the 34-item scale was calculated as .763. After CFA, with the removal of items F1Q9 and F4Q10, the scale was reduced to 32 items, and the Cronbach's alpha reliability coefficient of this 32-item scale was found to be .769. Additionally, no item-total correlations below .30 were observed. These results indicate that the scale has high internal consistency, both in its initial form and after CFA.

Partial correlations of the four-factor structure resulting from CFA were evaluated, and significant negative Pearson correlations of -0.163 between F1 and F2 and -0.096 between F1 and F3 were found ($p < 0.01$ and $p < 0.05$, respectively). Correlations between F1 and F4, F2 and F3, F2 and F4, and F3 and F4 were not statistically significant ($p > 0.05$). These results show that F1 has negative relationships with F2 and F3, but the relationships between other factors are not significant, indicating that each factor represents unique structures (Yaşlıoğlu, 2017).

Results and Recommendations

In this study, the aim was to develop a valid and reliable measurement tool to measure the quality and strength of sustainability communication in higher education institutions. A two-phase scale development process was followed. In the qualitative phase, a pool of 77 items was created; face validity was ensured after a preliminary pilot study; content validity was achieved through expert opinions and analysis; and the number of items was reduced to 46. In the quantitative phase, a pilot application was conducted, resulting in a 36-item structure based on item analysis. Subsequently, data from the surveys applied to the sample were analyzed in SPSS 25 for EFA. The results of the EFA indicated a model consisting of 34 items and four factors, establishing construct validity. These factors were named environmental sustainability communication, social sustainability communication, economic sustainability communication, and sustainability of communication. The CFA performed using AMOS 24 resulted in the removal of two additional items, leading to a 32-item scale that demonstrated an acceptable level of fit. The reliability analyses using Cronbach's alpha and composite reliability confirmed that the scale and its factors were reliable. Consequently, it was found that the developed sustainability communication scale for higher education institutions was theoretically and statistically appropriate, valid, and reliable.

Although previous studies have offered different perspectives on sustainability communication across various sectors and communication models, they typically have not provided a comprehensive solution by focusing on specific areas. This scale can be used as an effective, comprehensive, and reliable measurement tool for assessing the quality and strength of sustainability communication. The goal was to establish a holistic foundation for the field with a developed scale. The scale can play an important role in identifying and addressing issues in attitudes and practices related to sustainability communication. Particularly, it can make a valuable contribution to Turkish universities adopting the concept of sustainability and leading society in this area in the future.

The scale assesses sustainability communication in a one-dimensional manner. The fact that the concept of sustainability is not yet fully understood by the general public has created a significant need for measurement in this context. This study designed a measurement process to determine whether the messages intended to reach stakeholders are effectively understood. Communication has become a complex process that can be evaluated in multi-dimensional and 360-degree ways. Addressing communication in a one-dimensional manner in the context of evolving

communication under complex and intertwined factors such as Web 3.0, Web 4.0, artificial intelligence, current communication technologies and methods, and the social/new media revolution may cause a deviation from the main framework (sustainability) in the scale development process. Future research should consider other stakeholders besides participants and include other aspects of communication as measurement factors.

Sustainability is a term coined by the UN, aiming to save or shape the future of the world and humanity. Sustainability is an artificial concept introduced by an institution. The UN has characterized its future projection as "sustainable development." The sustainable development agenda consists of 17 goals for 2015–2030. It is desired that concepts and goals related to sustainable development be developed horizontally. Subsequent periods will update these goals. It is anticipated that scientific studies will reach the correct results if they move in line with this horizontal development. In this context, the scale items were primarily written within the framework of the UN SDGs and the most widely accepted sustainability reporting tool, GRI. Furthermore, it can be said that the scale will provide a comprehensive measurement as it includes items related to all factors of sustainability. Thus, when the sustainable development agenda is updated or the scope of the concept is changed in the future, the aim is to provide a dynamic measurement tool that can be renewed.

As a result, the "Sustainability Communication Scale in Higher Education Institutions" has the potential to be an effective tool for assessing sustainability goals and determining future steps in this area. This scale can function as a significant reference point for measuring universities' sustainability performance and making strategic improvements.

Regarding future recommendations, practitioners should implement regular training programs to adopt effective sustainability communication strategies and tools, organize activities to increase interaction with communities and the visibility of sustainability projects, and maintain continuous dialogue with stakeholders. Researchers should investigate the potential of the "Sustainability Communication Scale in Higher Education Institutions" to yield variable results with different stakeholder groups and expand the sustainability communication literature. Policymakers should ensure the inclusion of sustainability communication in policy processes, implement public and comprehensible communication strategies, and use media and digital tools to communicate sustainability goals to the public.

Declaration of Contribution Rate

The authors of the article have contributed equally to the study.

Declaration of Conflict of Interest

There is no potential conflict of interest in this study.

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