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A scale to measure sustainable campus services in higher education: "Sustainable Service Quality"

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ABSTRACT

This study aims to develop a measuring tool which can address two independent research areas in the literature: Sustainability in higher education and service quality in higher education. Both subjects are studied independently in the literature, showing a need for an integrated approach that bridges these areas. For achieving this purpose, a new scale was developed based on a questionnaire applied to two universities in Turkey. The scale aimed to measure the perceptions of the students regarding the quality of sustainable campus services. The questionnaire consisted of 22 questions on several aspects of campus services which are related to sustainability. A total of 234 samples were used for Exploratory Factor Analysis for determining the underlying structures in the data set. The scale was validated with satisfactory Kaiser-Meyer Olkin and Bartlett's test results. Five dimensions were extracted, which represent sustainable service quality. After validation, the scale was applied to two universities located in geographically and socio-economically different regions of Turkey. The term chosen for the proposed combined scale is Sustainable Service Quality (SusServQual). With additional data, t-tests were applied to 308 students aiming to compare the two universities based on perceived quality scores. The results show that the university located in the socio-economically more developed region performed better regarding the overall satisfaction score and four of the five dimensions. The scores were also weighted utilizing a modified method of Analytical Hierarchy Process. Instead of crisp numbers which forces the decision maker to think in mathematical terms while comparing criteria, linguistic terms, each of which corresponds to a fuzzy number were used. Thus, a more accurate evaluation was obtained where the decision maker's subjectivity and ambiguity of the situation are important.

1. Introduction

The concept of sustainability has been on the agenda of the world since the 1970s and is being discussed more and more intensively (Amaral et al., 2015). However, the establishment of a conceptual framework took place after the 1980s, and a precise definition was made in the report of the World Commission on Environment and Development (1987), which is commonly referred to as "The Brundtland Report". In this report, sustainability was defined as "*development that meets the needs of the present without compromising the ability of the future generations to meet their own needs*" (Nejati and Nejati, 2013). Since then, universities, as well as public and private sectors, have taken sustainability to their agenda (Velazquez et al., 2006). Today, a growing number of higher education institutions are trying to integrate sustainability into their systems and subsystems, operations, and curricula. According to Ragazzi and Ghidini (2017), this interest has two main reasons. First, universities have a significant impact on the environment through on-campus activities. Second, they play a crucial role in promoting sustainability by training future generations. Wright (2002) described this progress as a moral imperative for the universities mandated by hundreds of declarations. Despite all these efforts in the universities on sustainability, differences in definitions and interpretations indicated by Van Weenen (2000) continue. Consequently, practical applications and strategies vary significantly. As will be reported in the literature section, these differences and varieties have led to a theoretical dispersion, which has led to efforts to formalize the conceptual framework of sustainability in higher education.

As Beringer and Adomßent (2008) addressed and exemplified,

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sustainable university practices vary widely. This variety can be classified using different framings such as system vs. subsystem distinction, academic vs. non-academic distinction, physical vs. non-physical distinction, and so forth. In this vast sustainability literature, many viewpoints and contexts can be utilized. Nevertheless, few studies take students', who are the main target of higher education, views into consideration. On the other hand, universities achieve their mission not only via research but also via the students they educate. In this sense, universities are the service units which provide students with education and many other facilities. In the literature, the field where this aspect of universities is studied is commonly named "quality in higher education" or "service quality in higher education". One of the natural consequences of this variety in how sustainability issues addressed is the emergence of a field which can be named as "sustainability in higher education quality".

In the current literature, there are studies on the assessment of universities according to sustainability requirements. Likewise, there are numerous studies on service quality in higher education. However, to the best of the authors' knowledge, there is not any study which considers both, combines sustainability and service quality issues in the shared context of higher education. The starting point of this study is the idea of bridging these two fields (sustainability in higher education and service quality in higher education) both of which are given great emphasis and become the subject of numerous, albeit dispersed, studies. For achieving this purpose, a scale is developed based on the knowledge in both fields. ServQual, which is used widely for measuring service quality, is utilized and is modified according to the needs of a sustainable campus. The validity of the scale has been tested by applying Exploratory Factor Analysis (EFA) on the data gathered from a sample of 234 students in two universities located in two different regions of Turkey. The new structure of the scale dimensions after modifying the five-factor ServQual model has been determined, and the newly structured scale according to modified questions was named Sus-ServQual, which is chosen as an abbreviation for "Sustainable Service Quality".

Items and dimensions ("variables" and "factors" respectively in statistical terms) of the scale was weighted by an academic who has studies on sustainability, utilizing Analytical Hierarchy Process (AHP). However, a novel method was integrated into AHP, which enabled the decision maker to use linguistic terms instead of traditional crisp numbers. Each of these linguistic terms has a corresponding fuzzy number in a related table. The main advantage of this method is that it reduces the difficulties for the decision maker to evaluate the situations where subjectivity and ambiguity are important. In the literature, this method is named as "Pythagorean Fuzzy AHP (PFAHP)". In conclusion, the scale was determined to be valid, and no significant difference in the overall perceived quality was determined between the two universities.

The rest of the study continues as follows: In the second section, sustainable university and service quality in higher education are explained in detail. In the third section, the method used for weighing the items and factors, namely PFAHP, is explained. The fourth section is about material and method. Application of the EFA, the factor structure, and the final scale are presented in the fifth section. The sixth section represents the analyses and the results of the t-tests of the survey. The seventh section discusses the results. The last section concludes with the value and the limitations of the study as well as future directions.

2. Literature review

Literature section consists of two subsections. In the first subsection, the concept of the sustainable university is explained, and the studies related to the present study are reviewed. In the second subsection, service quality and its dimensions are explained.

2.1. Sustainable university

The concept of sustainability is based on three pillars, including economy, society, and environment, which can be defined as the dimensions of sustainability (Faghihi et al., 2015). The basic principle of sustainability for the societies is to take these three dimensions into equal consideration in development efforts. In this context, a sustainable university can be defined as follows (Velazquez et al., 2006):

> "*A higher educational institution, as a whole or as a part, that addresses, involves and promotes, on a regional or a global level, the minimization of negative environmental, economic, societal, and health effects generated in the use of their resources in order to fulfill its functions of teaching, research, outreach and partnership, and stewardship in ways to help society make the transition to sustainable lifestyles."*

This definition relates sustainability and higher education in two contexts: (1) higher education institutions have a mission for serving societies to achieve a sustainable life, (2) they should comply with the requirements of sustainability while they serve the first goal. In their study which investigated the theoretical framework of sustainability in higher education, Beringer and Adomßent (2008) pointed out the fact that this concept can be perceived and interpreted in different ways and indicated the difficulty of developing a single unifying theory. They also stressed that there is a broad spectrum changing from a whole, institutional transformation to partial initiatives. While some practices deal with environmental initiatives such as reducing energy consumption or paper cutting campaigns, others focus on academic aspects such as curricula design, or strategic management (Beringer and Adomßent, 2008). To provide a conceptual frame, they classified current studies into two main categories under the concept of sustainability in higher education: (1) sustainable university projects, (2) greening the campus projects. During the literature review process of this study, two contexts have emerged which can be useful for framing, thus better understanding the current literature: (1) characteristics of the papers in the literature, (2) characteristics of the practices. In the first context, papers can be classified into three categories: (1) studies which include original applications and practices, (2) theoretical studies which include the issues of definitions, classifications, measurement and assessment, (3) literature reviews and analyses based on secondary sources. In the second context, sustainability practices can be classified into three categories: (1) studies focusing on environmental sustainability and physical aspects, (2) studies focusing on "education of sustainability" or "sustainability in education" (3) studies focusing on institutional transformation. Considering the purpose of this study, whether the students are involved in or not, and whether service quality is considered or not can also be taken as parameters. The literature is summarized in the abovementioned context in the following paragraphs.

Velazquez et al. (2006) developed a managerial model for sustainable university based on the data from eighty higher education institutions around the world. The model they developed consisted of four phases in strategic management process towards a sustainable university: (1) developing vision, (2) developing mission, (3) creating sustainability committee, (4) developing a strategy. Wright (2002) conducted qualitative research listing major national or international declarations and policies since The Stockholm Declaration in 1972 to date. Reviewing the frameworks of

each declaration, Wright identified eight common themes and policies which were related to environmental sustainability in university: (1) moral obligation, (2) sustainable physical operations, (3) encourage sustainable research, (4) public outreach, (5) partnerships with government, (6) NGOs and industry, (7) develop inter-disciplinary curriculum, (8) ecological literacy. Shriberg (2002) studied the assessment tools for sustainability in higher education. He reviewed the generally used assessment tools and listed their strengths and weaknesses. He concluded that cross-comparison methods were needed. Alshuwaikhat and Abubakar (2008) addressed the lack of a sustainable approach for reducing the effects of campus activities on the environment. They proposed a sustainable campus framework consisting of three primary strategies which should be used integratively: "environmental management system", "public participation and social responsibility", and "sustainability teaching and research". In the model, detailed criteria for reducing the environmental effect, participation, and contribution to social sustainability and sustainability education were defined.

De Castro and Jabbour (2013) used this model to assess sustainability at Alpha University in India. They conducted a qualitative study with the students, employees, and academic staff about the issues on sustainability. They concluded that the university should strengthen the formalization of sustainability-related teaching and research activities to further contribute to sustainable development. Sammalisto et al. (2015) conducted a survey comprised of open-ended questions in a Swedish University to explore how the concept of sustainability is perceived by the students and the university staff. Their research revealed very different perceptions of sustainability from waste separation to the integration of the concept into course design. They also addressed the difficulties of full integration and the importance of top management. Saadatian et al. (2009) also conducted an explorative qualitative study in which they employed several qualitative technics including literature research, gathering and analyzing archival data from various media, interviews and short conversations with the university management, staff, and students. The purpose of their study was to critically evaluate the status of four Malaysian Universities, according to five rubrics they defined during their literature and archival research. They concluded that an awareness of the concept of sustainability in higher education existed, yet the universities were far from achieving the idealistic goals described in the literature and archival data.

Dagiliūtė and Liobikienė (2015) surveyed the perceptions of the students regarding sustainability who enrolled in environmental sciences, biomedicine, and physical sciences in a Lithuanian university during the 2011–2012 school year. The results indicated that the awareness of the students who followed the environmental course regarding the environment is higher than those who studied other courses. Faghihi et al. (2015) developed a dynamic model to reduce energy consumption within the scope of sustainable campus applications. In their model, two performance criteria, energy and money-saving, were analyzed using four hypothesis tests. Li et al. (2015) created a survey to capture the students' energy consumption patterns, behavioral tendencies in the Shanghai University campus in China and measured students' carbon footprint. Tiyarattanachai and Hollmann (2016) developed a questionnaire to compare the perceptions of the stakeholders in the Green Campus and Non-Green Campus universities in Thailand. The result of their study indicated that Green campus university served better quality life compared to Non-Green Campus.

Ragazzi and Ghidini (2017) performed a constructive analysis of the UI Green-Metric World University Ranking Method (UI-GMR) to identify strengths and weaknesses. They concluded that even though UI-GMR can be a standard guideline for constructing a green university as the first world university ranking, it needs to be more scientific and rigorous to plan sustainability policies in universities. Kayapinar-Kaya et al. (2019) also utilized Green-Metric in their study to compare public and private university campuses in Turkey in terms of sustainable-ecological parameters. They revealed that public universities are more successful than private universities in terms of green metrics. Regarding the dimensions of green metrics, the universities had the highest scores from education and research, waste, setting and infrastructure, energy and climate change, water, and transportation, respectively. Hajrasouliha (2017) developed a sustainable campus index to assess the sustainable physical characteristics of university campuses. The index consisted of ten sustainability indicator criteria under three headings: "urbanization", "green campus", and "life on campus". As a result, using one-way ANOVA and post-hoc analysis methods, private universities were found to perform better than the state universities in terms of sustainable campus applications. Yoshida et al. (2017) classified the facilities into three categories at Osaka University in Japan. They advanced a daily energy-use schedule and suggested strategies toward achieving a sustainable campus. Amr et al. (2016a) examined soil as an environmental factor for a sustainable landscape of the campuses of the universities in Egypt. They also examined water in the same sense (Amr et al., 2016b). As indicated above, there are some studies which included students as a stakeholder in different contexts in the current literature. For example, some of these studies considered students' perspective at some level utilizing interviews or short conversations to collect their opinions. Some other studies, like Li et al. (2015), measured students' behavioral tendencies to determine energy consumption patterns. Although involving students as a stakeholder, none of these studies included the perspective of service quality. The present study differs significantly from those studies in the sense that it combines the perspective of quality and measures both of them.

To the authors' best knowledge, the most similar study in the current literature was carried out by Nejati and Nejati (2013). They designed a scale to investigate students' perceptions of sustainable university. Their scale consisted of 28 items, and four dimensions were determined after the validation: community outreach, sustainability commitment and monitoring, waste and energy, land use and planning. While it is similar to the present study in that their scale was designed for measuring a university's contributions to sustainability, the present study is more service-oriented, and it differs in that it measures both perceptions and expectations. Furthermore, it includes two institutions and compares them relating to students' perceptions and sustainable university service quality scores.

2.2. Service quality

Teeroovengadum et al. (2016) describe service quality "*as a form of attitude, related but not equivalent to satisfaction, and results from the comparison of expectations with perceptions of performance*". There are different approaches to how to measure service quality. According to Ghotbabadi et al. (2015), the most prevalent service quality measurement model in the literature is ServQual. It is widely used for service-quality measurement within diverse industries such as banking, supply chain and logistics, public service, hospitality, food, airport, education. In this model, several types of gaps in the system consisting of a service provider's organization and the customer (Yousapronpaiboon, 2014) are defined. The gap which is used for measuring service quality is the one between customers' expectations and perceptions of quality.

ServQual model compares expected and perceived qualities of a particular service and consists of a total of 22 statements grouped

in five dimensions:

1. *Tangibles* dimension is related to the physical facilities, and appearance of personnel.
2. *Reliability* dimension is related to the ability of the service performance, which aims to provide promised service dependably and accurately.
3. *Responsiveness* dimension is related to the attitude of employee behaviors, desire to work and willingness to help customers
4. *Assurance* dimension refers to security and credibility of employees and their trust and confidence
5. *Empathy* dimension means individual attention of customers and communication with them.

There are numerous studies on the measurement of service quality in the literature. Measurement of the quality in higher education is also a significant research domain. Tan and Kek (2004) applied a survey based on ServQual and compared two local universities in Singapore. They concluded that cultural factors should be taken into consideration during the questionnaire development and evaluation process. Legčević (2009) proposed the ServQual model for measuring students' expectations and perceptions of service quality in the Faculty of Law at Osijek University in Croatia. According to the study, all dimensions produced negative quality gaps, and students were not satisfied with the service quality. Aghamolaei and Zare (2008) compared to service quality perceptions of two student groups in associated degree levels, Bachelor of Science (BS) and general medicine level. According to their result, there was not a significant difference between the expectations. Also, the expectation for service quality of the medical students was higher than the BS students. Oliveira and Ferreira (2009) used a modified ServQual to identify the gap score for the higher education sector in Brazil.

Zafiropoulos and Vrana (2008) assessed service quality in Greek higher education using a model based on ServQual and an adjusted questionnaire in an educational context and included students and staff in their research. The research revealed that staff's results differed significantly from students' results, indicating a gap in the way how students and academic staff perceive the quality of education. Hasan et al. (2008) adapted the ServQual model into the overall satisfaction level of bachelor's degree student in a private school. According to their result, empathy and assurance dimensions were critical for the level of a bachelor's degree. Yusof et al. (2012) developed a conceptual framework for service quality in research and-non research universities using a modified ServQual model. Calabrese and Scoglio (2012) developed a novel approach to evaluate service quality for both managers and scholars. Their assessment was different from ServQual and used a firm-specific quality dimension. ServQual gap structure with a critical success factor analysis was integrated and a general and flexible method proposed. Chatterjee et al. (2009) studied service quality of higher education by using the ServQual approach to prioritize quality parameters. They revealed that students expect an increase in both the quality of courses and the quality of teachers.

Dado et al. (2011) conducted an empirical investigation into the construct of higher education service quality using ServQual in Serbia and concluded that there was a significant gap between students' expectations and perceptions. Rezaei et al. (2017) proposed a survey analysis based on ServQual to measure educational service quality of the Kermanshah University of Medical Sciences (KUMS) in western Iran. Their result showed that responsiveness and reliability dimensions have the highest quality gaps in the Department of Dentistry, while empathy and assurance have the highest quality gaps in the Department of Applied Medical Sciences.

ServQual was also integrated with AHP and Fuzzy Set Theory. Lupo (2013) combined Fuzzy Set Theory and the AHP to overcome imprecise data from service performance analysis in the study he carried out to evaluate the service quality of the Management Engineering Programme in University of Palermo in Italy. In the study, student satisfaction level was evaluated using the ServQual, and then, criteria of the education service attributes were weighted using fuzzy AHP. Bayraktaroglu and Atrek (2010) measured students' perception and expectation levels by using ServQual and another model named "ServPerf". According to their study, both scales had very close convergent validity and reliability grade. Galeeva (2016) performed a visual, graphical modification of ServQual and compared it with ServPerf for higher education service quality developing valuable insights.

Mamun-Ur-Rashid and Zillur Rhman (2017) developed another modified ServQual model which included all service dimensions such as learning, teaching, recognition, internet and library facilities, non-academic administration, assessment system, and campus life. Their study revealed that only a small percentage of the students were satisfied with the quality of service of the university and, departments of internet and library, campus life, and non-academic administration needed to be developed. Wagner et al. (2018) evaluated the service quality provided in a higher education institution understanding the perceptions of Human Resources. Their study combined the ServQual scale, AHP and Quality Function Deployment (QFD) approach. Marimon et al. (2018) applied an empirical study to analyze the antecedents of students' satisfaction by utilizing Structural Equation Modelling Technique (SEM). Quality dimensions which play a crucial role in explaining antecedent student satisfaction were "curriculum" and "skills development". Sahney et al. (2004) determined the gap scores of the perceived and expected levels of service quality and, they applied QFD to identify the minimum design characteristics/quality components that meet students' requirements in the higher education system.

Table 1 summarizes literature reviews on service quality. As shown, none of the studies on service quality in higher education have taken sustainability issue into account. Considering this fact with the findings of the literature review on sustainability in higher education, which is presented in the previous subsection, the literature gap occurs, which indicates the need for bridging these fields of study.

3. Pythagorean Fuzzy Sets and analytic hierarchy process

3.1. Pythagorean Fuzzy Sets

In the decision-making process, Intuitionistic fuzzy set (IFS) is a powerful technique to tackle uncertainty and ambiguity (Xu and Liao, 2014). IFSs consist of a membership degree and a non-membership degree of each element with a hesitancy value. However, in some cases, IFS is not adequate, when the sum of squares of the degrees of membership and non-membership is greater than 1 (Garg, 2018). For instance, if decision maker gives the membership degree "0.6" and non-membership degree "0.7" in his evaluation, then this situation cannot be dealt with using IFS because the sum of the squares is greater than 1 ($0.6 + 0.7 > 1$). To deal with these cases, Yager (2013) developed Pythagorean fuzzy sets (PFS) by modifying the sum<1 condition to be square sum<1 condition. For example, regarding the abovementioned equations, it can be seen that $(0.6)^2 + (0.7)^2 < 1$. Therefore, PFS can be considered an extension of the existing IFS. Mohd and Abdullah (2017) emphasized that PFS are powerful and flexible in solving unresolved and ambiguous problems. Some basic concepts on the

Table 1
Results of the literature review on service quality in higher education.

Reference	Methodology	D/F	Fuzzy concept	*Application area*	Focused Group	G/S
Sahney et al. (2004)	ServQual, QFD	26 items and 5 factors	NF	University in India	Faculty experts	NA
Tan and Kek (2004)	ServQual	76 items and 8 factors	NF	Two universities in Singapore	Students	NA
Aghamolaei and Zare (2008)	ServQual	27 items and 5 factors	NF	Medical Sciences (Iran)	Students	NA
Zafiropoulos and Vrana (2008)	ServQual	22 items and 5 factors	NF	Higher education in Greece	Students and academicians	NA
Chatterjee et al. (2009)	ServQual	8 factors	NF	Indian university	Students	NA
De Oliviera and Fereira (2009)	ServQual	19 items and 5 factors	NF	Higher education sector in Brazil.	Students	NA
Hasan and Ilias (2009)	ServQual	46 items and 5 factors	NF	Private higher education in Malaysia	Students	NA
Legcevic (2009)	ServQual	22 items and 5 factors	NF	Faculty of law in Croatia	Students	NA
Dado et al. (2011)	ServQual	6 factors	NF	Engineering Management in Serbia	Students	NA
Yusof et al. (2012)	Modified ServQual	10 factors	NF	Research and non-research university	Students and academicians	NA
Lupo (2013)	ServQual, AHP	36 items and 4 factors	F	Management Engineering in Italy	Students	NA
Galeeva (2016)	ServQual and SERVPERF	23 items and 5 factors	NF	Higher education institutions in Russia	Students	NA
Bayraktaroglu and Atrek (2010)	ServQual and SERVPERF	22 items and 5 factors	NF	Business faculty in Turkey	Students	NA
Rashid and Rahman (2017)	Modified ServQual, Importance-Performance Analysis (IPA)	7 factors	NF	Private university in Bangladesh	Students	NA
Rezaei et al. (2017)	ServQual	5 dimensions	NF	University of Medical Sciences in Iran	Students	NA
Wagner et al. (2018)	AHP, ServQual, QFD	20 items, 5 factors	NF	Higher education system	Employees	NA

D:Dimension number, F:Factor number, NA:Non-available F:Fuzzy, NF:Non-Fuzzy, G/S:Green/Sustainable.

PFSs have been presented in below definitions.

Definition 1. Let a set X be a universe of discourse. A Pythagorean fuzzy set P is an object having the form (Zhang and Xu, 2019):

$$P = \{ < x,\ P(\mu_P(x), \nu_P(x)) > | x \in X\} \quad (1)$$

where $\mu_P(x) : X \mapsto [0,1]$ defines the degree of membership and $\nu_P(x) : X \mapsto [0,1]$ defines the degree of non-membership of the element $x \in X$ to P, respectively, and, for every $x \in X$, it holds:

$$0£\mu_P(x)^2 + \nu_P(x)^2£1\theta \bullet \textit{Zeng et al.}\ (2015) \quad (2)$$

For any PFS P and $x \in X$, $\pi_P(x) = \sqrt{1 - \mu^2{}_P(x) - \nu^2{}_P(x)}$ is called the degree of indeterminacy of x to P.

Definition 2. Let $\beta_1 = P(\mu_{\beta_1}, \nu_{\beta_1})$ and $\beta_2 = P(\mu_{\beta_2}, \nu_{\beta_2})$ be two Pythagorean fuzzy numbers, and $\lambda > 0$, then the operations on these two Pythagorean fuzzy numbers are defined as follows (Zeng et al. 2016):

$$\beta_1 \oplus \beta_2 = P\left(\sqrt{{\mu_{\beta_1}}^2 + {\mu_{\beta_2}}^2 - {\mu_{\beta_1}}^2{\mu_{\beta_2}}^2},\ \nu_{\beta_1}\nu_{\beta_2}\right) \quad (3)$$

$$\beta_1 \otimes \beta_2 = P\left(\mu_{\beta_1}\mu_{\beta_2},\ \sqrt{{\nu_{\beta_1}}^2 + {\nu_{\beta_2}}^2 - {\nu_{\beta_1}}^2{\nu_{\beta_2}}^2}\right) \quad (4)$$

$$\lambda\beta_1 = P\left(\sqrt{1 - (1 - {\mu_{\beta_1}}^2)^{\lambda}}, \left(\nu_{\beta_1}\right)^{\lambda}\right),\ \lambda > 0 \quad (5)$$

$${\beta_1}^{\lambda} = P((\mu_{\beta_1})^{\lambda}, \sqrt{1 - (1 - {\nu_{\beta_1}}^2)^{\lambda}}),\ \lambda > 0 \quad (6)$$

3.2. Pythagorean Fuzzy AHP

The AHP is a method which breaks down the problem into a hierarchy of criteria, sub-criteria, and alternatives (Lukman et al., 2010). For each hierarchy level, criteria are subjected to a pair-wise comparison utilizing expert opinion (Gómez et al., 2015). In situations which include subjective thinking, Fuzzy AHP (FAHP) is one of the most popular methods to address the uncertainty and vagueness of the evaluation processes.Zeng et al. (2016)

PFSs, an extension of IFS, is developed to provide more freedom to decision makers in expressing their opinions about the vagueness and uncertainties of the considered problem (Ilbahar et al. 2018). PFS in AHP (PFAHP) is a new methodology. Ilbahar et al. (2018) first employed PFAHP to prioritize the risk assessment criteria of construction projects. Gul (2018) applied PFAHP to weight the occupation risk parameters in the field of occupational health and safety. Oztaysi et al. (2018) assessed the education performance factors which can be used for collaborative feedback platform by using PFAHP. In the present study, PFAHP is used to weigh the items and factors of SusServQual scale. The steps of the process are explained below.

Step 1. The compromised pairwise comparison matrix $A = (a_{ik})_{mxm}$ is structured based on linguistic evaluation of experts using the scale in Table 2.

Step 2. The difference matrices $D = (d_{ik})_{mxm}$ between lower and upper values of the membership and non-membership functions are calculated using the equations below *(Ilbahar et al. 2018)*.

Table 2
Weighing scale for PFAHP (Ilbahar et al., 2018).

Linguistic term	Pythagorean fuzzy numbers			
	μ_L	μ_U	v_L	v_U
Certainly low important (CLI)	0.00	0.00	0.90	1.00
Very low important (VLI)	0.10	0.20	0.80	0.90
Low important (LI)	0.20	0.35	0.65	0.80
Below average important (BAI)	0.35	0.45	0.55	0.65
Average important (AI)	0.45	0.55	0.45	0.55
Above average important (AAI)	0.55	0.65	0.35	0.45
High important (HI)	0.65	0.80	0.20	0.35
Very high important (VHI)	0.80	0.90	0.10	0.20
Certainly high important (CHI)	0.90	1.00	0.00	0.00
Exactly equal (EE)	0.1965	0.1965	0.1965	0.1965

$$d_{ik_L} = \mu_{ik_L}^2 - v_{ik_U}^2 \tag{7}$$

$$d_{ik_U} = \mu_{ik_U}^2 - v_{ik_L}^2 \tag{8}$$

Step 3. Interval multiplicative matrix $S = (s_{ik})_{mxm}$is computed using Eq. (9) and Eq. (10):

$$S_{ik_L} = \sqrt{1000^{d_L}} \tag{9}$$

$$S_{ik_U} = \sqrt{1000^{d_U}} \tag{10}$$

Step 4. The determinacy value $\tau = (\tau_{ik})_{mxm}$is calculated using Eq. (11):

$$\tau_{ik} = 1 - \left(\mu_{ik_U}^2 - \mu_{ik_L}^2\right) - \left(v_{ik_U}^2 - v_{ik_L}^2\right) \tag{11}$$

Step 5. The determinacy degrees are multiplied with $S = (s_{ik})_{mxm}$the matrix for obtaining the matrix of weights, $T = (t_{ik})_{mxm}$ before normalization using Eq. (12).

$$t_{ik} = \left(\frac{s_{ik_L} + s_{ik_U}}{2}\right)\pi_{ik} \tag{12}$$

Step 6. The normalized priority weights w_i is computed by using Eq. (13).

$$w_i = \left(\frac{\sum_{k=1}^{m} t_{ik}}{\sum_{i=1}^{m}\sum_{k=1}^{m} t_{ik}}\right) \tag{13}$$

4. Material and method

In this section, information about the two universities and regions where they are located as well as the research process are provided.

4.1. Regions and the universities selected for the application

The two universities chosen for the study are located in different regions regarding geographical, social, economic, and cultural conditions. While Sıtkı Kocman University (SKU) is located in Aegean Region, MU University (MU) is located in Eastern Anatolia. Aegean Region is the second most developed region in Turkey. Receiving continuous migration from the east and southeast of the country, this region far outreaches the other in terms of several economic and social indicators such as population density, education, employment, and per capita income. It is also higher than the average value added per capita (*Türk Sanayici ve İşadamları Derneği, 2008*). On the other hand, population density in Eastern Anatolia is less, and it has lower-income families (*Lynn* et al., *2015*). MU is located in Tunceli, which is economically and demographically less active, less developed, thereby perceived as less attractive (albeit in a prejudiced way since it has a lot of underutilized tourism potential with natural wealth).

In 2011, Ministry of Development conducted a study named "*A Study For Socio-Economic Development Index of Provinces and Regions In Turkey*" in which the 81 provinces were ranked according to their socio-economic development and classified into six categories from the most developed ones to the least (Ministry of Development, 2013). In this study, Muğla, where SKU is located, was ranked as the 8th, belonging to the 1st category, and Tunceli, where MU is located was ranked as the 58th, belonging to the 5th category. Fig. 1 shows the general outlook of the results of SEGE-2011 and the locations of the two universities.

On the other hand, in 2002, Turkey transferred a system developed by the European Union (EU), named "The Nomenclature of Territorial Units for Statistics (NUTS)" following the requirements of the EU membership process. Twenty-six development regions were identified according to geographical, socio-economical, and demographical similarities of the 81 provinces upon request of the European Union. This classification system was called NUTS-2, "2″ showing the statistical data gathering level, i.e., each of the 26 regions. The 26 regions were categorized into four development levels. Muğla, where SKU is located, belonged to the 2nd level developed regions, whereas Tunceli, where MU is located, belonged to the 4th level developed regions.

Considering the above mentioned differences and disparities between the two regions where the universities are located, it is reasonable to assume that the students' profile is also different. Since Turkey is a big country, understanding social, economic, and other differences is vital for both academia and governmental level. Students attending MU, which is located in Tunceli, generally come from east and southeast of Turkey, where socio-economic conditions are known to be lagging behind the average of Turkey. SKU Vocational School is located in a subprovince of Muğla, and it is close to several touristic places, beaches, and places of entertainment. The universities selected can be viewed to represent two different faces of Turkey.

4.2. Research design and sampling

The study is based on a questionnaire consisting of two parts. The first part is about demographics, and the second part includes the scale which is adapted from ServQual according to the needs of a sustainable campus. The scale consists of 22 items as in ServQual. For the validity, Exploratory Factor Analysis (EFA) was conducted to the results of 234 students in MU and SKU. The scale is a five-point Likert type scale and each point means: 1 = "strongly disagree", 2 = "disagree", 3 = "no idea", 4 = "agree", 5 = "strongly agree".

The questionnaire (see Appendix-A) was simultaneously applied to the students of both universities face to face in February and March of 2018. Since the sample size for scale validation was determined as at least ten times the number of the variables based on the literature, EFA was applied to the data gathered from 234 students (137 from MU and 97 from SKU) whom the authors

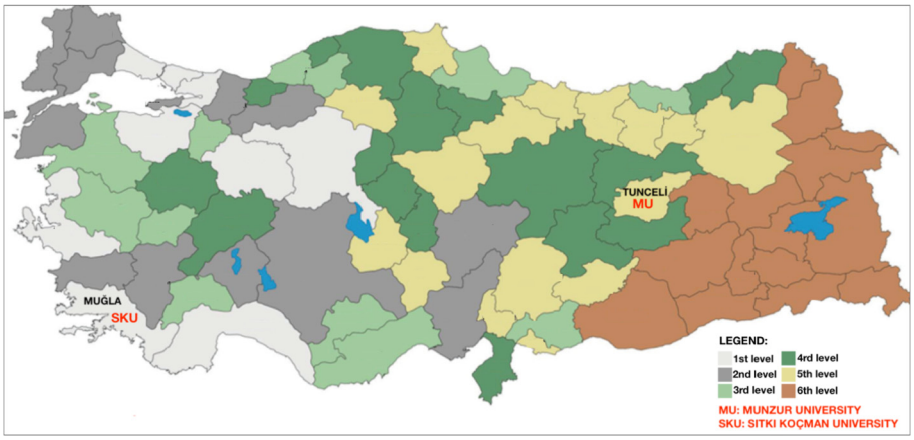

Fig. 1. Development levels of the provinces of Turkey and the locations of the universities.

reached in the first four weeks of the survey period. Additional 74 students were reached afterward; hence, independent sample *t*-Test was applied to 137 students in MU and 171 students in SKU.

During the literature review, it was seen that sampling adequacy for Factor Analysis is a debated issue. The focal point of the debates was the method of choosing the adequate sample size. To summarize the findings, sample size can be determined according to a fixed minimum (100 or higher), number of the variables, number of the factors, number of the variables by factors, and commonalities. *Costello and Osborne (2005)* reviewed two years' worth of PsychINFO articles in which factor analysis was used as a method. They revealed that the most preferred sample size was 2–10 times the variable items, as shown in Table 3. Although their analysis revealed that a 20:1 subject to variable ratio provided error rates well above the field standard alpha = 0.05 level, it was seen both in their study and in the abovementioned papers that a subject-to-variable ratio between 5 and 10 is the most applied method in practice. Since the authors of the present study were able to reach 234 students which is more than the subject-to-variable ratio of 10, it can be considered an acceptable level of sample size, although an issue of statistical and mathematical solidness still exists as in the literature generally.

To summarize the whole research process, a flowchart is prepared, which is shown in Fig. 2.

5. Exploratory factor analysis

Factor analysis is a method consisting of multiple steps to analyze the structure of the data, identify correlations, and reduce dimensions by detecting underlying latent structures (Norris and Lecavalier, 2010). Firstly, sampling adequacy will be evaluated using the Kaiser-Meyer-Olkin test. Secondly, factor extraction will be conducted, and the factor structure will be analyzed. Thirdly, the emerged factors will be described and named accordingly.

Table 3
Current practice in factor analysis (Costello and Osborne, 2005).

Subject to item ratio	% of studies	Cumulative
2:1 or less	14.7%	14.7%
>2:1 =<5:1	25.8%	40.5%
>5:1 =<10:1	22.7%	63.2%
>10:1 =<20:1	15.4%	78.6%
>20:1 =<100:1	18.4%	97.0%
>100:1	3.0%	100%

5.1. Kaiser-Meyer Olkin test

To decide whether variables suitable for factorability, two tests are commonly applied: Kaiser-Meyer Olkin test for adequacy and Bartlett's test for sphericity. These two tests were applied to the data using SPSS. The results are shown in Table 4.

In the literature, the KMO measure is evaluated according to the below criteria shown in Table 5 (Beavers et al., 2013):

Furthermore, the p-value of Bartlett's test for sphericity is smaller than 0.05, which indicates that the data is appropriate for the EFA (*Howard, 2016*). Comparing the results with the criteria mentioned in the literature, which is shown in Table 5, the data structure can be accepted for factor analysis.

5.1.1. Variable rotation and determining the factors

The next step in EFA is to select a method for extracting the factors. There are several statistical methods for analyzing the components in a dataset. Since the Principal Component Method is usually the most used one and also the default subroutine in SPSS for EFA (*Fabrigar and Wegener, 2012*) this method was preferred. It was also assumed that each dimension of service quality is correlated with the others at some level; therefore Oblique Rotation Method was chosen for better distribution of the variables to factors. The results are shown in Table 6.

As shown in Table 6, five dimensions were extracted from data, which can explain 63.089% of the total variance. To determine whether the scale and sub-scale items were consistent with each other, reliability analysis was conducted by calculating Cronbach's Alpha. Table 7 shows the reliability scores for the total scale and the subscales. The reliability of the total scale is excellent with a value of 0.918. Also, reliability scores of Factor 1, Factor 2, Factor 3 were satisfying with the values of 0.791, 0.801, and 0.858, respectively. The reliability scores of Factor 4 and Factor 5 were quite questionable (0.577 and 0.595) which showed a need for a reassessment of the items and redefining.

5.1.2. Describing and labeling the factors

After grouping the variables through factor analysis, the next step is to set a relationship between the statistical results and the theoretical aspect by conducting a semantic evaluation and analysis of the variables within each factor. This process was carried out by bearing the following fundamental questions in mind during the semantic analysis and asking them repeatedly: (1) "What are the similarities and common characteristics of the variables within this factor?", (2) "What differentiates these variables (in the related

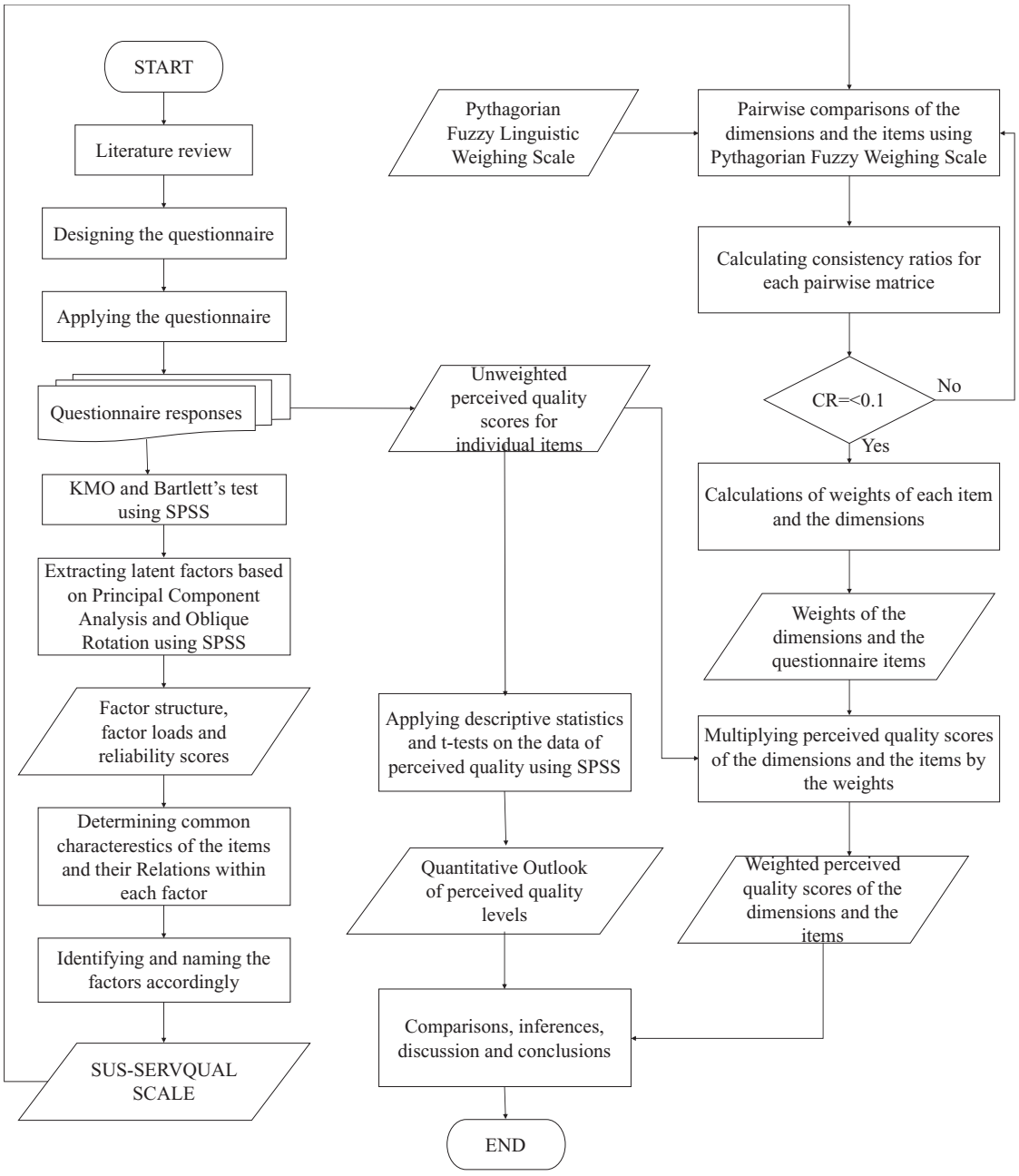

Fig. 2. Flowchart of the research process.

Table 4
KMO and Bartlett's test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.883
Bartlett's Test of Sphericity	Approx. Chi-Square	2370.578
	df	231
	Sig.	.000

Table 5
Interpretation guidelines for the KMO test.

Value	Degree of common variance
0.90 to 1.00	Marvelous
0.80 to 0.90	Meritorious
0.70 to 0.80	Middling
0.60 to 0.70	Mediocre
0.50 to 0.60	Miserable
0.00 to 0.50	Do not factor

factor) from the variables in other factors?" (3) "Is there any resemblance among the common characteristics determined for each factor?", (4) If the answer to question 3 is "yes", is there any other characteristic which is common in the grouped variables, but not exists for the variables in any other group?". To exemplify, variables 18, 19, 20, 21, and 22 were all related to service to some degree, ranging from affordable transportation to social aid. Variables 3, 6, 8, 9, and 10 were commonly related to materials and physical means of the university which enables the protection of the environment. Variables 11, 12, 13, 14, 15, and 17 reflected the willingness of the university regarding the environmental activities

Table 6
Total variance explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	8.189	37.223	37.223	8.189	37.223	37.223	6.239
2	2.067	9.397	46.620	2.067	9.397	46.620	3.162
3	1.308	5.946	52.566	1.308	5.946	52.566	4.843
4	1.263	5.743	58.309	1.263	5.743	58.309	3.311
5	1.052	4.781	63.089	1.052	4.781	63.089	3.236

Table 7
Reliability statistics.

	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Total	.918	.929	22
Factor 1 (5, 18, 19, 20, 21, 22)	.775	.831	5
Factor 2 (3, 6, 8, 9, 10)	.801	.823	5
Factor 3 (11, 12, 13, 14, 15, 17)	.858	.860	6
Factor 4 (1, 7)	.577	.578	2
Factor 5 (2, 4, 16)	.595	.597	3

Table 8
Factor names.

Factor		Common Characteristics	Dimension Name
Factor 1	18, 19, 20, 21, 22	Related to the *services for the students*	Services to Students
Factor 2	3, 6, 8, 9, 10	Related to the *material/physical means* or facilities concerning environmental protection	Physical Means
Factor 3	11, 12, 13, 14, 15, 17	Related to the universities' both responsiveness to environmental issues and also to students	Responsiveness
Factor 4	1, 7	Related to the natural resources with respect to the students	Natural Sources
Factor 5	2, 4, 16	Related to the universities' environmental-friendly operations or activities	Environmental Sensitiveness

and students' problems. Variables 1 and 7 were both related to the natural features which can be seen as natural sources. Variables 2, 4, and 16 had the shared characteristics of environmental-friendly operations or activities. Table 8 shows an overall assessment of the factors.

There was an exception in the factor structure which had to be dealt with. Although the result of the analysis shows that variable 5 is included in Factor 1, this variable seemed not related to the common characteristic as the other five variables in dimension 1, therefore, also considering the relatively low factor load, this variable was excluded.

6. Results and analysis of t-tests

Independent sample *t*-test was conducted to investigate whether there is a difference between the two universities regarding the variables, dimensions, and overall scores. Table 15 in Appendix-B summarizes the results for the overall and factor-based scores, combining the group statistics and t-tests obtained from SPSS as well as two additional columns added by the authors. Since the significance values of Levene's test for equality of variances are smaller than 0.05 for each factor as well as the overall perceived quality score (see the ninth column), variances of the two samples should be assumed to be not equal. Hence, p values in the bottom row in the 12th column for each item in the first column should be taken into consideration. P values of the two-tailed *t*-test in the twelfth column should be lower than 0.05 to reject the null hypotheses and accept the alternative hypotheses which state there is a significant difference between mean values of the related variables.

As the results indicate, the overall average of SKU is significantly higher than MU with the result of 2.3608 against 2.1477. Regarding Factor 3 (responsiveness), Factor 4 (natural sources), and Factor 5 (environmental sensitiveness), SKU is significantly higher scores than MU. For Factor 2 (physical means), MU superiors SKU. For Factor 1 (services to students), SKU has a higher score then MU but not significant.

Table 16 in Appendix-C summarizes the results for variable scores, combining the group statistics and t-tests obtained from SPSS as well as two additional columns added by the authors. For eleven variables out of twenty-one, there are significant differences between the mean values of perceived quality. For nine variables, SKU has significantly higher mean scores than MU. These variables are 1, 7, 11, 14, 15 16, 17, 18, and 22. Variable 1 and 7 are both included in the main factor of "natural resources" whereas variable 11, 14, 15 and 17 are included in the main factor named as "responsiveness". Variable 18 and 22 are two of the five items which belong to the factor of "services o students". Out of 21 variables, there are only two variables (9, 10) regarding which MU has statistically higher scores than SKU. These two variables belong to "physical means".

For 10 variables, either MU or SKU has higher scores than the other, but not statistically significant. SKU has slightly higher scores than MU regarding the variables 2, 3, 6, 8, 19, 21 whereas MU has slightly higher scores than SKU regarding the variables 4, 12, 13, 20.

After descriptive statistics and t-tests, weighted scores were calculated by multiplying weights by the unweighted scores for each factor and also variables.

Table 9 shows both weighted and unweighted scores for the dimensions. It can be seen that the order of the dimensions according to their weighs from the highest to the lowest are: "services to students", "responsiveness", "physical means", "environmental

Table 9
The weighted average for overall quality scores.

Dimensions		Perceived Quality			
		MU		SKU	
	Weight	Unweighted	Weighted	Unweighted	Weighted
Services to Students	0.244	1.986	0.484	2.078	0.508
Physical Means	0.205	2.302	0.471	1.989	0.405
Responsiveness	0.226	2.014	0.458	2.574	0.580
Natural sources	0.138	2.239	0.310	3.047	0.406
Environmental Sensitiveness	0.188	2.348	0.439	2.661	0.497
Overall Average		2.145		2.361	

Table 10
Weighted averages for services to students.

Services to students		Perceived Quality			
		MU		SKU	
	Weight	Unweighted	Weighted	Unweighted	Weighted
18	0.011	1.955	0.022	2.301	0.026
19	0.058	2.038	0.118	1.925	0.112
20	0.074	1.901	0.142	1.988	0.148
21	0.013	1.902	0.025	1.735	0.023
22	0.087	2.135	0.185	2.440	0.212

Table 11
Weighted averages for physical means.

Physical Means		Perceived Quality			
		MU		SKU	
	Weight	Unweighted	Weighted	Unweighted	Weighted
3	0.041	2.053	0.086	2.012	0.084
6	0.038	1.980	0.076	1.945	0.074
8	0.022	2.045	0.046	2.036	0.046
9	0.075	2.916	0.220	1.921	0.145
10	0.026	2.507	0.066	1.981	0.052

Table 12
The weighted average for responsiveness.

Responsiveness		Perceived Quality			
		MU		SKU	
	Weight	Unweighted	Weighted	Unweighted	Weighted
11	0.030	2.000	0.060	2.531	0.076
12	0.029	2.176	0.064	2.339	0.069
13	0.031	1.993	0.062	2.211	0.069
14	0.039	1.955	0.076	2.327	0.091
15	0.030	2.061	0.061	2.945	0.087
17	0.066	1.901	0.126	3.092	0.205

sensitiveness" and "natural sources", respectively. While the factors are listed top-down as environmental sensitiveness, physical means, natural sources, responsiveness, and services to students, when weighing applied, the list changes as services to student, physical means, responsiveness, environmental sensitiveness and natural sources for MU. On the other hand, scores of SKU students were listed top-down as natural sources, environmental sensitiveness, responsiveness, services to students and physical means considering the unweighted scores. When weighings considered, list changes as responsiveness, services to students, environmental sensitiveness, natural sources and physical means.

Table 13
The weighted average for natural sources.

Natural Resources		Perceived Quality			
		MU		SKU	
	Weight	Unweighted	Weighted	Unweighted	Weighted
1	0.090	2.454	0.221	3.251	0.293
7	0.047	2.023	0.096	2.660	0.127

Table 14
The weighted average for environmental sensitiveness.

Environmental Sensitiveness		Perceived Quality			
		MU		SKU	
	Weight	Unweighted	Weighted	Unweighted	Weighted
2	0.012	2.090	0.026	1.975	0.024
4	0.052	2.855	0.149	2.920	0.152
16	0.123	2.099	0.258	3.089	0.379

Tables 10–14 show the weighted and unweighted scores in the same manner as Table 9. Weighted scores were obtained by multiplying the weighs by the unweighted scores.

7. Discussion

According to unweighted scores, the results indicate that students in SKU were clearly more satisfied with the sustainable service quality than the students in MU. SKU also statistically predominated MU regarding responsiveness, natural sources, and environmental sensitiveness. It also had a slightly higher score regarding "services to students" dimension. However, this result was not statistically significant. The only dimension regarding which MU surpassed SKU was "physical means". Regarding this dimension, students of MU were significantly more satisfied than the students of SKU. The main reason for this result is that the survey was conducted on the whole campus of MU where there were more facilities, while it was only conducted at the vocational high school of SKU, which was located in one building in a small yard. The most logical explanation to the fact that SKU showed higher quality performance regarding other dimensions as well as the overall scores is the universities' differences related to institutionalization.

Regarding nine variables, SKU had significantly higher mean scores than MU. These variables were 1, 7, 11, 14, 15 16, 17, 18, and 22. Variable 1 and 7 were both included in the main factor of "natural resources" whereas variable 11, 14, 15 and 17 were included in the main factor named as "responsiveness". Variable 18 and 22 were two of the five items which belonged to the factor of "services to students".

In terms of the questionnaire items, SKU students seemed more satisfied with their universities regarding green field (V1) and daylight (V7). Their satisfaction levels with their institution's willingness about the matters of environmental sensitivity (V11), energy conservation (V14), solving students' problems (V15), finding internships and jobs (V17) and social support (V22) were also statistically higher than the students of MU. Waste management was one of the areas that MU had a higher score since it has a central campus. Also, Tunceli where MU is located, is a special area which has a national park, including rarely found species and strains. Thus, V9 was one of the two variables that MU had a higher score statistically. These reasons also explain the result of V21. However, there were some items whose results can't be interpreted in a

consistent manner and seem to be contradicted with the results of other variables (such as V11 contradicts with V12 and V13) which indicate a need for reconsideration of either the questionnaire items (regarding the design), or data quality (how students perceived questions), or both.

Similar studies, which measured student satisfaction regarding higher education services, resulted in different findings in the literature. In most of the studies, reliability and factor analyses were conducted after an original, or a modified ServQual scale were applied. Where modified scales were utilized, new dimensions were identified following dimension reduction, each given different name with different approaches. Sapri et al. (2009) found that the most significant factor after education quality was facilities management, including library, laboratory, and overall campus environment. Campus environment can be regarded as having both physical and natural elements, which is identified as factors in the present study. This is also in parallel with the results reached by Price et al. (2003), who conducted a survey in UK higher education institutions and revealed that undergraduate students attach great importance to physical means of a university. These findings also support the emergence of factors addressing the plausible aspects of a university such as physical means and natural resources. In the present study, physical means was the lowest scored factor by the students of SKU. Price et al. (2003) also found that proximity to home was an essential factor in university selection, especially in big cities. This finding can be interpreted as transportation, which is closely related to sustainability, is considered important by the students.

Tan and Kek (2004) used a modified ServQual scale and identified eight factors. According to their findings, communication and empathy were the least satisfying factors, whereas facilities and social activities were relatively more satisfying. De Olivieara and Ferreira (2009) also used a modified ServQual scale. Their findings showed that scores obtained for promptness, understanding and services for students are below average. This result is consistent with the results of the present study, where "services to students" factor had the lowest score for MU and below average score for SKU. Legcevic (2009) used the original ServQual scale and found that students were dissatisfied in all dimensions, but empathy was the least satisfying factor. Dado et al. (2011) identified six service quality factors. One of these factors, "career prospects", were closely related to the present study since it is similar to variable 17 (finding job and internship) and includes sustainability concept. Although a numerical comparison couldn't be made since they used a seven-point Likert type scale, it can be determined that gap score was the maximum and perceived quality score was below average. In the present study, there was a significant difference regarding variable 17 (MU had a score of 1.900 wheras SKU had a score of 3.902). Another similar result was that the perceived score of tangibles was the least, and the gap score was the second-lowest among factors. These results show a similarity to the results of MU in the present study. Zafiropoulos (2008) used original ServQual and the results also showed that both gap score and perceived quality score for empathy was the lowest. Tangibles were the second-lowest factor according to students' assessments.

An overall assessment of similar studies shows both supporting and not supporting findings. Since each study identified different constructs and named factors differently, factor based comparison is not possible. However, when the discussion sections and individual questionnaire items are carefully reviewed, a noticeable pattern emerges regardless of the local conditions where the studies conducted. Questionnaire items including the terms like "willingness", "communication", "sensitiveness", or "empathy" generally get lower scores than average. This shows that university students generally need to be understood by university management, and they are generally more dissatisfied regarding above mentioned factors than others, which can be attributed to their age. Another pattern is that students give importance to campus environment as well as their career prospects, and express higher than average expectations and lower than average satisfaction.

An important point which is to be considered is the fact that the two samples belonged to different levels of the educational system. Sample group in MU were undergraduate students, whereas the sample group in SKU were vocational education and training students. Awareness of sustainability concept and the expectations about it inevitably affect the results. There are some studies on this in the literature. Ibrahim et al. (2012) studied the quality of service offered by public and private education in the vocational training institute (TEVT) in Malaysia. They found that the perceived service quality in public education was higher than in private education. Mason et al. (2018) focused on how demographic factors influence service quality at vocational education and training colleges in South Africa. They developed hypotheses to identify whether there was a difference between demographic characteristics (gender, ethnicity, age, qualification, nated level registered for, NCv level registered for) and student's satisfaction level. Their study concluded that students in vocational education received a poor level of service, and service quality was not dependent on demographical features. The poor service quality was caused by insufficient administrative staff training, demotivated staff, and inadequate systems. There were already many differences between the two samples, such as social, economic, institutional conditions. Hence, taking educational levels as an additional parameter which affects the results requires more in-depth analysis.

8. Conclusion

In this study, a new scale adapted from ServQual was developed and applied to two Universities in Turkey. Exploratory Factor Analysis and t-tests were applied to the dataset. As a result of the EFA, five dimensions emerged related to the sustainability and service quality in a university campus, named as: (1) Services to students, (2) Physical means, (3) Responsiveness, (4) Natural resources, (5) Environmental sensitiveness. The first three dimensions were statistically reliable while the fourth and fifth had low reliability scores.

Due to statistical reasons concerning significance, comparisons were based on perceived quality. SKU, which is located in a touristic county of Muğla Province in Southwest Turkey, had significantly higher perceived quality score than MU (2.361 versus 2.148). This was a notable difference, considering the sample in SKU was taken from a small vocational school, whereas the sample in MU was taken from a whole campus environment. This result can be interpreted based on the differences in development between the two regions. SKU also had statistically higher scores than MU for responsiveness (2.570 versus 2.027), natural resources (2.943 versus 2.248), and environmental sensitiveness (2.648 versus 2.340). There was not any significant difference between the two universities regarding services to students, although SKU had slightly higher score (2.084 versus 1.986). Physical means was the only dimension regarding which MU had statistically higher score than SKU (2.298 vs. 1.977).

In total, SKU had higher scores for thirteen variables (62% of the total variables), whereas MU had higher scores for eight variables. When only statistically significant results are considered, superiority of SKU over MU becomes more apparent. While MU had

significantly higher scores than SKU regarding only two variables, SKU had significantly higher scores than MU regarding nine variables (82% of the statistically significant variables).

The study provides a comprehensive literature review and a typology of the studies, offering a frame of thought for academics. Sustainability, higher education, and service quality are three important fields by themselves in academia. There are also more specific fields combining any two of these fields, such as "sustainability in higher education" and "quality in higher education". Yet there is no study combining all three fields, proposing a new concept named "sustainable service quality in higher education", as well as a measuring tool. This SusServQual scale can be evaluated as a contribution to both academics and practitioners, namely higher education authorities and managers of universities who seek to measure students' perceptions regarding sustainable campus services. Another contribution to academics is that it uses a new weighing method for the AHP, which is called Pythagorean Fuzzy Sets. This method provides decision makers with more flexibility and reflects vagueness, which is a part of life.

There are also some limitations of the study including (1) scope, (2) design and validity, (3) statistical solidness, (4) data quality, (5) standardization. The scope of the study does not include the dimensions of sustainability other than physical factors. Although the scale was statistically validated by the KMO and Bartlett's tests as well as Cronbach's Alpha values, it can be further improved by reviewing and refining questionnaire items. Language and cultural factors must be taken into account for using the scale in different countries.

Another limitation is that the data of SKU was gathered from a vocational school due to practical reasons such as the data could not be collected from the central campus. It should be considered that the results may differ when faculty students and SKU Campus are included. There might also be differences in the perceptions and intellectuality of vocational school students and BSc students. For the reasons listed, the study can be considered as a starting point for "SusServQual".

Universities can be viewed as units where complex production processes take place with many inputs and outputs. Each of the processes such as education, ancillary services, laboratory activities, transportation can be viewed as part of production activities. The most significant aspect of sustainability regarding production is that it requires these activities to create minimum waste and pollution, consequently minimum damage to the environment. This study is a contribution to sustainability in higher education in terms of campus sustainability and can provide a perspective on other aspects such as products and services, particularly when the sub-dimensions such as waste management, conservation of natural resources, and energy efficiency are considered. The perspective of students as one of the primary inputs as well as the outputs of all these activities has the potential to make significant contributions in organizing these activities in the most efficient and environmentally friendly manner, enabling cleaner production for the universities.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix-A

		Perceived quality of university					Expected quality of university				
		Strongly disagree				*Strongly agree*	*Strongly disagree*				*Strongly disagree*
No	*Questions*	1	2	3	4	5	1	2	3	4	5
Q1	The university has adequate green field.										
Q2	The university has lighting automation in the classrooms.										
Q3	Solar panels are used in the buildings for heating.										
Q4	Environment-friendly products are used in the dining hall.										
Q5	Recycle bins are used in the university.										
Q6	Motion sensors are used in WCs.										
Q7	There is enough daylight in the classrooms.										
Q8	Environment-friendly vehicles are used in the university (bicycles, electric-busses etc.)										
Q9	There is a waste facility in the university.										
Q10	There is a protected area for endemic plants in the university										
Q11	The university is willing to inform the students on environmental sensitivity.										
Q12	The university is willing to carry out voluntary works on environmental problems.										
Q13	The university is willing to organize seminars and meetings about environmental problems.										
Q14	The university is sensitive about energy conservation (placing signs of measures and warnings).										
Q15	The university is sensitive to the problems of the students and returns rapidly.										
Q16	Healthy and organic products are sold in the dining hall and canteen of the university.										
Q17	The university is willing to find internships and jobs to the students.										
Q18	The university provides service for disabled students.										
Q19	Transportation to the university is affordable.										
Q20	Social means of the university is adequate.										
Q21	Student communities carry out free nature tours.										
Q22	The university provides students with social aid.										

Appendix-B

Table 15
Results of independent sample *t*-test for overall scores and dimensions

						Independent Samples Test										Interpretation	
							Levene's Test for Equality of Variances		*t*-test for Equality of Means								
							F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference			
Item and Campus		N	Mean	Std. Dev.	Std. Error Mean									Lower	Upper	Superiority Status	Significance
Factor_1	MU	133	1,9857	0,94275	0,08175	Equal variances assumed	6,669	0,010	−0,860	297	0,391	−0,09832	0,11435	−0,32336	0,12672	SKU > MU	Not significant
	SKU	166	2,0840	1,01338	0,07865	Equal variances not assumed			−0,867	290,414	0,387	−0,09832	0,11344	−0,32159	0,12495		
Factor_2	MU	133	2,2980	0,79192	0,06867	Equal variances assumed	16,215	0,000	2,931	297	0,004	0,32179	0,180	0,10571	0,53787	MU > SKU	Significant
	SKU	166	1,9762	1,04911	0,08143	Equal variances not assumed			3,021	296,003	0,003	0,32179	0,10652	0,11217	0,53141		
Factor_3	MU	133	2,0271	0,79937	0,06931	Equal variances assumed	13,575	0,000	−5,244	297	0,000	−0,54301	0,10355	−0,74680	−0,33922	SKU > MU	Significant
	SKU	166	2,5701	0,95603	0,07420	Equal variances not assumed			−5,348	296,443	0,000	−0,54301	0,10154	−0,74284	−0,34318		
Factor_4	MU	133	2,2481	0,88896	0,07708	Equal variances assumed	9,120	0,003	−5,791	297	0,000	−0,69465	0,11995	−0,93070	−0,45860	SKU > MU	Significant
	SKU	166	2,9428	1,13139	0,08781	Equal variances not assumed			−5,945	296,897	0,000	−0,69465	0,11684	−0,92460	−0,46470		
Factor_5	MU	133	2,3396	0,81815	0,07094	Equal variances assumed	6,893	0,009	−2,898	297	0,004	−0,30799	0,10629	−0,51717	−0,09881	SKU > MU	Significant
	SKU	166	2,6476	0,98292	0,07629	Equal variances not assumed			−2,956	296,553	0,003	−0,30799	0,10418	−0,51301	−0,10297		
Overall	MU	133	2,1477	0,73076	0,06337	Equal variances assumed	8,786	0,003	−2,312	297	0,021	−0,21317	0,09220	−0,39460	−0,03173	SKU > MU	Significant
	SKU	166	2,3608	0,83817	0,06505	Equal variances not assumed			−2,347	294,853	0,020	−0,21317	0,09081	−0,39189	−0,03444		

Appendix-C

Table 16
Results of independent sample *t*-test for variables

Item and Campus		N	Mean	Std. Dev.	Std. Error Mean	Independent Samples Test										Interpretation	
							Levene's Test for Equality of Variances		*t*-test for Equality of Means								
							F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference			
														Lower	Upper	Superiority Status	Significance
V1	MU	132	2,4545	1,12137	0,09760	Equal variances assumed	10,025	0,002	−5,397	289	0,000	−0,79703	0,14769	−1,08772	−0,50634	SKU > MU	Significant
	SKU	159	3,2516	1,35464	0,10743	Equal variances not assumed			−5,491	288,999	0,000	−0,79703	0,14515	−1,08270	−0,51135		
V2	MU	133	2,0902	1,01846	0,08831	Equal variances assumed	12,680	0,000	0,838	292	0,403	0,11507	0,13728	−0,15512	0,38526	MU > SKU	Not significant
	SKU	161	1,9752	1,28428	0,10122	Equal variances not assumed			0,857	291,537	0,392	0,11507	0,13433	−0,14930	0,37944		
V3	MU	131	2,0534	1,06202	0,09279	Equal variances assumed	7,580	0,006	0,300	287	0,764	0,04078	0,13572	−0,22635	0,30790	MU > SKU	Not significant
	SKU	158	2,0127	1,21554	0,09670	Equal variances not assumed			0,304	286,196	0,761	0,04078	0,13402	−0,22301	0,30457		
V4	MU	131	2,8550	1,16436	0,10173	Equal variances assumed	0,004	0,947	−0,442	292	0,659	−0,06528	0,14763	−0,35584	0,22527	SKU > MU	Not significant
	SKU	163	2,9202	1,32861	0,10406	Equal variances not assumed			−0,449	289,785	0,654	−0,06528	0,14553	−0,35171	0,22114		
V6	MU	133	1,9850	0,93732	0,08128	Equal variances assumed	34,522	0,000	0,286	296	0,775	0,03951	0,13823	−0,23252	0,31154	MU > SKU	Not significant
	SKU	165	1,9455	1,35365	0,10538	Equal variances not assumed			0,297	289,755	0,767	0,03951	0,13308	−0,22242	0,30144		
V7	MU	131	2,0229	0,97243	0,08496	Equal variances assumed	61,432	0,000	−4,437	291	0,000	−0,63759	0,14370	−0,92042	−0,35476	SKU > MU	Significant
	SKU	162	2,6605	1,39281	0,10943	Equal variances not assumed			−4,602	285,241	0,000	−0,63759	0,13854	−0,91028	−0,36490		
V8	MU	131	2,0458	0,91031	0,07953	Equal variances assumed	28,777	0,000	0,068	292	0,946	0,00899	0,13306	−0,25289	0,27088	MU > SKU	Not significant
	SKU	163	2,0368	1,28567	0,10070	Equal variances not assumed			0,070	287,659	0,944	0,00899	0,12832	−0,24358	0,26156		
V9	MU	131	2,9160	1,20281	0,10509	Equal variances assumed	1,602	0,207	6,811	294	0,000	0,99482	0,14607	0,70735	1,28229	MU > SKU	Significant
	SKU	165	1,9212	1,28304	0,09988	Equal variances not assumed			6,862	285,974	0,000	0,99482	0,14499	0,70944	1,28019		
V10	MU	132	2,5076	1,06646	0,09282	Equal variances assumed	4,883	0,028	3,779	293	0,000	0,52598	0,13918	0,25207	0,79989	MU > SKU	Significant
	SKU	163	1,9816	1,27885	0,10017	Equal variances not assumed			3,852	292,737	0,000	0,52598	0,13656	0,25721	0,79475		
V11	MU	129	2,0000	0,95197	0,08382	Equal variances assumed	48,693	0,000	−3,870	291	0,000	−0,53049	0,13708	−0,80029	−0,26069	SKU > MU	Significant
	SKU	164	2,5305	1,30795	0,10213	Equal variances not assumed			−4,015	289,355	0,000	−0,53049	0,13212	−0,79053	−0,27044		
V12	MU	131	2,1756	0,95660	0,08358	Equal variances assumed	33,743	0,000	−1,209	294	0,227	−0,16382	0,13546	−0,43042	0,10278	SKU > MU	Not significant
	SKU	165	2,3394	1,29491	0,10081				−1,251	292,563	0,212	−0,16382	0,13095	−0,42154	0,09390		

						Equal variances not assumed											
V13	MU	133	1,9925	0,94945	0,08233	Equal variances assumed	29,630	0,000	−1,727	297	0,085	−0,21836	0,12644	−0,46720	0,03047	SKU > MU	Not Significant
	SKU	166	2,2108	1,18480	0,09196	Equal variances not assumed			−1,769	297,000	0,078	−0,21836	0,12343	−0,46126	0,02454		
V14	MU	132	1,9545	0,86372	0,07518	Equal variances assumed	52,608	0,000	−2,873	295	0,004	−0,37273	0,12972	−0,62803	−0,11742	SKU > MU	Significant
	SKU	165	2,3273	1,27434	0,09921	Equal variances not assumed			−2,994	287,672	0,003	−0,37273	0,12447	−0,61772	−0,12773		
V15	MU	132	2,0606	1,00196	0,08721	Equal variances assumed	41,161	0,000	−6,107	293	0,000	−0,88418	0,14479	−1,16914	−0,59922	SKU > MU	Significant
	SKU	163	2,9448	1,39776	0,10948	Equal variances not assumed			−6,317	288,946	0,000	−0,88418	0,13997	−1,15967	−0,60869		
V16	MU	131	2,0992	0,99888	0,08727	Equal variances assumed	25,502	0,000	−7,001	287	0,000	−0,98937	0,14131	−1,26751	−0,71123	SKU > MU	Significant
	SKU	158	3,0886	1,33726	0,10639	Equal variances not assumed			−7,190	284,052	0,000	−0,98937	0,13760	−1,26022	−0,71852		
V17	MU	131	1,9008	0,95156	0,08314	Equal variances assumed	33,896	0,000	−8,434	293	0,000	−1,19070	0,14118	−1,46856	−0,91284	SKU > MU	Significant
	SKU	164	3,0915	1,37379	0,10727	Equal variances not assumed			−8,773	287,543	0,000	−1,19070	0,13572	−1,45783	−0,92357		
V18	MU	132	1,9545	1,00277	0,08728	Equal variances assumed	41,085	0,000	−2,459	296	0,015	−0,34666	0,14099	−0,62414	−0,06918	SKU > MU	Significant
	SKU	166	2,3012	1,35051	0,10482	Equal variances not assumed			−2,541	294,690	0,012	−0,34666	0,13640	−0,61510	−0,07822		
V19	MU	131	2,0382	1,07707	0,09410	Equal variances assumed	12,817	0,000	0,823	289	0,411	0,11317	0,13756	−0,15758	0,38392	MU > SKU	Not significant
	SKU	160	1,9250	1,23650	0,09775	Equal variances not assumed			0,834	287,871	0,405	0,11317	0,13569	−0,15390	0,38023		
V20	MU	131	1,9008	1,08737	0,09500	Equal variances assumed	8,149	0,005	−0,649	295	0,517	−0,08719	0,13432	−0,35153	0,17715	SKU > MU	Not significant
	SKU	166	1,9880	1,19589	0,09282	Equal variances not assumed			−0,656	289,095	0,512	−0,08719	0,13282	−0,34861	0,17423		
V21	MU	133	1,9023	1,10003	0,09538	Equal variances assumed	4,005	0,046	1,242	297	0,215	0,16732	0,13473	−0,09783	0,43246	MU > SKU	Not significant
	SKU	166	1,7349	1,20186	0,09328	Equal variances not assumed			1,254	291,744	0,211	0,16732	0,13342	−0,09526	0,42990		
V22	MU	133	2,1353	1,09946	0,09534	Equal variances assumed	33,429	0,000	−2,057	297	0,041	−0,30442	0,14802	−0,59571	−0,01313	SKU > MU	Significant
	SKU	166	2,4398	1,39457	0,10824	Equal variances not assumed			−2,111	296,931	0,036	−0,30442	0,14424	−0,58828	−0,02056		

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