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Service modularity in e-learning programs: an analysis from the perceived usefulness perspective

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5 **Service modularity in e-learning programs: an analysis from the perceived usefulness**
6 **perspective**

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9 **Abstract**

10 **Purpose** – This study investigates the effects of service modularity on the perceived usefulness
11 (PU) of e-learning programs through the perceived ease of use (PEoU) and service customization.
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14 **Design/methodology/approach** – Structural equation modelling was used to test four hypotheses
15 with survey data from 517 undergraduates in Turkey.
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18 **Findings** – Results show service modularity affects the PU of e-learning programs through the
19 PEoU. Service customization negatively moderates the effect of service modularity on the PEoU,
20 but positively moderates the effect of the PEoU on the PU of e-learning programs.
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23 **Originality/value** – The concept of service modularity is explored in the e-learning context from
24 the students' perspective. This study shows that the standardized interfaces across course modules
25 increase the PU of e-learning programs by improving the ease of use. It also shows, interestingly,
26 that service customization, enabled by modularity, is not always appreciated by service consumers,
27 because of the potential extra effort demanded in communicating their unique needs to service
28 providers.
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40 **Practical implications** – This study offers insights that support the decisions of policymakers and
41 higher education institutions on how to design appealing e-learning programs cost-effectively.
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44 **Social implications** – This study reveals the determinants of the PU of e-learning, which could
45 support the democratization of access to higher education in emerging countries where barriers to
46 higher education are relatively greater than in developed countries.
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50 **Keywords:** service modularity, e-learning, perceived usefulness, higher education, emerging
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1. Introduction

E-learning, “instruction delivered on a digital device (such as a desktop computer, laptop computer, tablet, or smart phone) that is intended to support learning” (Clark and Mayer, 2016, p. 8), could increase social equality and access to education by eliminating time and space constraints (Coussement et al., 2020). High-quality higher education may be inaccessible simply due to cultural and social factors preventing mobility across cities and countries (Adeel and Yeh, 2018), especially in emerging countries characterized by income inequality (Prakhov and Bocharova, 2019). E-learning programs, supported by technological tools, offer a solution to such mobility problems and thus democratize access to education (Dumford and Miller, 2018). Nonetheless, e-learning programs may be seen as a less-demanding alternative for those unable to reach the required standards for on-campus programs, raising doubts over whether the quality of these programs can meet their particular needs (Gaskell and Mills, 2014).

It is therefore vital for higher-education institutions to investigate ways to increase the perceived usefulness of e-learning programs to increase enrollment. Providing a user-friendly and customized experience is critical in attracting students’ interests (Dumford and Miller, 2018). E-learning programs can provide a cost advantage to universities by enabling the mass delivery of the content and lectures (Govindarajan and Srivastava, 2020). However, service customization requires the provision of service variety and the involvement of users, and thus, decreases operational efficiency (Balthu and Clegg, 2021), hence increasing the cost of education service delivery (Finne, 2018). Thus, it is crucial for service providers to devise smart service design strategies considering both student experience and operational efficiency, bearing in mind Horton’s (2012) assertion that, “E-learning can be the best learning possible—or the worst. It all depends on design” (p. 2).

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4 Recently service modularity has emerged as a powerful concept for designing and
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6 managing the complexity of service systems through which interfaces are shared among
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8 components in a given service architecture and are standardized and specified to allow for greater
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10 reusability and combinability (Voss and Hsuan, 2009). The reusability of modules in different
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12 service configurations yields efficiency in the service provision (Bask et al., 2011; Moon et al.,
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14 2010). In the e-learning context, modular design strategies can enable cost-effective mass
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16 customization, but despite the potential benefits, it is not clear whether the principles of modularity
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18 in themselves are sufficient to ensure that students find e-learning programs useful. There are three
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20 main reasons for investigating this issue in greater depth.
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26 First, research on service modularity has predominantly been investigated in the field of
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28 operations management, with an almost exclusive focus on the service provider's perspective (e.g.,
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30 Avlonitis and Hsuan, 2017; Bask et al., 2014; Peters et al., 2020), e.g., on the attainment of
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32 operational outcomes, such as efficiency, flexibility, and customization through modularity. The
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34 users' perspective has been largely overlooked with an implicit assumption that modularity
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36 guarantees user appreciation. Herein, users' expectations and perceptions merit particular attention
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38 for determining whether users, who have yet to experience the service, indeed find it useful
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40 (Brogowicz et al., 1990). With digitalization, service consumers increasingly engage with new
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42 technologies as service co-producers (Field et al., 2018), which increases the relevance of their
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44 perceptions of technology's usefulness and ease of use (Davis, 1989). Thus, research on service
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46 experience and customer perspective on modularity (Brax et al., 2017) can be enriched by
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48 investigating users' perceptions and expectations.
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4 Second, service modularity enables mixing-and-matching of service modules, hence
5 increasing customization and variety of services (Bask et al., 2010) to enhance users' experience.
6 Service customization entails personalization and tailoring of services per individual customer's
7 preferences (Voss and Hsuan, 2009). For mass service customization, modular services enable
8 cost-effective option solutions (Frandsen, 2017; Rajahonka and Bask, 2016) without major
9 modifications in offerings (Ulkuniemi and Pekkarinen, 2011). However, as service variety
10 increases so does the complexity of managing the wide range of options. Due to technological
11 uncertainties, e-learning programs can be perceived as complex and not useful by the users. As
12 such, service modularity can guide higher education institutions to devise and implement
13 standardized procedures, rules, and technologies (Anido-Rifón et al., 2014). In e-learning settings
14 with large course pools, it is possible to customize the online communication channel of content
15 format, level of interaction, exam schedule, and other aspects through commonality and
16 combinability to achieve cost-effectiveness. Students, in turn, would perceive e-learning as more
17 useful when they have a sense of control over a curriculum containing a large pool of elective
18 courses, allowing them to determine their own specialization. Consequently, there is an opportunity
19 to investigate the relationship between service modularity and service customization from the
20 users' perspective.
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44 Finally, qualitative research methods such as case studies have been the predominant
45 approach in service modularity research, resulting in a lack of empirical quantitative studies on the
46 benefits and risks of service modularity, particularly considering customers' perspectives (De
47 Mattos et al., 2021). Furthermore, most research focuses on developed countries; hence, there is
48 the opportunity to enrich the literature with empirical studies conducted in emerging countries.
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4 Motivated by these research opportunities, we aim to explore the notion of modular service
5 design for e-learning by taking an empirical approach examining the impact of students'
6 expectations on their perceptions of e-learning programs. We are guided by the following two
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8 research questions: Does the modularity level of e-learning programs affect their perceived
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10 usefulness? What are the roles of service customization and the perceived ease of use in the
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12 relationship between service modularity and the perceived usefulness of e-learning programs?
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14 Accordingly, we test whether students' expectations of modularity of e-learning programs affect
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16 their perceptions of these programs' usefulness. In order to understand this effect, we examine the
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18 intervening effects of service customization and the perceived ease of following an e-learning
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20 program.
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28 This research contributes to the current body of knowledge by i) examining the emerging
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30 research on service modularity from students' perspective in an online higher education setting, ii)
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32 showing the subtle role of service customization in the e-learning context, iii) providing insights
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34 for higher education institutions in emerging countries to improve their performance, and iv)
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36 providing guidance to policymakers for democratizing the access to high-quality higher education
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38 through e-learning.
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43 The paper is structured as follows. The theoretical background is articulated followed by
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45 the development of hypotheses. Next, methodology, data analysis, and results are described.
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47 Finally, contributions and implications of the study with limitations and further research directions
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49 are discussed.
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2. Theoretical background

2.1 Expectations and their influence on perceptions

The design of service delivery systems is vital in managing service operations for efficiency, customization, convenience, and quality outcomes (Roth and Menor, 2003). A focus of service operations which is critical for customizing services and meeting customer needs (Field et al., 2018) is customer interactions (Sampson, 2012). However, such interactions cannot occur until potential customers have experienced the service. Thus, it is important for the service design to gain an understanding of customers' perceptions and expectations.

Individuals' perceptions are affected not only by interaction with the environment via their senses, but also their expectations (i.e. their pre-beliefs and thoughts) (De Lange et al., 2018). Customers' expectations can be distinguished according to whether they are based on predictions or desires (Woodruff et al., 1983). The predictive expectations can be formed for a particular future transaction, therefore, assuming customers are familiar with the service provider, they can predict their service experience. In contrast, when expectations are based on wishes and desires, customers imagine the ideal service without needing to consider any particular service provider (Higgs et al., 2005). This implies that, although customers have little or even no experience with a particular service category, they are able to form expectations (Franke et al., 2013; McGill and Iacobucci, 1992), which influence their perceptions, accordingly.

In service quality, Brogowicz et al. (1990) propose that customer perceptions are not necessarily based on actual experiences, as they can emerge from expectations formed via alternative ways such as word-of mouth communication (e.g., subjective norm), service provider image, and advertising. Attracting potential customers should be the concern of service providers,

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4 because if potential customers perceive that an offering fails to meet their service expectations, they
5 will reject it. Likewise, Boulding et al. (1993) hold that the perceived service quality depends on
6 not only the actual delivered service performance, but also on prior customer expectations of the
7 service delivery.
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13 2.2 *The perceived usefulness of technology*

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16 With the proliferation of technology in many service operations, customers become involved in
17 using new technologies as service co-producers (Field et al., 2018). Thus, their perceptions of these
18 technologies are important for service providers. Technology Acceptance Model (TAM) (Davis,
19 1989), a commonly used and referred information systems theory to support previous academic
20 work on e-learning (e.g. Salloum et al., 2019), depicts when a user accepts new technology.
21 Perceived usefulness (PU) and perceived ease of use (PEoU) are two core constructs in TAM model
22 as the determinants of the actual use of new technology. PU is defined by Davis (1989, p. 320) as
23 “...the degree to which a person believes that using a particular system would enhance his or her
24 job performance.” However, potential users might not perceive the system as sufficiently useful,
25 when they believe that it is difficult to use. Considering this, PEoU is proposed to be the
26 determinant of PU, and defined by Davis (1989, p. 320) as “...the degree to which a person believes
27 that using a particular system would be free of effort.” To increase understanding of the
28 circumstances under which new technology is found useful, external variables need to be
29 considered (e.g., Venkatesh and Davis, 2000). Subjective norm and image are particularly relevant
30 variables on forming customers’ expectations/perceptions of as yet unexperienced service and
31 related technology (Brogowicz et al., 1990).
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2.3 *Service customization*

Although customization can enhance many service performance measures (Squire et al., 2006), the scale and scope of customization are important considerations in determining how far the expected results are attained. In mass customization, service standardization can be achieved (Weyers and Louw, 2017) via modular architectural design (Frandsen, 2007). However, this may not be successful when there is a need for full customization, i.e., involving customers in the design phase (Squire et al., 2006). Rather than seeking differentiation in some services, e.g., in commoditized services (Coltman and Devinney, 2013); customers might simply prioritize good operational performance, e.g., delivery time in logistics services. Also, in the professional services industry, customers lacking technical knowledge might prefer simplification to customization in the service delivery processes (Lampel and Mintzberg, 1996).

2.4 *Service modularity*

With the proliferation of service-dominated economies, the concept of service modularity is an important emergent research area (Brax et al., 2017; Frandsen, 2017). The conceptualization and applicability of service modularity are evidenced in travel (Avlonitis and Hsuan, 2017; Voss and Hsuan, 2009), healthcare (Broekhuis et al., 2017; De Blok et al., 2014; Peters et al., 2020; Silander et al., 2017; Vähätalo and Kallio, 2015), human resources (Hofman and Meijerink, 2015), logistics (Bask et al., 2014; Rajahonka et al., 2013), legal services (Giannakis et al., 2018), among other service contexts. Although modularity has long been debated and applied for on-campus programs in the education industry (French, 2015), it has rarely been studied in the e-learning context.

The literature on service modularity has its roots in the product modularity literature (De Mattos et al., 2021; Mikkola, 2006), which is relatively mature, and scholarly attention stems

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4 mainly from modular products' enabling of cost-effective mass customization (Baldwin and Clark,
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6 2000; Duray et al., 2000). Accordingly, the conceptualization of terminologies in service and
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8 product modularity has parallels, as seen in the pairs of terms "service modules"/"product sub-
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10 assemblies", and "service offering"/"final product". Service modules are defined as "*...service unit*
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12 *that can be offered to a customer in itself or as a part of a service offering creating the value*
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14 *perceived by the customer*" (Rahikka et al., 2011 p. 358). The modularity of the service offering
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16 refers to "*...the changeability/replaceability of service modules*" (i.e. combinability) and the fact
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18 that "*...the same service module can be used for many different service offerings*" (i.e.
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20 commonality) (Rajahonka et al., 2013 p. 189). These features of modular services are considered
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22 effective in the achievement of customization for different users (Johnson et al., 2021; Moon et al.,
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24 2010).

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30 The growing literature on service modularity draws on the decomposability principle of
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32 modularity (Eissens-van der Laan et al., 2016), which first isolates interdependencies within
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34 modules, and then enables the management of remaining minimum dependencies between service
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36 modules via standardized interfaces "preestablished way to resolve potential conflicts" (Baldwin
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38 and Clark, 2000, p. 73). However, further considerations are required in service modularization via
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40 decomposition (Eissens-van der Laan et al., 2016) due to the multidimensionality of service—its
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42 delivery process and outcome dimensions (Grönroos, 2000). Modularizing of services should be
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44 guided by further distinctive issues, such as service process predictability, task complexity, and
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46 consumers' active/passive roles in the service delivery (Eissens-van der Laan et al., 2016;
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48 Tuunanen and Cassab, 2011), because these influence customers' perceptions of utility. For
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50 example, modularization that enables reuse of familiar service processes may be appreciated by
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4 customers, especially in cases where considerable cognitive effort is needed to choose among the
5 many service options (Tuunanen and Cassab, 2011).
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8 9 *2.5 Modularity in higher education*

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11 The shift towards the modular structure in on-campus programs (Goldschmid and Goldschmid,
12 1973; Buss, 1995) has been a strategy to meet the increasingly diversifying student needs by
13 attaining high resource efficiency within budget limitations (French, 2015). In modular programs,
14 the curriculum is divided into course modules, defined as “*self-contained, independent unit of a*
15 *planned series of learning activities designed to help the student accomplish certain well-defined*
16 *objectives*” (Goldschmid and Goldschmid, 1973, p. 16). Students choose the modules from a wide
17 range of options based on their needs, giving them greater flexibility and control over the
18 curriculum (Buss, 1995). The credit-based system provides linkages between course modules, e.g.,
19 ensures substitutability among modules with the same credit. Also, the accumulation of credits for
20 course modules leads to qualification for graduation (Dejene, 2019). This system boosts mobility
21 by allowing students to resume their degrees in other institutions (French, 2015).
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38 However, the usefulness of modular programs has been questioned in the literature. One
39 disadvantage is that enabling students to control the selection of course modules may not be in
40 students’ best interests (French, 2015), especially when they are immature (Dejene, 2019).
41 Moreover, the process of choosing course modules can be frustrating for students (Goldschmid and
42 Goldschmid, 1973). Another disadvantage is that the modular structure might fragment learning,
43 inhibiting progressive courses and the achievement of cumulative learning outcomes (Rich and
44 Scott, 1997). In addition, the use of modular structures to maximize resource efficiency due to cost
45 concerns leads to large class sizes (Sewagegn and Diale, 2019) and homogenized teaching methods
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(Poynter, 2002). Such a structure might impose a lack of group identity, because there are different students in each course module (Buss, 1995).

3. Hypotheses

Service modularity places a great emphasis on the standardizations of interfaces (Bask et al., 2010; Voss and Hsuan, 2009), which are “*the set of rules and guidelines governing the flexible arrangement, interconnection, and interdependence of service components*” (De Blok et al., 2014, p. 30). The aim of service modularity is not to maximize variety, but to keep the variety at manageable levels (Brax et al., 2017). It is therefore important for service modularity to ensure the smooth flow of users across service modules (De Blok et al., 2014; Silander et al., 2017), enhancing the experience of users during service consumption.

Modularity can be exploited to reduce the service complexity of e-learning programs imposed by technological uncertainty (Kreye, 2019), by offering standardized procedures, rules, and technologies (Anido-Rifón et al., 2014). For example, students are able to reach course module content via any media device (e.g. laptops, tablets, and mobile phones), and easily navigate all modules with the help of standardized visual design. Although the delivery of courses would differ in terms of instructors’ teaching styles, the required level of standardization of the course format layouts could be achieved; therefore, students would easily be able to follow the announcements, reach course content, and join course sessions when simultaneously taking many courses. The student complaints quoted in Greasley et al. (2004) show that these issues are highly important for a user-friendly experience. Another issue is the standardization of course module credits across different elective alternatives, eliminating concern over meeting graduation criteria when selecting or substituting course modules, and allowing easy adaptation to the different processes in e-learning

(Kurilovas and Kubilinskiene, 2020). Therefore, we hypothesize that the modularly structured e-learning program would change students' perceptions of the effort that e-learning requires:

H_{1a}. Service modularity positively affects the perceived ease of e-learning use.

As proposed in TAM (Davis et al., 1989) and confirmed by later studies (e.g., Brandon-Jones and Kauppi, 2018; Mohammadi, 2015; Venkatesh and Davis, 2000), when users find technology easy to use, they perceive it as useful. Similarly, students' perception that the e-learning program is useful corresponds to the ease of learning to use the management system, ease of access course materials, and ease of communicating with their peers and instructors. Thus, we hypothesize the following relationship:

H_{1b}. The perceived ease of using e-learning programs positively affects their perceived usefulness.

We propose that standardization enabled by service modularity can improve the perceived usefulness only if the chosen/used standards are easy to use. As mentioned earlier, the standard visual designs and course format layouts enable students to use different media devices and navigate across course models respectively; however, they may not be found useful unless the chosen standard is user-friendly or compatible with dominant technologies (e.g., working with popular computer operating systems). The standardization of course module credits, despite allowing choice among different elective courses, might not be found useful, if for example, the advisors' handwritten signature is required for approval, simply because the e-signature option is unavailable. Based on these arguments we hypothesize the following mediation effect:

H₁. The perceived ease of use mediates the relationship between service modularity and the perceived usefulness of e-learning programs.

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4 The service-dominant logic focuses on the exchange of services and places a great emphasis
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6 on the customization of offerings (Vargo and Lusch, 2004). Service customization refers to
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8 tailoring the service to meet the varying, and even unique, needs of each individual with the aim
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10 of increasing customer satisfaction (Coelho and Henseler, 2012). However, the need for large-scale
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12 customization entails finding economically viable solutions. As such, modular service offerings
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14 enable cost-effective mass service customization (Frandsen, 2017; Rajahonka and Bask, 2016).
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16 Using service modularity, services can be provided to consumers in different contexts without
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18 major modifications of the service offering (Ulkuniemi and Pekkarinen, 2011).
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24 Designing e-learning programs to improve and customize education needs to consider
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26 students' educational backgrounds, learning styles, and mobile technologies for educational
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28 purposes (Dumford and Miller, 2018). To this end, commonality and combinability are important
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30 attributes of modularity to enable higher education institutions to serve different student groups in
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32 a cost-effective manner. A large course pool could allow students to tailor their e-learning
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34 experience by configuring service modules (i.e., course modules) (Lin and Pekkarinen, 2011). For
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36 higher education institutions, this is an economically feasible solution because the course modules
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38 become a part of a large number of students' curriculum. Hence, we hypothesize the following
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40 relationship:
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44 *H_{2a}*. Service modularity positively affects service customization in the e-learning setting.
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48 Customization aims to ensure a service delivery tailored to specific user needs. Previous
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50 studies show positive outcomes for service customization, for example, on customer satisfaction
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52 (Hu et al., 2016) and loyalty (Coelho and Henseler, 2012). It is likely that students perceive e-
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54 learning as useful to the extent that the e-learning service is customized, particularly when they
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4 feel that they have greater control over the curriculum due to the large pool of elective course
5 alternatives. Such options allow students to determine their learning path, allowing them to
6 specialize in a particular sub-field. At a more micro-level, each course can be customized with
7 respect to the content format (e.g., videos, podcasts, slides, articles, etc.), the level of interaction,
8 course and exam schedules, and the length of lectures and course modules. Students are expected
9 to show more willingness to be engaged in such a learning environment. Hence, our hypothesis is
10 as follows:
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20 *H_{2b}*. Service customization positively affects the perceived usefulness of e-learning programs.
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23 Modularly designed e-learning programs give students greater control by allowing them to
24 choose courses from numerous available options, and determine their sequence through mixing-
25 and-matching. However, perceived usefulness will not be guaranteed unless the majority of courses
26 in the large course pool are aligned with students' interests. Imagine, for example, an e-learning
27 MBA program offering many marketing and finance elective courses, which make little sense for
28 students aiming to specialize in other fields, e.g., in operations management. Therefore, modular
29 e-learning programs providing many options may be the necessary (but not satisfactory) condition
30 for the perceived usefulness. Options should be relevant to students' profiles/needs/interests.
31 Hence, we hypothesize the following mediation effect:
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44 *H₂*. Service customization mediates the relationship between service modularity and the perceived
45 usefulness of-e-learning programs.
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49 Studies reveal a range of variables affecting students' expectations, decisions, and
50 behaviors on the e-learning programs (Abdullah et al., 2016). Among these, culture has a
51 significant effect on the use of technology-based services in emerging countries (Cruz-Cárdenas et
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4 al., 2019). The impacts of “subjective norm” (Venkatesh et al., 2003), and “image” (Moore and
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al., 2019). The impacts of “subjective norm” (Venkatesh et al., 2003), and “image” (Moore and Benbasat, 1991) are highly relevant to the cultural contexts of many emerging countries. For example, Turkey has a collectivist culture (Hofstede, 1983), in which individuals’ behaviors are influenced by community members’ views and beliefs. In the higher education setting, “important others” could include the students’ peers, family members, friends, and potential employers, whose views on e-learning could influence the students’ perceptions of its usefulness. Considering that subjective norm and image are two external variables discussed as the antecedents of the perceived usefulness (Venkatesh and Davis, 2000), we hypothesize the following relationships:

H₃. Subjective norm positively affects the perceived usefulness of e-learning programs.

H₄. Image positively affects the perceived usefulness of e-learning programs.

All hypotheses are shown in the research model in Figure 1.

-- Figure 1 --

4. Methodology

4.1 Context of the study

Turkey has a great potential for the e-learning market (Kimiloglu et al., 2017), as it has the largest proportion (15.8%) of young population in Europe (OECD, 2020; Turkish Statistical Institute, 2018) and high rates of internet penetration (72%) and mobile connectivity (93%) (We Are Social and Hootsuite, 2019). The higher education system in Turkey, comprising 207 universities, is coordinated and governed by The Council of Higher Education (2019). In total, 526 institutes associated with universities offer postgraduate programs in 54 different areas (Günay, 2018), some of which are e-learning programs (Hertsch et al., 2014).

4.2 *Sample and data collection*

We focus on expectations and perceptions of the usefulness of e-learning programs informing an enrollment decision. We collected data from undergraduates in on-campus programs, whose expectations and perceptions of e-learning programs are highly relevant for higher education institutions in the process of widening the scope of online courses. In order to ensure relevant responses, an additional criterion in our sampling was that respondents had taken at least one online course module. For this reason, the sample consisted of students on on-campus programs studying at one of two Turkish universities offering some online courses, in Izmir and Istanbul.

The data was collected within the month of November 2019. After excluding unengaged responses and those with more than 10% missing values, the final sample size was 517. The percentages of male and female students were 59% and 41% respectively. The majority of the respondents were between 19 and 23 years old (84.1%), and over 60% were either in their third or final year of four-year undergraduate programs.

4.3 *Survey instrument and measures*

A survey questionnaire was administered physically in the classrooms, in order to minimize the number of unengaged responses. Respondents were requested to state their level of agreement with survey questions using a five-point Likert scale ranging from “strongly disagree” to “strongly agree”. The questionnaire items were either adapted or modified from the validated scales of previous studies. The students were requested to imagine themselves as potential students of an e-learning program. Thus, we used the perceptions-only scales, shown to perform well in terms of reliability and validity (Brandon-Jones and Silvestro, 2010).

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4 The survey items were translated into Turkish, the respondents' native language, and
5 adapted accordingly; some items were modified regarding the e-learning service context. For
6 example, Duray et al.'s (2000) modularity scale developed for physical products was modified to
7 reflect students' perspectives on the service modularity in the e-learning context. Accordingly, the
8 course modules in the e-learning service represent the replicable and interchangeable components
9 of physical products. Some course modules can appear in many students' programs (i.e. standard
10 nodes), but it is possible for students to personalize their e-learning service experience through
11 elective courses. For the face validity, authors collaborated on the modifications, and then
12 consulted academicians and experts on the appropriateness of these. These were then pretested.
13 The back-translated version of the items is given in Appendix 1. Table I lists the original and
14 adapted definitions of research constructs.
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30 -- Table I --
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33 *4.4. Data analysis*

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35 Our research constructs were latent variables, not directly observable, therefore, covariance-based
36 structural equation modelling (SEM) was used to test the hypothesized direct and mediation effects.
37 SEM can simultaneously analyze both latent and observed variables in multiple equations and
38 measure latent variables reliably by enabling control of the measurement errors of multiple
39 indicator variables (Kline, 2016). Thus, SEM is recommended for testing direct and mediation
40 effects between latent variables (Baron and Kenny, 1986; Holmbeck, 1997). Before testing these
41 effects, a number of preliminary analyses were made. First, very few missing values found were
42 imputed using the predictive mean matching method. Second, a common method bias was checked.
43 No single factor was found to explain the majority of shared variance (Podsakoff and Organ, 1986)
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4 and the correlations among research constructs were found lower than 0.9 (Bagozzi et al., 1991),
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6 ensuring the absence of a serious common method bias problem. Third, the measured variables'
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8 skewness values were found lower than 2.1, and the kurtosis values were found lower than 5.2,
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10 indicating no severe violation of normality (Ryu, 2011). Last, the sample size (517) was sufficiently
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12 large to satisfy the widely accepted rules of thumbs (e.g., larger than 200) (Kline, 2016) and more
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14 than five times larger than the number of free parameters estimated (56) in the model (Bentler,
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16 1995).
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21 **5. Results**

22 *5.1 Measurement model*

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24 Confirmatory factor analysis (CFA) was used to operationalize latent constructs. Table II shows
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26 the results of CFA. The measured items with factor loadings lower than 0.7 (SM_6 , SC_6) were
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28 excluded because the amount of variance explained by their latent constructs was below 50% (Hair
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30 et al., 2005). The item SM_1 was also dropped because it caused a discriminant validity problem by
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32 cross-loading on service modularity and service customization. After dropping these items, the
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34 factor loadings of the remaining items greater than 0.7 indicate construct validity (Table II). The
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36 composite reliability and Cronbach's alpha values were around 0.9, and the average variance
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38 extracted (AVE) value was above 0.6 (Table II), ensuring the construct reliability and convergent
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40 validity respectively (Chin, 1998).
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47 -- Table II --
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51 Regarding the discriminant validity, the square roots of all constructs' AVEs were found
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53 higher than their correlation with other constructs, indicating the achievement of discriminant
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55 validity (Fornell and Larcker, 1981). Nevertheless, since this test was barely achieved for the
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4 construct pair of service modularity and service customization, a further test, the item-level
5 discriminant validity test, was made. This test also ensured the achievement of discriminant
6 validity, since the correlations across the items of service modularity and service customization
7 were found lower than their factor loadings in the model (Chin 2010).
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13 14 *5.2 Structural model*

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16 The possible multicollinearity problem was first checked among the predictors of the dependent
17 variable (PU) in the model. The variance inflation factor values found lower than 3 for all variables
18 indicated no such problem (O'Brien, 2007). Then, a number of model fit indices were checked to
19 control the model fitness. The good fit between the model and data was shown by the values of
20 relative Chi-square ($\chi^2 / df = 2.62$), comparative fit index (CFI = 0.96), Tucker Lewis Index (TLI
21 = 0.95), Parsimony ratio (PRATIO = 0.88), Standardized Root Mean Squared Residual (SRMR =
22 0.08); and Root Mean Square Error of Approximation (RMSEA = 0.06) (Hu and Bentler, 1999). It
23 should be noted that three modifications were made in order to achieve these fit values. First, the
24 direct effect of service modularity on PU was specified in addition to its indirect effects in the
25 model. Second, the covariance between subjective norm and image was specified, which is
26 theoretically meaningful, considering that one's image is closely related to opinions in one's
27 surroundings. Finally, the covariance between the error terms of IM₃ and IM₄ was specified, which
28 is methodologically proper, since both are the indicators of the same construct (image).
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47 *5.3 Results of direct effect tests*

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49 The results of the hypotheses testing for the direct relationships in the model are shown in Table
50 III. There is support for the effects of service modularity on PEoU (H_{1a}) and service customization
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(H_{2a}), and also the effects of PEOU (H_{1b}), subjective norm (H₃), and image (H₄) on PU. However, interestingly, the effect of service customization on PU (H_{2b}) is not supported.

The magnitudes of the supported hypothesized effects are sufficiently strong, as their standardized effects are greater than 0.10 (Kline, 2016). The variance in PU explained by its predictors in the model is 30%. The variances in service customization and the PEOU explained by service modularity are 52% and 26% respectively.

-- Table III --

5.4 Results of the mediation analyses

The hypothesized mediation effects were tested with three SEM models: a model of total effects, a model of indirect effects, and a model of mediating effects (Holmbeck, 1997). The results (Table III) did not support the mediation of service customization, because of its insignificant effect on PU. However, PEOU fully mediates the relationship between service modularity and PU, because of the elimination of the significant direct effect of service modularity on PU when the effect of PEOU is considered. As further evidence, the model fit values remain virtually unchanged after adding the direct path between service modularity and PU to the model of indirect effects, and also, there is a significant fall in the coefficient of service modularity in PU in the mediating effect model compared to the total effect model (Holmbeck, 1997).

5.5 Results of the moderation analyses

Although the mediation of service customization could not be supported, its moderation effect was also tested as further analysis using product terms (Baron and Kenny, 1986). The service customization's interaction effect with service modularity on PEOU and its interaction effect with PEOU on PU were tested via the bootstrapping method (a bias-corrected percentile method and

5000 bootstraps resamples) (Hayes, 2018). The findings reveal that service customization weakens the effect of service modularity on PEOU (coefficient = -0.127, standard error = 0.025, 95% bias-corrected CI [-0.175, -0.079]; $p < 0.01$; $\Delta R^2 = 3.3\%$), whereas it strengthens the effect of the PEOU on the PU (coefficient = 0.090, standard error = 0.039, 95% bias-corrected CI [0.013, 0.166]; $p < 0.05$; $\Delta R^2 = 1\%$). Figure 2 illustrates the moderation effects of service customization. Please note that low and high levels in Figure 2 refer to -1/+1 standard deviation values of the respective variables.

-- Figure 2 --

Based on the findings reported above, Figure 3 below shows the final research model of this study.

-- Figure 3 --

6. Discussion and conclusion

Considering the growth of the service sector in emerging countries, such as in Turkey (World Bank, 2020), it is important for these countries to enhance service provision by developing strategies that exploit technological systems. However, the users' acceptance of these systems hinges on the degree to which they are perceived as useful and easy to use. To this end, the service design and its interface with technology would determine the level of acceptance of such technologies. Given the education sector's strong influence on the economy, and the challenges of providing high-quality higher education faced by emerging countries, e-learning is a field of great potential if carefully designed. A key consideration is whether service modularity can overcome these barriers by increasing the PU of e-learning programs.

6.1 Theoretical contributions and implications

Service modularity is a relatively unexplored research area (Brax et al., 2017; De Mattos et al. 2021 Frandsen, 2017), investigated mainly from service providers' perspectives with qualitative research methods (De Mattos et al., 2021). Therefore, our study complements the existing research with quantitative analysis, revealing users' perspectives on the benefits of service modularity. Examining the specific roles of PEOU and service customization, our study empirically shows that service modularity positively affects students' perceptions of the e-learning service. Hence, it gives insights into the application of service modularity in the context of the education sector in an emerging country, providing a clearer understanding of how to increase the PU of e-learning.

This study further explains the causal relationship between service modularity and the PU of e-learning programs. Our findings did not support the mediating role of service customization, but were found to support the mediation of the PEOU. This implies that the standardization brings the simplification that students seek in e-learning programs. This view corroborates the argument that service users appreciate simplicity in the case of substantial information asymmetry between service providers and users, which is common in professional services such as in auditing and healthcare (Lampel and Mintzberg, 1996). Previous studies on modularity in healthcare services (Silander et al., 2017; Vähätalo and Kallio, 2015) emphasize this issue. As patients have limited knowledge, these studies highlight the efficiency-increasing role of standardization in service modularity rather than re-configurability. However, these studies take a service provider perspective, making it impossible to know whether service users/patients appreciate this approach. Our study, in contrast, shows empirically that students appreciate convenience (the ease of use) provided by modularity in the e-learning context. This finding sheds new light on arguments over the importance of convenience in the delivery of experiential intensive services (e.g., in education)

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4 (Brax et al., 2017), underlining that, under the conditions of information asymmetry, it is indeed a
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6 highly prioritized criterion.
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10 Our findings also provide empirical evidence for the potential linkage between service
11 decomposition logic and user expectations. The modularity of e-learning programs indicates a
12 process oriented decomposition (Eissens-van der Lan et al., 2016) where a pre-specified number
13 of courses are required within a set time for graduation, although these may be taken in different
14 sequences/combinations. Eissens-van der Lan et al. (2016) imply that a process-oriented logic is
15 more appropriate for achieving efficiency than it is for variety. To some extent, our findings support
16 this conjecture from the perspective of users who prioritize convenience (efficiency in
17 interactions).
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29 Despite the positive effect of service modularity on service customization, we could not
30 identify any mediation of service customization between service modularity and PU. Information
31 asymmetry may again be a possible explanation; lack of information on the service content might
32 prevent students being aware of their own needs. Moreover, students know education is a highly-
33 regulated sector with e-learning programs already designed for specific needs, which might lead
34 students to believe that service customization is less critical. An alternative explanation is that due
35 to regulations, extensive customization, i.e. full customization (Squire et al., 2006), is impossible;
36 thus, students may find the limited customization available less attractive. Due to these factors,
37 students might perceive e-learning programs as a commoditized service, and thus expect a higher
38 operational performance rather than differentiation (Coltman and Devinney, 2013).
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53 Not being able to identify the mediating role of service customization is aligned with the
54 argument that a service experience in certain service types may be less critical for consumers
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4 focused on service outcome (Beltagui and Candi, 2018), such as in financial services (Maddern et
5 al., 2007). Customization is a service feature often promoted to enhance user experience, provided
6 the resulting escalating costs do not erode its advantages. For this reason, service modularity is
7 proposed to achieve both variety and efficiency (Bask et al., 2011; Moon et al., 2010; Voss and
8 Hsuan, 2009). Nevertheless, modularity was originally suggested in the context of demand
9 heterogeneity (Schilling, 2000). Any particular e-learning program can provide students with a
10 wide range of output configurations in terms of specialization, knowledge, and skills; nevertheless,
11 demand heterogeneity may be lacking if students are focused merely on the diploma (i.e., the
12 outcome), a completely standardized output for all, i.e., standard service result (Weyers and Louw,
13 2017). Students aiming merely for a graduate diploma may overlook the customization aspect
14 because of the potential extra effort involved in communicating their unique needs. Consequently,
15 it is important to note that the service provision could lead to different types of output (e.g., in
16 education services, the learning vs the diploma), and users' demand for heterogeneity, i.e. the need
17 for customization, could vary accordingly.

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37 Our study reveals the subtle moderating role of service customization, although we could
38 not find its mediation effect. Accordingly, service customization weakens the impact of service
39 modularity on PEOU, indicating that interaction with the service provider required by the
40 customization process might represent an undesired extra effort. In fact, the literature suggests a
41 higher level of service provider-user interaction to better address user needs (Vargo and Lusch,
42 2004). However, our findings imply that such inevitable interaction can have a negative impact on
43 the decision to utilize this service, due to the expected difficulty during the service experience. Our
44 findings concur with Tuunanen and Cassab (2011) that, rather than increasing perceived utility, the
45 modularization enabling extensive customization of services among many variation options only
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4 adds a burden, especially when the respective service task is complex. However, we additionally
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6 show that service customization strengthens the impact of PEOU on PU, implying that service
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8 customization might support the PU of e-learning programs, but only after ensuring the ease of use
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10 in the respective service operations.
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14 By particularly focusing on service modularity and customization in the e-learning context,
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16 our study shows how expectations of potential service users influence their perceptions of service,
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18 which is critical for their actual service use decision in service quality. By showing the positive
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20 effects of subjective norm and image on the PU of e-learning, our findings also support alternative
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22 mechanisms in service quality influential in the potential users' perceptions (Brogowicz et al.,
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24 1990). Accordingly, a higher level of approval towards e-learning programs in the potential users'
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26 environment leads them to regard e-learning programs as useful, especially when they believe that
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28 e-learning degrees are valued by potential employers and have a positive effect on their career path.
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32 33 *6.2 Practical implications* 34

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36 According to our findings, policymakers and higher education institutions can increase the demand
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38 for e-learning programs by exploiting the power of modularity. In emerging countries, the
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40 modularization of e-learning programs has the potential to democratize access to education
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42 programs, accelerating economic development by decreasing income inequality and reducing the
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44 disparity with developed countries. However, institutions should attend to students' perceptions
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46 and expectations, as well as the idiosyncratic characteristics of e-learning services. Due to the
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48 information asymmetry, between lecturers and students, institutions should not initially expect
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50 students to participate in the service design process. Therefore, in service customization aimed at
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52 the promotion of e-learning programs, unnecessary and excessive complexity should be avoided
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4 early in the process. Instead, service modularization should initially prioritize the ease of use via
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6 the standardization of aspects such as course delivery, technology, and course credits. Higher
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8 education institutions should take a cautious approach to service customization, understanding that
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10 it can support the perceived usefulness, once students have fully mastered the process of e-learning.
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12 Hence, the aim should be to convince potential users of the relative effortlessness of the service
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14 customization process for an enhanced service experience. For instance, institutions can minimize
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16 required effort by devising tools and techniques (e.g., applying tests to determine learning styles)
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18 aimed at understanding the specific needs in the customization process. Alternatively, outcome-
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20 based service decomposition, exploiting the feature of re-combinability, may be a more user-
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22 friendly approach than the process-based decomposition in which the technical course module
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24 names might seem less familiar (Broekhuis et al., 2017).
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30 Our findings show that subjective norm and image significantly affect PU. In this respect,
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32 policymakers should lead in promoting e-learning degrees at the community level in emerging
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34 countries, such as in Turkey, where others' opinions are highly influential on individuals'
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36 decisions. Such action could take the form of promoting collaborative partnerships with
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38 internationally prestigious universities to provide successful e-learning programs. Such practices
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40 would create awareness and positive perception towards e-learning, encouraging greater
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42 enrollment. These efforts could also include provision for employer comparison of e-learning
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44 degree program graduates with their on-campus counterparts. Any hesitation over the decision to
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46 enroll in an e-learning program would be overcome if it was shown to increase employability.
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6.3 Limitations and directions for further research

One limitation was the necessity for our research aim to measure the research constructs based on the undergraduates' perceptions regarding a possible future e-learning program. Another limitation is that the empirical data was only from one country, Turkey. Future studies could explore the experiences of actual users in different contexts and settings.

In order to achieve discriminant validity between the constructs of service modularity and service customization, we eliminated one item (SM₁), potentially because the service modularity scale was adopted from a scale developed for manufactured products. Hence, future research could aim to develop a new scale specific to service modularity.

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Appendix 1. Survey questions

Please answer questions below, imagining yourself as a potential student of an e-learning program.

Service Modularity (Duray et al., 2000):

E-learning programs should allow me to...

SM₁: design course modules according to my needs.

SM₂: choose elective course modules among alternatives.

SM₃: add elective course modules to a regular program.

SM₄: take course modules of other course programs offered by the same institution.

SM₅: modify the regular e-learning program.

SM₆: use common core technology in all course modules.

Service Customization (Lin and Hsieh, 2011; Wu, 2014):

E-learning programs are tailored so that they should...

SC₁: understand my specific needs.

SC₂: have my best interests at heart.

SC₃: have features that are personalized for me.

SC₄: provide options according to my needs.

SC₅: allow me to choose among different service alternatives in the program.

SC₆: give me greater control over customizing service.

Perceived Ease of Use (Tarhini et al., 2013):

PEoU₁: Learning to operate the system of e-learning programs would be easy for me.

PEoU₂: It would be easy to get the system of e-learning programs to do what I want it to do.

PEoU₃: My interaction with the system of e-learning programs would be clear and understandable.

PEoU₄: It would be easy for me to become skilful at using the system of e-learning programs.

Perceived Usefulness (Tarhini et al., 2013):

E-learning programs would...

PU₁: allow me to accomplish learning tasks more quickly.

PU₂: improve my learning performance.

PU₃: make it easier to learn course module content.

PU₄: increase my learning productivity.

PU₅: enhance my effectiveness in learning.

Subjective Norm (Venkatesh et al., 2003):

SN1: People who influence my behavior think that I should enroll in an e-learning program.

SN2: People who are important to me think that I should enroll in an e-learning program.

Image (Moore and Benbasat, 1991):

IM1: Having an e-learning program degree would improve my image within my future employer organization.

IM2: Because of my e-learning program degree, others in my future employer organization would see me as a more valuable employee.

IM3: People in my future employer organization who have an e-learning program degree would have more prestige than those who do not.

IM4: Having an e-learning program degree would be a status symbol in my future employer organization.

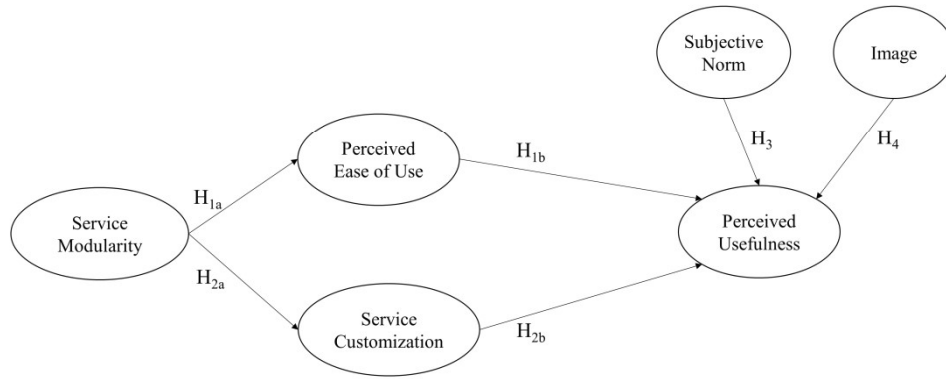


Figure 1. Research model

Figure 1. Research model

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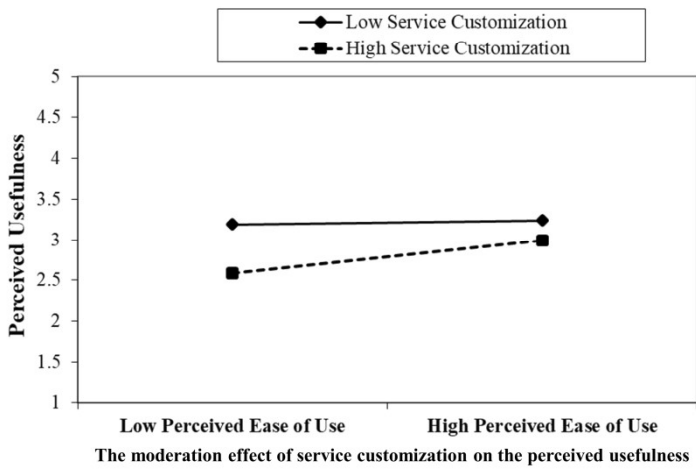
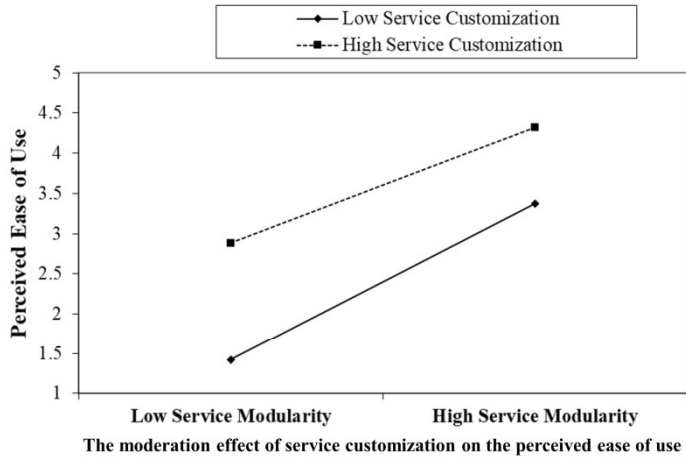


Figure 2. The moderation effects of service customization

Figure 2. The moderation effects of service customization

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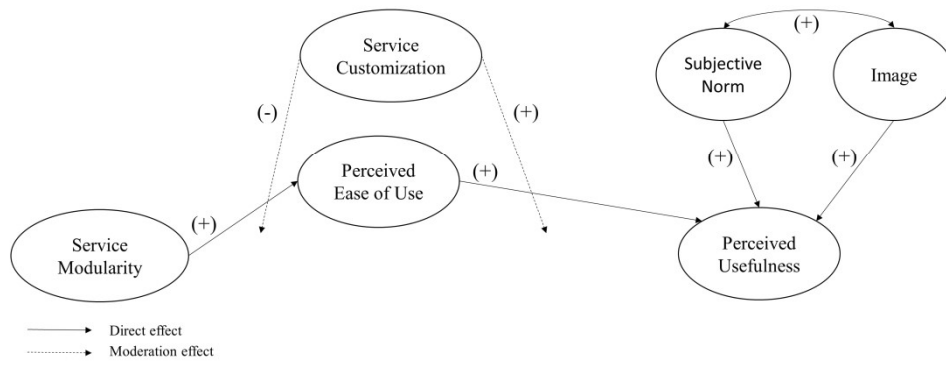


Figure 3. Final research model

Figure 3. Final research model

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Table I. Operational definitions of research constructs

Construct	Original Definitions	Adapted Operational Definitions
Perceived Usefulness	“The degree to which a person believes that using a particular system would enhance his or her job performance” (Davis, 1989)	The degree to which a student believes that enrolment on an e-learning program would enhance his or her learning performance.
Perceived Ease of Use	“The degree to which a person believes that using a particular system would be free of effort” (Davis, 1989)	The degree to which a student believes that using an e-learning is free of effort.
Service Modularity	“The degree to which services can be combined for customers from a group of distinct service modules” (Gremyr <i>et al.</i> , 2019)	The degree to which a student expects that e-learning program can be combined from a group of distinct course modules.
Service Customization	“The degree to which customers expect (service) products to be tailored to their specific needs” (Rafiq and Ahmed, 1998)	The degree to which students expect e-learning programs to be tailored to their specific needs.
Subjective Norm	“The degree to which an individual perceives that important others believe he or she should use the new system” (Venkatesh <i>et al.</i> , 2003)	The degree to which a student perceives that important others believe that he or she should enroll in an e-learning program.
Image	“The degree to which use of an innovation is perceived to enhance one's image or status in one's social system” (Moore and Benbasat, 1991)	The degree to which use of an e-learning is perceived to enhance one's image or status in one's social system.

Table II. The results of CFA, convergent validity, and reliability

Construct	Item	Factor Loading	Average Variance Extracted	Composite Reliability	Cronbach's α
Service Modularity	SM ₁	----- ^a	0.615	0.864	0.862
	SM ₂	0.787			
	SM ₃	0.819			
	SM ₄	0.817			
	SM ₅	0.708			
	SM ₆	----- ^b			
Service Customization	SC ₁	0.754	0.636	0.897	0.894
	SC ₂	0.813			
	SC ₃	0.860			
	SC ₄	0.762			
	SC ₅	0.793			
	SC ₆	----- ^b			
Perceived Ease of Use	PEoU ₁	0.829	0.647	0.880	0.878
	PEoU ₂	0.838			
	PEoU ₃	0.755			
	PEoU ₄	0.792			
Perceived Usefulness	PU ₁	0.865	0.766	0.942	0.944
	PU ₂	0.901			
	PU ₃	0.905			
	PU ₄	0.812			
	PU ₅	0.889			
Subjective Norm	SI ₁	0.918	0.850	0.919	0.913
	SI ₂	0.926			
Image	IM ₁	0.831	0.711	0.907	0.918
	IM ₂	0.975			
	IM ₃	0.785			
	IM ₄	0.765			

^a The item (SM₁) was dropped due to its cross-loading on service modularity and service customization.

^b Items with factor loadings lower than 0.7 were dropped.

Table III. The results of hypothesized direct and mediation effects in the structural model

Direct effects						
		Path coeff.	Unstd. estimate	Std. error	p-value	Result
H _{1a} : SM → PEOU		0.505	0.484	0.048	p < 0.001	Supported
H _{1b} : PEOU → PU		0.320	0.399	0.064	p < 0.001	Supported
H _{2a} : SM → SC		0.718	0.714	0.053	p < 0.001	Supported
H _{2b} : SC → PU		0.045	0.054	0.079	p = 0.500	Not Supported
H ₃ : SN → PU		0.266	0.246	0.044	p < 0.001	Supported
H ₄ : IM → PU		0.267	0.268	0.048	p < 0.001	Supported
H₁: The mediation of PEOU between SM and PU						
		Path coeff.	Unstd. estimate	Std. error	p-value	Mediation effect
<u>A model of total effect:</u>	SM → PU	0.164	0.200	0.059	p < 0.001	
<u>A model of indirect effect:</u>	SM → PEOU	0.480	0.455	0.048	p < 0.001	
	PEOU → PU	0.295	0.369	0.054	p < 0.001	Supported
<u>A model of mediating effect:</u>	SM → PEOU	0.482	0.457	0.048	p < 0.001	
	PEOU → PU	0.318	0.397	0.063	p < 0.001	
	SM → PU	-0.070	-0.083	0.059	p = 0.159	
H₂: The mediation of SC between SM and PU						
		Path coeff.	Unstd. estimate	Std. error	p-value	Mediation effect
<u>A model of total effect:</u>	SM → PU	0.164	0.200	0.059	p < 0.001	
<u>A model of indirect effect:</u>	SM → SC	0.706	0.703	0.053	p < 0.001	
	SC → PU	0.003	0.004	0.049	p = 0.937	Not Supported
<u>A model of mediating effect:</u>	SM → SC	0.706	0.704	0.053	p < 0.001	
	SC → PU	0.044	0.053	0.077	p = 0.496	
	SM → PU	-0.058	-0.069	0.078	p = 0.374	

Note: In the models of indirect and mediating effects, other predictors of PU in our research model were included as covariates.

S1. Descriptive statistics and the correlation of research constructs

Constructs	Mean	Std. Dev.	1	2	3	4	5	6
1. SM	4.444	0.729	0.784					
2. SC	4.292	0.733	0.783	0.797				
3. PEoU	3.722	0.700	0.559	0.492	0.804			
4. PU	3.249	0.927	0.187	0.198	0.415	0.875		
5. SN	3.072	0.935	0.197	0.165	0.221	0.457	0.922	
6. IM	2.456	0.898	0.084	0.098	0.185	0.448	0.500	0.843

The values shown in bold are the square root values of the constructs' AVEs.

SM: Service Modularity; SC: Service Customization; PEoU: Perceived Ease of Use; PU: Perceived Usefulness; SN: Subjective Norm; IM: Image