LÁSZLÓ BERÉNYI – NIKOLETT DEUTSCH

TECHNOLOGY ADOPTION AMONG HIGHER EDUCATION STUDENTS
TECHNOLÓGIAELFOGADÁS FELSŐOKTATÁSI HALLGATÓK KÖRÉBEN

The acceptance of technology is of decisive importance in enhancing diffusion of innovation. Personal opinions and attitudes to technology offer particular foundational points for associated development. This study contributes to greater understanding of factors influencing technology acceptance among higher education students. Findings are based on measuring factors of contribution (optimism, proficiency) and inhibition (dependency, vulnerability) drawn from the technology adoption propensity (TAP) instrument and also by calculating TAP index scores derived from a sample of 873 Hungarian higher education students. Results indicate moderate technology adoption propensity driven by high optimism. Tyes of study (business, engineering, administrative) were used as grouping factors for the analysis. Optimism indicates similar results by criterion of study type, but proficiency in technology use is highest among engineering students. Considering goals of the Hungarian National Digitalization Strategy, targeted training programs and acquisition of more experience are necessary in order to improve proficiency in use of technology.

Keywords: **technology acceptance; technology adoption propensity, higher education students, analysis of variance**

A technológia elfogadottsága döntő jelentőségű az innovációk elterjedésében. A technológiával kapcsolatos személyes vélemények és attitűdök alapvetően meghatározók a fejlődés szempontjából. A kutatás célja, hogy hozzájáruljon a technológia elfogadását befolyásoló tényezők megértéséhez felsőoktatási hallgatók körében. A tanulmány a technológiaelfogadási hajlandóság (TAP) modellben megfogalmazott támogató (optimizmus, jártasság) és gátló (függőség, sebezhetőség) tényezőinek mérését, továbbá a TAP-index kiszámítását használja eszközként. A kutatási minta 873 magyar felsőoktatási hallgató válaszait tartalmazza. Az eredmények mérsékelt technológiaátvételi hajlandóságot mutatnak, amelyet a magas optimizmus vezérel. Az elemzésben a tanulmányok típusa (üzleti, mérnöki, közigazgatási) szerepelt csoportosító tényezőként. Az optimizmus hasonló eredményeket mutat a hallgatók között, de a használatban való jártasság a mérnökhallgatók körében magasabb. A Nemzeti Digitalizációs Stratégia céljait figyelembe véve a jártasság javítására irányuló képzési programokra és több szakmai tapasztalatszerzésre van szükség.

Kulcsszavak: **technológiaelfogadás, technológiaátvételi hajlandóság, felsőoktatási hallgatók, varianciaelemzés**

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Competition between businesses and accelerated changes in customer expectations have mutually reinforcing effects. Furthermore, traditional product development and project management methods have become progressively outdated given that greater time pressure for faster market introduction of novel products or services can no longer be achieved through such means (Berényi & Soltész, 2022; PMI, 2017). This phenomenon is amply documented in management science and the speed of change has remarkably increased with the accelerated development of information technology. By dealing with strategic and other aspects of technology management (Deutsch, Hoffer, Berényi & Nagy-Borsy, 2019), understanding of various factors of technology acceptance and the motivation for using technology are highlighted in this article. In particular, we attempt to locate an appropriate toolset for measuring technology acceptance. In relation to this objective, this study aims to investigate the topic area by using the technology adoption propensity (TAP) instrument developed by Ratchford & Barnard (2012) for measuring contributory and inhibitory factors in relation to accepting new technologies. The study also focuses on higher education students from business, engineering, and public administration fields in order to compare their approach to technology use. Results can thus be used to establish targeted marketing strategies and to support education program development.

The diffusion of innovation model (Rogers, 1964; Rogers, 2003) is widely used for describing the spread of a new product or service. Moreover, the model has been successfully extended to examine the life cycle of technologies, business units, or entire business organizations. By describing dynamics of diffusion and by calculating business impacts as costs and revenues, a reasonable expectation is that of forecasting consumer behavior. Location of innovators and early adopters as consumers, and then measuring the extent of accelerated technology adoption by the early majority, requires a comprehensive understanding of influencing factors of purchasing intentions and crucial intermediate decisions. For example, sales and price cuts of related goods and services may be powerful tools in the short term, but achievement of strategic benefits entails exploration of motivational and inhibitory factors rooted in personal attitudes.

Technology acceptance has a wider effect beyond that of business, and governmental interest has accordingly emerged. Relatedly, the Hungarian government prepared a National Digitalization Strategy (2022) to provide direction for the subsequent eight years. Although it focuses on information technology, the implied consequences of the strategy for society as a whole are remarkably broader. The introductory narrative of the strategy summarizes the COVID-19 pandemic and highlights that only those countries and societies that consciously use digital technologies in all aspects of life can compete internationally in the short term and beyond on a consolidated level. IT infrastructure development is especially noteworthy, and access to building local and international networks is also provided within the strategic remit. Enhanced use of this background is constantly expanding in mobile technologies in particular with trends following changes measured in the European Union. In parallel, the need for a comprehensive strategy is urgent, which is accordingly justified by overall complexity and interdependence of the digital ecosystem. Such efforts include development of personal aspects in relation to use of technology.

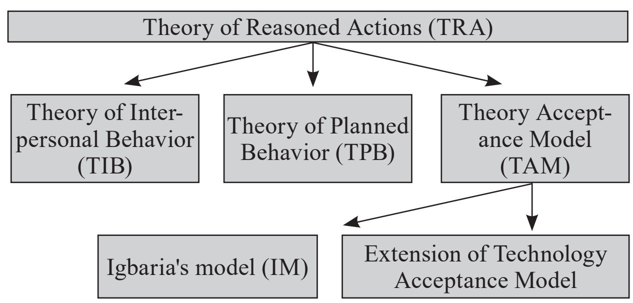
This paper is organized as follows: the initial sections provide an insight into popularly accepted technology acceptance models and compares them to the measurement of technology adoption propensity. The research methodology and the sample characteristics are then presented with the empirical study based on 873 responses from higher education students. This section also emphasizes operation of the TAP index and its composition in terms of sub-samples. The concluding section outlines implications in line with the remit of the Hungarian National Digitalization Strategy.

Adoption and acceptance models

Understanding consumer motivation for purchasing new products and services and accompanying attitudes has long been a prime focus of research attention. In this regard comprehensive overviews have been presented by Isaias & Issa (2005), Keszey & Zsukk (2017), and Taherdoorst (2018). Several researchers have also used related models for various purposes (for example, Berényi, Deutsch, Pintér, Bagó, & Nagy-Borsy, 2021); IT applications are also emphasized in for examples blockchain technology (Semenova, 2020), digital entertainment (Aranyossy, 2022) and in financial technologies (Horváth, 2022; Shahzad, Zahrullail, Akbar Mohelska, & Hussain, 2022; Firmansyah, Masri, Anshari & Besar, 2023). The use of IT in education dramatically increased in the COVID-19 lockdown period (Alassafi, 2021; Halász & Kenesei, 2022). Moreover, challenges presented by chatbots and artificial intelligence (AI) applications may become key issues for the future (Luo, Lau, Li & Si, 2022; Chocarro, Cortiñas & Marcos-Matás, 2023). Nonetheless, challenges in IT acceptance can be traced back to the emerging role of digitalization in business models with a wider remit than those of digital data, automatization, and network building. Madaras in particular (2020) highlights the role of digital consumer access as one of the four prime areas emerging from the growing field of research.

Figure 1

Acceptance models derived from the theory of reasoned actions



Source: based on Taherdoost (2018)

In Figure 1 Taherdoost (2018) derives various models from the theory of reasoned action (TRA) developed by Fishbein and Ajzen (1975), which was formed as a generic model for predicting personal choices and behavior. The model introduced the concept of the intention to perform a certain behavior which precedes actual behavior and which is influenced by personal attitudes and subjective norms. Ajzen (1991) added further explanatory factors and interrelations to the concept and published the theory of planned behavior (TPB). The additional element is that of perceived behavioral control measuring perceived ease or difficulty of performing a particular behavior.

The technology acceptance model (TAM) was developed by Davis (1986) and was later updated and extended by Venkatesh & Davis (2000) and by Venkatesh & Bala (2008) to include a more complex system of explanatory variables. The main elements of this model are respectively, perceived usefulness, perceived ease of use, intention to use, and usage behavior and it is widely regarded as a popular framework among researchers for establishing statistical analysis. It was principally designed to measure how users come to accept and use technology in the field of information systems, but opportunities are not limited to this area alone. Igbaria's model (IM) further emphasizes that extrinsic and intrinsic motivational factors influence the acceptance or rejection of new technology (Igbaria & Schiffman, 1994).

Venkatesh et al. (2003) produced a unified view which was summarized in the unified theory of acceptance and use of technology (UTAUT) model. Behavioral intention and use of behavior were retained in this model, but the structure is somewhat simplified. Behavioral intention is deemed to be influenced by performance expectancy, effort expectancy, social influence, and facilitation conditions. Moreover, gender, age, experience, and voluntariness of use act as control variables.

Although not explicitly highlighted in the models mentioned in this section, the foundations for this study are assumed to be pre-defined for subsequent evaluation. Task-technology fit models (Goodhue & Thompson, 1995) also incorporate task characteristics and the existing relationship between adapting a given technology and its adequate nature to perform a given task also acts as an element of analysis for the purpose of this study.

Justification for and content of the TAP instrument

A common characteristic of behavioral, technology acceptance, task-technology fit, and unified models is that interpretation is limited to a pre-defined technology. However, the structure and variables used in the previously presented models allows for general applicability and adaptation of frameworks in relation to newly set objectives. In accordance with the need for predicting future behaviors it is assumed missing products or services or limited knowledge and experience for purposes of evaluation exist to some extent. Acceptance models thus include several general factors as moderating variables with various and continuous extensions of the TAP model thereby suggesting a need to focus on background variables. There are generally two instruments widely available for approaching barriers presented in task-dependent evaluation. Firstly, the technology readiness index (TRI), and the updated TRI 2.0 were developed (Parasuraman, 2000; Parasuraman & Colby, 2014). Secondly, the technology adoption propensity model was developed by Ratchford & Barnhart (2012). The TAP instrument can be traced back to emergence of the technology readiness index (TRI) model (Parasuraman, 2000). However, Ratchford and Barnhart (2012) found TRI to be somewhat cumbersome with its 36 survey items, and also that some elements were no longer relevant due to ongoing trends in technology use. Therefore, subsequent researchers developed a compressed and refined model with 14 items to measure consumer beliefs and attitudes toward new forms of technology. The revised version of the TRI model (Parasuraman & Colby, 2015) however still employed a reduced number of survey items.

Ratchford and Ratchford (2021) used the TAP scale to study a range of 19 varieties of use of technology, including online travel, online purchase, online investment, online utility bill payments, video chat, and electronic security. The reliability and validity of these instruments were tested in a Hungarian sample by Martos, Kapornaky, Csuka & Sallay (2019), with results based on the TAP model. TAP is essentially a survey-based instrument, and the measure of technology adoption propensity is known as the TAP index with a scoring system based on four factors. There are two contributory factors (optimism and proficiency) in relation to accepting new technologies which are described as follows: (related questions are presented in Table 1):

- Optimism. This is the belief that technology provides a better life for consumers. It incorporates the perceived usefulness factor present within the TAM models. The index also focuses on how technology may enhance the respondent's life rather than how it enhances the generalized lives of others.
- Proficiency. This incorporates competencies necessary to learn to use new technologies. Considering that performance depends on ability and intentions, proficiency can predict relevant information, both applicable to technology developers and also in terms of education policy in order to locate specific areas of focus (Ratchford & Barnhart, 2012).

In addition to contributory factors, two inhibitory factors (dependence and vulnerability) are considered with related questions designed for reverse coding.

- Dependence. This is defined as the sense of being overly dependent on technology. Spending too much time with technology, especially info-communication tools, may thus have a harmful impact on personal lifestyles and social contacts.
- Vulnerability. In general the belief that the use of technology can lead to harmful impacts may increase distrust in it. Several malicious activities made possible by technology are well known which may engender skepticism and a need for protection against them as such (Ratchford & Barnhart, 2012).

Table 1
Technology adoption propensity survey items

Optimism	Technology gives me more control over my daily life
	Technology helps me make necessary changes in my life
	Technology allows me to more easily do the things I want to do at times when I want to do them
	New technologies make my life easier
Proficiency	I can figure out new high-tech products and services without help from others
	I seem to have fewer problems than other people in making technology work
	Other people come to me for advice on new technologies
	I enjoy figuring out how to use new technologies
Dependence	Technology controls my life more than I control technology
	I feel like I am overly dependent on technology
	The more I use a new technology, the more I become a slave to it
Vulnerability	I must be careful when using technologies because criminals may use the technology to target me
	New technology makes it too easy for companies and other people to invade my privacy
	I think high-tech companies convince us that we need things that we don't really need

Source: based on Ratchford & Barnhart (2012)

Research design

Research goal

The Hungarian National Digitalization Strategy (2022) was developed in 2022 for the period 2022-2030. Essentially, the strategy aims to help Hungary put digital infrastructure, the economy, education, and digital public services at the heart of its competitiveness and modernization efforts by recognizing the need for digital transformation. The second pillar of the strategy concerns digital competencies, including enhancement of knowledge, improving acceptance of technology, and exploiting opportunities.

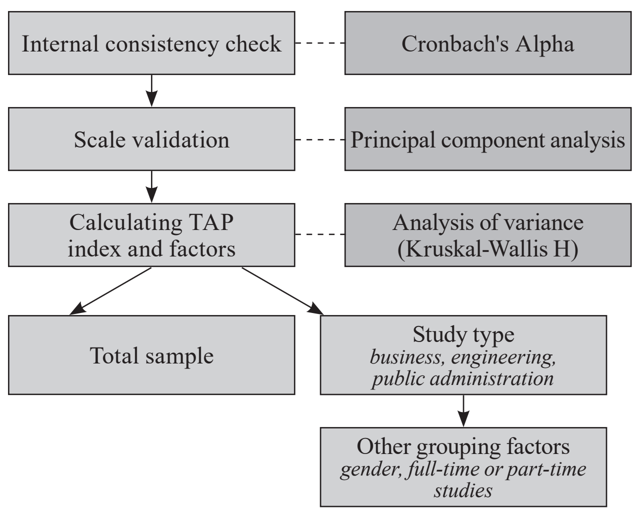
This present study aims to contribute to the knowledge base with regard to factors influencing technological innovation and the understanding of personal aspects of acceptance of technology. Moreover, IT plays a dominant role in technology and a broader and general interpretation of technology is crucial since the process and the influencing factors of acceptance are not limited exclusively to use of IT. Emprical investigations related to higher education students present a limitation, but their attitudes and beliefs should be considered given that they form the basis of educated future generations. In this regard, the generation theory developed by Strauss & Howe (1991) offers a framework to predict consumer and labor market decisions (see Meretei, 2017; Szabó-Szentgróti, Gelencsér, Szabó-Szentgróti, & Berke, 2019; Csiszárik-Kocsir, Garai-Fodor, & Varga, 2022). Major challenges were identified in this study based on generational differences between people working together. However, understanding thinking patterns and value systems of higher education students can support business and social goals. There are thus two research questions formulated for this study:

- What is the level of technology adoption propensity among higher education students?
- Does technology adoption propensity differ by criterion of the type of study?

Research process

Data collection was performed by using a voluntary online survey designed to explore the individual approaches to technology-related questions. The survey questionnaire includes the instrument for measuring technology adoption propensity (TAP) and calculating the TAP index based on methodology developed by Ratchford and Barnard (2012) with a reversed coding function used for inhibitory factors. Data collection also incorporated English language translation of the questions devised by Martos et al. (2019). The research analysis process is outlined in Figure 2.

Figure 2
Analysis process and methods



Source: authors' own work

Internal consistency was initially tested by use of the Cronbach's Alpha indicator, and dimension reduction was applied to check validity of suggested factors drawn from the original model. Due to the scales used and the absence of normal distribution in the measures, non-parametric tests were preferred for analysis. Mean values were used for a simplified representation of the results wherever it was found to be appropriate, and were supplemented with characteristics of the distributions.

Statistical analysis was supported with use of IBM SPSS and Microsoft Excel tools by following technical instructions set out by Sajtos & Mitev (2007) and Pallant (2020):

- Dimension reduction used principal component analysis with Promax rotation for checking the factor structure.
- The variance analysis test included use of the significance test of the Kruskal-Wallis H indicator.
- Correlation analysis used the Spearman's rank correlation method.

Sample characteristics

The research sample consisted of 873 Hungarian higher education students. Data collection is still ongoing and responses in this study are drawn from 2021 and 2022. The study types applicable to respondents cover disciplines of business, engineering, and public administration. The sample composition is summarized in Table 2.

Table 2

Sample composition (number of respondents)

Grouping factor		business	engineering	public administration
Total sample		452	151	270
Gender	female	287	49	154
	male	165	102	116
Full-time or part-time	full-time	388	79	187
	part-time	63	72	83

Source: authors' own work

Reliability analysis indicates acceptable results for deployment of the technology adoption propensity questions (Cronbach's Alpha = 0.703, n=14).

Scale validation

Since the TAP instrument forms the core tool of the analytical process, the appropriateness of the initially suggested TAP factors was checked in the research sample. Measures of sampling adequacy were found to be acceptable (KMO=.761; Bartlett's Test of Sphericity sig.=.000). Principal component analysis offered four factors with an eigenvalue higher than 1, representing 58.42% of the variance. Use of PROMAX rotation (K=4) with Kaiser Normalization in 5 iterations confirmed the original factor composition (Table 3).

Table 4

Matrix for checking the Fronell-Larcker criterion

	Optimism	Proficiency	Dependence	Vulnerability
Optimism	0.715			
Proficiency	0.356	**0.768**		
Dependence	-0.091	-0.047	0.760	
Vulnerability	-0.034	-0.032	0.356	**0.705**

Source: authors' own work

By following rationale outlined by Hair et al. (2014), the Fronell-Larcker tool is deemed acceptable based on composite reliability (CR) values since they are greater than 0.7. The average variance extracted (AVE) values are greater than 0.5, except for the vulnerability factor, which is just below this level. By taking limitations of the study into account, this result is acceptable but further investi-

Table 3

Pattern matrix of principal component analysis with composite reliability (CR) and average variance explained (AVE)

	1.	2.	3.	4.
Optimism (CR=0.801, AVE=0.511)				
Technology allows me to more easily do the things I want to do at times when I want to do them	-0.062	**0.796**	-0.131	0.144
Technology helps me make necessary changes in my life	-0.084	**0.768**	0.057	-0.097
New technologies make my life easier	-0.012	**0.778**	0.017	0
Technology gives me more control over my daily life	0.205	**0.464**	0.24	-0.052
Proficiency (CR=0.845, AVE=0.577)				
Other people come to me for advice on new technologies	**0.857**	-0.105	0.034	-0.032
I seem to have fewer problems than other people in making technology work	**0.885**	-0.043	-0.041	0.049
I can figure out new high-tech products and services without help from others	**0.788**	0.009	-0.044	0.012
I enjoy figuring out how to use new technologies	**0.467**	0.361	-0.02	0.022
Dependence (CR=0.803, AVE=0.577)				
I feel like I am overly dependent on technology	0.022	0.135	**0.774**	-0.146
Technology controls my life more than I control technology	-0.071	-0.054	**0.687**	0.254
The more I use a new technology, the more I become a slave to it	-0.024	-0.058	**0.813**	0.017
Vulnerability (CR=0.747, AVE=0.497)				
I think high-tech companies convince us that we need things that we don't really need	0.05	-0.156	0.071	**0.646**
New technology makes it too easy for companies and other people to invade my privacy	0.036	-0.025	0.054	**0.716**
I must be careful when using technologies because criminals may use the technology to target me	-0.041	0.2	-0.101	**0.749**

Source: authors' edition based on SPSS output gation of the vulnerability component would be required with an extended sample. Table 4 summarizes correlations between the factors, replaced with the square roots of the AVE values in the main diagonal. For the Fronell-Larcker criterion to be accepted in this regard the AVE of each construct should be higher than the highest squared correlation with that of any other construct (Hair et al., 2014).

Results and discussion

Following novel products and services

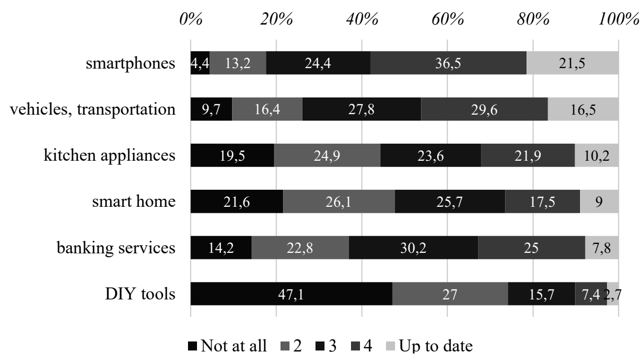
In line with variables presented in the TAM and UTATUT models, personal interest in novel products and services can be acknowledged as an indicator of technology acceptance. It can also be assumed that such interest supports technology acceptance. Original studies based on the TAP instrument (Ratchford & Barnhart, 2012; Ratchford & Ratchford, 2021) measured the actual use of products and services by deployment of binary yes/no questions as a grouping factor for the TAP index score. This study attempts to use a different approach for piloting purposes in accordance with our research goal. Respondents were asked to assess on a five-point scale whether they are interested in novel products and services in some areas with items selected based on researchers' decisions, including those based on topics highlighted in the literature. The current dominance of information technologies is prominent in the literature, but technology itself has a broader interpretation (Pataki, 2013). Beyond specifically outlined IT-related areas (smartphones, smart homes, and banking services), survey results also indicates reference to household related topics. Technological development is continuous in terms of use of household tools and associated methods, but do not form the focus of public attention in relation to public discussion of technology. Kitchen appliances and do-it-yourself (DIY) tools both specifically cover the remit of household issues in our survey.

Based on the distribution of responses, students' interests are not uniform, and some topics are particularly prominent. Smartphones form the greatest focus of attention among students, followed by that of new technological solutions in vehicles and transportation (Figure 3). The ratio of uninterested students is the lowest in relation to the latter categories. Interest in smart home and kitchen appliances presents a more scattered picture, which is similar to interest in modern banking solutions and most respondents are not interested in DIY tools. Correlation analysis confirmed moderate but significant results between survey items to suggest predictability of a general personal approach to novel products and services. The highest values were found in correlations between smartphones and smart homes (Spearman's rho=0.425), smart homes and transportation (Spearman's rho=0.386), and smartphones and transportation (Spearman's rho=0.368).

Based on the model on components of technology (Szakály, 2002; Deutsch, Hoffer, Berényi & Nagy-Borsy, 2019), infoware is included as well as technoware, humanware and orgware ingredients, thereby encompassing all equipment and procedures on information supply of the transformation process. In line with general appreciation of information technologies, especially mobile solutions, prominent interest in smartphones is understandable. The spread of information requires use of novel products and procedures, but it simultaneously assists in acceptance of other innovations (Csordás & Nyirő, 2012).

Figure 3

Distribution of responses on following novel products and services



Source: authors' own work

General interest in vehicles and transportation can be derived from a need to solve environmental problems, but its economic role and vulnerability should however not be ignored (see Mészáros, 2010; Keszey & Tóth, 2020).

Electric vehicles currently represent innovation in terms of technological development within a broad spectrum of scientific interest ranging between engineering and business perspectives, but transportation has nonetheless become a key objective of the 'sharing economy' (Zilahy, 2016).

Correlation analysis of responses indicated significant results for each item. The strongest correlation was found between smartphones and smart homes (Spear-

Table 5

Correlation coefficients between survey items on following novel products and services

	smart homes	vehicles, transportation	kitchen appliances	DIY tools	banking services
smartphones	0.425	0.368	0.119	0.113	0.186
smart homes		0.386	0.250	0.339	0.290
vehicles, transportation			0.090	0.29	0.288
kitchen appliances				0.123	0.212
DIY tools					0.260

Source: authors' own work based on SPSS output man's rho=0.425, sig.<0.001), and the lowest was between smartphones and DIY tools (Spearman's rho=0.113, sig.<0.001). The correlation coefficients are summarized in Table 5 (n=873 for each category and significance is lower than 0.001 except for the value 0.008 between transportation and kitchen appliances). The moderate and especially low Spearman's rho values would suggest that perceptions of different technologies are not highly interdependent.

Survey results suggest a picture of a mixed sample due to the multimodal distribution of the TAP index score (Figure 5). The TAP index value is lower than 2 in 0.4% of responses, 2 or higher but lower than 3 in 44.6% of responses, 3 or higher but lower than 4 in 52.2% of responses, and above 4 in 1.7% of responses in relation to the total sample. The distribution thus cannot be considered as normal for the total sample and also for business and engineering students (Table 7).

Table 6

Mean values and the analysis of variance results, following novelties

	smartphones	smart homes	vehicles, transportation	kitchen appliances	DIY tools	banking services
business students	3.6	2.53	3.28	2.85	1.77	2.86
engineering students	3.62	2.99	3.3	2.54	2.38	2.90
public administration students	3.51	2.70	3.22	2.82	1.91	2.94
Kruskal-Wallis H	0.702	15.107	0.602	7.085	43.15	0.741
d_f	2	2	2	2	2	2
Asymp. Sig.	0.704	0.001*	0.740	0.029*	0.000*	0.690

*Source: authors' own work based on SPSS output, * significant at p<0.05*

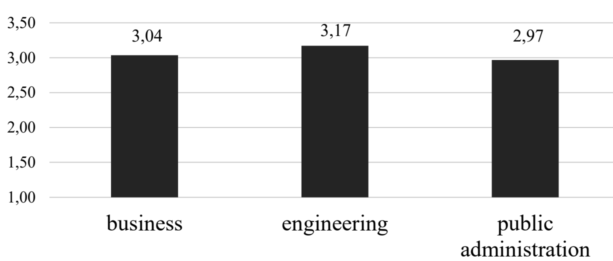
A variance analysis test was conducted to explore differences in approaches between students based on their study types. Results confirmed significant differences for smart homes, kitchen appliances, and DIY tools, while values for smartphones, transportation, and banking services are broadly similar. Table 6 illustrates test results (significant differences are marked with *) and the mean values of student evaluations by criterion of study type.

TAP index score by criterion of study type

The TAP index score was expressed on a five-point scale (1 to 5); higher values represent a higher level of technology adoption propensity. The mean value of the TAP index score is medium (3.04) for the entire sample, and is highest among engineering students and lowest among public administration students (Figure 4). The Kruskal-Wallis test (H=19.215, d_f=2, sig.<0.001) statistically confirmed significant differences by criterion of study type.

Figure 4

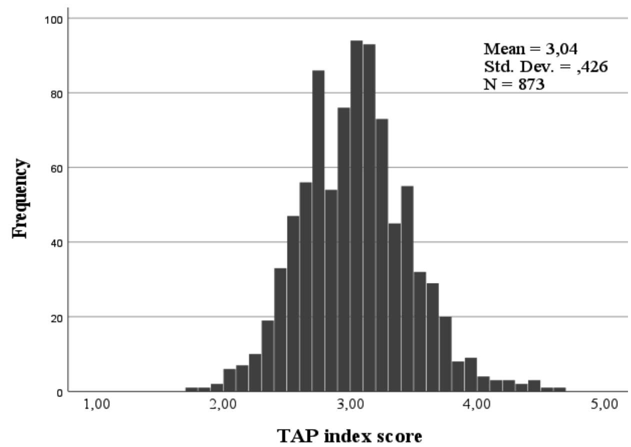
TAP index score by study type



Source: authors' own work

Figure 5

Distribution of the TAP index score, total sample



Source: authors' own work based on SPSS output

Table 7

Normality test results

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	d_f	Sig.	Statistic	d_f	Sig.
business	0.038	452	0.127	0.987	452	0.000*
engineering	0.076	151	0.033	0.976	151	0.010
public administration	0.041	270	0.200	0.997	270	0.823
total sample	0.031	873	0.042	0.993	873	0.001

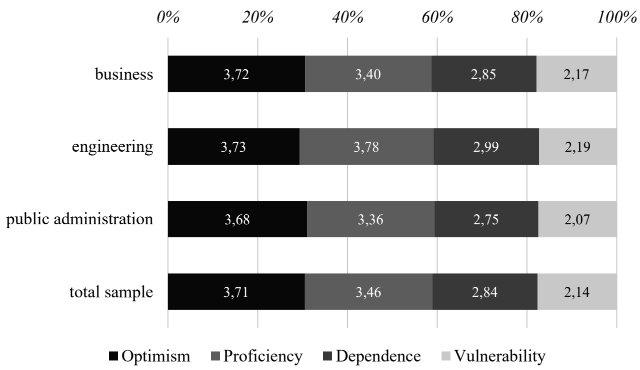
Source: authors' own work based on based on SPSS output,
** significant at p<0.05*

TAP index composition

The TAP index comprises four factors, consisting of optimism, proficiency, dependence, and vulnerability. Mean values are used to simplify presentation of results (Figure 6).

Figure 6

TAP index composition by criterion of study type

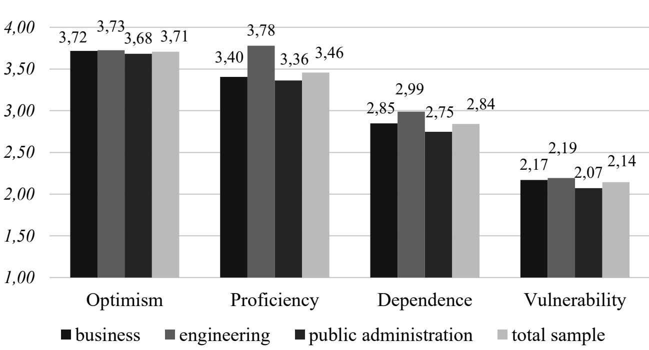


Source: authors' own work

Results indicate similar mean values among sub-samples in relation to optimism, while engineering students display higher values in other factors (Figure 7) and distributions of values confirms these differences. In further relation to the optimism factor, 83.4% of business, 82.3% of engineering, and 81.2% of public administration students possess a factor value above the medium level. Furthermore, engineering students consider themselves as the most proficient in terms of using technology. The factor value is above medium for 81.4% in this category, while the value is 64.8% for business and 60.8% for public administration students. Simultaneously, high dependence values are more common for engineering students whereby 39.1% possess a factor value above the medium level. The same factor value is 34.5% for business and 32.9% for public administration students. The vulnerability factor displays similar results in that 12.6% of engineering, 8.8% of business, and 7.1% of public administration students are placed above the medium value.

Figure 7

TAP factor scores by criterion of study type



Source: authors' own work

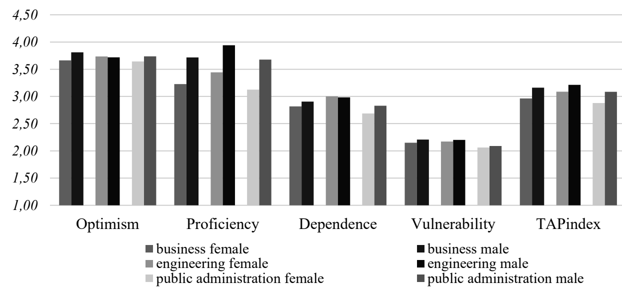
The non-parametric analysis of variance test by criterion of study type confirmed significant differences in relation to proficiency (Krusal-Wallis H=29.734, d_f=2, sig.<0.001) and dependence (Kruskal-Wallis H=6.281, d_f=2, sig=0.043).

Analysis according to grouping criteria

Sample characteristics allows for analyzing differences in the TAP index factors and score by gender (Figure 8) and by comparing scores of full-time and part-time students (Figure 9). The data set is summarized in Table 8. In the case of part-time students, a greater extent of work experience can be reasonably assumed.

Figure 8

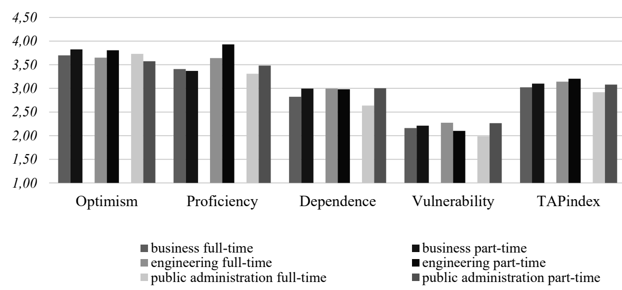
TAP factor and TAP index scores by gender



Source: authors' own work

Figure 9

TAP factor and TAP index scores for full-time and part-time students



Source: authors' own work

Results suggest that male students, compared to female and part-time students, and compared to full-time counterparts, possess higher TAP factor and TAP index scores in most cases. A remarkable exception is that of relatively higher vulnerability of full-time engineering students (2.27 full-time compared to 2.10 part-time). Assumed work experience of part-time students is also reflected in differences in the TAP index scores, but the composition displays higher optimism of full-time students of public administration students and relatively high vulnerability of engineering students. A non-parametric analysis of variance test was conducted for each sub-sample which however could not confirm the significance of these differences (Table 9). The TAP index is significantly different in terms of gender in each sub-sample and among public administration students in relation to their full-time or part-time study status. Moreover, dependence and vulnerability factor scores are significantly different only within the category of public administration students.

Table 8

TAP scores in terms of grouping factors

		Optimism	Proficiency	Dependence	Vulnerability	TAP index
business	female	3.66	3.23	2.82	2.15	2.96
	male	3.81	3.72	2.90	2.21	3.16
	full-time	3.70	3.41	2.82	2.16	3.02
	part-time	3.83	3.37	2.99	2.21	3.10
engineering	female	3.73	3.44	3.00	2.17	3.09
	male	3.72	3.94	2.98	2.20	3.21
	full-time	3.65	3.64	3.00	2.27	3.14
	part-time	3.81	3.93	2.98	2.10	3.21
public administration	female	3.64	3.13	2.69	2.06	2.88
	male	3.74	3.68	2.83	2.09	3.08
	full-time	3.73	3.31	2.64	1.99	2.92
	part-time	3.58	3.48	3.00	2.26	3.08

Source: authors' own work

Correlations between following novel products and services and TAP factors

A prominent question arises as to whether a correlation exists between following novel products and services and TAP factors. The Spearman's rho and significance values as such are summarized in Table 10, which indicate a significant but low or at least moderate correlation between TAP factor scores and scores for students following novel product and services, except for kitchen appliances. In the cases of smartphones, smart home, transportation, and banking services, optimism indicates a positive correlation; proficiency significantly correlates with following DIY tools as novel products or services. The highest correlation values were located between smartphones–proficiency and smart home–proficiency correlated pairs. Optimism and proficiency factors seem to be able to explain given levels of following novel products and services, while inhibitory factors by contrast suggest a somewhat negligible impact in this regard.

Conclusion

The Hungarian National Digitalization Strategy (2022) emphasizes that a systematic approach is required to develop digital ecosystems. The introductory part of the strategy points out that while access to modern infrastructure is available, there exists a formidable barrier to further improvements in terms of a high proportion of people without digital skills and a low willingness to participate in learning programs. Understanding technology adoption propensity can thus be considered as a suitable tool for measuring attitudes to IT technologies and their use in society as a whole, in line with the original purpose of the developers of the instrument (Ratchford & Barnhart, 2012). Results of this study have confirmed applicability of the TAP instrument in order to describe the approach to novel products and services. Enhancement of investigation through further research may allow for mapping individual characteristics by deployment of different grouping factors such as by profession or other attributes.

Table 9

Analysis of variance test results in terms of grouping factors

Grouping factor	Sub-sample (d_f=1)		Optimism	Proficiency	Dependence	Vulnera-bility	TAP index
Gender	Business	Kruskal-Wallis H	8.086	45.801	1.705	0.924	22.478
		Asymp. Sig.	0.004*	0.000*	0.192	0.336	0.000*
	Engineering	Kruskal-Wallis H	0.051	10.254	0.069	0.231	4.574
		Asymp. Sig.	0.821	0.001*	0.793	0.631	0.032*
	Public administration	Kruskal-Wallis H	0.846	28.698	1.208	0.152	17.053
		Asymp. Sig.	0.358	0.000*	0.272	0.697	0.000*
Full-time or part-time	Business	Kruskal-Wallis H	2.411	0.001	1.691	0.094	1.113
		Asymp. Sig.	0.120	0.976	0.193	0.759	0.291
	Engineering	Kruskal-Wallis H	1.188	4.336	0.033	1.565	0.327
		Asymp. Sig.	0.276	0.037*	0.857	0.211	0.567
	Public administration	Kruskal-Wallis H	4.003	2.489	10.227	9.535	9.443
		Asymp. Sig.	0.045*	0.115	0.001*	0.002*	0.002*

*Source: authors' own work based on based on SPSS output, * significant at p<0.05*

Table 10
Correlation analysis results between following novel products and services and TAP factors and index scores

		Optimism	Proficiency	Dependence	Vulnerability	TAP index
smartphones	Correlation Coefficient	0.251	0.396	-0.058	0.037	0.262
	Sig.	0.000*	0.000*	0.087	0.276	0.000*
smart homes	Correlation Coefficient	0.195	0.331	0.002	0.067	0.249
	Sig.	0.000*	0.000*	0.964	0.048*	0.000*
vehicles, transportation	Correlation Coefficient	0.130	0.285	0.051	-0.006	0.208
	Sig.	0.000*	0.000*	0.135	0.859	0.000*
kitchen appliances	Correlation Coefficient	0.043	-0.052	0.019	0.045	0.013
	Sig.	0.208	0.125	0.579	0.181	0.706
DIY tools	Correlation Coefficient	0.039	0.278	0.087	0.054	0.215
	Sig.	0.251	0.000*	0.010*	0.108	0.000*
banking services	Correlation Coefficient	0.156	0.185	0.032	-0.025	0.162
	Sig.	0.000*	0.000*	0.346	0.461	0.000*

*Source: based on SPSS output, * significant at p<0.05*

In relation to the first research question on the level of technology adoption propensity, moderate results were found by the TAP index score for all students. Few respondents possess an exceptionally low or high TAP index score in the sample, and it is encouraging to note that the proportion of students with higher than medium values exceeds those below the medium value. Such experience is encouraging as a whole and may serve to enhance further diffusion of technology use in any given field, but the relatively high ratio of 'laggards' is of concern. Survey results also indicate strong potential for utilization of optimism to adopt new technology given that it possesses a relatively high value, while the vulnerability component indicates a relatively low value for the entire sample. It follows that a suitable policy goal should be to improve proficiency of use.

The second research question concerned differences in technology adoption propensity between business, engineering, and public administration students. Results confirmed the assumption on differences between professions represented by the study type followed by higher education students. Principally, our study found statistically significant differences to suggest existence of a strong need for targeted development strategies. High optimism and low vulnerability emerged to be general characteristics regardless of the study type of respondents, while proficiency in use and dependence were higher for engineering students than for others. The optimism factor value exceeds that of proficiency except for engineering students, which therefore emphasizes the prominence of the need for education and training in use of technology. Gender differences indicate a more active approach of males compared to females, while greater assumed work experience for part-time students confirmed significantly higher technology adoption propensity in this regard, primarily for public administration students.

In relation to goals of the National Digitalization Strategy, the results of this study suggests it is highly suitable for enhancing high-level optimism that use of technology generally provides a better life. However, proficiency in use should be strengthened and emphasized as the main contributor to technology adoption. The positive impact of work experience corroborates the overall need to gain experience in technology use through practice. Results indicating differences in study type also have implications in terms of targeted training strategies for different professions.

Limitations and further research

As may be expected, there are some notable limitations within the scope of this research project. Despite use of validated methodology for measuring technology adoption propensity and the careful planning of data collection and analysis, the generalizability of results is limited. The research sample was relatively large, but systematic and random sampling was not performed. Professions represented by business, engineering, and public administration students do not cover the entire range of professions served by higher education. Distortions in results derived from the self-adminstered voluntary survey exist, but these were controlled by the validated methodology used for evaluation. Moreover, since there are limited empirical studies available based on the TAP instrument, discussion of comparisons was not distinctly feasible. We consider this study as an explanatory research basis for further testing of methodology and for preparing further data collection, including on an international scale. In order to ensure broad interpretation of results, we intend to construct a sample base that allows for use of a regression model approach to replace the use of analysis of variance tests.

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