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From the Editors-in-Chief

HOPES FOR A BETTER (TECHNO) FUTURE

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Abstract: *During the last few months, we have seen plenty of discussion about text-generating AI chatbots like ChatGPT. We have also seen many different kinds of affects and emotions connected to these tools. People are curious, suspicious, intrigued, or maybe even afraid of what our future will be like. Therefore, we need hope. In this editorial we want to stress the importance of hope and argue that people should not be left alone with suspicion, fear and doubt about how technology will change their future.*

Keywords: *hope, future, AI, affects, emotions.*



Technologies have always been loaded with plenty of positive expectations and negative fears (Boyd, 2014), alongside narratives of utopian and dystopian futures. This is the case with digital technologies, too. They are considered helpful, but many studies reinforce a pessimistic view of digital technologies as harmful, addictive, and even toxic for people (Lavis & Winter, 2020). Different kinds of affects are connected to digital technologies. In this issue of *Human Technology*, for example, Andrea Bencsik and Timea Juhasz write about technostress in worklife, and Julia Siderska, Moh'd Alsqour, and Sameh Alsaqoor, discuss employees' attitudes towards implementing robotic process automation technology in service companies. They argue that people need to rely on their digital co-workers. Still, it is evident that many humans are suspicious of digital technologies. The debate around social media usage is one such example, too much social media is considered dangerous for youth and young people, but on the other hand, older people are strongly encouraged to take part in digital worlds for not to be marginalized from society.

Anthropologist Sherry Ortner (2016) has suggested that to understand the foundations of well-being and a good life, we need to study more than just the "harsh dimensions of social lives". However, we tend to get stuck on these harsh dimensions instead of thinking about how hope, well-being, and a good life are created in everyday contexts. People should not be left alone with suspicion, fear and doubt about how technology will change their future.

We need hope

Hope is vital for our well-being and an essential element of our daily lives. Anthropologist Ghassan Hage (2004) has argued that society's main task is to create and offer hope for its members. Hope is also connected to our ability to imagine our futures. Psychologically, hope – the personal rainbow of the mind – can be defined as "the perceived capability to derive pathways to desired goals and to motivate oneself via agency thinking to use those pathways" (Snyder, 2002, p.249). Anthropologist Hirokazu Miyazaki (2004) conceptualizes hope within a more cultural frame as a method of knowing and connects hope analytically with desires, arguing that these two are not necessarily distinguishable. In Miyazaki's research, hope is not seen as an endpoint of some process. If you approach hope as an endpoint, "the newness or freshness of the prospective moment that defines that moment as 'hopeful' is immediately lost" (Miyazaki, 2004, p.8).

Hope and future expectations have an essential role, especially in young people's lives. Youth are often described as the makers of the future, with the sense of hope as a basic element of their everyday life. Hope relates to a recognition of continuity and trust in achieving one's goals. In general, hope encourages and moves young people forward. It can also be strengthened through concrete activities connected to creativity, culture, or a relationship with another person and the environment (Tikkanen, 2012.)

Hope is connected to an awareness of the ability to receive support and help from others, if needed. In this way, hope becomes a collective, shared achievement or goal. Even minor actions can add and strengthen hope. By focusing on small but significant actions, we may understand what hope means in everyday life context. Hope is often connected with positivism because they both are future-oriented and future-minded. However, Bruininks and Malle (2005, 354) have shown that people think about hope and positivity differently.

Different interpretations occur when considering features like importance, likelihood, and perceived personal control. These differences are likely to predict different behaviors.

Hope is both individual and collective, and it may become visible as a hidden counterforce. Scrutinizing hope within everyday technology use is vital because otherwise important encounters may remain hidden, and hope becomes an empty word. As an affect, hope identifies the hotspots that need to be supported to reach a good future. When thinking about people's hope in digital environments, we need to consider who can act and who has agency which does not belong inherently to humans but is produced in enactment, as a quantum physicist, philosopher of science, and feminist theorist Karen Barad (2007, p.214) has argued. Thus, agency is not the property of a person or a thing but a matter of intra-acting.

During the last few months, we have seen plenty of discussion about text-generating AI chatbots like ChatGPT. People have tested them, and even had fun while using them, but rules on how to use them have been discussed and debated. In Finland, for example, the Jyväskylä University School of Business and Economics took the bull by the horns and allowed the use of artificial intelligence in studies. At the same time, teaching staff have been thinking about and writing instructions for the ethical use of chatbots and other similar tools. In Poland, several universities, including the Technical University of Lodz, are engaged in a heated discussion about the use of AI technologies in academic research and practice. Liberal attitudes, of a conscious or opportunistic part of the community, clash with approaches attempting to restrict the use of AI. Despite the introduction of a number of regulations in many universities, defining ethical principles, a reflexive observation is that technology has probably surpassed modern expectations of people who are not ready for its possibilities. This actually puts to the test the subjective hope necessary for the proper coexistence of humans and technology, and the key seems to be the explainability and regulation of technology use.

Text-generating AI tools will also affect the work of scientific editors, and we, as Editors-in-Chief of Human Technology, have also pondered what this will mean in our work. ChatGPT has already been listed as a co-author in some scientific articles, but many scientists disapprove of this and see authority as something more than "just" writing: an author needs to make a significant scholarly contribution (Stokel-Walker, 2023). However, this kind of thinking makes the more-than-human-becomings and intra-actions visible, forcing us to think further about our research's ontological and epistemological foundations.

Thus, the big question is how to use text-generating AI tools wisely? What does wisely actually mean in this case? What are the ethical guidelines to follow when using AI tools? There are many hopes connected to these tools, and you do not need to be a clairvoyant to see that there will likely be an equal amount of dashed hopes. Most probably, the discussion will follow binary logic and see these tools through the lenses of dystopias and utopias. How could we address the question of AI tools in such a way that we would avoid thinking that these technologies affect all people in all situations in the same way? How could we offer more hope than shame?

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THE DIGITAL WORLD AND ATYPICAL WORK: PERCEPTIONS AND DIFFICULTIES OF TELEWORKING IN HUNGARY AND ROMANIA

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Abstract: *IT solutions have been transforming the world of work, albeit with varying intensity, for decades. They affect, among other things, the organisation of work, work structures, employment patterns and working time. Solutions such as artificial intelligence (AI), business intelligence (BI), robotic process automation (RPA), workflow, process mining, etc. are now a daily reality in the corporate sector, be it physical or mental work. However, the spread of digital solutions across organisations, spaces and sectors is uneven. Can the impact of this uneven spread be observed in employment, especially in atypical forms of employment? In our questionnaire research, we seek to establish how employees with tertiary education in two pairs of sectors (Hungarian and Romanian non-profit sectors and Hungarian non-profit and for-profit sectors) in two countries perceive some demographic characteristics of teleworking. In our research, we analysed the responses of Hungarian and Romanian working-age citizens with tertiary education who had been working in telework for at least one year at the time of completing the questionnaire. In addition to the deterioration of work relationships and the lack of personal contacts already shown by many studies, it is observed that the work-life balance is upset for single people and those without children, while the number of children does not influence opinions on teleworking. The differences observed and presented in the study are typically not gender-specific but largely based on globalised perspectives.*

Keywords: *digitalisation, telework, Hungary, Romania, for-profit sector, non-profit sector.*



INTRODUCTION

The COVID-19 pandemic has led to a global increase in online activities replacing face-to-face activities. Advances in information and communication technologies have enabled citizens in many parts of the world to perform at least some activities of daily life virtually rather than physically. Teleworking, telehealth, online learning, and online shopping (e-shopping) have become prominent substitutes for face-to-face work, healthcare, education and shopping (Gyenge et al., 2021; Kitukutha et al., 2021; Pierce et al., 2021; Ryadi, Kurniasari, & Sudiyono, 2021; Wijesooriya et al., 2020).

Globalisation and the coronavirus epidemic have led to an increasing transformation of the labour market, with a growing demand for non-traditional, i.e., atypical employment (Chernozhukov et al., 2021; Suhányi et al., 2022). Atypical employment is a specific form of employment that differs from traditional full-time employment in many ways in terms of location, time and schedule (Baruch, 2000; Gajendran, Harrison, 2007).

In today's advanced, globalised world, work in many non-manual jobs is no longer bound by time and space, and certain services can be provided from anywhere in the world thanks to info-communication technology (Abulibdeh, 2020; Raišienė et al., 2021). These factors have contributed to the spread of atypical employment. The coronavirus epidemic has brought teleworking to the fore as one of the most commonly used types of atypical employment (Kahn et al., 2021; Bonacini et al., 2021; Karácsony et al., 2021; Lipták, Musinszki, 2022). (Part-time work, temporary agency work, outsourcing and fixed-term contracts are also popular types of atypical employment.)

In their study, Belzunegui-Eraso and Erro-Garcés summarised the concept of telework and its most characteristic features. They highlighted the inadequate legal regulation of the field and the importance of cost reduction by employers, which is considered the most important (Belzunegui-Eraso, Erro-Garcés, 2020). They also discussed the difficulty of reconciling work and private life when working from home. Telework has many advantages and disadvantages at both organisational and individual levels. Among the advantages are that telework practices help productivity, profitability and flexibility. This is accompanied by a reduction in absenteeism and employee turnover (Frolick, 1993). For employees, the home office has offered greater flexibility in terms of work schedules and use of time and energy, contributing to better job satisfaction and quality of life. The home office also offers autonomy and greater concentration (Rupietta, 2016). In their study, Moretti and colleagues highlighted that workers perceived working from home as less productive and stressful. They particularly valued the travel time saved to work, but were not happy about the isolation from colleagues (Moretti et al., 2020). Some organisations have raised concerns about productivity loss, the maintenance of corporate culture, and health and safety at work as a result of the rise of home working, while workers were more concerned about social interaction, internet connectivity and increased workload (Marzban et al., 2021).

The conditions of telework and its medium- to long-term effects on employees should be examined. Little is known about the impact of working from home on the management of work-life balance for teleworkers. Palumbo (2020) looked at working from home and work-life balance, finding that among public sector workers, work-life balance was disrupted, with teleworkers more worried and tired, which could even lead to burnout. Allen and his colleagues have shown that flexible working hours (especially part-time) can help to balance

family and work responsibilities, and are particularly useful for mothers with young children (Allan et al., 2013). Telework has different circumstances to flexible working and in many cases means working from home for more than 8 hours a day, so it was not necessarily the best option for mothers with young children during the COVID-19 pandemic. They often found it difficult to balance work and private life, family responsibilities and childcare. For many office workers, the transition from the familiar office space to working from home can be challenging, and often they have lost track of time and have not had enough time to do housework. Such challenges can be stressful and negatively affect the employee's workload and thus reduce productivity (Awada et al., 2021). An optimal work environment, proper ergonomics and necessary equipment are essential to creating an efficient workspace that enhances productivity and increases employee engagement in the workplace (Awada et al., 2021).

DIGITAL TECHNOLOGIES IN INTELLECTUAL WORK

One possible interpretation of digitalisation is that digitalisation is the use of digital technologies. This has an impact on many areas of business. In administrative, financial and decision support functions, digitisation is mainly manifested in the automation and robotisation of routine processes, the use of business intelligence and the use of data analytics (Möller et al. 2020). At the country level, it is an obvious dependency of digitalisation in financial services and economic development (Pakhnenko et al., 2021). The steep development of digital tools for business needs allows for increasing competitive advantages to a great extent (Roshchuk et al., 2022). The AI-based technologies of business forecasting are helpful for business development and customer needs satisfaction (Kolková & Ključnikov, 2022; Angammana & Jayawardena, 2022).

The essence of Robotic Process Automation (RPA) is that when a process is robotised, the activities performed by humans are replaced by a software robot. The robot can even work continuously with a suitable schedule on several different processes. More and more companies are interested in RPA for business process automation (Sobczak, 2022). By operating robots beyond working hours, the load on some systems can be more balanced and the risk of error when processing data can be reduced compared to manual processing. (Bitó, 2018) RPA can replicate human behaviour to perform robotised activities faster and more efficiently than humans, but currently, it needs clear decision rules to do so. Typically, it is worth considering such a solution in areas where repetitions are very frequent, data are structured and well-standardised, and decision regularity can be established without human intervention (Isensee et al., 2018).

Business intelligence was defined by Dresner (cited in Power, 2002) in 1989 as an umbrella concept. According to his interpretation, business intelligence is a set of concepts and methods for improving business decision-making using fact-based support systems. According to one of the leading BI software companies, business intelligence combines business analytics, data mining, data visualization, data-related tools, infrastructure and best practices to empower organizations to make data-driven decisions. (<https://www.tableau.com/learn/articles/business-intelligence>) Today, business intelligence has entered its third generation. The latest generation of business intelligence software allows decision-makers in an organisation to quickly discover, create and

analyse data without the need to learn complex tools or become involved in IT. BI 3.0 is focused on collaboration, beneficial for workgroups (Eggert & Alberts, 2020)

Automation and digitalisation are also having an impact on today's global and national labour markets. In the literature, how innovation shakes up an industry or a social subsystem is referred to as 'digital transformation' or 'disruptive technology'. Digital transformation affects the whole enterprise, including those in intellectual jobs. This significantly affects the employability of labour force (Kovacs & Vamosi Zarandne, 2022) and influences the human mobility trend due to the impact of digital technologies development and intellectual employment consequently (Oliinyk et al., 2022). As a result, macroeconomic stability is affected by the digital transformation (Tiutiunyk et al., 2021). Peter Diamandis and Steven Kotler are responsible for the 6D model, which aims to show how digital technology is evolving and how this evolution is changing the environment around us (Diamandis & Kotler, 2016) The first stage is digitisation itself, where information becomes digital, i.e. it becomes computer processable. For example, in the accountancy profession, this means recording invoices in accounting software. The next stage (2D) describes the nature of the digital process, which is characterised by slow growth at first, imperceptible, and then after a point a surge in growth, at which point the familiar is destroyed and usually eliminated. After the destruction, there comes a phase (3D) where we can enjoy the positive effects of change and these digital technologies become free for everyone, everywhere and free. To continue with the example mentioned above, digitalisation is leading to a structural change in the focal points of the accounting service. Currently, data capture dominates. The service model based on data capture is now being transformed and the focus is shifting towards a more advisory-focused service. These changes in the environment, therefore, in-depth examination of the working conditions, competency expectations and responsibilities of employees in each functional area.

Changes in labour market demand and existing labour shortages further increase the demand for robots, as many production processes can be well-automated and do not necessarily require a live workforce (Jouhki, 2019; Sands, 2022). In Hungary, labour shortages have been highest in industrial production for many years, especially in manufacturing, motor vehicle production and warehousing. In the European Union, robots are used in warehousing in many countries (Royackers, van Est, 2015). In Hungary, the labour market is so empty that those who are unemployed today, due to their low employability, are left with the only option, the so-called Hungarian specificity of public employment. Public employment is a type of active employment policy instrument, whereby local governments provide work for the unemployed. Typically, they do not perform value-added work and thus do not contribute to the GDP of the country concerned, but are mostly engaged in park maintenance and mowing lawns in the municipality. Public employment was originally introduced as transit employment but has remained a permanent solution for the disadvantaged unemployed. In other words, many people are stuck in public employment and do not re-enter the primary labour market (Lipták, 2020). The needs of the labour market need to be met, so robots are needed for some jobs.

The robots work consistently at the right quality 24 hours a day, up to three shifts, they don't get tired, they don't need lunch breaks, they won't ask for payment and they only need electricity (Danaher, 2017). This greatly reduces production costs and the number of potential errors. Due to the impact of the coronavirus epidemic, the demand for robots has further increased (Shen et al., 2020). Due to high turnover and existing labour shortages, farm organisations have had to look for a cost-effective solution that has been available for years, namely robots (Suchacka et al.,

2021). Artificial intelligence still has many untapped potentials that could be well applied in the workplace. Collaborative robots, i.e. cobots, can take over dangerous and tedious jobs that are a burden for the live workforce. due to the generational shift in the labour market, younger age groups are more accepting of robots because they do not want to do tedious or dangerous assembly work (Bińczycki & Sławomir, 2022). Thus, shortly, we can expect to see robots and live workers working together in the labour market in several countries. 5D (dirty, dull, dangerous, domestic, dextrous), a generic term for dirty, dull, dangerous, degrading and manual work (such as packaging, quality control and assembly), is no longer so popular among the young generation. This further reinforces the demand for robots (Sandoval et al., 2022).

There is a common fear that robots will take jobs away from the live workforce (Smids et al., 2020). This is not true for several reasons, firstly they solve labour shortages and secondly, the freed workforce can be upgraded to perform higher-skilled tasks (Ford, 2015). Low-skilled and automatable tasks are performed by robots and it is not uncommon for robots and live workers to work together (Liang et al, 2016; Decker et al., 2017; Nishimura, et al., 2019). The European Union has a particularly high employment rate (197 million people) and a high demand for highly skilled workers. The future lies in knowledge-intensive sectors. And if some jobs were to disappear, new occupations would be created, as automation needs to be controlled, serviced and maintained. Production line jobs, machine operator jobs, driver jobs, cashier jobs, data entry jobs and customer service jobs could all fall victim to automation. But more and more analysts, process designers, programmers, engineers and researchers will be needed.

RESEARCH METHODOLOGY AND THE SAMPLE

Our research team deals with the changes in the labour market. Within the framework of that, we examine where and how the main trends and key events of our days (e.g. digitalization, generation Z, social innovation, coronavirus) can be pinpointed. We wish to present one section of our research in this study. We are looking for a reply to the question of how the employees with a higher education degree in the Hungarian and Romanian non-profit sectors and in the Hungarian non-profit and for-profit sectors consider telework (opinions and difficulties) relative to age, marital status and number of children. To understand approaches to telework we carried out primary research (questionnaire survey).

In order to determine the attitudes of Hungarian and Romanian workers towards teleworking, online surveys were conducted November 2021 in both countries using the snowball method. A 5-point Likert scale (1: least typical, 5: most typical) was used to measure the extent to which the advantages and disadvantages of telework are considered typical. It includes factors related to freedom and flexibility of work (freedom from daily working hours and fixed place of work; no need to look neat), isolation (deterioration of interpersonal relationships; missing face-to-face meetings with colleagues; isolation); family relationships (more time with family); work efficiency (you work more efficiently from home), increased workload (much more work than in the office); cost-related aspects (increased household expenses, reduced travel time and costs). Difficulties were measured using dichotomous (yes-no) questions. These include communication difficulties with superiors, colleagues, and business partners, the imbalance between working time and free time, raising a young child, deterioration of family relationships, etc.). For data collection

Google Forms, for data analysis SPSS Statistics Version 26 was used. After data cleaning, 247 responses were suitable for further analysis. The criterion for participation was at least some experience with telework in the last year. The sample composition can be seen in Table 1.

Table 1. Sample composition.

Description	Romanian non-profit	Hungarian non-profit	Hungarian for-profit
Age			
20-34	16	22	51
35-	49	57	52
Marital status			
in relationship	50	65	81
single	15	14	22
Children			
yes	37	45	37
no	28	34	66

For the qualitative and geographic attributes, the test of independence was performed using a chi-square test for independence. The test of independence was considered feasible if the frequencies expected for independence (Expected Count - f_{ij*}) were not less than 1 and the values of 1-5 could only be assumed by no more than 20% of the cells. The intercorrelation of the sample data was determined by Cramer's V coefficient.

In the analysis of variance, we tested for the presence of mixed correlations (quality-quantity attribute) using a hypothesis test. The prerequisite for an analysis of variance is equality of variances and normal distribution of all quantitative variables. Due to the Likert scale, the condition for normality was not met, but due to the robustness of the F-test, the tests of ANOVA were considered acceptable in the case of equality of variances. (Sajtos, Mitev, 2007) The equality of variances was tested using Levene's test.

Principal component analysis was performed to group respondents based on their opinions on teleworking. At first, the normality of the distribution of the variables was tested. Metric (not dummy) variables are used. We also used a homogeneous sample, of which size was above 100, therefore, after the necessary conditions were met, we considered it acceptable to conduct the principal component analysis. The Kaiser-Meyer-Olkin (KMO) criterion is one of the most important measures to assess how appropriate the variables are for factor analysis. If the measure is above 0.7, it is considered suitable (Sajtos, Mitev, 2007). The scree plot diagram showed that three-factor components can be distinguished. Varimax (variance maximization) rotation with Kaiser normalization was used. The value of the variance explained must be at least 60%. A variable is considered a member of a component if the weight of the component is at least 0.5.

RESULTS AND DISCUSSION

Comparison of the Hungarian and Romanian Non-profit Sectors

Perceptions of Teleworking

The opinions of people working in the non-profit sector on teleworking differ in the two countries. Hungarian employees gave the highest scores for reduced travel time (4.01), the lack of personal relationships (3.99), appearance (3.77), and greater freedom (3.67). In contrast, Romanian employees rated the deterioration of external relations (4.07), the lack of personal relations (4.06), the greater freedom (3.69) the reduction of travel time and costs (3.63) as the most important variables (Figure 1).

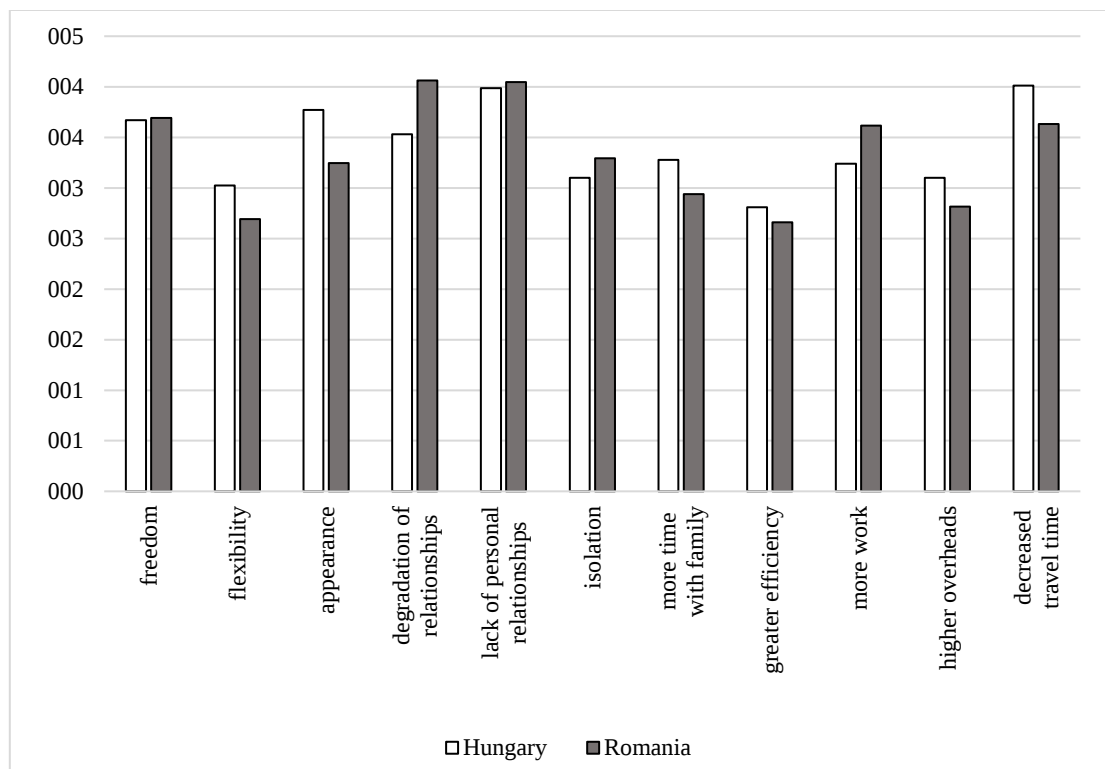


Figure 1. Opinions of employees in the non-profit sector.

It can be concluded that permanent teleworking leads to a deterioration of interpersonal relationships, and this is perceived as such by employees in both countries. Our research findings are consistent with the previous results of Tavares (2015) and Forgács (2011). The most frequently mentioned disadvantage of teleworking from the employees' point of view is the isolation caused by the fact that they usually work alone, the deterioration of interpersonal relations and the absence of face-to-face meetings, face-to-face conversations and group discussions (Tavares, 2015). Telecommuting has put an end to the separation of work and life, since in this situation most employees' workday did not start at the usual time, but according to a more flexible schedule (Forgács, 2011). It is not easy to find the right balance

between work and family, because in teleworking there is not always an exact time for starting work (Vrchota et al., 2019).

It was checked whether the test factors were uncorrelated pairwise using the Kaiser-Meyer-Olkin index (the closer its value is to 1, the more applicable the principal component analysis) and the Bartlett test (based on a simple hypothesis test). The Kaiser-Meyer-Olkin coefficient is 0.712, which is good (Table 2).

Table 2. KMO and Bartlett's Test (Hungary, non-profit sector).

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.712
Bartlett's Test of Sphericity	Approx. Chi-Square	284.243
	df	55
	Sig.	0.000

A scree plot was used to decide how many component groups to form in the procedure. A breakpoint was observed after the third component, so three components were tried. The rotation was performed using a varimax procedure with Kaiser normalisation. A variable is considered a member of a component if the component has a weight of at least 0.5 (Table 3). Principal Component Analysis results suggest that the opinions of Hungarian employees can be grouped into three components. The first component is *isolation and a lack of personal relationships*, the second one is *greater efficiency and family orientation*; and the third one is *freedom and flexibility*.

Table 3. Characteristics of teleworking according to the opinions of employees in the Hungarian non-profit sector, the rotated component matrix.

Variables	Component		
	1	2	3
Human relationships are broken down	0.853	0.012	-0.077
Loneliness	0.840	-0.140	0.101
Lack of personal contact with colleagues	0.792	-0.041	-0.009
Much higher household overheads	0.587	0.116	-0.010
The respondents work much more than before, in the traditional way	0.335	0.792	-0.203
Reduction in travel time and costs	-0.018	0.679	0.212
More efficient teleworking	-0.229	0.675	0.440
The respondents can spend more time with their families while teleworking	-0.183	0.597	0.508
It gives me more freedom	0.056	0.297	0.756
No need to look fit and dress nicely	0.027	-0.123	0.731
The freedom from daily working hours and being tied to a specific location	-0.005	0.373	0.672

Note: Groups of variables that can be defined by components are marked in different colours.

The calculations have also been made based on the answers from the Romanian non-profit sector (Table 4). In Romania, also three components were detected, which are *freedom and flexibility*; *isolation and degradation of relationships*; and finally *higher overheads* (Table 5).

Table 4. KMO and Bartlett's Test (Romania, non-profit sector).

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.736
Bartlett's Test of Sphericity	Approx. Chi-Square	143.194
	df	55
	Sig.	0.000

Table 5. Characteristics of teleworking according to the opinions of employees in the Romanian non-profit sector, the rotated component matrix.

Variables	Component		
	1	2	3
The freedom from daily working hours and being tied to a specific location	0.776	-0.094	-0.178
It gives me more freedom	0.737	-0.133	-0.305
More efficient teleworking	0.699	-0.302	-0.004
No need to look fit and dress nicely	0.678	0.077	0.146
The respondents can spend more time with their families while teleworking	0.571	-0.180	0.406
Reduction in travel time and costs	0.473	0.163	-0.358
Loneliness	-0.081	0.735	0.025
Human relationships are broken down	-0.087	0.726	-0.020
Lack of personal contact with colleagues	-0.112	0.663	0.299
The respondents work much more than before, in the traditional way	0.001	0.618	-0.021
Much higher household overheads	-0.079	0.201	0.824

Note: Groups of variables that can be defined by components are marked in different colours.

We also examined opinions about teleworking by demographic characteristics such as age group, marital status, and whether you have children. As for age, we formed groups of people under 35 or over 35. ANOVA test result suggests a weak significant relationship between age and the following variables: teleworking offers greater freedom, appearance and reduced travel time. There was no significant relationship between marital status and employees' perception of telework according to the ANOVA test results, therefore, the attitudes towards teleworking do not depend on marital status. The Hungarian employees with no children considered the reduced travel time (4.00) the most typical attribute of teleworking, followed by greater freedom (3.82). Employees with children considered the lack of personal relationships (4.04), the deterioration of relationships (3.74) as well as the reduced travel time (3.74) as the top three attributes of teleworking. In both groups, the lowest score was attributed to greater efficiency and flexibility. A very interesting result emerged when a specific number of children was investigated. In contradiction with earlier findings claiming that telework is particularly popular among people with three or more children, we found that the number of children does not influence the employees' opinion on teleworking. The result of the ANOVA test detected no significant relationship between them.

Difficulties During Teleworking

In examining difficulties, first, we focused on communication difficulties. Survey questions were related to communication difficulties with the respondent's boss, colleagues and business partners. Our research findings show that 25% of respondents experienced

communication difficulties with their superiors. The fewest problems were mentioned by employees under 35 years old (18.4%), while the most problems were experienced by employees in the Romanian non-profit sector (32.3%). Opinions do not differ significantly by age, marital status, number of children and country. Within an organisation, maintaining contact with colleagues caused much more difficulties than communicating with superiors. A spectacular deterioration is observed among employees under 35 years old (18.4% vs. 28.9%), single people (20.7% vs. 34.5%), people without children (21.0% vs. 33.9%) and in the Romanian non-profit sector (32.3% vs. 41.5%). Slight, but significant differences were found in the opinions of communication difficulties by countries ($\chi^2 = 5.838$, $p = 0.016$, $df = 1$, Cramer's $V = 0.201$). The lack of devices causes greater difficulty than communication with either the boss or colleagues. 35.4% of the respondents were concerned about a lack of devices during home working. It was a big difficulty for childless people (41.9%), single people (41.4%) and people aged over 35 (37.7%). Those for whom this was less difficult were under 35 (28.9%), people with at least one child (30.5%) and Romanian employees (33.8%).

We investigated the relationship between telework and personal life from three aspects: working time and free time balance, raising the underage child(ren) and change in family relationships. Striking a balance between working time and free time represented the greatest difficulty. An outstandingly high proportion of respondents (75.4%) answered that for the past year, it had been difficult for them to create a balance between working time and leisure. The lowest score was given by respondents with children. The majority of single employees (89.7%), childless employees (82.3%), and Romanian respondents (81.5%) reported difficulties. Only 18.1% of the respondents considered the degradation of family relationships as a key issue. However, Romanian non-profit sector, childless people (21.5%), single people (20.7%), people aged over 35 (19.8%) and respondents with children (18.5%) had more difficulties with it than others.

Raising children under 18 makes teleworking even more difficult. 47.2% of the respondents over 35, and 61.7% of the respondents with children answered that raising children when teleworking is very challenging. As opposed to that - due to obvious demographic reasons - only between 3 and 5% of the respondents below 35 and those without children experienced difficulties in this regard. In both cases, there are medium strong, significant relationships. (Age – difficulty: $\chi^2 = 21.293$, $p = 0.000$, $df = 1$, Cramer's $V = 0.385$; child – difficulty: $\chi^2 = 51.036$, $p = 0.000$, $df = 1$, Cramer's $V = 0.595$.)

Differences in the Hungarian For-profit and Non-profit Sectors

Opinions on Teleworking

There is a discrepancy between the opinions of employees of for-profit and non-profit organisations on teleworking. Figure 2 shows that the highest mean score (4.11) was given by employees in the for-profit sector for freedom, followed by a reduction in travel time (4.04), which substantiates previous findings in the literature that teleworking offers a higher level of freedom and frees the employee from the routine of travelling to work every day (de Abreu e Silva & Melo, 2018). Being isolated (2.73) and higher overhead costs (2.91) were ranked as the least important factors. In contrast, non-profit sector employees considered reduced travel

time (4.01) and lack of personal relationships (3.99) as the most important factors. The least important factors to them were efficiency (2.81) and flexibility (3.03). The current study does not support previous research in this area, because according to Raišienė et al. (2020) (no sector-specific analysis), the performance of teleworkers can increase by up to 30% compared to traditionally employed workers.

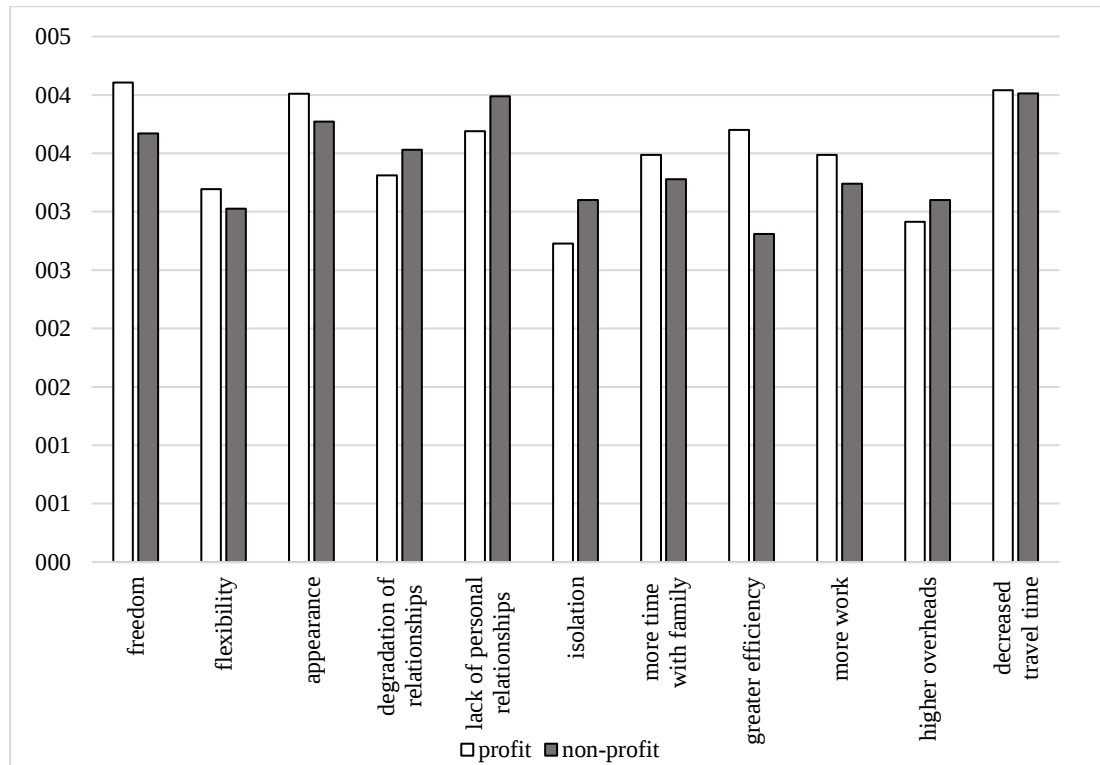


Figure 2. The opinion of the Hungarian employees in the for-profit and non-profit sectors.

It was made again a principal component analysis and compared the results between only the Hungarian for-profit and non-profit sectors. The Kaiser-Meyer-Olkin coefficient is 0.651, which is good (Table 6).

Table 6. KMO and Bartlett's Test (Hungary, for-profit sector).

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.651
Bartlett's Test of Sphericity	Approx. Chi-Square	281.966
	df	55
	Sig.	0.000

Table 7. Characteristics of teleworking according to the opinions of employees in the Hungarian for-profit sector, the rotated component matrix.

Variables	Component		
	1	2	3
More efficient teleworking	0.819	-0.119	0.104
Reduction in travel time and costs	0.708	0.015	0.056
It gives me more freedom	0.665	0.043	-0.535
The respondents can spend more time with their families while teleworking	0.510	-0.218	-0.256
No need to look fit and dress nicely	0.425	0.411	0.197
Loneliness	-0.079	0.846	-0.045
Human relationships are broken down	-0.044	0.816	0.072
Lack of personal contact with colleagues	-0.057	0.723	0.189
The freedom from daily working hours and being tied to a specific location	0.426	0.180	-0.725
The respondents work much more than before, in the traditional way	0.376	0.268	0.635
Much higher household overheads	0.043	0.175	0.584

Note: Groups of variables that can be defined by components are marked in different colours.

Principal Component Analysis resulted in three-factor components in the for-profit sector (Table 7). They are 1. *freedom and efficiency*; 2. *isolation*; 3. *flexibility and extra work*. In the non-profit sector, also three but somewhat different factor components were made (see above Table 4): 1. *isolation and a lack of personal relationships*; 2. *greater efficiency and family orientation*; 3. *freedom and flexibility*.

Looking at the opinions of employees by age, we found that there is a small discrepancy between persons under 35 and over 35 concerning the attributes of teleworking. Individuals under 35 tended to give higher mean scores to freedom, appearance, and reduced travel time, while individuals over 35 considered freedom and lack of personal relationships to be the most important factors. The opinions of employees without children did not differ significantly from those with children, and the sector had no real influence on them. This is a surprising finding, as it is often claimed in the literature that telecommuting can be a good solution for people with children Kazainé (2020). However, when the effect of the number of children was also incorporated into the analysis, we found that teleworking allowed more time with family for employees with children in the for-profit sector (4.49). Individuals with three children considered the reduced travel time as the most typical attribute of teleworking (4.63). We found completely different opinions in the non-profit sector. For employees with three or more children, freedom (4.20), lack of personal connections (4.00), and isolation (4.00) were the most important attributes, while the least typical responses were more time for family (3.20) and flexibility (3.20).

Difficulties During Telework

When comparing the opinions of the employees in the for-profit and non-profit sectors in Hungary, different results were obtained. Here, nearly a quarter (25.3%) of respondents also experienced communication difficulties with their boss. In contrast to the non-profit sector in both countries, the largest percentage of difficulties were reported by people under 35 (31.5%) and single people (33.3%). The lowest percentage of difficulties was reported by respondents working in the non-profit sector (19.0%) and individuals over the age of 35 (21.1%). In terms of age, there is a significant correlation when a value of 11.3% is reached

or, in the case of a breakdown by sector, a value of 8.7% is indicated. A similar phenomenon can be observed in the case of communication with business partners. 16.6% of respondents have experienced communication difficulties with their business partners. The most difficulties continued to be reported by those under 35 (19.2%) and those living alone (30.6%). A weak significant relationship between communication and marital status can be demonstrated ($\chi^2 = 6.455$, $p = 0.011$, $df = 1$, Cramer's $V = 0.188$). Within the organisation, maintaining contact with colleagues caused slightly more difficulties than communicating with supervisors at work (28.6 vs. 25.3%). Higher than average difficulties were reported by those living alone (38.9%), those without children (35.0%), those under 35 (32.9%), and those working in the private sector (33.0%). A weak significant influence of the number of children on the communication difficulties was found ($\chi^2 = 4.495$, $p = 0.038$, $df = 1$, Cramer's $V = 0.157$). Based on our research findings it can be concluded that:

- people aged under 35 had more communication difficulties than people aged over 35,
- single people had more communication difficulties than people living in a relationship,
- people without children had more communication difficulties than people with children,
- people working in the private sector had more communication difficulties than people working in the non-profit sector.

28.0% of the respondents faced the problem of lack of office equipment in the telework. The above phenomenon was also observed here. The lack of equipment causes above-average difficulties to childless persons (32.0%), single persons (36.1%), persons under 35 years of age (30.1%) and persons working in the private sector (36.7%).

The balance between work and leisure is the greatest difficulty. 62.6% of the respondents think that it was difficult for them to balance work and leisure during the pandemic. By age and marital status, there was no significant difference in the opinions. However, by sector, significantly different opinions about work-life balance were found ($\chi^2 = 4.058$, $p = 0.044$, $df = 1$, Cramer's $V = 0.140$). *In the private sector, the balance between work and leisure is even more difficult.* 70.9% of private sector representatives, while only 56.3% of those working in the non-profit sector believe that finding the right balance is a difficulty. Harder family relations were seen as a difficulty by only 12.1% of respondents. Difficulties significantly above the mean were only cited by those over 35 (14.7%) and those working in the non-profit sector (15.2%).

Opinions about the hardships of teleworking while raising a minor child differ significantly by age and number of children. 40.4% of respondents over the age of 35 and 55.6% of respondents with children indicated that raising children while teleworking was a hardship. In contrast, only 2-4% of respondents without children and those younger than 35 indicated difficulty. In both cases, these are moderately strong significant relationships. (Age - Difficulty: $\chi^2 = 30.004$, $p = 0.000$, $df = 1$, Cramer's $V = 0.406$; Child - Difficulty: $\chi^2 = 65.766$, $p = 0.000$, $df = 1$, Cramer's $V = 0.601$).

CONCLUSIONS

Teleworking has a strong impact on communication within the organization as well as on the individual's life and family relationships. We found that in teleworking, communication with colleagues is a greater difficulty than communication with superiors. The difficulties in communicating with colleagues, apart from employees in the Romanian non-profit sector, are most evident among single teleworkers with no children. In addition to communication difficulties, the lack of work equipment is also higher than average among single teleworkers and teleworkers without children. In these two segments, difficulties at work have a negative impact on the work-life balance.

The opposite phenomenon is observed for workers in the non-profit and private sectors. While in the private sector, it is more difficult to maintain contact with colleagues and managers, more non-profit sector employees than private sector employees feel that there is a lack of work-life balance and that their family relationships are broken.

Finally, when comparing opinions and difficulties, we would like to highlight one more point. On the one hand, both the literature on the advantages and disadvantages of teleworking and the respondents' opinions shows that teleworking leads to a deterioration in human relations. The responses make it worth looking at work and family relationships separately. Only one-sixth of respondents think that deterioration in family relationships is a difficulty. In contrast, difficulties in communicating at work suggest that both deterioration in relationships and a lack of personal relationships are perceived at work.

It is too early to predict the extent to which working from home will be a part of our daily lives once the pandemic is contained. Nevertheless, we believe that the lessons of this extraordinary period will reveal and show the extent to which the supposed and hoped-for benefits of teleworking are working in practice and which disadvantages are more pronounced.

In the period of the COVID pandemic, the relationship between most workers to work has changed in time, space and the way work is organised. The home office was one of the most important forms of adaptation, in which achieving business goals remained a priority. It became clear that managers still needed to evolve to this working arrangement and to lead their teams remotely, focusing on results rather than process-centred management. Employees perceived the home office as less stressful and particularly appreciated the time saved in commuting to work but were unhappy about being isolated from colleagues and were most concerned about social interactions, internet connectivity and increased workload.

There are impacts of the changing work environment, we have studied them in two countries and two sectors and they can be used to help HR professionals in companies adopting digital solutions to manage the negative impacts.

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EMPLOYEES' ATTITUDES TOWARDS IMPLEMENTING ROBOTIC PROCESS AUTOMATION TECHNOLOGY AT SERVICE COMPANIES

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Abstract: *Robotic Process Automation (RPA) technology emerged as an innovative solution that supports the maintenance of operational processes and ensures business continuity, especially during the coronavirus pandemic. A survey was conducted for the purposes of this study. The main objective of the survey was to identify employees' attitudes towards RPA implementation in Polish service companies. The attitudes related to their involvement in the design and implementation of RPA solutions and their awareness of the fact that performing repetitive tasks is inefficient were scored the highest. The surveyed managers were of the opinion that employees waste time because they are occupied rewriting data between systems instead of developing the company, so they should be transferred to doing more complex and value-added work. Moreover, the involved statistical analyses also considered the correlations between employees' attitudes and determinants of RPA adoption.*

Keywords: *Robotic Process Automation, RPA, employees' attitudes, software robots.*



INTRODUCTION

Humanity is on the threshold of the Industry 4.0 revolution, where advanced technologies such as artificial intelligence, robotics, data analytics, or Internet of Things can create breakthrough applications like virtual agents, social robots, or autonomous vehicles (Schwab, 2017). In general, the effects of technology adoption on productivity (or labor savings) and the effects of automation through robots and AI on employment are hotly contested topics among researchers, traders, and labor economists. Meanwhile, the literature argues that the rate at which new technologies that increase productivity are destroying jobs may outpace the rate at which people can find new uses for those who have lost their jobs (Vermeulen et. al, 2018). Some arguments provided in this debate stress how the introduction of automation, robots, and artificial intelligence affects a large share of workers and can lead to a future of high unemployment (Brynjolfsson & McAfee, 2011; Ford, 2015; Frey & Osborne, 2017). In opposition to that, there is a substantial number of scientific papers arguing that, although some people will be replaced by automation, technological advancement will also increase the need for labor. Despite the fact that automation boosts productivity and hence raises unemployment, there are counter-effects such as higher product demand, increased demand for new skills and competencies, and even new professions required for novel goods and services (Vermeulen, 2018; Autor, 2015; Autor & Salomons, 2018; Gregory & Salomons, 2016; Carbonero & et al. 2020; Smithikrai, 2022).

In this paper, the authors present the results of the research conducted in Polish service companies aimed at identifying and discussing the employees' attitudes towards supporting their work with the use of RPA technology and effective cooperation with hybrid systems in a workplace. Are they satisfied after implementing RPA solutions or do they express their reluctance and fears of keeping their jobs? The present descriptive study was conducted on a sample of 132 managers of banks and other financial institutions.

The authors formulated the following research questions:

1. What are the employees' attitudes towards implementing RPA technology at enterprised and effective cooperating with hybrid systems in a workplace?
2. What are the correlations between employees' attitudes and the determinants and barriers to RPA technology adoption?

The paper is structured as follows. The literature review in the first Section is followed by the presentation of the research method. In the third chapter, the results of the analysis of empirical data are introduced and discussed. The conclusions are formulated in the last section. In this part of the paper, research limitations are also described as well as future research areas are suggested.

LITERATURE REVIEW

Recent technology advancements are accelerating more quickly than ever in order to remain ahead of the consequences and obtain new capabilities (Agarwal et. al, 2020). Some authors attempt to investigate as many possible future, emerging, and disruptive technologies that could be used to mitigate the effects of the coronavirus. The IT sector's technologies were critical during the COVID-19 pandemic and will also play a vital role in the post-pandemic world, particularly those which can lessen the human workload, manage the company and ensure business continuity (Nadikattu, 2020, Kedziora & Smolander, 2022). Robotics, artificial intelligence, data analysis, cloud computing, and Virtual Reality are among the most frequently mentioned technologies (Bullock et al. 2020; Kononiuk & Gudanowska – eds., 2021; Mbunge et. al 2021; Ejdys & Gulc, 2022; Halicka & Surel, 2022; Jurczuk, 2022).

For several years now, technological change has dominated discussions about the future of global labor markets. The enormous impact of ICT on people today might be especially obvious in areas such as work and education (Jurek et al., 2021a; Jurek et. al., 2021b). There is reason to believe that there will be major upheavals as a result of digitization and automation. Robotization is an important aspect of this technological change. While the process has already been going on for several decades, it is the massive expansion of the tasks that robots are performing that has made robotization a hot topic (Carbonero, 2020).

Although the global pandemic has mainly had bad economic consequences, at the same time there are some active technological advancements. It should be emphasized that recently, RPA and AI have primarily reached their peak (Lasso-Rodriguez, 2020; Winkler, 2020; Sobczak, 2022). RPA is an emerging technology automating simple business tasks and it links artificial intelligence and software capabilities to mimic human worker activity (Asiatiani et. al., 2022; Van der Aalst et. al, 2018). With the use of this technology, routine and rule-based tasks can be shifted from people to software robots (Geyer-Klingeberg et al., 2018). This possibilities are widely used in CRM systems (Roshchuk et al., 2022), trading technologies (Maknickienė et al., 2020), forecasting in business (Kolková & Ključnikov, 2022), fostering the further development of knowledge management (Oliinyk et al., 2021), technology acceptance model (Ryadi, Kurniasari & Sudiyono, 2021). In recent years, the use of software robots has become one of the most significant and rapidly expanding technologies (Kedziora et. al, 2021). Software robots are considered a disruptive solution and one of the most cutting-edge digital transformation trends that organizations can implement to reduce costs, save time, maximize resources through automating repetitive tasks, and maintain business continuity in the process of unprecedented and unexpected crisis events. In addition, it also aids in ensuring that an uncompromised customer service level and normal operational efficiency are maintained and execution of the processes is more efficient (Asatiani et. al. 2022; Siderska, 2020; Kedziora et. al, 2020). Better yet, it is designed for human and digital workers to work together, collaborate and move projects back and forth as well as play with each other's strengths, and cover their weaknesses (Kulp, 2021). Many organization have implemented robots to tackle the difficulties the COVID-19 outbreak has brought forth (Kedziora, 2022). In comparison to manual labor, robots and stand-alone systems provide a number of benefits (Shen et. al, 2021). Robots can act as employees to help respect social distancing restrictions (Nah & Siau, 2020). Consequently, there is a wide scope

for adjusting robots to perform routine and repetitive tasks with accuracy and dependability. (Javaid et. al, 2020).

The debate on the proliferation of robots is blooming, with the number of studies constantly increasing. Mainly the impact of robots on employment is a highly often debated topic in academic and public debates (Carbonero, 2020). Throughout history, there has been plenty of research on the effects of automation technologies and employees' concerns about losing their employment. Although Keynes foresaw potential technological unemployment, he believed it to be a passing period of economic maladaptation (1930/1965). Hurd outlined new professions and job enhancements that automation would bring (1958). Ivanov and Kuyumdzhiev analyzed data from more than 500 Bulgarians to determine their attitudes toward the automation of their jobs. The analysis reveals that certain populations are more afraid of automation than others, as shown by their opinions and demographics (2020). Rago recognized the shift of automation technologies but believed the fear of automation was unfounded, as automation generated more jobs owing to lower product prices and the creation of new jobs (1965). Over the next fifty years, the growing adoption of automation technologies has fueled fear of automation not only among manufacturing workers but also among service workers. Each automation technology has both enhancing as well as replacing impacts. (Decker et al., 2017; Frey, 2019; Ivanov & Webster, 2019). Improving the effects means improving work performance and employee productivity by adopting new technologies. With the substitution effect, the new technology replaces workers who previously performed the same task. The proliferation of automation technologies is changing the nature of what human workers do (Ernst et al., 2019), raising hopes and fears that employees will lose their jobs and be replaced (Fiaidhi et al., 2018; Nam, 2019; Spencer, 2018). However, greater productivity and the automation of cognitively routine work is a boon, not a threat. The numerous evidence prove the positive impact of industrial robots on productivity and labour market changes (Şahin, L. (2020). Because of this, new technology always has disruptive impacts throughout the adoption and development phases, and it typically takes some time to reveal its true value (Cramer D., Kasparov G., 2021).

Although the topic is hot and all the more willingly taken up in the subject literature, many authors stress that the wide-world debate and deepened research are still necessary. Researchers examine factors for ICT technologies' success and strategic effects resulting from the adoption of such solutions. Gupta (2019) considered the driving features, factors, and strategies responsible for the adoption and acceptance of ICT technologies. The consequences of digital transformation of business models are discussed by Straková et al. (2022). Bhalerao & Patil (2021) explored the factors preventing the adoption of ICT in SMEs and discussed the benefits due to such implementation by companies, while Chairoel et. al. (2015) identified conceptual factors affecting ICT adoption in Indonesian SMEs.

The growing interest of researchers is also noticed in the field of identification of factors influencing the successful implementation of RPA technology in companies as well as of investigation of benefits, challenges, and suitability of the technology. Many authors underline the need to identify and understand determinants and barriers to adopting IT solutions, including RPA technology. E-Fatima et. al. (2022) critically examined the potential barriers to the adoption of RPA technology in the beef supply chains, focusing on the efficient implementation of such solutions. Pramod (2021) gathered the applications, benefits, and challenges of providing such solutions to companies. Brzeziński (2022) identified the

benefits of RPA implementation in the logistics of a production company. Also, very recent studies were presented by Sharma et. al. (2022) with the main aim to examine the contextual determinants of RPA adoption in service industries in the emerging economy. This subject was also covered in the author's previous article (Siderska, 2021).

Although software robots provide many benefits, organizations still face various challenges due to a lack of frameworks and knowledge. Prior studies have provided limited scientific knowledge on the workers' perspectives, attitudes, and reactions as well as factors that restrain or obstruct the overall RPA technology adoption process and effective implementation in relation to employees' attitudes (Costa et. al. 2022).

Although increasingly people must interact with robot technologies, many humans are reluctant to work with robots. Robert (Robert, L.J.) introduced a new work-specific scale AWRO for assessing employees' willingness and attitude toward working with a robot. Lattika et. al. (2021) conducted research on over 1000 Americans and proved that they had a more positive attitude toward robots as equipment than as coworkers.

Software robots more and more often play the role of coworkers, teammates, or even supervisors, which have been evolving from a futurological idea to real adaptations, and previous teams of employees are being transformed into hybrid systems. Gladden posted a few future research questions related to features of such artificial agents that make them capable of being incorporated into the companies and related to the need of identifying workers' opinions towards effective cooperating within hybrid systems in a workplace, consisting of humans and agents (Gladden et. al, 2022). This research gap justified the studies undertaken by the authors in this paper and constituted the fundamentals of the analyses.

As previous studies have provided limited scientific knowledge on the workers' perspectives and in response to the research gap stressing the need for considering human reactions to RPA, the authors examine in this paper the employees' attitudes towards adopting this technology at companies and effective cooperating within hybrid systems in a workplace.

RESEARCH METHODS

The results of the analyses in this article are the continuation of the studies undertaken by Siderska in 2020. In her previous paper, titled "*Adaptation of Robotic Process Automation technology to ensure business continuity during COVID-19 pandemic*", Siderska presented the identified 22 features of RPA solutions, related to perceived usefulness, ease of use, security, and functionality of such technology. Moreover, she conducted also the diagnosis of the impact of the ongoing COVID-19 pandemic on companies' operations. The statistical analyses assumed then the identification of the differences in the evaluation of individual RPA technology features, mainly in terms of perceived usefulness, ease of use, security, and functionality. With the use of the 5-point Likert scale respondents also assessed the determinants and barriers to RPA technology adoption. To check the connections among determinants and barriers to decision-making on adopting the RPA solutions and the evaluation of this technology, analyses of the Pearson correlation coefficient have been also done then. To complete the assumed considerations, linear regression analyses were performed for particular determinants of RPA technology implementation. The research was

conducted then among 110 representatives of Polish banks, financial and insurance institutions, media, utility units and e-commerce enterprises. The survey was directed to the chief technology officers, chief information officers, chief operating officers, heads of back offices, security, financial and sales departments as well as other employees responsible for technology and development of enterprises operating in the service. All these results were presented and discussed in this paper (Siderska, 2021).

According to identified research gaps, the authors examine in this present paper only the workers' perspective, not the technology-oriented perspective, with the main aim to recognize and introduce workers' and managers' opinions and attitudes related to the implementation of software robots at service organizations. Such an approach had not been considered and analyzed by Siderska and other authors before.

Using the computer-assisted web interview (CAWI) method, quantitative data was gathered as part of a diagnostic survey. Deliberate sampling was chosen by the authors as RPA is still an emerging technology in Poland and thus not many companies have adopted such a solution so far and it is hard to estimate the population.

The survey has been conducted among the representatives of Polish service enterprises in May-July 2021. The study was based on nationwide research carried out on 132 respondents from banks (59%), financial and insurance institutions (41%). The survey was conducted among the management staff of these organizations (CTOs, CIOs, and COOs). To answer the posted research questions, statistical analyses were engaged with the use of the Statistica v.13.1 packages. The last steps of the research process assumed the analysis of the obtained results and the formulation of conclusions.

RESULTS AND DISCUSSION

The research included the evaluation of qualitative characteristics. The analysis of such data has its specificity, consisting of the application of adequate statistical tools for comparison. To characterize the structure of the examined variables measured on a rank scale, basic descriptive statistics about employees' attitudes and managers' opinions were calculated in the form of measures of position and variability. Spearman rank correlation coefficients were calculated to ascertain the strength of the association between the variables measured on the Likert (rank) scale. Counts and structure index values (percentages) were calculated and presented in tables for variables measured on a nominal dichotomous scale. All analyses assumed a significance level of 0.05 and were performed using the Statistica v.13.1 packages.

$$r_s = 1 - \frac{6 \sum_{i=1}^n d_i^2}{n(n^2 - 1)}$$

where:

$d_i = R_{x_i} - R_{y_i}$

is the difference between the ranks of X and Y for the observation i .

The analysis of the research results started with the investigation of the basic descriptive statistics for the analyzed employees' attitudes towards RPA adoption and the assessments of how important the indicated attitudes of employees ("emp_1 - emp_6" variables) and managers' opinions were in the success of the implementation of RPA technology in the surveyed companies (variables "inv_1 - inv_7" and "st1 - st11") (table 1).

Table 1. Basic descriptive statistics for employees' attitudes (variables "emp_1 - emp_6") and opinions of managers (variables "inv_1 - inc_7").

Abbr.	Employees' attitudes	M	Me	Min	Max	SD
emp_1	Employees' involvement in the design and implementation of RPA solutions	4.06	4.00	2.00	5.00	0.86
emp_2	Employees' satisfaction with the decision to start implementing RPA solutions	3.60	4.00	2.00	4.00	0.62
emp_3	Employees wanted to be pioneers in implementing RPA solutions	3.35	3.00	2.00	5.00	0.87
emp_4	Employees feel satisfaction after implementing RPA solutions	3.10	3.00	1.00	5.00	1.36
emp_5	Employees' resistance and reluctance	3.16	3.00	1.00	5.00	1.47
emp_6	Employees' fears of keeping their jobs	3.70	4.00	1.00	5.00	1.35
inv_1	Employees who perform repetitive tasks are inefficient	3.86	4.00	2.00	5.00	1.04
inv_2	Young employees are not motivated to perform boring, repetitive tasks	2.85	3.00	1.00	5.00	1.09
inv_3	The wage pressure in Poland is the highest in Europe, which increases the cost of back office labor	3.22	3.00	2.00	5.00	0.132
inv_4	It is very difficult to find specialists with the required competencies on the market	3.02	3.00	1.00	4.00	1.07
inv_5	The creators of systems implemented in the enterprise no longer work in it	2.51	2.00	1.00	5.00	1.19
inv_6	Employees squander time because they are occupied rewriting data between systems and do not have time for operations that advance the company. (Asatiani & Penttinen, 2016)	4.03	4.00	2.00	5.00	1.02
inv_7	Understanding that automation of business processes is requisite (Kucia et. al. 2021, Santos et. al. 2018)	3.40	4.00	2.00	5.00	0.98

The analyses for employees' attitudes gave rise to the conclusion that the highest score was for the variable emp_1, assuming eEmployees' involvement in the design and implementation of RPA solutions). It is a very constructive result and the appropriate way to manage the implementation of technological innovations in the enterprise. Involving employees in the process of adapting such technologies influences their positive attitude and reduces their fear of being replaced by machines. The mean of the variable emp_6 (Employees' fears of keeping their jobs) is almost the same as that of the variable emp_2 (Employees' satisfaction with the decision to start implementing RPA solutions). In the analysis for managers' opinions, the highest scoring answer was variable inv_6 (Employees squander time because they are occupied rewriting data between systems and do not have time for operations that advance the company) and variable inv_1, assuming that employees who perform the repetitive task are inefficient. Those surveyed expressed also their understanding that automation of business processes is requisite and will be common in the near future.

Subsequent analyses aimed to verify whether there were statistically significant correlations between employees' attitudes (variables "emp_1 - emp_6") and barriers to technology adoption (variables "barriers_1 - barriers_7"). For this purpose, Spearman's rank correlation coefficient was used (table 2).

Table 2. Correlation of Spearman's rank order (employees' attitudes and barriers).

Pair of variables	N	R Spearman	t(N-2)	p	Pair of variables	R Spearman	t(N-2)	p
emp_1 & barriers_1	132	0.08	0.71	0.479	emp_4 & barriers_1	0.00	0.04	0.966
emp_1 & barriers_2	132	-0.10	-0.96	0.337	emp_4 & barriers_2	-0.02	-0.22	0.826
emp_1 & barriers_3	132	-0.30	-2.92	0.004	emp_4 & barriers_3	-0.27	-2.56	0.012
emp_1 & barriers_4	132	-0.21	-2.04	0.045	emp_4 & barriers_4	-0.05	-0.48	0.632
emp_1 & barriers_5	132	0.02	0.19	0.851	emp_4 & barriers_5	-0.02	-0.16	0.873
emp_1 & barriers_6	132	0.04	0.41	0.684	emp_4 & barriers_6	0.10	0.96	0.342
emp_1 & barriers_7	132	0.02	0.18	0.856	emp_4 & barriers_7	-0.18	-1.68	0.096
emp_2 & barriers_1	132	0.08	0.78	0.435	emp_5 & barriers_1	0.02	0.15	0.878
emp_2 & barriers_2	132	-0.07	-0.61	0.545	emp_5 & barriers_2	-0.03	-0.27	0.785
emp_2 & barriers_3	132	-0.04	-0.34	0.732	emp_5 & barriers_3	-0.18	-1.72	0.089
emp_2 & barriers_4	132	-0.22	-2.09	0.039	emp_5 & barriers_4	-0.06	-0.53	0.594
emp_2 & barriers_5	132	-0.13	-1.22	0.226	emp_5 & barriers_5	-0.01	-0.14	0.892
emp_2 & barriers_6	132	-0.04	-0.36	0.720	emp_5 & barriers_6	0.11	1.04	0.303
emp_2 & barriers_7	132	-0.12	-1.14	0.256	emp_5 & barriers_7	-0.21	-2.01	0.048
emp_3 & barriers_1	132	-0.05	-0.46	0.649	emp_6 & barriers_1	0.13	1.18	0.241
emp_3 & barriers_2	132	0.17	1.59	0.116	emp_6 & barriers_2	-0.15	-1.40	0.166
emp_3 & barriers_3	132	0.14	1.28	0.205	emp_6 & barriers_3	-0.12	-1.14	0.257
emp_3 & barriers_4	132	0.05	0.46	0.646	emp_6 & barriers_4	-0.25	-2.44	0.017
emp_3 & barriers_5	132	-0.12	-1.16	0.250	emp_6 & barriers_5	-0.00	-0.02	0.982
emp_3 & barriers_6	132	0.01	0.13	0.901	emp_6 & barriers_6	0.00	0.02	0.984
emp_3 & barriers_7	132	0.04	0.33	0.739	emp_6 & barriers_7	-0.16	-1.52	0.132

The analysis of the relationship between employees' attitudes and barriers to technology implementation gave rise to six statistically significant negative weak correlations $p < 0.05$. It was found that the attitudinal feature emp_1 (Employee involvement in the design and implementation of RPA solutions) was negatively related to the characteristics barriers_3 (Numerous exceptions and frequent process changes) and barriers_4 (Many paper documents entering the processes). It can therefore be concluded that as the importance of the results for attitudes increased, the significance of the results for barriers to technology implementation decreased. A significant negative correlation was also found between the variable emp_2 (Employees' satisfaction with the decision to start implementing RPA solutions) and the variable barriers_4 (Many paper documents entering the processes), thus it can be concluded that as the importance of the results for attitudes increased, the significance of the results for barriers to technology implementation decreased. The same negative correlations were found between the variable emp_4 (Employees feel more satisfied after implementing RPA solutions) and the variable barriers_3 (Numerous exceptions and frequent process changes). It was found that the characteristic emp_5 (Employee resistance and reluctance) was negatively related to the variable barriers_7 (Problems with maintaining a proper level of data). It was also found that the attitudinal variable emp_6 (Employees' fears of keeping their jobs) was negatively related to the feature barriers_4 (Numerous paper documents entering the processes). Thus, it can be concluded that in the case of the analyzed relationships, when the importance of the results for attitudes increased, the significance of the results for barriers to technology implementation decreased.

Subsequent analyses were concerned with verifying the association between the employees' attitudes (variables "emp_1 - emp_6") and determinants of technology implementation (variables "st1-st11"), (table 3).

Table 3. Correlation of Spearman's rank order (employees' attitudes and determinants)

Pair of variables	N	R Spearman	t(N-2)	p	Pair of variables	R Spearman	t(N-2)	p
emp_1 & st_1	132	0.02	0.16	0.87	emp_4 & st_1	0.07	0.64	0.53
emp_1 & st_2	132	0.05	0.48	0.63	emp_4 & st_2	0.03	0.29	0.77
emp_1 & st_3	132	0.16	1.54	0.13	emp_4 & st_3	0.04	0.34	0.73
emp_1 & st_4	132	0.10	0.94	0.35	emp_4 & st_4	0.03	0.24	0.81
emp_1 & st_5	132	0.16	1.52	0.13	emp_4 & st_5	0.07	0.69	0.49
emp_1 & st_6	132	0.07	0.65	0.52	emp_4 & st_6	0.04	0.38	0.71
emp_1 & st_7	132	0.04	0.35	0.72	emp_4 & st_7	0.00	0.03	0.98
emp_1 & st_8	132	0.16	1.48	0.14	emp_4 & st_8	0.12	1.15	0.25
emp_1 & st_9	132	0.12	1.11	0.27	emp_4 & st_9	0.02	0.15	0.132
emp_1 & st_10	132	0.06	0.53	0.60	emp_4 & st_10	0.05	0.44	0.66
emp_1 & st_11	132	-0.00	-0.03	0.98	emp_4 & st_11	0.03	0.26	0.80
emp_2 & st_1	132	-0.04	-0.40	0.69	emp_5 & st_1	0.06	0.56	0.57
emp_2 & st_2	132	-0.07	-0.66	0.51	emp_5 & st_2	-0.04	-0.37	0.71
emp_2 & st_3	132	0.20	1.93	0.06	emp_5 & st_3	-0.03	-0.28	0.78
emp_2 & st_4	132	0.04	0.40	0.69	emp_5 & st_4	-0.08	-0.71	0.48
emp_2 & st_5	132	0.18	1.66	0.10	emp_5 & st_5	-0.04	-0.33	0.75
emp_2 & st_6	132	-0.01	-0.13	0.90	emp_5 & st_6	-0.04	-0.32	0.75
emp_2 & st_7	132	-0.12	-1.13	0.26	emp_5 & st_7	-0.08	-0.72	0.47
emp_2 & st_8	132	0.01	0.07	0.95	emp_5 & st_8	0.03	0.25	0.81
emp_2 & st_9	132	0.03	0.26	0.79	emp_5 & st_9	-0.02	-0.22	0.83
emp_2 & st_10	132	0.08	0.74	0.46	emp_5 & st_10	-0.03	-0.23	0.82
emp_2 & st_11	132	0.02	0.22	0.83	emp_5 & st_11	0.01	0.11	0.92
emp_3 & st_1	132	-0.05	-0.50	0.62	emp_6 & st_1	0.02	0.21	0.84
emp_3 & st_2	132	0.06	0.60	0.55	emp_6 & st_2	-0.07	-0.67	0.50
emp_3 & st_3	132	-0.06	-0.56	0.57	emp_6 & st_3	0.18	1.70	0.09
emp_3 & st_4	132	0.05	0.47	0.64	emp_6 & st_4	-0.01	-0.06	0.96
emp_3 & st_5	132	0.02	0.22	0.83	emp_6 & st_5	0.12	1.08	0.28
emp_3 & st_6	132	0.01	0.07	0.95	emp_6 & st_6	-0.01	-0.13	0.90
emp_3 & st_7	132	0.10	0.132	0.38	emp_6 & st_7	-0.14	-1.36	0.18
emp_3 & st_8	132	0.02	0.16	0.87	emp_6 & st_8	0.02	0.20	0.85
emp_3 & st_9	132	0.03	0.32	0.75	emp_6 & st_9	-0.05	-0.49	0.63
emp_3 & st_10	132	0.08	0.72	0.47	emp_6 & st_10	0.03	0.27	0.79
emp_3 & st_11	132	0.05	0.45	0.65	emp_6 & st_11	0.01	0.11	0.91

The analysis of the results in table 3 gave rise to the conclusion that employees' attitudes were not significantly correlated with the determinants of the use of RPA solutions in the company ($p > 0.05$).

The subsequent analyses were concerned with verifying the links between statements in employees' attitudes (variables "emp_1 - emp_6") and managers' opinions (variables "inv1-inv7")

Table 4. Correlation of Spearman's rank order (employees' attitudes and managers' opinions).

Pair of variables	N	R Spearman	t(N-2)	p	Pair of variables	R Spearman	t(N-2)	p
emp_1 & inv_1	132	0.03	0.3	0.76	emp_4 & inv_1	0.02	0.2	0.83
emp_1 & inv_2	132	0.06	0.5	0.59	emp_4 & inv_2	-0.03	-0.3	0.75
emp_1 & inv_3	132	0.21	2.0	0.05	emp_4 & inv_3	0.21	2.0	0.05
emp_1 & inv_4	132	0.25	2.4	0.02	emp_4 & inv_4	0.19	1.8	0.08
emp_1 & inv_5	132	0.10	1.0	0.34	emp_4 & inv_5	0.01	0.1	0.93
emp_1 & inv_6	132	0.10	0.9	0.36	emp_4 & inv_6	0.06	0.6	0.58
emp_1 & inv_7	132	0.05	0.5	0.64	emp_4 & inv_7	0.01	0.1	0.94
emp_2 & inv_1	132	-0.11	-1.0	0.30	emp_5 & inv_1	-0.03	-0.3	0.80
emp_2 & inv_2	132	0.20	1.9	0.07	emp_5 & inv_2	-0.05	-0.4	0.66
emp_2 & inv_3	132	0.08	0.7	0.46	emp_5 & inv_3	0.16	1.5	0.13
emp_2 & inv_4	132	0.19	1.7	0.08	emp_5 & inv_4	0.16	1.5	0.14
emp_2 & inv_5	132	0.19	1.8	0.08	emp_5 & inv_5	0.02	0.2	0.87
emp_2 & inv_6	132	0.01	0.1	0.94	emp_5 & inv_6	-0.02	-0.2	0.86
emp_2 & inv_7	132	0.21	2.0	0.05	emp_5 & inv_7	-0.01	-0.1	0.93
emp_3 & inv_1	132	0.01	0.1	0.91	emp_6 & inv_1	-0.06	-0.5	0.61
emp_3 & inv_2	132	0.01	0.1	0.93	emp_6 & inv_2	0.10	0.9	0.35
emp_3 & inv_3	132	-0.02	-0.2	0.85	emp_6 & inv_3	0.12	1.1	0.25
emp_3 & inv_4	132	-0.11	-1.0	0.32	emp_6 & inv_4	0.25	2.4	0.02
emp_3 & inv_5	132	-0.06	-0.6	0.56	emp_6 & inv_5	0.17	1.6	0.11
emp_3 & inv_6	132	-0.03	-0.3	0.80	emp_6 & inv_6	0.04	0.4	0.72
emp_3 & inv_7	132	0.02	0.1	0.132	emp_6 & inv_7	0.08	0.7	0.46

The analysis of the relationship between employees' attitudes and barriers to technology implementation and gave rise to four statistically significant positive weak correlations $p < 0.05$. It was found that the feature related to employees' attitudes emp_1 (Employees' involvement in the design and implementation of RPA solutions) was positively related to the variable inv_4 (It is very difficult to find specialists with the required competencies on the market). So it can be concluded that as the importance of the results for attitudes increased, so did the significance of this statement. It was found that the attitudinal variable emp_2 (Satisfaction of employees with the decision to start implementing RPA solutions) was positively related to the feature inv_7 (Understanding that automation of business processes is requisite). Thus, it can be concluded that as the importance of the results for attitudes increased, so did the significance of this statement. It was found that the attitudinal feature emp_4 (Employees feel more satisfied after the implementation of RPA solutions) was positively correlated with the variable inv_3 (The wage pressure in Poland is the highest in Europe, which increases the cost of back office labor). Therefore, it can also be concluded that with an increase in the significance of the results for attitudes, the significance of this statement also increased. It has been proved that the attitudes feature emp_6 (Employees' fears about keeping their jobs) was positively related to the variable inv_4 (It is very difficult to find specialists with required competencies on the market).

CONCLUSIONS

The results of this study contribute to scientific knowledge and also have practical implications for managers and decision-makers in the field of process automation related to the adoption of RPA algorithms in enterprises. All the more important is that RPA is considered as a technology with the prospect of further growth in adoption.

The analyses of the employees' attitudes allow to conclude that the highest score was for the feature related to employees' involvement in the design and implementation of RPA solutions. Such engagement is the result of respecting the organizational culture by managers, which plays a key role during crisis moments. Building it in the era of the COVID-19 pandemic is especially crucial because the involvement of employees, their cooperation, and proper identification with the organization allow for appropriate changes in management and support the company to survive the crisis.

The respondents indicated the most frequent barriers to technology adoption related to improperly prepared processes in enterprises as they are still non-optimized, non-standardized, and non-digitized with frequent changes and a large number of exceptions, and a significant proportion of paper documents entering the processes.

The factors highly assessed by managers and thus significantly influencing decisions on the implementation of RPA technology in enterprises during the pandemic were: understanding that investing in innovative technologies is essential in achieving competitive advantage; the ability to maintain processes' business continuity and fulfill operational objectives as well as achieving lower operating costs. These ratings confirm the usefulness and functionality of this technology and the appropriateness of its use in ensuring business continuity during the pandemic.

The huge enthusiasm that accompanies the robotization of business processes makes managers perceive this technology as a universal solution to their problems. Meanwhile, research conducted by an international team of researchers shows that it does not always happen as expected. It turns out that while robots are increasingly replacing human labor, there are also cases in which humans take over robots' tasks again. Researchers called such a phenomenon re-manualization and it results from the fact that some managers who introduce robots are too enthusiastic, their lack of understanding for the specifics of this solution and the use of a robot without prior preparation of the team for this fact (Modliński, et. al, 2022).

Modern technologies should support people in their everyday life and work, and not replace them. Innovative technological and IT solutions should support people's creativity, and allow them to perform activities requiring intelligence, sensitivity, and empathy. Some authors claim that interrelations between computers and creativity are constantly being redefined as technology rapidly evolves (Wojciechowski, A. & Korjonen-Kuusipuro, K., 2021). Simple, tedious, routine activities should be transferred to algorithms and machines. The authors are convinced that artificial intelligence, automation, and robotization will not replace humans. Both humans and algorithms offer different opportunities and strengths. The real question is, how can human intelligence with artificial intelligence develop augmented and hybrid intelligence?

RPA software spending worldwide has almost quadrupled in the last four years. Over the past four years, investment in RPA software has nearly doubled globally. However, according to Ernst & Young, between one-third and half of the organizations that made the

switch to RPA experienced project failure (2016). A contributing factor to such failure is the aim to entirely eliminate human involvement in the process. This confirms the authors' belief that algorithms alone, without human supervision, are not enough. Their role should be to support employees, relieve them from tedious and simple work, and release their potential. It is people with their creativity, sensitivity, and the ability to draw conclusions that are the foundation of every enterprise. Certainly, automation and robotization will develop dynamically in the future, so it is extremely important now to inform employees about plans for the implementation of such solutions in the enterprise so that they are part of this process, and do not feel threatened and fear for their jobs.

People have to rely on their digital co-workers. To build that trust, leaders need to help them understand what these tools can and cannot do. Leaders must demonstrate their role in supporting employees in the human-machine team by clearly defining business processes and demonstrating how human-machine teams create value. In today's economy, human-machine cooperation is gaining ground. It is fundamental to make efforts to achieve strategic business goals and customers and employees will begin to anticipate it. Employees are changing rapidly, and companies are looking for automation to ensure stability. Businesses are experiencing the pressure of automation due to low unemployment, but they are also seeing the strategic benefits of human-machine collaboration (Kulp, 2021).

RPA focuses on developing better, more effective ways to carry out repetitive tasks in a way that significantly more closely complements human abilities than completely replaces them. Organizations should continue to use business process automation solutions as this can be partially used as a business continuity enabler in the eventuality of a similar crisis. It is primarily intended to free employees from monotonous, time-consuming and simple tasks, and provide more demanding opportunities for the company to evolve. Moreover, it redirects the employees' potential to the demanding tasks of increasing competitiveness and improving service quality. The time is now for business processes to be redesigned so that people and machines can work together to provide the best experiences for both customers and employees.

Limitations

The presented investigations should be considered as a pilot study. The analysis was carried out on a not representative group of service enterprises and the selection of the sample was deliberate. Such a procedure was adopted because relatively few enterprises in Poland have implemented RPA technology to automate simple business activities and processes. It is also worth noting that the research was conducted only at the time of the coronavirus restrictions. The aim was to identify employees' attitudes towards RPA technology adopted to ensure business processes in organizations. It is a specific time of crisis and it is thus important to conduct similar research in other, different streams.

Future research

As part of the ever-evolving digital transformation, Robotic Process Automation is attracting a lot of business attention. While RPA is a hot topic in the business world, a theoretical and

succinct examination of RPA is still lacking in academic research. There is not enough research and literature on RPA as a specialist area of information technology (Aldossari & Zin 2019). Further research could include a thorough evaluation of RPA technology, elaborating on roadmaps for effective implementation, and revealing factors influencing the adoption of RPA technology. The authors suggest undertaking a scientific discourse and conducting comprehensive, in-depth scientific research aimed at formulating recommendations addressed to the management staff of enterprises, thus providing examples of good practices and success stories. They would be important from the point of view of creating an organizational culture in enterprises in which employees accept such innovative technologies and automation and are involved in the process of adopting such solutions to support their common work. The authors can also provide a discussion about the future-oriented development of computer-related functions, integration, and processes for software robots. The authors are convinced that software robots will collaborate with humans and work side-by-side with them, freeing up human attention for tasks requiring creativity and social skills. Thus, a new understanding of the function of human resources is required, together with the identification of new roles in business processes. In the conditions of the future human-robot interaction and collaboration, it seems to be a key issue.

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IMPACT OF TECHNOSTRESS ON WORK-LIFE BALANCE

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Abstract: *One of the many factors that contribute to the success of an organisation is the use of professional information technology (ICT). The pandemic situation of recent years has highlighted the benefits of using state-of-the-art ICT. However, exploring the negative consequences is a less popular topic. The aim of this research is to identify the most significant risks factors of technostress that threaten the balanced performance of employees at work and the possibility of work-life balance. In 2021, statistical correlations between risk factors for technostress were identified using SPSS 26, based on the opinions of 237 Hungarian higher education staff. Using SPSS AMOS 27, a proprietary model was built to test the impact of the most serious risks on personal and work life. The results show that three factors have the greatest impact on work-life balance, which also affect organisational performance. Loss of leisure time due to techno-overload and techno-invasion, and a feeling of techno-uncertainty due to lack of ICT competence cause a sense of threat. These compromise work-life balance and, at the same time, work performance. The mutually reinforcing negative effects influence the sense of well-being (happiness) at work, the feeling of job security and force employees to learn continuously.*

Keywords: *info-communication technology, organisational performance, risk, well-being, work performance.*



INTRODUCTION

Information and Communication Technology (ICT) is the driving force behind the new economic revolution. If we look at it from a positive perspective, it can be seen as a set of tools at the disposal of the modern worker. Information available everywhere and at any time, easier communication within the organisation, and ever faster technologies can all be counted as benefits (Stadin et al., 2019). On the negative side, we can say that the psychosocial workload is increasing, that the opportunities offered to the worker by new technologies are turning into pressure in the form of rising expectations from all sides (Califf et al., 2020; Rohwer et al., 2022). Technostress (stressful situations caused by technology) is the most critical of the negative effects of intensive use of smart devices. According to one of the first publications in the literature, technostress is defined as all the negative effects that technology has, directly or indirectly, on attitudes, opinions, behaviour or physically on the human body (Weil and Rosen, 1988). More serious problems are information overload and connectivity problems. Any effect caused directly or indirectly by technology that negatively affects attitudes, thoughts, behaviour, or causes negative physiological changes (Niedhammer et al., 2021).

As organisational ICT systems evolve, their use requires staff constantly to renew and update their digital skills (Fischer et al., 2018; Salazar-Concha et al., 2021). It is undeniable that the importance of technology in all organisational domains has been enhanced, with AI-driven systems now coming to the fore (Day et al., 2012; Seaward, 2018; Korzynski et al., 2021). The continuous evolution of technology is reflected in the relationships between and within organisations, regardless of size and type, both horizontally and vertically. This evolution is forcing resource-rich and resource-constrained operators continuously to adapt (Boyer-Davis, 2020). It also automatically brings with it pressure on staff to adapt to changing competence needs (Martínez-Navalón et al., 2023). The pandemic situation of recent years has only increased this pressure, as from one moment to the next, employees have had to work not only in a different environment (home office), but often without support, using unfamiliar systems (Rosen et al., 2010; Scaramuzzino & Barfoed, 2021; Schmidt et al., 2021). The often chaotic world of IT has created a challenging and stressful situation. The consequences of this situation are still felt today. It is therefore no coincidence that technostress has become an important area of scientific research in recent years (Saim et al., 2021; Whelan et al., 2022). The studies have mainly taken an organisational approach to the problem and have tended to neglect the personal side. According to Champion (1988 in La Torre et al., 2018), technostress is the cost of using technology, which has a wide range of effects. This implies that the compulsion to use smart devices cannot be clearly separated into the work and private spheres (Cahapay & Bangoc 2021; Pflügner, 2022). The link between them, the compulsion to use, does not end when working hours are over. This constant on-call situation is one of the reasons why people are often unable to switch off and disconnect from these devices, and privacy suffers (Körner et al., 2019; Aziz et al., 2021). This shift in the work-life balance poses a serious risk to the health and social relationships of individuals, while on the organisational side it threatens the success of the organisation as a whole through workplace performance (Popma, 2013; Efilti & Çoklar, 2019; Dragano & Lunau, 2020; Wu et al., 2023).

The aim of this research is to examine the interaction between the different elements of technostress, defining the most serious risk effects. Then, by examining the most critical factors, to highlight the threats to successful organisational functioning.

Research questions

Q1: Is there a link between the risk factors for technostress?

Q2: What are the most important risk factors for stress and its consequences?

Q3: Which areas of work and/or private life are most affected by technostress-related problems?

Q4: What risks do technostress situations pose to organisational functioning?

In the following chapters, after a brief literature review, the empirical research, its methodology and results are presented. Finally, the discussion and conclusions conclude the paper.

LITERATURE REVIEW

Technostress is not an entirely new term, it was coined at the same time as the first major IT developments (Broad, 1984). After this period, there were fewer publications on the subject. People became aware of the need for progress, and the need to adapt, which was still in evidence, became part of everyday practice. The last few years, and in particular the changes brought about by the pandemic, have greatly enhanced the importance of the subject. Research has suddenly proliferated, indicating the widening scope of the problem. The field has an interdisciplinary character, forming a link between information systems and psychological and business management research. It is a constantly evolving phenomenon, as new types of information systems (including applications and tools, artificial intelligence solutions) are constantly emerging and their use requires new approaches from users (Tarafdar et al., 2017).

Thus, the scientific explanation of technostress has gradually expanded and changed over the last 40 years in response to environmental conditions and experiences. According to Brod's (1982, 1984) definition, we are talking about a phenomenon in which individuals are unable to adapt or cope in a healthy way with new information and communication technologies. According to the later Weil and Rosen (1997) formulation, technostress is defined as any negative impact on attitudes, thoughts, behaviour or body physiology caused directly or indirectly by technology. In the literature, the studies of Ragu-Nathan et al. (2008) provided a new milestone and definition of stress as the experience of stress by IT users when using technology. In other words, it refers to information overload that makes employees partially or completely unable to cope with the difficulties and challenges caused by IT. Learning new technology can also be included in this group. In their research, the components of technostress were characterised as stressor-related events. In their study, Tarafdar et al. (2010) focused not only on the stress factors experienced by people working with IT technology but also on the technological environment. In doing so, they highlight the increasingly important social and economic role of this research area.

With the rise of the digital world, automation and information and communication technology, practitioners have been able to identify a growing number of factors and components that have been identified as the root causes of technostress and that can provide a general theoretical basis for deeper analysis. According to Weil and Rosen (1997), technostress results from an organisation's failure to properly implement IT technology-based systems that influence individual experience.

Based on the summaries of empirical research reviewed by La Torre et al. (2018), the causes of technostress can be grouped into three categories: individual factors such as age, gender, education, and personality traits (Srivastava et al., 2015, Khedhaouria and Cucchi 2019), technology-related factors, and work-related conditions.

Alphonse et al. (2018) approached the relationship between technostress and well-being from a CSR perspective, through interviews with managers. They investigated the importance of technostress risks to employees for SMEs' managers. Five areas were identified where management can have an impact on risk management and thereby affect employee well-being. These are: work organisation, working conditions, working conditions, job content and interpersonal relationships. Their results show that, although the need to reduce risk is articulated, the translation of this need into action plans is rarely impeccably implemented.

The relationship between technostress and trust is also a major influence. This is because the human-technology relationship, personal and impersonal trust, determines the use of IT tools and the quality of software applications. Personality traits, as an individual characteristic, and the organisational culture have a proven influence on its manifestations. Psychological and then economic research has supported a significantly positive relationship (Oksanan et al., 2021; Pflügner et al., 2021). Among the factors studied, employee performance, satisfaction and burnout have been the main focus (Srivastava et al., 2015, Khedhaouria & Cucchi, 2019).

The following technostressor groups are accepted in the literature (Tarafdar et al., 2007; Ragu-Nathan, 2008; Pearson et al., 2009):

- Techno-overload: the IT system encourages employees to work faster and longer.
- Techno-invasion: the IT system also permeates employees' personal lives, making them available at all times. And employees feel compelled to stay in constant contact.
- Techno-complexity: due to the inherent configuration/quality of the IT system, employees do not feel that their own computer skills are adequate/necessary for their work.
- Techno-uncertainty/techno-complexity: refers to the constant changes and upgrades of software and hardware that can cause stress for employees.
- Technological unreliability: refers to situations where users feel threatened by the loss of their jobs.

Other work-related stressors have subsequently been identified in addition to the primary groups listed (Brown et al., 2014; Ninaus et al., 2015; Suh and Lee 2017; Stich et al., 2017):

- Mismatch between actual and desired PC use;
- Teleworking intensity;
- Email-related stressors (e.g. high email volume, poor email quality);
- Frequent interruptions during working hours.

The influence of these factors depends on personal psychological peculiarities. Particularly, it is proved that people characterized by higher dispositional anxiety perceived the new technology as more stressful in terms of technostressors (Jurek et al., 2021).

The most noticeable effects of technostress that can be observed in the functioning of organisations are:

- Increased role overload;
- Role conflict;
- Reduced job satisfaction;
- Fatigue and burnout.

The rise of a computer-driven economy and society has also contributed to an increase in the number of overworked workers, with the consequence of increased stress. At the societal level, its side effects have been shown to cause increasing problems in work relationships, personal relationships and health (Tarafdar et al., 2010).

The development of techno-overload is fuelled by workers' multitasking, work at home and failures in the technological background (hardware, software problems). Slow networks, network outages, outdated equipment and inconsistent data retrieval are major problems that prevent workers from achieving maximum efficiency as well as being able to support organisational goals as intended.

Across the functional areas of organisations, there is almost no area where some element of technostress risk is not present. According to Da Cunha et al. (2015), the negative consequences that flow from employees to the organisation include biased information input, and corrupt autonomy on the part of employees. In addition, the progressively increasing use of decentralised applications increases the negative effects of these trends.

Managing work-related stress requires skilled managers who can identify stressors and develop plans to reduce them in order to improve efficiency (Skakon et al., 2010). These measures became important within the employer value proposition development (Samoliuk et al., 2022). Çiçek and Kiliç (2021) investigated the role of transformational leadership. The results of the study show that transformational leadership behaviour negatively affects technostress. According to Ray (in FutureTalks.hu, 2020), as more and more artificial intelligence is created in the world, more and more emotional intelligence will need to be brought into leadership. These dependencies as well as the significance leader's role became especially obvious during the pandemic (Sarihasan et al., 2022). Thus, the issue of trust will continue to be a central theme in the strategic thinking of organisations.

The above shows that the proliferation and continued use of IT systems is having an increasingly powerful impact on the health of employees. Employees are forced to play catch-up in order to work faster, which in an ill-prepared and incompetent situation can pose a serious mental strain. It is common knowledge that mental problems can eventually lead to physical illness (Da Cunha et al., 2015). Thus, technostress has a direct impact on the well-being of employees within the organisation and on their health in their private lives.

An online survey carried out in 2008 shows that one third of employees find it problematic that their professional life takes over their private life (Paridon and Hupke, 2009). For example, employees in managerial positions find it more difficult to maintain the boundary between work and private life due to the obligation of being constantly available. The same can be said of employees who are in regular contact with clients. According to a survey carried out by the German IT trade association BITKOM in 2011, 88% of employees in the sector are available to customers, colleagues or superiors outside working hours. In fact, 29% of employees say they answer the phone at any time for professional matters.

Other studies point to a conflict between work, professional and private roles. This leads to an increase in the psychosocial burden of the individuals concerned (Tarafdar, 2011a). The study also shows that role conflict is more damaging than role overload and can be a source of further health problems. The intrusion of professional life into private life limits the possibility for workers to rest and recuperate. The link between the intensive use of ICT and fatigue is mainly manifested in poor sleep (Punamäki, 2007). Of course, it is not only the smartphone that is to blame for poor sleep quality. In some cases, sleep problems are simply the result of excessive work pressures on the worker, the so-called 'work mania' (iPass, 2011).

We know that chronic and/or severe fatigue can be associated with various health problems, such as weakened defence mechanisms, mood disorders, heart disease and neurological disorders. It is also known that fatigue is a safety risk and is responsible for the increase in accidents at work (Swaen, 2003; Dembe, 2005). Finally, fatigue resulting from chronic technostress also has a strong negative impact on productivity (Hung, 2011; Tarafdar, 2007). A survey of university students reveals that their cognitive performance is highly dependent on the quality of their sleep (Lund, 2009). Excessive workloads do not spare young people either, and technostress has a negative impact on students' academic productivity (Upadhyaya & Vrinda, 2021; Pillai et al., 2021; Alvarez-Risco et al., 2021; Iskandar, 2021). This problem is of course also true for workers. Research among university professors (Li & Wang, 2021; Magistra et al., 2021; Dung, 2021) and employees of for-profit organisations (Savolainen et al., 2021; Pflügner et al., 2021; Oksanen et al., 2021; Nemteanu & Dabia, 2021; Stadin et al., 2021) show similar results. Both techno-overload and techno-invasion are significantly associated with higher turnover intention, higher work-life conflict and can lead to burnout (Kenneth, 2021; Hwang et al., 2021).

In all of the above cases, the presence of technostress is a risk. For the employee, it is mainly health, social and job retention, while for the organisation it is economic and technological. In several European countries, there is a legal obligation for managers to carry out a risk assessment at the workplace, taking psychosocial factors into account. In many cases there are serious shortcomings in this risk assessment, as shown in research by Beck and Lenhardt. (2019). Several studies in the literature report on the results of assessments carried out in the spirit of legal obligations. These are not primarily concerned with technostress and the risk of its consequences. Other risk assessments of the risks to workers tend to focus on problems arising during work and/or in connection with working conditions, irrespective of the phenomenon of technostress. Qualitative studies have been conducted with SMEs' managers in Brussels (Pavlista et al., 2021) and Germany (Alphonse et al., 2018). Five areas were identified where leadership has an impact on risk management and thus can influence employee well-being. These are: work organisation, working conditions, working conditions, job content and interpersonal relationships at work. Their results show that, although the need to reduce risk is articulated, the translation of this into action plans is rarely flawless. It can be seen that there are serious shortcomings even in what can be considered classic working conditions. Thus, the identification and quantification of the risks of technostress are currently neglected.

Based on the above, it can be said that technostress has an impact on both the work and private lives of employees. Workplace performance is not only a function of professionalism and organisational conditions, but also of the way in which employees feel about their work.

In recent years, there has been an upsurge in research into these effects, which are broadly covered by the term wellbeing (Czerw, 2019; Hou et al, 2022; Katajavuori et al., 2023).

Well-being is the experience of health, happiness and a good life. There are many approaches to the conditions and characteristics necessary to experience this feeling (Kun & Gadanecz, 2022; El-Sharkawy et al., 2023; Lera et al., 2022), particularly, in terms of work activities (Aliyev, 2022). The literature suggests that it includes mental health, life satisfaction, a sense of purpose and the ability to cope with stress. In general terms, well-being simply means feeling good. But this simplification is not sufficient for scientific research and the use of research findings. It is worth deepening the thinking further and separating out areas where a more precise picture of the characteristics of well-being can be obtained. The literature identifies 5 areas where research on well-being should be extended. These are (Rath & Harter, 2010; Baker, 2020):

- Emotional well-being: generating emotions that lead to good feelings (stress management and relaxation techniques, self-love).
- Physical well-being: developing a healthy lifestyle, physical exercise habits for good physical fitness.
- Social well-being: building and maintaining a support network (communication, meaningful relationships, overcoming loneliness).
- Workplace well-being. Pursuing interests, values and life purpose (achieving meaning, happiness and professional development).
- Social well-being. Active participation in a well-functioning community, culture and environment.

To talk about general well-being, all of these types must be functioning to some extent. Of these, well-being at work is the focus of this research. Aiming to show how the impact of technostress affects employees' workplace activities, relationships, health and sense of security. Overall, the impact of risk factors on organisational functioning.

The requirements for risk assessment are best met by integrated risk assessment (Meulbroek, 2008). In risk assessment calculations (hazard identification, modelling of accident scenarios and consequence analysis), the emotional part of the human factor is generally not taken into account. However, it is very important to be aware of the influence of human behaviour and emotions when assessing the risk of technostress in terms of organisational functioning, management, culture and cooperation. In their research, Dragano and Lunau (2020) investigated the risk of digital technologies on the mental health of employees. The results did not provide a clear answer, confirming the need for further research.

In the next chapter, we will address the research questions in the empirical investigation by formulating our hypotheses.

Test Model

On the basis of the theoretical review and our own experience, we set up an analytical model in which we drew hypothesised relationships between the elements of the risk factors. Hypotheses were then formulated with these relationships in mind.

- H1 All technostress risk factors examined are significantly related to each other.
 H2 The risk factors that have the most pronounced impact on employees' behaviour, work and personal life can be identified.
 H3 Of the risks caused by technostress, work-life balance is the most at risk.
 The model is shown in Figure 1 below.

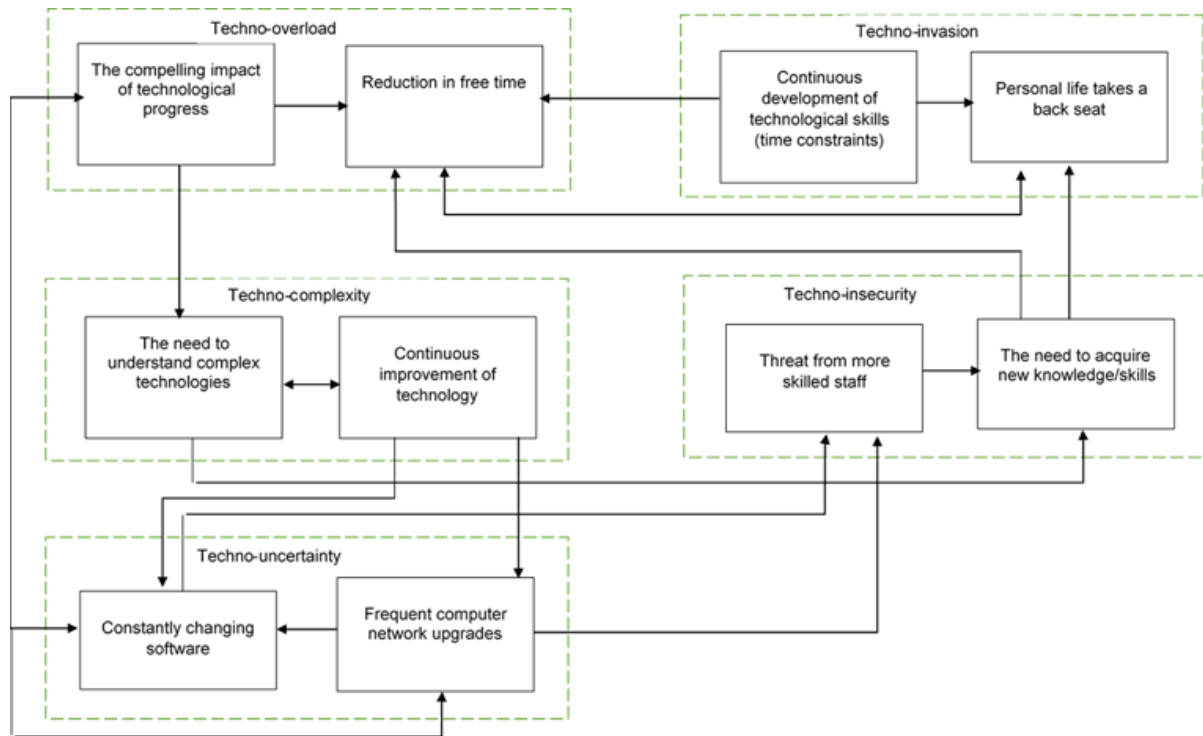


Figure 1. Test model
 Source: own construction

METHODOLOGY

In 2021, we launched a quantitative research in the form of a questionnaire survey. The questionnaire was sent to 62 higher educational institutions in Hungary. According to the Hungarian Central Statistical Office (KSH, 2021), in 2021 there were 23 511 teachers working in higher education in Hungary. The sample size was 237, which at the 95% confidence level for a population size of 23 511 represents a margin of error of 6.33% based on Creative Research Systems (2023). This means that the sample size provides a good basis for analysis and the results can be accepted with a confidence level of almost 95%. The questionnaire was sent by direct mail after a test phase. The questionnaire was available to all employees and was completed anonymously on the Internet. The questionnaire contained 48 questions. Respondents were asked to rate their level of agreement with each statement on a five-point Likert scale. A five indicated total agreement and a one indicated total disagreement. The structure of the questionnaire is shown in Table 1 below.

Table 1. Questionnaire structure.

1. Group of questions	2. Group of questions	3. Group of questions	4. Group of questions	5. Group of questions
Job title, position, work schedule, satisfaction, etc.	Attitude, security, motivation, appreciation, etc.	Information provision, technological readiness, equipment, institutional support	Respondents' own experience and feelings about the use of ICT technologies and tools	Demography

As the research targeted all higher education institutions, we aimed for a representative sample. Questionnaires were sent out via the deans, asking for management support in returning responses. Unfortunately, the response rate was not very high. About 11% of the questionnaires sent out were returned. Statistical evaluation was carried out using SPSS 26 software. Multiple regression statistical methods, including path analysis, were used to test the hypotheses. A significance level of 5% was used in the evaluation. Then, using SPSS AMOS version 27, we created a new proprietary model in which we examined the most important risk factors (stressors). The aim was to assess the correlation of risk factors affecting organisational performance. The sample characteristics are summarised in Table 2 below.

Table 2. Sample characteristics.

Characteristics	%
Gender	39,7% male 60.3% female
Age	19.4 % 35 years or younger 39.3% 35 - 45 years old 23.6% 45 - 55 years old 17.7% over 55 years
Highest level of education	1.3 % upper secondary education 98.7 tertiary education
Position	7.2% PhD student 1.7% administrative assistant 91.1% teacher, researcher

EMPIRICAL RESULTS

In our analysis, we examined how each technostress risk factor interacts with the other and the direction of the effect. We used pathway analysis to analyse how techno-overload, techno-invasion, techno-complexity, techno-uncertainty and techno-insecurity are strong risk drivers. The indicators used to measure techno-overload are the compelling impact of technological development and the Reduction in free time. In the case of techno-invasion, we looked at the continuous development of technological skills (lack of time) and the eclipse of personal life. Within techno-complexity, we analysed the need to understand complex technologies and the continuous improvement of technology. In measuring techno-insecurity, we looked at the threat posed by more skilled employees and the need to acquire new knowledge/skills. For the last risk factor, techno-uncertainty, we analysed the impact of constantly changing software and the frequent upgrading of computer networks. The results of the linear regression are summarised in Table 3.

Table 3. Linear regression results.

Parameters		Model summary				Standardised coefficients
Dependent	Independent	r ²	F	df	Sign	β
Reduction in free time	The compelling impact of technological progress	,105	27,563	1	,000	,324
Reduction in free time	Lack of time	,067	16,929	1	,000	,259
Reduction in free time	Personal life takes a back seat	,220	66,451	1	,000	,470
Reduction in free time	The need to acquire new knowledge/skills	,074	18,739	1	,000	,272
Personal life takes a back seat	Lack of time	,149	41,223	1	,000	,386
Personal life takes a back seat	Reduction in free time	,220	66,451	1	,000	,470
Personal life takes a back seat	The need to acquire new knowledge/skills	,095	24,671	1	,000	,308
The need to understand complex technologies	The compelling impact of technology	,227	68,891	1	,000	,476
The need to acquire new knowledge/skills	Threats to staff's technological skills	,111	29,481	1	,000	,334
Constantly changing software	Continuous improvement of technology	,254	79,806	1	,000	,503
Constantly changing software	Frequent computer network upgrades	,352	127,778	1	,000	,593
Frequent computer network upgrades	Continuous improvement of technology	,220	66,321	1	,000	,469

Source: own construction

Only significant relationships are shown in the table. The beta coefficient shows how much one variable affects the other. In Figure 2, the authors have marked these values. R square represents the proportion of the variance of the dependent variable in a regression model explained by an independent variable. The R squared coefficients, i.e. the changes in the variance of the dependent variable due to the independent variable, are higher in the following cases: Constantly changing software and Frequent computer network upgrades, which is 35%, Constantly changing software and Continuous improvement of technology, which is 25%, The need to understand complex technologies and The compelling impact of technology, which is 23%, Personal life takes a back seat and Reduction in free time, which is 22%, and Frequent computer network upgrades and Continuous improvement of technology, which is also 22%. The explanatory values are usually low and medium, for which there could be several reasons. The most respondents were university lecturers and researchers. Their employment is on flexible working hours, the content of their work is different from that of those in the business sector, and the opportunities for individual training are different from those in business organisations.

The results of the analysis demonstrate that the pressures of technological development, the lack of time associated with the continuous development of technological skills, the strong influence of technology on personal life and the need to acquire new knowledge/skills, each separately represent a risk to the sacrifice of employees' leisure time. The risk of personal life being overshadowed is compounded by the lack of time due to the continuous development of technological skills, the loss of free time and the need to acquire new knowledge/skills. There is a significant relationship between the constraints of technology and the need to understand complex technologies, with the threat of more educated employees influencing the risk of acquiring new knowledge/skills. A significant relationship can be found between constantly changing software, continuous technological development

and practical computer network upgrading as risk factors. Based on the significant relationship in the theoretical model, the following statements can be made.

- If workers are forced by the constant evolution of technology to do more work than they can handle, if they feel they do not have enough time to learn and develop their technological skills, and if technology is intruding into their personal lives, they are taking a high risk (at the expense of their free time) to keep up to date with the use of new technologies. *This risk is primarily a health risk, both mental and physical.*
- If workers need longer to understand and master the use of new technology, they risk sacrificing personal time. *This poses sociological and health risks.*
- If they feel that technology is intruding on their personal lives, they risk not having enough time to learn and develop their technological skills. *Health and job retention risk.*
- If they have to sacrifice their holidays and weekends to keep up to date with new technology, or if they need longer to understand and use new technology, they are also risking their free time. *Health and social (family life) risks.*
- In addition to the sacrifice of leisure time, the pressures of technological development also affect workers in terms of the complexity of understanding and using new technology. *Job retention and workplace relations (social) risk.*
- The feeling of being threatened by more skilled employees has a positive impact on the time taken to learn new technologies, but also poses a risk to organisational trust. *Social risk.*
- The constantly changing software within the institution, the continuous technological development and the frequent upgrading of computer networks reinforce each other. *Technological, economic and social risk.*

The background to these findings is provided by the network of relationships shown in Figure 2.

The results show that the first hypothesis (H1) is confirmed, as significant associations between these risk factors can be found. Based on the significance values written on the relationship, the second hypothesis (H2) is also considered to be confirmed, as the most pronounced risk factors (see coloured model elements) are detected. These factors show the most correlation. The technology constraint is significantly related to the complexity of understanding new technology, which suggests that there is a significant relationship between techno-overload and techno-complexity. Techno-overload and techno-invasion also influence each other, as there is a significant relationship between the marginalisation of personal life and the loss of leisure time. The crowding out of personal life has an impact on the need to acquire new knowledge/skills, which results in a significant relationship between techno-invasion and techno-insecurity. In addition to the strong impact on personal life, the need to acquire new knowledge/skills also has an impact on the loss of leisure time. On this basis it can be declared that techno-uncertainty is also linked to techno-overload. A link between techno-complexity and techno-uncertainty was found, as continuous technological development within the organisation is significantly related to constantly changing software. The results show that it is the marginalisation of personal life that is the real problem, and where the greatest risk is to be found. Based on the results, the third hypothesis (H3) is also accepted.

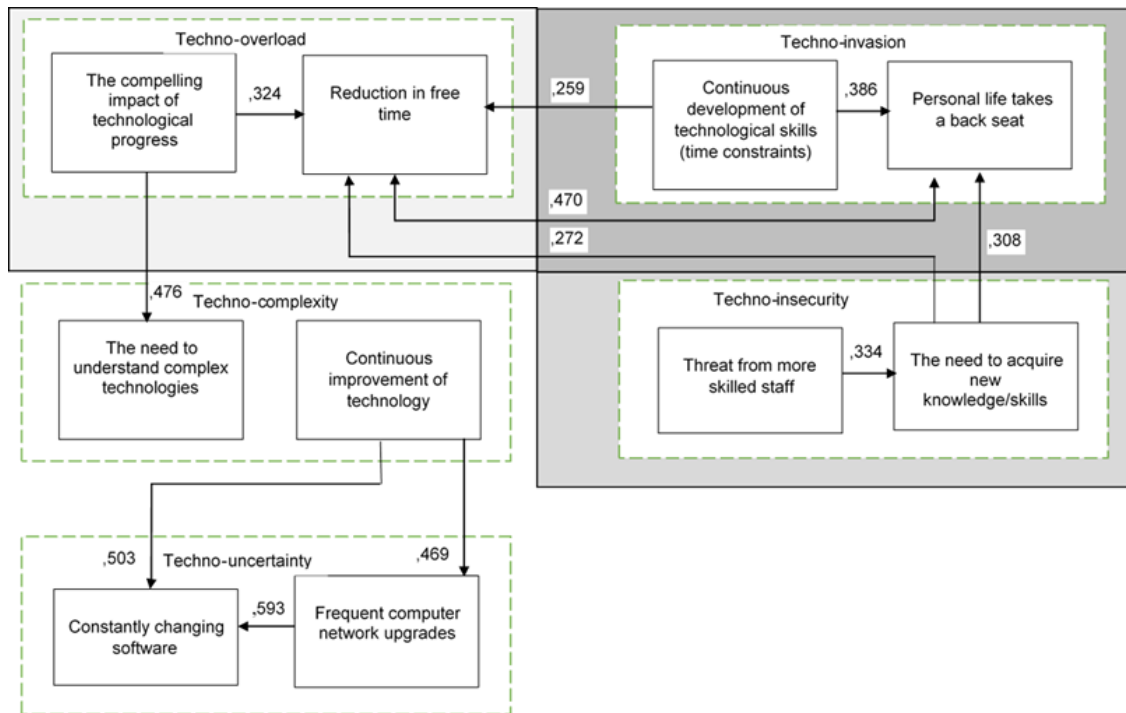


Figure 2. Significant association pattern of technostress risk elements.

Source: own construction

In response to the results so far, we can say that the respondents confirm the results of the statistical analysis. The main problem perceived by staff is in the area of work-life balance. This is the area most at risk, as was shown in the path analysis. In fact, learning new skills requires more effort, can initially slow down work processes, and the fact that additive effort is often only possible beyond working hours and not within them is an additional stress factor. This increases the problem of reconciling work and private life and poses a risk to performance at work. The threat posed by the higher level of knowledge of the more skilled worker is perceived as less pronounced. The statistical results allow a similar conclusion. The standard deviation values are generally large, except in the case of the fear of losing one's job due to the knowledge of the more qualified employee. This implies that there was heterogeneity in the respondents' opinions on each of the findings (see Table 4).

Table 4. Most important risk factors for technostress.

	Statements	Average	St. deviation	Components value
Plus efforts/techno-overload Cronbach's Alpha: .735	(PI1) Technology makes me work harder than I can handle.	2.65	1.100	.887
	(PI2) Not enough time to learn and develop my technological skills.	2.51	1.068	.653
Threat to private life/techno-invasion Cronbach's Alpha: .769	(P1) I have to sacrifice my holidays and weekends to keep up to date with new technology.	2.61	1.247	.840
	(P2) I feel that technology is encroaching on my personal life.	2.71	1.184	.797
Work threat/techno-uncertainty Cronbach's Alpha: .752	(W1) I feel threatened by staff for their newer technological skills.	1.81	0.905	.848
	(W2) I need more time to understand and use the new technology.	2.30	1.081	.820

Source: own construction

For further analysis, we focused on the 3 most pronounced risk factors, which are grey-coded in Figure 2 (techno-overload, techno-invasion, techno-uncertainty).

The variables were compressed into three factors by Varimax rotation (KMO Barlett test: .859 Kb Chi-squared: 594.612, df:15 sig.: .000, explained fraction 81.058%) for further analysis (see component values (Table 4, column 5) and factor names (Table 4, column 1)).

The survey asked respondents how secure they felt in their jobs. A high proportion of respondents (80%) generally felt so. The mean score on a scale of 5 was 4.1.

On a scale of one to five, respondents were also asked to rate how happy they were at work. Also a large proportion (77%) of respondents said that they are usually happy, with an average score of 3.97.

22% of those surveyed have to constantly update their technological skills to keep up to date at work.

A model was created using SPSS AMOS version 27, in which the risk factors (stress factors) in Table 4 were examined: extra effort/techno-overload, threat to privacy/techno-invasion, threat to work/techno-insecurity. The question was asked about their impact on job security, happiness at work (well-being), and continuous renewal of technology knowledge. These outputs are fundamental determinants of employees' performance at work and thus put organisational performance at risk.

The 'absolute model fit': the Khi-square was significant (33.449, df: 16, p: .0006). The RMSEA (Root Mean Square Error Approximation) value: .068, which should typically be below 0.08. For Incremental Model Fit, CFI: .975, NFI: .954, TLI: .928. For Parsimonious Fit, Khi squared/df: 2.091. The model is shown in Figure 3.

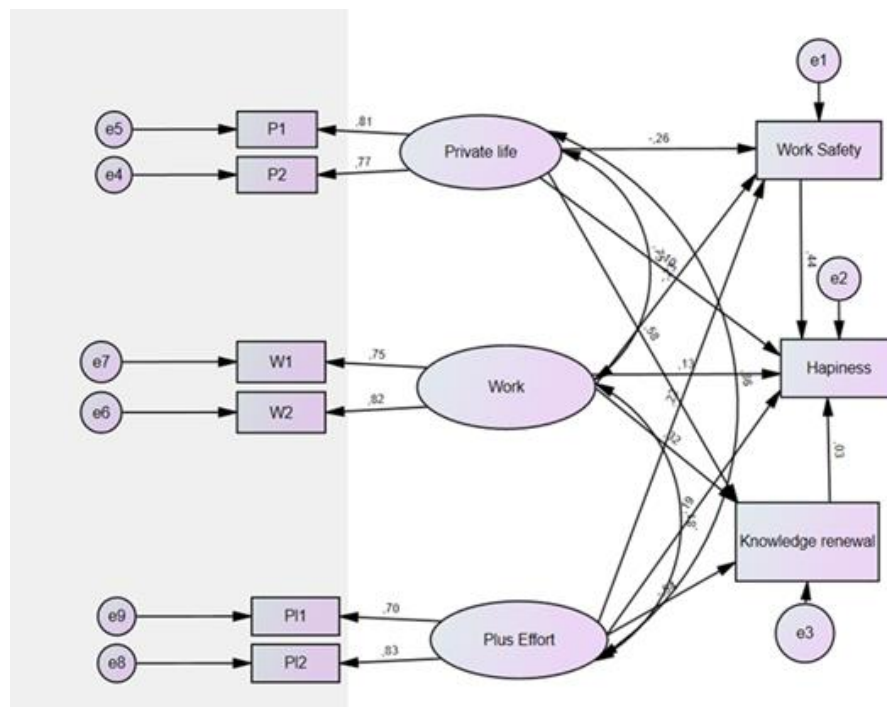


Figure 3. Effects of stressors on job security, job-generated happiness, and continuous technology knowledge renewal (risk value).

Source: Own construction (the components of the factors (P1, P2, W1, W2, PI1, PI2) are shown in Table 4

The graph shows that the more extra energy someone invests in learning technological skills, the more it will affect their personal life (work-life balance). The risk of losing a job generates more work (time spent learning) to learn new technologies and skills. And the fear of losing a job puts a stigma on personal life. A strong significant relationship can be demonstrated with regard to the need to sacrifice work-life balance in order to develop and constantly update technological skills. There is also a strong significant relationship between happiness and satisfaction at work.

Overall, the results of the research demonstrate that technostress factors pose a risk to work-life balance, workplace trust and, through this, organisational performance.

DISCUSSION

In response to the results so far, we can say that the results of the model analysis confirm the results of the statistical analysis. The main problem is perceived to be in the area of work-life balance. As was shown in the path analysis, this is the area most at risk. In fact, learning new skills requires more effort, may initially slow down work processes, and the fact that additive effort is often only possible beyond working hours and not within them is an additional stress factor. This increases the problem of reconciling work and private life and poses a risk to performance at work. The threat posed by the higher level of knowledge of the more skilled worker is perceived as less pronounced. The statistical results allow a similar conclusion. The standard deviation values are generally large, except in the case of the fear of losing one's job due to the knowledge of the more qualified employee. This means that there was heterogeneity in the respondents' opinions on each of the statements, but relatively high agreement on the likelihood of losing a job (see Table 4).

Previous research findings in the higher education sector show a mixed picture. In some areas similar results (Upadhyaya and Vrinda, 2021), in others different (Choi and Lim, 2016; Abilleira et al., 2021). This may be due to the fact that the higher education research presented in the literature has focused exclusively on students (Pillai et al., 2021; Alvarez-Risco et al., 2021; Iskandar, 2021) or exclusively on teachers (Li and Wang, 2021; Magistra et al., 2021; Dung, 2021). However, they did not survey the entire higher education workforce, including staff in support areas. This fact certainly has a major impact on the results obtained and the final conclusions. Results from the for-profit sector can be found in the literature (Savolainen et al., 2021; Pflügner et al., 2021; Oksanen et al., 2021; Nemteanu and Dabia, 2021; Stadin et al., 2021) which reach similar conclusions regarding the correlation of factors. We found one study that, similar to the questions of the present study, investigated the problem of reconciling work and family life through stress factors (Kenneth et al., 2021). The previous studies have mainly approached the issue from the perspective of the perception of stress, and the risk of technostress is not included in the study models. Likewise, the focus on the impact on organisational performance is limited (Hwang et al., 2021), mainly from the perspective of organisational culture, emotional intelligence, organisational trust, which are factors that fundamentally influence well-being and happiness at work. Some studies have been found that support our thinking that personality traits, human behaviour, and choice of leadership style can reduce the risk of technostress on organisational performance (Çiçek and Kiliç, 2021; Magistra et al., 2021; Kuzaini et al., 2021; Spagnoli, et al., 2021; Khan, 2021). This so-called "soft" approach is gaining ground

and there is a growing body of research that seeks to explore the impact of these factors. Soft factors and/or their comparative absence have been shown increasingly to put organisational performance at risk.

CONCLUSION

Overall, the results of the research show that the technostress factors are significantly related to each other. Based on the questions within the factors, the most significant factors that influence the sense of well-being in both work and personal life can be identified. As is known from the literature, a sense of well-being at work has a strong impact on work performance. Therefore, management should pay attention to those factors that pose a risk primarily to organisational performance. These are the possibility of work-life balance, happiness at work and the need to continuously renew knowledge. The pronounced risk of these factors can be clearly demonstrated by the analysis of our own model.

Limitations of the research include the limited possibilities for data collection and the reluctance of respondents to answer. The composition of the sample includes few opinions from support staff, which could have a negative impact on the results. Also, the results may be distorted by the fact that respondents had to answer on the basis of their own value judgements, which may vary according to the current mood and feelings at work.

The further direction: The aim is to increase the sample size possibly with an international perspective. Having shown in the research that technostress has a clear impact on work-life balance, the next step in the analysis is to test the relationships between age, marital status, position and family-friendly factors in organisational culture on an extended sample. The next research will focus on the profit-oriented sector, where data collection is ongoing. A comparison of the results will highlight the difference between the two areas, drawing attention to the management decisions that need to be made.

A novel finding of the research, which contributes to both theory and practice in published research to date, is that technostress factors are risk-assessed and that employee/organisational happiness is included among the factors that risk organisational performance. This relationship is closely related to work-life balance. Also, the approach of including not only teaching/research staff in the sample (even if in low numbers), but also those employed in support jobs, opens new avenues for further research. This perspective highlights that the success of higher education depends as much on the support staff as on the lecturers and students. In addition to the quantitative factors that qualify performance, the role of people – a major psychological risk factor – must be taken seriously in the changed workplace. It must also be seen that well-being is not just a buzzword in the field of HR management, but an organisational characteristic with risks that have a serious impact on organisational performance.

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TOWARDS THE STANDARDISED SET OF STIMULI FOR THE UNCANNY VALLEY PHENOMENON STUDIES

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Abstract: *This paper presents a pre-validated set of 12 static 3D stimuli for the needs of uncanny valley-related studies. We provide the set along with guidelines on how to use it, which are based on the aggregated data analysis covering previous laboratory and online studies. Guidelines cover the models' characteristics (in terms of human-likeness and other visual traits), issues related to the stimuli presentation and study groups. As the set is publicly available, we believe that it enhances future studies aimed at replicating the uncanny valley effect.*

Keywords: *uncanny valley, visual stimuli, replicability, human-robot interaction.*



INTRODUCTION

As Palomaki et al. (2018, p. 3-4) point out, the International Federation of Robotics estimated that by 2019 more than 42 million robots had been sold for personal use; meaning, they were quickly becoming an unavoidable element of our social ecosystem. This ecosystem consists of more and more robots with human-like traits, (i.e., social robots and various humanoid robots). What is important to understand about this ecosystem is that it should be perceived widely, not only as inhabited by real physical robots, but also their digital counterparts: computer graphics in video games, virtual assistants, virtual and augmented reality agents.

Picarra, Giger, Pochwatko, and Mozaryn (2016, p. 18) notice that a growing number of such robots will have an unavoidable effect on our expectations concerning robots: “(...) designing robots with human-like traits can enhance their interactive and social proficiency. Also, different degrees of human-likeness seem to impact differently potential user’s expectations and behavior”. This brings us to the idea of the so-called uncanny valley hypothesis (hereafter UVH). The hypothesis was formulated by Masahiro Mori (see Mori, MacDorman, and Kageki 2012). Mori hypothesises that when we present a subject with a series of different human-like models (including robots), certain models will trigger negative reactions (uneasiness, eeriness). As he suggests, this uneasiness will be caused by the almost humanlike characteristics of robots. We may imagine models presented in order, from the least human-like (like e.g., robotic arm) to the most human-like ones on the X axis. On the Y axis, we could present the affinity level. The specific name of the dependent variable is still under debate (e.g., Kätsyri, Förger, Mäkräinen, & Takala, 2015; see also Ratajczyk, 2022). It may be referred to as affinity, likability, general emotional reaction (positive/negative) and others. According to Mori’s suggestion, we will observe a growing level of affinity as we move towards human-like models, but past a certain level of human-likeness, the level of affinity will rapidly decrease. This is the “valley” (or as MacDorman and Norri Kageki call it “descent into eeriness” – Mori et al. 2012).

Recently, we have observed a growing body of UVH studies. However, as we may read in the extensive meta-analysis of such studies, “[I]t is surprising that empirical evidence for the uncanny valley hypothesis is still ambiguous if not non-existent.” (Kätsyri et al., 2015). One of the possible causes of such a situation, identified by Kätsyri et al., is the stimuli used for the research. “Mori himself used anecdotal examples to characterise different degrees of human-likeness (industrial robots, toy robots, prosthetics and even puppets, corpses and zombies)” (Kätsyri et al., 2015). In the literature, we can observe several different approaches to the study of UVH. Some researchers rely on real robots, but the vast majority of studies use various visual stimuli, such as 2D static pictures, animations, or videos. It is very seldom met that one set of stimuli appears in more than one study. This is strongly pointed out in Palomaki et al. (2018). Based on their attempts of replicating UVH effects, these authors conclude the following: “[t]o our knowledge there is generally a lack of pre-validated stimulus materials known to reliably, robustly, and repeatedly elicit the UV effect, such as a common repository of “uncanny” robot pictures (or other objects) – or specific guidelines to create such stimuli” (Palomaki et al., 2018).

This quote provides a direct motivation for this paper. As we have conducted four studies in which we have used the same set of visual stimuli, we have decided to analyse the

aggregated data in order to learn more about the models as well as produce the guideline for their use for future studies.

In what follows, we discuss related work and provide a background for certain design decisions and choices related to the set of 12 stimuli we use. After this, we introduce the set of models in section “The set”. Next, we shortly describe four studies in which these models were used and present analyses of the aggregated data taken from these studies. In our analyses we address the following questions:

- (i) Do the online and laboratory studies have different results when it comes to human-likeness evaluation and emotional reaction?
- (ii) Do we observe gender differences in the models’ assessment?
- (iii) Is there a correlation between the evaluation of human-likeness and time needed for the evaluation?

Section “ABOT Database Robot Human-Likeness Predictor Study” presents the evaluation of our data set in terms of human-likeness by using the ABOT Database Predictor tool. Section “Selected studies and their implications for the stimuli usage” contains selected results from the studies with the set, which offer potentially useful implications for the future use of the set. We end the paper with a discussion of the limitations of our study and the guideline for the future usages of the stimuli set. The guideline covers: models’ characteristics, stimuli presentation and study groups recommendations.

It is worth stressing that in this paper we do not focus on the examination of the uncanny valley effect. Our main goal is to test additional variables of a potentially disturbing nature (assessment of humanlikeness, experimental conditions), within the set of models which was used in our previous studies. Hence, we have decided to use the aggregated data from all of the studies with the described models. This meta-analysis allows for pointing out certain consistent observations across different groups of subjects (overall 237 participants) and different experimental conditions (laboratory and online). The main contribution here is the pre-validated set of models (publicly available for researchers) along with the guideline for its use and detailed discussion of factors and variables which should be controlled in future studies with the described set. As such we believe that this work enhances future studies aimed at replicating the uncanny valley effect (for computer generated graphics).

RELATED WORK

There are various sets of pictures of robots which were used as stimuli in UVH studies and are available for researchers. Mathur et al. (2020) shared a set of pictures of robots and humans acquired *via* Internet search with the strict exclusion criteria. In their study, they tested one of the UVH explanations (namely the categorization difficulty) with the use of this set. Narrower version of the set (only robots, without pictures of actual human faces) was also used by Mathur and Reichling (2016) in an attempt to replicate the shape of the uncanny valley proposed by Mori. The set of pictures used in these studies consists only of head views of real robots and human faces. Models are presented on different backgrounds and they differ slightly when it comes to their presentation (head position, neck visibility, light level). In the case of our set of stimuli we have decided on the evaluation of CGI (computer generated imagery) models. The reason for that was that the uncanny valley effect is also

recognized in animations and that we planned to use our models mainly for on-screen presentations. Another difference is that in our set models are presented with the whole body and are all in neutral pose. The use of CGI allows us to prepare the scene and the pose of a model freely, according to the needs of a particular study. Also, as the models are rendered in the 3D we can easily modify them and export only selected parts (e.g. only faces or only hands, etc.).

There are several studies which evaluated CGI characters from popular cartoons and animated movies (e.g., Dill et al., 2012; Katsyri, Makarainen, & Takala, 2017). The results show that semi-realistic movies more likely elicit uncanny feeling contrary to cartoonish and fully realistic movies. Mentioned studies used well known, popular characters from movies. Because cultural connotations may influence the emotions that characters evoke (for a discussion of such connotations related to the presented set of models see Łupkowski & Gierszewska, 2019) it is important to build additional knowledge on the basis of the evaluation of neutral characters and draw conclusions for future UVH research. Thus our decision was to prepare new models for the set and not use already known characters.

There are also studies which focused on identification of visual factors of characters which may cause specific emotional responses in the audience. Schwind, Wolf, and Henze (2018) presented design guidelines based on UVH research for CGI developers to prevent the uncanny valley. Zhang et al. (2020) prepared similar general guidelines for UVH researchers in order to reduce inconsistencies among studies. McDonnell, Breidt, and Bulthoff (2012) tested the influence of rendering styles on virtual agents' reception. They found that particular style of rendering may change the pleasantness of characters, but it does not change the trust toward these agents. All three studies focused on visual aspects of stimuli. We also discuss these issues for our set of models.

Additionally, Zhang et al. (2020) present the results of the UVH literature review, where they juxtapose online and laboratory studies, but they did not compare the differences explicitly. This is the topic we analyse for our set of models as we think that it is important to know whether the same model is evaluated differently in an online and in a laboratory study.

THE SET

Our set of models prepared for the needs of UVH studies described below consists of 12 static 3D images. As such, these studies are in line with an approach to study UVH by presenting static pictures to the subjects (see e.g., MacDorman, Green, Ho, & Koch, 2009; Geller, 2008; Piwek, McKay, & Pollick, 2014 or Schneider, Wang, & Yang, 2007).

The models (which can be found in the Appendix) were retrieved from 3D character banks (see <http://tf3dm.com> and <https://www.mixamo.com/>) and initially rendered using the Unity environment (<https://unity3d.com/>). All the models were chosen arbitrarily and then consulted with two designers experienced in game development. The models can be used in 2D studies (as pictures), as well as in static and dynamic (after applying an animation) 3D studies.

The models cover various levels of degrees of human-likeness (DOH), ranging from simplistic robots, through androids, animated characters, and up to human models. As we have discussed in (Łupkowski, Rybka, Dziedzic, & Włodarczyk, 2017), for the initial tests

we have also included three models presenting zombies as the visual stimuli. Based on the evaluation of the human-likeness issues for these models reported in (Łupkowski et al., 2017, p. 130) and the subject literature, like the aforementioned analysis of (Katsyri et al., 2017), we have resigned from further use of these models. The key features which we took into account were: visible facial features, detail level of the model (e.g., visible hands and fingers), and overall style of the model. For example, models intended as simplified robots do not have visible eyes and their hands and feet are not detailed. Also, the joints of various body parts are clearly visible, which gives them a very mechanical appearance. Models have the same height and are presented with a front face in a neutral pose. This presentation allows evaluation of body proportions, body elements (such as hands, feet), and even facial expressions.

It is worth noting that the set intentionally does not cover photo-realistic human renders. For all the models, we are dealing with computer-generated graphics only in order to have a consistent appearance. As pointed out by Zibrek & McDonnell (2014) different styles of rendering may possibly introduce additional confounding variables.

Along with this paper, we share the complete set of models. It may be downloaded from: https://osf.io/sxmju/?view_only=c7d7d042b5d2440aa3f66e6fb02fa538. This package contains all the models in the 3D *.blend format. For the needs of this paper we have re-rendered all the models with the open-source Blender 3D software (<https://www.blender.org/>). The aim was to make potential stimuli modifications easier and accessible for a wide audience as Blender 3D files allow for: (i) easy and fast rendering of 2D files of high resolution; (ii) easy modifications of the models (perspective change or lights placement on the scene); (iii) potential application of the models in different study scenarios (animation, virtual reality, augmented reality). This allows for easy preparation of the stimuli for the needs of future studies.

ANALYSES OF THE AGGREGATED RESULTS

Studies Selected for the Analysis

For the need of analysis presented below we aggregate data retrieved from the studies listed below. In all of them the same set of visual stimuli was used.

1. Łupkowski, Rybka, Dziedzic, & Włodarczyk (2019), *The Background Context Condition for the Uncanny Valley Hypothesis*;
2. Łupkowski, Gierszewska (2019), *Attitude Towards Humanoid Robots and the Uncanny Valley Hypothesis*;
3. Ratajczyk, Jukiewicz, & Łupkowski (2019), *Evaluation of the uncanny valley hypothesis based on declared emotional response and psychophysio-logical reaction*;
4. Łupkowski, Kulinski (2020), *Aspekty percepcji wirtualnych modeli humanoidalnych w kontekście zjawiska doliny niesamowitości [Perceiving human-like humanoid models – case study for the uncanny valley studies]*.

In these studies models were presented one by one to our subjects (in different orders) along with questions. These studies had different aims and research questions, but all four shared the same question addressing the presented models' degree of human-likeness. The subjects performed this evaluation by answering the following question: *How much does the*

presented model resemble a human? (Answer on a scale 1-5, where: (1) Completely not human-like; (2) Rather not human-like; (3) Beginning to look human-like; (4) Rather human-like; (5) Completely human-like).

Three of the studies also asked the question addressing the comfort dimension: *How comfortable are you when you watch this model in a given environment?* (Answer on a scale 1-5, where: (1) very comfortable, (2) quite comfortable, (3) neutral, (4) uncomfortable, (5) very uncomfortable). Emotional reaction towards models has been specified as a *comfort* as our goal was to identify stimuli which are troubling and far from being enjoyable (see “Limitations of the Study” section for discussion of limitations of such a choice).

Overall, 237 participants took part in these four studies (137 in the laboratory studies and 100 in the online study). We present the summary of these study groups in Table 1.

Table 1. Study groups summary.

Study	N	Age (mean)	Women	Form
Łupkowski et al. (2019)	64	20.70±1.81	44	laboratory
Ratajczyk et al. (2019)	43	24.21±3.80	21	laboratory
Łupkowski, Kuliński (2020)	30	21.67±2.18	15	laboratory
Łupkowski, Gierszewska (2019)	100	27.78±8.28	55	online

In what follows, we use the aggregated data to answer some interesting questions related to the use of the set we used. As indicated in the introduction, these questions will be:

1. Do the online and laboratory studies have different results when it comes to human-likeness evaluation and emotional reaction?
2. Do we observe gender differences in the models’ assessment?
3. Is there a correlation between the evaluation of human-likeness and time needed for the evaluation?

Answers to the above questions identify important factors related to the stimuli and are useful in formulating guidelines for their future use.

Studies Versus Laboratory Studies

Firstly, we will analyse whether we observe differences in the evaluation of human-likeness and comfort of the models between online and laboratory conditions. We find such knowledge to be very important for future studies. In many cases, it is much easier to organise and conduct online studies. However, the price is the lack of control over the exact way of displaying the visual stimuli (i.e. different screen sizes, colour profiles, web-browsers, etc.) and other disturbing factors (e.g., a subject is disturbed by incoming notifications from another web-browser tab).

Human-likeness

We use the human-likeness evaluation results to establish the alignment on the X axis of the UVH graph (see discussion in Łupkowski et al. 2017). As the measure of human-likeness score for a given robot we use the median of subjects evaluation. This measure was

successfully used in previous studies. Let us remind that the subjects answered the following question for each model: *How much does the presented model resemble a human?* (Answer on a scale 1-5, where: (1) Completely not human-like; (2) Rather not human-like; (3) Beginning to look human-like; (4) Rather human-like; (5) Completely human-like).

When we compare the online and the laboratory results, we can notice that they are significantly different for almost every model (see Table 2). However, when we consider only the median results for the robots, we may notice that they do not differ between laboratory and online conditions. This is illustrated in Figure 1. This result indicates that when we use median results for ordering the models, we can also decide to use the online form of study (and the form of presenting the models should not have an impact on the ordering).

Table 2. Online versus laboratory human-likeness evaluation. Mann-Whitney U test results (with Benjamini-Hochberg correction for multiple comparisons).

Model	Test Results	
Red robot	U = 5864.5	p = 0.006
Woman	U = 5857.5	p = 0.017
Blue robot	U = 5864.5	p = 0.026
Battle robot	U = 5226.0	p = 0.002
Animated boy	U = 5343.0	p = 0.002
Silver robot	U = 5889.0	p = 0.027
Man in a cap	U = 5516.0	p = 0.001
Black-skinned man	U = 5395.5	p = 0.001
Animated girl	U = 5478.5	p = 0.005
Android woman	U = 5358.0	p = 0.002
Robot smiley	U = 4998.0	p = 0.001
Animated woman	U = 6306.0	p = 0.129

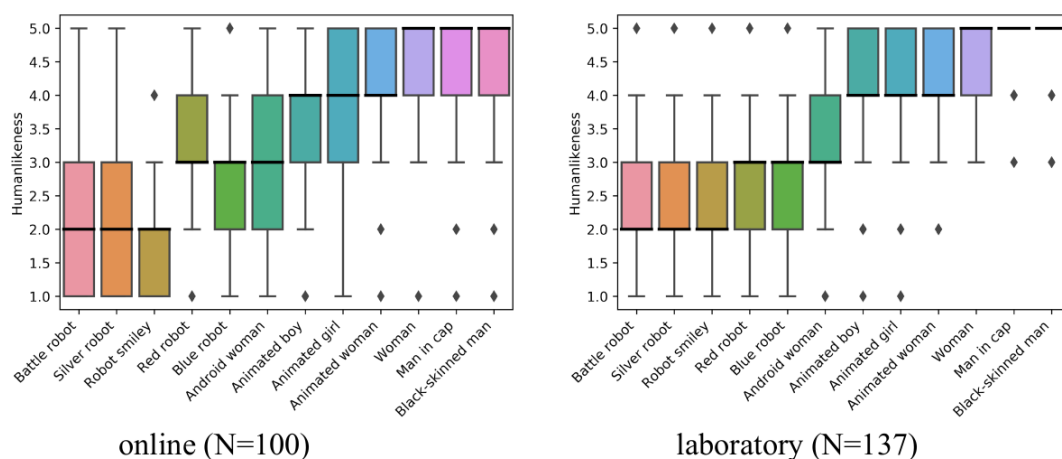


Figure 1. Online versus laboratory human-likeness evaluation (median results for robots).

This conclusion is supported by another observation. One may notice that the set can be divided into four sub-groups of models. We will refer to them as: (1) robots; (2) androids; (3) humanoids; and (4) humans. What is important is that the same sub-groups are visible across all four analysed studies (see Figure 2). This result is useful for future studies with the presented stimuli set, as we may potentially reduce the number of stimuli by selecting one representative stimulus for each established category, or, if needed, exclude a given category from the study (e.g., include only robots and androids as stimuli).

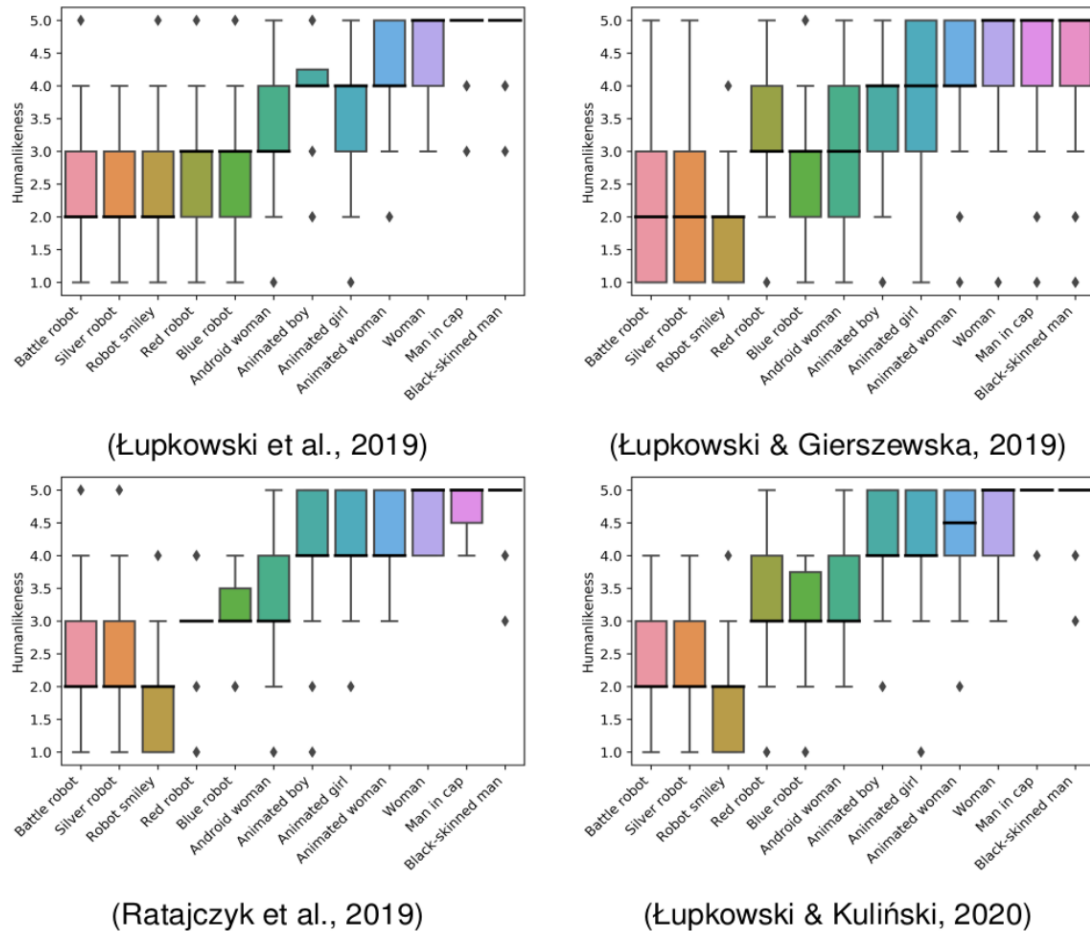


Figure 2. Sub-groups of the stimuli across the four studies.

Comfort

For the comfort dimension, we compare the results of Łupkowski et al., 2019) and (Ratajczyk et al., 2019) (laboratory condition; N=107) with (Łupkowski, Gierszewska, 2019) (online condition; N=100).

As pointed in section “Studies selected for the analysis” subjects reported their comfort of observing each model by answering the following question: *How comfortable are you when you watch this model in a given environment?* (Answer on a scale 1-5, where: (1) very comfortable, (2) quite comfortable, (3) neutral, (4) uncomfortable, (5) very uncomfortable).

Table 3 presents differences between the comfort evaluation, which are not significant for most of the models. Two notable exceptions are the red robot and the blue robot. As in the above case of human-likeness, this result indicates that we may use the proposed set in both online conditions and in laboratory ones. The variable of comfort should not differ between these two conditions. See “Limitations of the Study” section for a broader discussion.

Table 3. Online versus laboratory comfort evaluation. Mann-Whitney U test results (with Benjamini-Hochberg correction for multiple comparisons).

Model	Test Results	
Red robot	U = 3835	p = 0.001
Woman	U = 5184	p = 0.377
Blue robot	U = 4159	p = 0.012
Battle robot	U = 5078	p = 0.340
Animated boy	U = 5283	p = 0.438
Silver robot	U = 4934	p = 0.269
Man in a cap	U = 4980	p = 0.283
Black-skinned man	U = 4606	p = 0.090
Animated girl	U = 5120	p = 0.348
Android woman	U = 4891	p = 0.267
Robot smiley	U = 4583	p = 0.090
Animated woman	U = 4535	p = 0.090

Are There Any Gender Differences in the Assessment of the Models?

Based on the results reported in the HRI literature (see e.g. Pochwatko et al. 2015; Picarra, Giger, Pochwatko, and Goncalves 2016; Picarra, Giger, Pochwatko, and Mozaryn 2016) we expect to observe gender differences in the evaluation of our models. Picarra, Giger, Pochwatko, and Goncalves (2016) (see also Picarra, Giger, Pochwatko, and Mozaryn 2016) suggest that the possible explanation for these differences is that male and female participants associate robots with different contexts, such as the participant could potentially interact with robots in different settings, i.e. industrial vs. domestic robots or help with unemployment vs. help at home.

What is interesting in the aggregated data from our studies is that the differences between men and women are not significant for the human-likeness dimension evaluation. The only exception to this observation is for the model of the battle robot. As illustrated in Figure 3, men perceive it as more human-like than women.

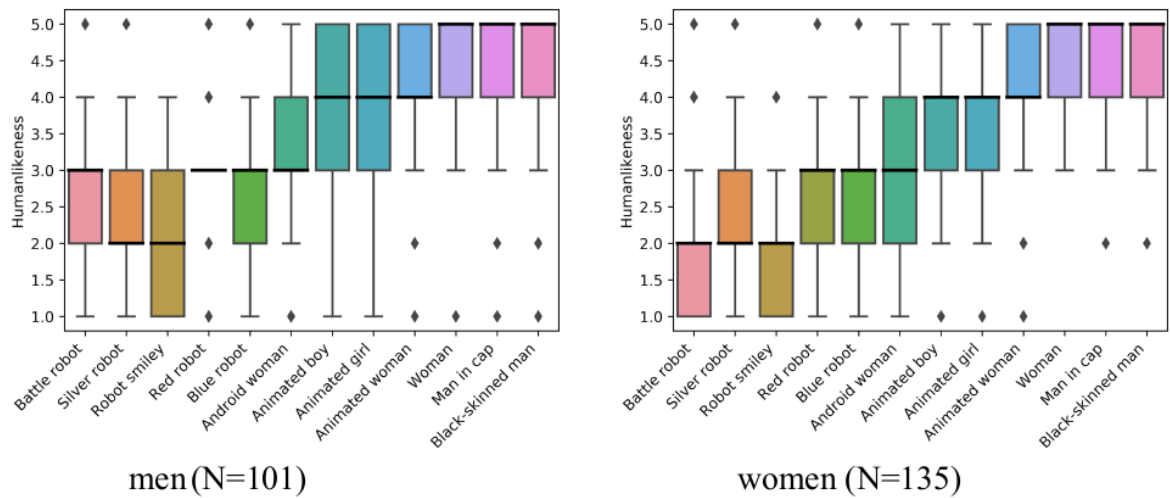


Figure 3. Men versus women in human-likeness evaluation.

As for the comfort evaluation, we do not observe any differences between men and women. Detailed test results are presented in Table 4.

Table 4. Men vs. women in human-likeness and comfort evaluation. Mann-Whitney U test results (with Benjamini-Hochberg correction for multiple comparisons).

Model	H-L test results	Comf. test results
Battle robot	U = 3346, p < 0.001	U = 5008, p = 0.498
Red robot	U = 4712, p = 0.312	U = 5043, p = 0.498
Blue robot	U = 4225, p = 0.066	U = 4672, p = 0.498
Silver robot	U = 4469, p = 0.183	U = 4896, p = 0.498
Android woman	U = 4496, p = 0.183	U = 4636, p = 0.498
Robot smiley	U = 4604, p = 0.247	U = 5027, p = 0.498
Animated boy	U = 4803, p = 0.387	U = 4571, p = 0.498
Animated girl	U = 4902, p = 0.393	U = 4908, p = 0.498
Animated woman	U = 4088, p = 0.034	U = 4708, p = 0.498
Woman	U = 4948, p = 0.393	U = 4990, p = 0.498
Man in cap	U = 4969, p = 0.393	U = 4871, p = 0.498
Black-skinned man	U = 4879, p = 0.387	U = 5054, p = 0.498

Is There a Correlation Between the Human-likeness Evaluation and Time Needed for this Evaluation?

In two of the analysed studies (Ratajczyk et al., 2019) and (Łupkowski, Kulinski, 2020), the procedure included the measurement of the time taken in providing answers to questionnaire questions (N=73, laboratory condition). This measurement allows us to test whether we would observe a correlation between the time taken providing the answer to the question about human-likeness and the evaluation provided in the answer.

As illustrated in Figure 4, we observe a significant correlation between the mean time of human-likeness evaluation (in seconds) and median values of this evaluation – $r_s = -0.604$, $p = 0.037$. The less human-like a model was perceived, the more time a subject needed to provide his/her evaluation.

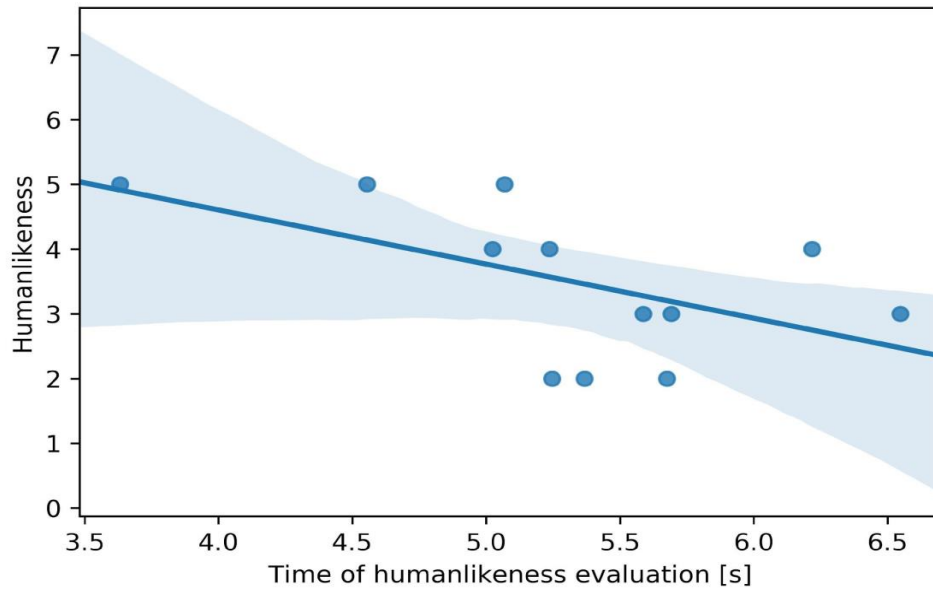


Figure 4. Correlation of human-likeness scores with time taken for the evaluation.

When it comes to the implications for the future use of the set, these results indicate that it is valuable to collect response times along with answers. These measurements will reveal interesting relationships between self-reported data and more objective measures.

We may also hypothesise that such a correlation suggests that the human-likeness scale is not uniform (see also the discussion in Katsyri et al. 2015 or Łupkowski et al. 2017). This means that the more leftmost a model on this scale, the more difficult the evaluation is. This difficulty is based on the model's appearance, as the least human-like models do not have visible facial features, or even hands or feet. This observation implies the usefulness of supplementing self-reported human-likeness evaluation with additional questions addressing aspects of the models which are important to the subjects while they are asked for human-likeness evaluation. Additional data (probably of qualitative characteristics) would provide us with a more in-depth understanding of the human-likeness evaluation process.

ABOT DATABASE ROBOT HUMAN-LIKENESS PREDICTOR STUDY

In this section we present the evaluation of the set with the use of the ABOT (Anthropomorphic roBOT) Database (<http://abotdatabase.info/>). It is a collection of real-world anthropomorphic robots that has been created for both research and commercial purposes (Phillips, Zhao, Ullman, & Malle, 2018). Each robot in the database is described with the Human-likeness score and Dimension scores for: Body-Manipulators (torso, legs, arms, hands, fingers), Facial Features (head, face, eyes, mouth), and Surface Look (gender,

head hair, skin, nose, eyebrow, eyelashes, apparel). Exemplary robots along with their ABOT scores are presented in Figure 5. These factors were established as the result of the study described in (Phillips et al., 2018, p. 107-110). At the time of designing the set of models, we were not aware of the ABOT Database. However (as we have described in section “The Set”) we took into consideration the following factors while choosing the models: facial features, presence of hands and feet, etc. Thus, for the needs of this paper, we have also decided to supplement our own choices and reported study results with the evaluation of the set against a very interesting ABOT tool designed for human-likeness prediction.

The ABOT Robot Human-Likeness Predictor (<http://abotdatabase.info/predictor>) is an online tool associated with this database. This tool allows the estimation of how human-like a given model will be perceived. After answering a series of questions for a given model (covering parameters like elements of clothing, skin appearance, the presence of hair, limbs description, etc.), the predictor provides the *Human-likeness score* and *Dimension scores*. With these scores, one can compare the model to the robots already present in the core collection of the ABOT Database¹. Thus, we have decided to use the Predictor to estimate the human-likeness of our stimuli.

The detailed results are presented in Table 5. One may notice that according to the estimations, animated characters and human groups were evaluated as almost completely human-like (received H-L score is 94.55). This is understandable, as the model underlying these predictions was developed for commercial robots. As for robots and androids, we observe that their results vary and therefore provide more insights for these sub-groups of models. For the robots group, we observe that the lowest estimated H-L score is for the Silver-robot (all the dimensions are also the lowest for this model, as it has no hands and feet, no clothes or skin, and its facial features are only suggested). Then, we have the Robot Smiley with 10 points more, which is in turn followed by the battle robot, which scores more points. For the android group, we do not observe the same differences in the H-L score, as they received over 60 points. These models do not differ in the body manipulators’ dimension and have a similar surface appearance. When it comes to facial features, only the Android Woman, who has a human-like facial feature, is found.



Figure 5. Exemplary ABOT Database entries.

Table 5. Detailed results of the ABOT Predictor for the set of models.

Model	Body manipulators	Surface look	Facial features	H-L Score
Silver robot	0.60	0.00	0.50	34.18
Robot smiley	1.00	0.00	0.50	44.22
Battle robot	1.00	0.14	0.75	57.59
Blue robot	1.00	0.14	0.50	62.39
Red robot	1.00	0.15	0.50	62.52
Android woman	1.00	0.29	1.00	65.44
Animated boy	1.00	1.00	1.00	94.55
Animated girl	1.00	1.00	1.00	94.55
Animated woman	1.00	1.00	1.00	94.55
Woman	1.00	1.00	1.00	94.55
Man in cap	1.00	1.00	1.00	94.55
Black-skinned man	1.00	1.00	1.00	94.55

The ABOT H-L score allows for establishing only three sub-groups for the stimuli set – humanoids and humans (described in subsection “Human-likeness”) are merged into one group with the H-L score of 94.55. This may be explained in the light of the main purpose of the ABOT Database Predictor – it was designed on the basis of existing robots. Sub-groups of robots (Silver Robot, Robot Smiley, Battle Robot) and androids (Blue Robot, Red Robot, Android Woman) are preserved. Notably, exactly the same models are included in these sub-groups as the ones presented in Figure 2.

SELECTED STUDIES AND THEIR IMPLICATIONS FOR THE STIMULI USAGE

Context Condition

The main inspiration for studying the context condition comes from Hanson’s (2005) critique of the uncanny valley phenomenon. The claim is that a well designed humanoid robot approached in a relevant environment will not trigger a negative reaction. Also, the intuitive approach to the uncanny valley hypothesis, especially for the case of computer generated models, suggests that models would appear more familiar and acceptable when presented in an expected and known context (i.e., from science fiction animations or computer games).

The context condition of the set was studied in (Łupkowski et al., 2019) and (Ratajczyk et al., 2019). For these experiments, two sets of stimuli were prepared: (A) models on a neutral background (an empty room with uniformly coloured greyish walls); and (B) models on a background that was suitable for the given model. By suitable we mean a background presenting a context that is relevant to a given model. Robots were placed in the industrial context of a factory, androids in science-fiction scenery, animated characters on a cartoon-like background, and humans in a background depicting a city. The goal was to place the model in a background that the model would not be surprising to see. Examples are presented in Figure 6.

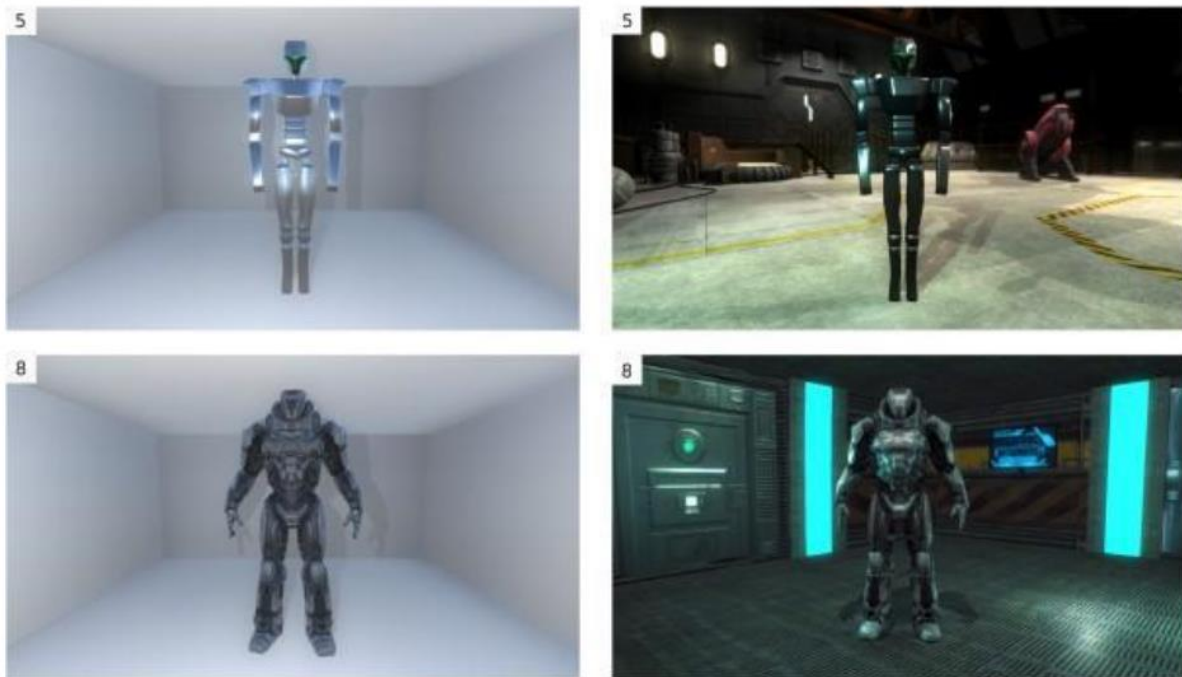


Figure 6. Exemplary stimuli used for the context condition study.

For (Łupkowski et al., 2019), we have checked the differences in (declared) comfort scores and (declared) emotional reactions between the two sets of stimuli. In (Ratajczyk et al., 2019), the difference was measured in terms of electrodermal activity (EDA). Based on these results, both studies ended with the conclusion that we observe no statistical differences between models from groups (A) and (B). No influence of the background on the perception of models was observed.

A practical application of this result is that there is no need to render complex images for future studies using our stimuli. As our study shows, models may be used on a uniform background (of an empty room) and are already available in this form. In our opinion, this solution is also more convincing, as there are no elements in the background which may disturb a subject. Naturally, we agree that further studies concerning the background condition for the uncanny valley phenomenon are needed – especially with real robots (see e.g. von der Pütten, Krämer, Becker-Asano, & Ishiguro, 2011; Zlotowski et al., 2015).

Perceived Characteristics of the Models

In the study (Łupkowski, Gierszewska, 2019), we asked our subjects questions, which were addressing the perceived characteristics of the models. These questions were of the following form: *Mark on a given scale to which extent you would agree that the presented model is trustworthy/hostile/strong*. Answers were provided on a 5-point scale: 1—totally disagree to 5 —totally agree. Detailed results are presented in Table 6.

Table 6. A comparison of models' features (medians; Łupkowski, Gierszewska 2019)

Model	Intelligent	Trustworthy	Hostile	Strong
Red robot	3.0	3.0	2.0	3.0
Woman	3.0	3.0	2.0	3.0
Blue robot	3.0	3.0	3.0	4.0
Battle robot	3.0	2.0	1.5	2.0
Animated boy	3.0	3.0	1.5	2.0
Silver robot	3.0	3.0	3.0	3.0
Man in cap	3.0	3.0	3.0	3.0
Black-skinned man	3.0	3.0	3.0	3.0
Animated girl	3.0	3.0	2.0	2.0
Android woman	4.0	3.0	3.0	4.0
Robot smiley	2.0	2.0	3.0	4.0
Animated woman	3.0	3.0	3.0	3.0

We interpret answers where median is equal 3 as showing that a given feature is not relevant for the model. For the intelligence feature, the Android woman received the highest scores. On the other hand, we observe the lowest scores for the Robot smiley. As for the trustworthiness of the models, we observe lowered scores for the Battle robot and Robot smiley. When it comes to the hostility feature, we observe that the Red robot, Woman, Man in a cap, and Animated girl were all perceived as rather not hostile. The Animated boy received the lowest scores (median=1.5), which is in line with the results for the emotional reaction presented in Table 7. For the strength feature models Robot smiley, Android woman, and Blue robot were scored higher than others. The exceptional model here is the Battle robot, which received a maximal score for this feature. This observation is also in line with the reported emotional reaction for that model.

Table 7. The summary of dominant declarative emotional reactions for models (Łupkowski & Gierszewska, 2019).

Model	The dominant reaction	% of declarations
Red robot	neutral	65%
Woman	neutral	45%
Blue robot	neutral	57%
Battle robot	neutral	76%
Animated boy	friendly	63%
Silver robot	neutral	39%
Man in cap	neutral	55%
Black-skinned man	neutral	50%
Animated girl	strange	39%
Android woman	anxiety	39%
Robot smiley	anxiety	44%
Animated woman	neutral	51%

As mentioned above, in our study we also asked about a declared emotional reaction for the models. Subjects answered the question: *What is your emotional reaction for the presented model?*. Subjects could choose maximally two among four possible answers: (i) “the model seems to be friendly”; (ii) “my reaction is neutral”; (iii) “the model looks strange”; (iv) “the model makes me feel anxious”. The summary of the dominant declarative emotional reactions for the models is presented in Table 7.

For the majority of models, the reaction is rated as neutral. The Animated boy is clearly perceived as friendly. Moreover, it is the only model with this evaluation result. This result is in line with perceived features: a low level of hostility and a low level of strength. The Animated girl is rated as strange, which, as we discuss in (Łupkowski, Gierszewska, 2019, p. 110), may be the result of an imperfect rendering of the model (it is worth to stress that the model was corrected in the re-rendering process for the set published along with this paper). As for the anxiety response, this was a dominant declared emotional reaction for the Robot smiley, Android woman, and especially for the Battle robot (rated also as the strongest model, highly hostile, and with a low trustworthiness level).

LIMITATIONS OF THE STUDY

We are aware of certain limitations of the presented study – which are mainly a consequence of the idea of analysing the aggregated data from previous studies and certain limitations of them. First of all, as an indicator of emotional reaction towards stimuli, we use only the *comfort* scale. The main reason for such a (limited) choice was to utilise an analysis of results from completed and published studies that used the same set of stimuli, as well as the same questions for participants. In the future, it would be valuable to examine the stimuli with other UVH-focused scales, such as *eeriness* and *likability*.

Secondly, the set of models does not contain fully photo-realistic humanlike characters. The research indicated that highly photo-realistic humanlike models are required to examine the full shape of the uncanny valley (Katsyri et al., 2015; Palomaki et al., 2018). However, semi-realistic models seem to be sufficient to reveal the decrease in likability (Bartneck, Kanda, Ishiguro, & Hagita, 2007; Burleigh, Schoenherr, & Lacroix, 2013; Katsyri et al., 2017). In the current paper, we focused on the examination of differences between online and laboratory studies, gender differences in models assessment and correlation between human-likeness evaluation and time needed for this.

SUMMARY

In this paper, we have presented a set of stimuli for several UVH-related studies. We describe and discuss the results of analyses performed on the aggregated data from previous studies in which this set has been used. We also used some of the particular results reported in these studies. Additionally, we used the ABOT Database Prediction tool to evaluate human-likeness scores for the models in the set. On the basis of our results, we formulate the following guidelines for the future use of this set:

A. Models

1. The set forms four sub-groups on the human-likeness dimension: robots; androids; humanoids; humans. Within these sub-groups, median scores for the models are all equal.

2. It is possible to select a representative model for each sub-group. One may focus on the models with certain interesting characteristics (as summarised in Table 6) or emotional evaluation (Table 7).

3. It is also possible to omit a given sub-group of models, e.g. excluding the humanoids sub-group to focus only on the robot-android-human continuum. This is also suggested by the ABOT Predictor analysis (as humanoids reach human scores in this tool).

4. ABOT Predictor scores allow for the use of our models in addition to the ABOT Database robots for future UVH-related studies (as we have shown how they relate to each other on the human-likeness continuum).

B. Stimuli presentation

1. Models need not be embedded within an advanced background. They may be presented in an empty room to avoid potential distractions.

2. The set may be used successfully within both laboratory and online study scenarios.

3. Models should be presented one by one, preferably in a randomised order.

4. The negative correlation that was observed for the human-likeness evaluation and the time needed to answer questions suggests that the time measure is a valuable additional measure for future studies. What is more, it would be beneficial to use additional questions, which address factors that are taken into account by subjects while evaluating human-likeness.

C. Study groups

1. We should bear in mind that the aggregated data used in this paper comes from a relatively narrow age group (see Table 1). Results may vary for other age groups, and certainly further studies addressing age variation are needed.

2. We have not observed any gender differences for the human-likeness evaluation for the majority of the models, and no gender differences for the comfort evaluation. This result needs further studies, but also suggests that the studies with the set need not otherwise be balanced for gender.

As we stated in the Introduction, we believe that the publicly available pre-validated set of stimuli described here along with the guidelines formulated above enhances future studies aimed at replicating the uncanny valley effect (for computer generated graphics).

ENDNOTES [NOT FOOTNOTES]

1. The validation study for the ABOT Predictor is presented in (Phillips et al., 2018, p. 110-111). It is also worth mentioning that the ABOT Database entries were used as the basis for the evaluation of UVH (see Kim, Bruce, Brown, de Visser, & Phillips, 2020).

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THEMATIC ANALYSIS OF GOOGLE PLAY REVIEWS OF LIFESTYLE APPS

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Abstract: *Worldwide, numerous studies have been conducted on m-health applications and the results show that, if well-designed, they can regulate and track medication and reduce healthcare costs. The aim of this research is to analyze the experiences of users connected to different lifestyle apps, in particular (1) to explore the negative, neutral and positive topics in the reviews, and (2) to discover the role of health improvement among the comments. The present paper is part of a complex empirical research project. A qualitative and quantitative content analysis was conducted of the user reviews in the Google Play store for the 16 lifestyle apps selected during the first phase of the empirical research (quasi experiment). All in all, 2,835 comments were analyzed. The negative comments mentioned unreliable tracking functions, problems with updates, or high prices. The neutral comments outlined some missing functions or problems with the operation of the app. The positive comments were related to health improvement, usefulness, ease of use, engagement and willingness to recommend the app. Physical activity, facilitating a specific diet, weight loss, wellbeing, tracking progress and health awareness were among the common health aspects of the lifestyle apps. The results of this research will be particularly useful for consumers, app developers and service providers who focus on health awareness and health promotion.*

Keywords: *m-health market, lifestyle app, content analysis, Google Play reviews*



INTRODUCTION

The m-health market shows dynamic development both on the supply and demand side. The mobile health market is expected to continue to grow in the upcoming years and is predicted to exceed 300 billion U.S. dollars by 2025 (STATISTA, 2021). That would be a threefold increase from around 99 billion dollars in 2021. Lifestyle applications (LA), the most common health-related applications, include fitness apps, nutrition and diet apps, and meditation apps (Pires et al., 2020). Based on the available data, revenue in lifestyle applications on the international market was projected to reach 23.55 billion dollars in 2022. Fitness applications provide the most revenue, followed by meditation and lastly nutrition applications. These apps aim to assist users in health maintenance and prevention of illness. Within LA, the use of fitness apps is the most common and there is a significant increase year by year. The use of fitness applications was the highest in the EU-27 (estimated rate of user penetration - 21.29%), followed by Hungarian use (17.10%), and finally the international penetration rate (11.06%) in 2021 (STATISTA, 2022a). Interestingly, Hungarians do not prefer nutrition applications - the usage rate is less than four percent; meanwhile the average proportion of those using meditation applications in the European Union countries and Hungary is between 8 and 10 percent. Therefore, compared to the worldwide penetration rate, the use of LA apps in Hungary is significant, but it lags behind the average of EU member states. This finding justifies the focus on the Hungarian target audience in the analysis of the usability of apps that positively influence lifestyle.

The use of m-health applications is also greatly influenced by how different applications are available and how much money is spent on using them. Domestic data on the use of applications clearly indicate that Hungarians prefer free available applications over paid applications, both in terms of fitness, meditation and nutrition applications. Relying on the data of STATISTA, we can gain insight into the top 10 global (STATISTA, 2022b) and Hungarian (MobileAction, 2022) most popular fitness and sports applications in the Google Play and Apple App Store by monthly downloads, and the leading health and fitness apps (STATISTA, 2022c) (*Appendix 1*).

According to recent results the m-health adoption may improve health outcomes (Jaana et al., 2019). After using m-health apps the patients perceive health benefits such as improved health habits and they are likely to use them on a regular basis (Ross et al., 2020; Desveaux et al., 2018). The perceived usefulness is not always related to illness, but may provide different health benefits such as better physical condition or relaxation, a more favorable mental state, and an enhanced quality of sleep. Shabir et al. (2022) investigated lifestyle apps, including apps related to sports and fitness, diet and nutrition, stress management and disease prevention by reviewing qualitative studies.

With the emergence of mobile app stores, researchers have paid attention to the user evaluations and reviews posted in the app stores. Previous studies examined the relationships between the features of m-health apps and the user ratings (Pagano & Maalej, 2013; Mendiola et al., 2015; Schumer et al., 2018), and the features and user feedback (Franco et al., 2016). Some research focused on the specific questions related to the applications, namely complaint aspects (Fu et al., 2013), error and user evaluation (Bavota et al., 2015), the features of nutrition apps in detail (Briggs et al., 2021), the quality factors (Stoyanov et al., 2015, 2016), gamification (Schmindt-Kraepelin et al., 2020), and the user-documented food consumption

data (Maringer et al., 2018). Another important area in the research of m-health applications is the assessment of the change in user behavior and the analysis of the impact on health (Banerjee et al., 2020; McKay et al., 2019). Some authors investigated the wide range of mobile applications, which can be divided into thirty different categories, including the category of health and fitness (Bavota et al., 2015; Fu et al., 2013; Pagano & Maalej, 2013). More researchers focused on only one specific LA app, like diet and nutrition apps (Franco et al., 2016; Schumer et al., 2018; Briggs et al., 2021; Maringer et al., 2018), and calorie-counting apps (Banerjee et al., 2020). Furthermore, in previous studies m-health apps in general were analyzed (Martin et al., 2015; Schmidt-Kraepelin et al., 2020), and some types of m-health apps, like well-being and mental health apps (Stoyanov et al., 2015), and medical, health, and fitness apps (Mendiola et al., 2015). In several studies, authors applied two main parameters to select the m-health applications for analyses: the most-downloaded apps and the minimum value of average user rating in App Stores.

This research is a part of complex empirical research (Figure 1). The authors conducted an exploratory study, a quasi-experiment among 22 university students for a 14 week period. The subjects of the experiment chose 16 different lifestyle apps to use over a semester. The authors aimed to highlight the usability aspects of LA apps, and the perceived health improvement. Participants related their experiences in a focus group interview and they also completed a questionnaire which aimed at discovering the usability aspects (MAUQ scale) of the app. Now the authors present the results of the 2nd step of the research, namely the results of the content analysis. A broad range of comments on the Google Play Store were analyzed relating to 16 different lifestyle apps. Based on the literature review many authors have analyzed reviews and apps but the majority of the studies focused on specific LAs, like fitness and nutrition apps. In this paper we try to add insight into more types of lifestyle apps and determine the factors of negative, neutral and positive opinion, in addition to highlighting the role of health improvement in the review process. Previous research results certified that user comments have an impact on the adoption and evaluation of applications, therefore we analyzed the content of the opinions relating to the use of the four (fitness, diet, meditation, and other health management) LA applications in detail. As one of the main advantages of LA is disease prevention, we see the analysis of the impact of LA apps on health, based on user experience and opinions, as a priority issue. Since the marketing aspect of the usability of lifestyle applications based on the opinions of app stores has not yet been analyzed in the marketing literature, this study fills this gap.

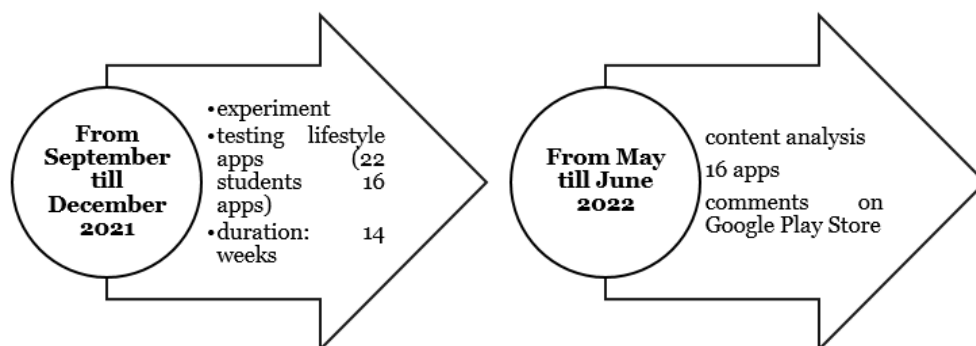


Figure 1. The stages of the empirical research.
[Source: own compilation]

The remainder of this paper is structured as follows: First we review the theoretical background and formulate the research questions. Second, we discuss data usage and the methodology. Third we summarize the findings of the empirical results. After this we present the discussion. Finally, this paper is ended with conclusions and implications.

LITERATURE REVIEW

With the emergence of mobile app stores such as the Apple App Store and Google Play Store, researchers have increasingly focused on analyzing user ratings and reviews posted in these app stores. In several studies, the authors examined a wider range of applications and analyzed experiences related to applications that can be classified into different categories (e.g., entertainment, music, lifestyle, health and fitness, etc.). Attention has been paid to examining which functions users value the most and which factors receive the most complaints in the different app categories. Fu et al. (2013) processed and analyzed over 13 million user reviews of 171,493 Android apps in the Google Play Store by using the WisCom system. They found that in the case of health and fitness apps the top-3 complaint aspects are accuracy (38%), stability (11%) and attractiveness (10%). Not surprisingly, users also criticized the accuracy and the stability when reviewing sports and lifestyle apps. Pagano and Maalej (2013) found that shortcomings, bug reports, and feature requests had a strong influence on negative ratings, while helpfulness and feature information on positive ratings. In some studies, the authors focused on identifying spam reviews. The examination of application errors and their effects also received attention, whereby the authors analyzed the effect of application errors on user evaluations (Bavota et al., 2015). Authors analyzed 5,848 free apps from the Google Play Market, and they considered each category (e.g., lifestyle, entertainment, photography, medical, games, health and fitness, sports, etc.). Furthermore, they involved 45 professional Android developers to explore the extent of the experienced problems when using apps, and the degree of relation of these problems to the unfavorable user ratings. The results indicate that apps with high user ratings are less fault- and change-prone than the low rated ones. In addition, some researchers have examined the sampling issues of research on m-health applications. In many studies, the full collection of user reviews available in the application store was used for the analyses. However, several authors applied only the partial dataset to utilize user comments, and some of them did not use review data at all. Researchers investigated over 2,7 million user reviews and found that app metrics such as price, rating, and download rank differ significantly based on the completeness of the processed comments (Martin et al., 2015). Stoyanov et al. (2015) developed the indicators to measure the quality of applications (MARS=Mobile App Rating Scale), based on opinions and evaluations by an expert panel. There were sixty well-being and mental health apps that were randomly selected using an iTunes App Store search. Experts identified four objective quality subscales: engagement, functionality, aesthetics, and information quality and one subjective quality subscale. Researchers found that apps showed a moderate correlation between the iTunes star rating and the total MARS score.

Researchers investigating m-health applications highlighted the valuable features of apps and discovered the relationship between the user's evaluation and the elements of usability. Schumer et al. (2018) explored the assessment of the various characteristics of diet and

nutrition apps available in the Google Play Store. They chose apps with a rating of 4 or higher which are available for free or can be purchased. The authors identified a total of 86 diet and nutrition apps that were freely available in the United States. The average rating was slightly higher for dietary applications compared to nutritional applications. Diet and nutritional tracking, food database and education were the most commonly utilized features among the identified apps in their research. On the other hand, reminders and feedback were some of the least commonly applied features across the same apps. However, from the aspect of body weight management, the reminders may be an essential tool in order to sustain adherence to the use of the diet and nutrition apps. Although their paper only examined free apps, based on prior studies, the authors suggested that cost might be an important factor affecting user satisfaction with diet and nutrition apps. Previous studies have shown that more expensive apps were more likely to receive higher ratings in terms of credibility and trustworthiness than those with negligible costs (West et al., 2012). It was ascertained that there is a higher proportion of advertisements in diet and nutrition apps in comparison to prior studies assessing health and wellness apps in general (Huckvale et al., 2015; Schumer et al., 2018). They highlighted the risks of advertising within apps due to its association with compromising privacy by allowing personal data to be sent to advertisers (Huckvale et al., 2015). In another study, the main features of the most popular nutrition apps were analyzed and their technologies for dietary assessment and user feedback compared (Franco et al., 2016). Apps were selected from the two largest UK online stores (the Google Play Store for Android and the iTunes App Store for iOS) based on the number of installs and reviews. A total of 13 apps were evaluated and the results focused on the energy balance between dietary intake and physical activity. Franco et al. (2016) found that all the apps storing dietary intake used the same technologies for data input (i.e., text search and barcode scanner) and nutrition assessment method (i.e., food diary record); however, the apps did not have a decision engine capable of providing personalized diet advice. Nutrition apps for weight management were selected from the Apple App Store and Google Play Store (Briggs et al., 2021). Two important conditions were defined for the selection of the applications: they must have the ability to track calories and have at least 500,000 installations. These American researchers evaluated the features of the free and upgraded versions of nutrition apps ($n = 15$) within 4 categories: (1) dietary intake, (2) anthropometrics, (3) physical activity, and (4) behavior change strategies. They then concluded that most nutrition apps possess more features dedicated to dietary intake, anthropometric, and physical activity tracking but they lack behavior change content features. Mendiola et al. (2015) focused on understanding what a user values in a healthcare application. The aim of their research was to identify the features that patient-consumers value most and contribute positively to the evaluation of an application. These authors filtered out the apps associated with reputable health organizations which were defined as developers or evaluators with relationships with content-credible health care entities. Finally, 234 medical, health, and fitness apps were selected from the Apple iTunes Store and the Google Play Marketplace in the US. These apps were manually evaluated for the presence and characteristics of twelve app features. Using regression analysis, they came to the conclusion that five functions (plan or orders, export of data, usability, and cost) contributed significantly and positively to the evaluation of the users of the applications, while the tracking function made it worse.

When examining applications, not only usability, but also hedonistic aspects can be important. Gamification of m-health applications is considered a promising approach to

maintain long-term user motivation. Schmidt-Kraepelin et al. (2020) investigated the implementation of game mechanics in 1000 apps from the US Apple App Store and US Google Play Store and analyzed the relationship between the degree of gamification of m-health apps and user ratings. The research results point out a high degree of gamification in both app stores and indicate a positive relationship between the degree of gamification of m-health apps and user ratings in the Apple App Store. Furthermore, their study suggests that the use of gamification in the Google Play Store is substantially more common than in the Apple App Store.

Another fertile area in the research of m-health applications is the assessment of the change in user behavior and the analysis of the impact on health. The quality and effectiveness of the calorie-counting apps for weight control and behavior change among Indian youth were examined (Banerjee et al., 2020). Popular calorie-counting apps (n=20) were selected from the Google Play store and their quality was assessed on attributes like standards used, content accuracy, user interface and sources of database. The authors of this study found that over 65 per cent of apps overestimated or underestimated the calorie intake. Comparing the intervention (n = 30) and control (n = 28) groups, there was no significant difference in food consumption. Nevertheless, the physical activity in the intervention group increased during the eight weeks while using one of the top 3 apps. A recent study reviewed a large sample of healthy lifestyle apps in order to determine the apps' potential for promoting health-related behavior change (McKay et al., 2019). Five lifestyle behavior categories were identified: smoking, alcohol use, physical activity, nutrition, and mental well-being from the Australian Apple iTunes and Google Play stores. Apps with an average user rating between 3 and 5 were included, if they had been updated within the last 18 months, if the app description included two of the 4 behavior modification features (goal setting, action planning, self-monitoring, and feedback), and if they were in English. Finally, 344 apps were reviewed, which were classified as physical activity (n=275), healthy eating (n=23), mental well-being (n=27), smoking (n=14), and alcohol (n=5) category.

McKay et al. (2019) developed the App Behavior Change Scale (ABACUS) to determine behavior change potential, which contains 21 items. The selected behavior change apps were evaluated in two ways using previously developed rating scales: the Mobile App Rating Scale (MARS) for functionality and the ABACUS for potential to encourage behavior change. The average MARS score (2.93 out of 5) indicates low-to-moderate functionality and the average score for the ABACUS (7.8 out of 21) indicates a low-to-moderate number of behavior change techniques included in apps. The authors of the study determined the most common behavior change techniques included in apps: instruction, self-monitoring behavior, customizing features, reminders and prompts of activity. They then recommended developing and improving the app design to promote significant lifestyle behavior change and better health. Food consumption behavior is a significant part of health behavior. In order to explore this behavior, the authors extended the data collection to the application websites, too. Maringer et al. (2018) investigated the publicly available information from the UK app stores and app-related websites. These authors focused on the user-documented food consumption data and sought to identify the opportunities and challenges associated with using this data for nutrition research. 176 apps were selected based on user ratings and English language support. They concluded that this data offers promising opportunities for a better understanding of food

consumption behavior. However, data exchange protocols and terms of use and privacy statements limit possibilities to process and share user-documented food consumption data.

The aim of the research is to analyze the experiences of users connected to different lifestyle apps.

Q1: What criteria do users use to evaluate the different LAs apps in the Google Play store? What are the major themes that are mentioned in the negative, neutral and positive comments?

Q2: How do health aspects appear among the comments based on the different types of LAs apps? What is the ratio of comments related to perceived health improvement?

To answer the research questions, we conducted a qualitative and quantitative content analysis of the user reviews visible in the Google Play store for the 16 lifestyle apps selected for the previously conducted quasi-experiment.

METHODS

The authors of this paper were interested in the general opinion and satisfaction of users connected to the 16 different LA apps: (6) fitness, (4) diet and nutrition, (3) mindfulness, (3) other health management apps (*Appendix 2*). This research question was analyzed by content analysis. We collected the comments available in the Google Play Store and analyzed the comments of Hungarian users. The comments were collected based on the star-rating system. In the case of three apps, two sports and fitness activity tracking apps (Garmin Connect, 30 Days Fitness Challenge) and one diet and nutrition app (Yazio) the comments of 2022 were chosen for analysis due to their extremely high number.

In the case of content analysis (analysis of comments in Google Play) thematic analysis was used to identify themes in the data. The first and second authors of this paper read each comment carefully. Once reviewed, the first author labeled relevant words, expressions and sentences and created a preliminary list of codes and the second author reviewed the list. Both researchers had ongoing meetings to identify and discuss discrepancies. Differences were minimal and a tertiary researcher was not required. A codebook was developed with the identification of codes and descriptions. The codes were grouped into themes and subthemes, thus categories were created. The refining of the list was a collaborative job and redundant themes were removed (Bryman, 2016; Kvale, Brinkmann, 2009).

In this paper we highlight the main themes that were identified related to the negative (★, ★★), neutral (★★★) and positive (★★★★, ★★★★★) comments connected to the analyzed categories of LAs. Health improvement aspects and incidence rate were also identified. During the analysis qualitative data and univariate statistics are presented.

RESULTS

In this chapter, we analyze the opinions and experiences of using the apps based on the research questions and the major types of the lifestyle apps. Four major types of LA were analyzed and the results are presented related to these categories, i.e., sports and fitness, diet and nutrition, mindfulness and other health related apps.

In the sports and fitness activity apps category users expressed their satisfaction in Google Play. They were mainly satisfied with Pedometer, and 30 Days Fitness Challenge. The other apps like Garmin Connect, My Workout Plan and 'FitApp running and walking' were evaluated as really good apps. '30 Days Fitness Challenge' was mainly commented on by females, who were generally satisfied with the app. 'Garmin connect' was evaluated by many people, especially men. 'My Workout Plan' was commented on by only a small number of people, and only a few comments were analyzed. 'FitApp run and walk' was reviewed by many Google users. Generally, it is true that people expressed their satisfaction. The majority of the comments were positive, except for Pedometer; however this app received a very good overall rating (4.9 stars).

Regarding the analyzed diet and nutrition apps people are very satisfied with the apps, especially with CalorieBase and Yazio and Water Reminder. In the case of 'Water Reminder' two comments could be found in Google Play. 'Water Time' is an app that counts water from drinks and a water diary and history with a user-friendly design. Mainly women commented on each app. In the case of 'CalorieBase many comments could be read in Google Play. In the case of 'Yazio' only the comments of 2022 were analyzed.

Three different stress relief and relaxation apps were analyzed, which were evaluated as very good in Google Play. 'Forest' is an app that helps its users focus on productivity and it was the best app of the year in 2015 and 2016. Plant a seed in Forest encourages people to put down their phone and stay focused to get things done. In the case of 'Yoga Challenge' only a few people expressed their thoughts.

Two apps – the 'Flo' and 'Women's Calendar' - developed for women were analyzed. The 'Flo' was commented on by 167 people and the Women's Calendar by 171 females. It is interesting that one male commented on Flo that it is a *'Very good app. I know now what is happening with my wife and with our baby. You should maybe have some father sections.'* Only one disease management app was analyzed, namely the 'MyTherapy', which is an ad-free, award-winning pill reminder and medication tracking app. People were generally satisfied with this app and the majority of the commenters were males (*Appendix 2*).

Negative comments

People tend to express their disappointment rather than their satisfaction (Shah et al., 2021). Most of the negative comments are about unreliable tracking (inaccurate tracking of performance in the case of sport-and fitness apps). Problems with downloads and updates also occurred as well as issues with updates, or the connection with a smart watch, complaints that it was too expensive, or issues with cash refunds (if the user does not want to use anymore). The negative comments highlighted the price of the app, or incorrect deduction of fees, too many advertisements, constant breakdown of the app, problems with new versions, or with the sound, or sharing performances on social media platforms or with other members of the group to motivate each other. In the case of diet and nutrition apps people had problems with the number of ads, the app crashing after updates, registration (not accepting the email address, all the user names are already taken), unreliable tracking, loss of previously registered data, slow, problems with individual goals. Most people want to get back their money or they dislike the app pushing them to subscribe to the pro version. The users complain about the complicated settings and the language barriers. Similar problems occurred in the case of nutrition instead of

sport-and fitness apps. In the case of mindfulness apps negative comments were about dissatisfaction of the pro version of the app, problems after updates or constant crashing. Commenters complained about the price and the different features that you have to pay for it or some users found it too expensive.

Some people complained about problems with updates, or mentioned some concrete problems that would be useful for IT specialists. Other problems also occurred with Hungarian language availability and data storage or transfer of previous data. In the case of ‘Women’s Calendar’ more negative comments occurred. The most serious ones were connected to the loss of data after an update that caused inconvenience for the users or the selection of some pills. In the case of MyTherapy some users mentioned some negative experiences like language barriers, or missing functions (Table 1).

Table 1. Typical negative comments. [Source: own compilation]

Quotations	Topics
<i>‘No warm-up and stretching.’</i>	Unreliable tracking
<i>‘It does not correctly describe the muscles worked.’</i>	
<i>‘The calorie content is not the same as stated by the manufacturer.’</i>	
<i>‘No warm-up and stretching.’</i>	Unreliable function
<i>‘Adding own diet, just importing recipes.’</i>	
<i>‘Reminder function is not working well.’</i>	
<i>‘The latest update has screwed up the options of labeling photos’</i>	Problems with update
<i>‘It has not been working since the last update.’</i>	
<i>‘Statistics and tracking work only in pro version.’</i>	High prices
<i>‘Very expensive!’</i>	
<i>‘Way too loud. Volume cannot be changed only if you upgrade and pay for it’</i>	
<i>‘Constant break down of the app’</i>	Technical problems
<i>‘It does not remember the settings, so is inconvenient to use’</i>	
<i>‘Complicated settings.’</i>	
<i>‘If I don’t log in for two or more days, it doesn’t send notifications, for example: drinking water and taking pills.’</i>	Language barriers
<i>‘Not available in Hungarian.’</i>	
<i>‘The Hungarian language pack is unfortunately not understandable in some places, and I couldn’t set the language to English.’</i>	

Neutral comments

Neutral comments were related to the fact that the user has just started to use the app and will share their experiences based on the results. Some neutral comments mentioned some missing functions, sudden crash of the app or disappearing music or map. Users gave ideas on how to develop the app. Other important aspects of the neutral comments were the high number of ads in the free version. However inaccurate tracking, and technical problems with data entry also appeared among the neutral comments, just as with negative comments (Table 2).

Table 2. Typical neutral comments. [Source: own compilation]

Quotations	Topics
<i>'Other apps count the calories you've burned. If they could add this feature it would give the users motivation.'</i>	Missing functions
<i>'More specific exercise related to special body parts.'</i>	Ideas for developers
<i>'More types of liquids, like herbal teas, soups, alcoholic beverages, etc. should be included in the app.'</i>	
<i>'Can the advertising space be smaller?'</i>	Communication clutter in the free version

Positive comments

In the case of fitness apps, positive comments highlighted the health improvement (weight loss, progress in fitness), the ease of use and the willingness to recommend. Satisfied users expressed their positive emotions connected to the app and the results that they have achieved. Most people expressed their like of the exercises and the usefulness of the app and the positive word of mouth. Most of the commenters were satisfied with the app because it is simple, great, perfect, easy to use, attractive and effective.

In the case of nutrition apps pretty similar aspects were mentioned. The positive comments highlighted the usefulness of the app, weight loss, help in controlling eating, easy usage, attractive visual appeal, functions, engagement, large storage surface, and constant development of the app (from IT specialists). Most of the reviewers have positive opinions and acknowledge the reminder function of the app in case of the Water Reminder.

In the case of mindfulness apps most people were satisfied with the app because they thought that it was useful and helped them study and work better, enabled heightened concentration and helped in not losing focus or minimizing their smartphone usage and social media addiction. Some people came up with ideas on how to develop the app, and what kind of functions would help the users. Some positive comments acknowledged the gamification function of the app. Positive emotions and engagement appeared among the comments.

In the case of women cycling apps the majority of the users admitted the benefit of the app: simple usage, good functions, attractive interface, interesting content and articles and of course the usefulness and the supportive function of the app was highlighted, too. The satisfied users highlighted the usefulness (planning, tracking cycle rides, etc.), and the design of the app and they admitted that it is easy to use. In the case of other health management apps the majority of commenters expressed their general satisfaction and acknowledged the usefulness of the app (Table 3).

Table 3. Typical positive comments. [Source: own compilation]

Quotations	Topics
<i>'It is an excellent stimulant for exercise and weight loss.'</i>	Health improvement
<i>'Since I've been using this app my water intake has improved dramatically'</i>	
<i>'I don't forget to take my pills anymore.'</i>	Usefulness
<i>'I have lost 24 kg since June 2021'</i>	
<i>'Fully capable of tracking my meds.'</i>	Functions
<i>'It has good functions.'</i>	
<i>'The supportive function is very good.'</i>	
<i>'It has interesting articles and content.'</i>	
<i>'This is the best game in the world and a very good challenge.'</i>	General satisfaction
<i>'I found it has all the functionality I needed. Thanks a lot.'</i>	
<i>'I recommend it to everyone.'</i>	Willingness to recommend
<i>'The free version contains every basic function that I require, and it is easy to use.'</i>	Ease of use
<i>'I love it. Great. Super.'</i>	Positive bonds
<i>'I really like the fact it counts calories. Great app!'</i>	
<i>'Simply the best. Inspiring.'</i>	
<i>'The best app measuring running activity.'</i>	

Health aspects

Positive comments also focused on health aspects and were mainly mentioned in the case of fitness and nutrition apps. Commenters highlighted a physically active life and the benefits of regular exercises. In the case of nutrition apps, the control of a special diet for different motivations (chronic disease or weight loss) reinforced the importance of apps that help their users control their calorie intake. Many commenters admitted the facilitating role of apps in changing former lifestyles, with comments reporting amazing weight loss and improvement of wellbeing (both physical and mental). Progress in body shape (flat belly, muscular body) was also highlighted especially in the case of fitness apps. In the case of other health management apps body awareness was also mentioned by the commenters (*Table 4*).

Table 4. Typical comments related to health improvement. [Source: own compilation]

Quotations	Topics
<i>'I have become so muscular.'</i>	Physical activity
<i>'Moves all parts of the body.'</i>	
<i>'It is tiring, useful, makes me sweat.'</i>	
<i>'Good support for a successful diet.'</i>	Diet
<i>'I suffer from diabetes. I can follow my nutrition intake.'</i>	
<i>'Good help in changing my lifestyle.'</i>	Losing weight
<i>'1 month - 10kg', '1 week -2 kg'</i>	

<i>'Relaxing.'</i>	
<i>'I already feel so good after using it for the first time.'</i>	
<i>'I can practice self-control.'</i>	General wellbeing
<i>'It helps me to concentrate and I feel so much better in myself.'</i>	
<i>'Good to track my progress.'</i>	
<i>'The results are visible after one month.'</i>	Progress
<i>'I wasn't planning to lose weight, but I'm enjoying the fact I'm so much more flexible now.'</i>	
<i>'I can understand how my body works and my symptoms.'</i>	Body knowledge

DISCUSSION

Reading opinions about the use of m-health applications is not only important for consumers, but also for application developers and app stores. In the international literature, some authors used several different research approaches and research methods to explore and learn about user experiences and both negative and positive opinions. In many studies, the full collection of user reviews available in the application store was used for the analyses. However, several authors used only the partial dataset to utilize user comments. The aim of the present study was to explore the different dimensions determining satisfaction with a lifestyle app. Former study analyzed the Google Play and Apple Store comments from different perspectives and mainly fitness and (Fu et al., 2013) or nutrition apps (Schumer et al., 2015, Franco et al., 2016). Attention has been paid to examining which functions users value the most and which factors receive the most complaints in the different app categories.

First the authors of this paper raised the research question *'What criteria do users use to evaluate the different LAs apps in the Google Play store? What are the major themes that are mentioned in the negative, neutral and positive comments?'* Generally, users are satisfied with the apps. People are willing to share their negative, and positive experiences with the analyzed apps. All in all, 2,835 comments were analyzed. The negative comments were related to technical aspects, namely update problems, the price of the app (pro version), and the number of ads in the free versions. West et al. (2013) showed that the more expensive apps were more likely to receive higher ratings in terms of credibility and trustworthiness than those with negligible costs. Previous studies highlighted accuracy, stability, attractiveness (Fu et al., 2013) shortcomings, bug reports and feature requests (Pagano & Maalej, 2013) as major sources of complaints. In this empirical research we could also identify accuracy, namely unreliable tracking, stability, as in problems with updates, or technical problems as did Bavota et al. In terms of popularity, we found that reviewers had problems with unreliable functions as did Mendiola et al. (2015), stating that the tracking function in the case of healthcare apps has a negative effect on the evaluation process.

Most of the studies analyzed complaints or negative and positive ratings (Pagano & Maalej, 2013), but not the neutral ones. In the present empirical research the neutral comments expressed some missing functions, or problems with the operation of the app and communication clutter. Huckvale et al. (2015) highlighted the risks of advertising within apps due to its association with compromising privacy by allowing personal information to be sent to advertisers. In the case of all the analyzed apps, commenters came up with some ideas on

how to make a perfect app that would help develop user friendliness and the achievement of user goals.

Pagano and Maalej (2013) found that helpfulness and feature information determine positive ratings. We also found similar results. Positive reviews were related to health improvement, the achievement of goals, overall satisfaction, engagement and the willingness to recommend the app. Mendiola et al. (2015) came to the conclusion that previously defined goals, export of data, usability, and cost contributed significantly and positively to the evaluation of the users of the applications. Even though former studies emphasized the importance of gamification especially in the case of Android operating system (Schmidt-Kraepelin et al., 2020), we could not identify this element as a major theme among the positive reviews. On the other hand, we were also curious about the ratio of negative, neutral and positive comments, considering the ratio of negative comments was the highest in the case of women's cycle tracking apps and diet and nutrition apps. Users expressed their general satisfaction and positive experiences mainly in the case of stress relief, relaxation and disease management apps.

Another fertile area in the research of m-health applications is the assessment of change in user behavior and the analysis of the impact on health (Banerjee et al., 2020, McKay et al., 2018, Maringer et al., 2019). Briggs et al. (2021) highlighted that diet and nutrition apps lack behavior change content features. The second research question investigated '*How do health aspects appear among the comments based on the different types of LAs apps? What is the ratio of comments related to perceived health improvement?*' Health aspects appeared among the positive comments. Physical activity, facilitating a special diet, and weight loss were mentioned by the reviewers. Some people highlighted the improvement in wellbeing from both mental and physical aspects. As in previous studies (Pagano & Maalej, 2013) pointed out the helpfulness and usefulness of lifestyle apps. Some users reported their progress, and their knowledge about their body, and symptoms depending on the type of apps. Users mainly commented on their results and health improvement in the case of nutrition and fitness apps. All in all, we can say that people express their satisfaction based on technical information, ease of use, usefulness and functions of the apps, whereas health aspects are marginal, and mainly present in the case of nutrition and fitness apps (Table 5).

Table 5. Comments of lifestyle apps in Google Play. [Source: own compilation]

Lifestyle apps	Ratio of negative comments (★, ★★)	Ratio of neutral comments (★★★)		Ratio of positive comments (★★★★, ★★★★★)			Ratio of health-related comments	
	%	n	%	n	%	n	%	n
Sports and fitness activity tracking apps (6*, 765**)	14.1	108	6.4	49	79.5	608	2.3	18
Diet and nutrition apps (4*, 1275**)	18.8	240	8.6	109	72.6	926	4.2	54
Stress relief and relaxation apps (3*, 326**)	11.0	36	4.6	15	84.4	275	1.2	4
Other health management apps (3*, 469**)	17.7	83	6.4	30	75.9	356	1.5	7

Note. *Number of analyzed apps **number of comments

CONCLUSIONS

Results of the study showed that technical problems, features, or inaccurate tracking are the basic reasons for dissatisfaction. Negative reviews were typical in the case of diet and nutrition apps, because these types of apps require the highest level of effort from the users. Neutral reviews were related to missing functions, and also to communication clutter. Positive reviews highlighted health improvement, usefulness, functions or features, ease of use and engagement. Previous researchers placed high emphasis on behavior change (Banerjee et al., 2020) and regarding health improvement the reviewers pointed out physical activity, diet, losing weight and general wellbeing.

The results of our research will be particularly useful for consumers, app developers and service providers who focus on health awareness and health promotion. In the case of healthcare, it can contribute to reducing the burden on the health care system and to the integrated development of telemedicine and traditional healthcare. Many cardiovascular diseases can be treated with the improvement of physical and mental health. The use of LAs contribute to this improvement, since apps are good facilitators for making lifestyle changes. Technical aspects, like ease of use and aesthetics, design or user experience are more important factors for users than health aspects in the evaluation process.

The findings of this research have some limitations. First, only certain LAs were analyzed related to different fields, like physical activity, diet, relaxation and other health issues. In the case of two fitness and one nutrition app the reviews of 2022 were analyzed. As previous researchers (Schmidt-Kraepelin et. al., 2020) highlighted, gamification aspects are present in the Google Play Store rather than in the App Store. Second, all the apps received a relatively good review (above 4 stars) from users.

Future research efforts should be geared towards investigating the ratio of the identified themes. This method would enable multivariate statistical analysis (ANOVA), that is to highlight differences between different LAs (fitness, diet, mindfulness, other health management). A quantitative research should be conducted to measure the usability and user satisfaction. The previously developed and adopted scales (MAUQ - Zhou et. al., 2019, uMARS - Stoyanov et al., 2016, ABACUS - McKay, et. al., 2019) should be tested in Hungary. In our opinion the basic aspects of usability and behavior change should be extended with the identified themes due to the content analysis. Scale development (qualitative research, focus group interviewing) and validation (quantitative research) will be the future aim of the research.

IMPLICATIONS FOR APPLICATION

At population level, it has a prominent role in the field of prevention. Excess weight, obesity and cardiovascular diseases are some of today's most pressing public health issues worldwide, and Hungary is no exception. Numerous m-health apps available in app stores deal with weight-related behaviors, such as eating behavior, physical activity and mental health. Using lifestyle apps can contribute to health management, disease prevention and well-being of users.

For developers, it offers the possibility to expand the services available free of charge and to manage and analyze Big Data in compliance with GDPR regulations. They can perfect the app and learn how to meet user needs.

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Appendix

Appendix 1

10 most popular fitness and sports applications in Google Play and Apple App Store,
Worldwide, in March 2022, by monthly downloads (in millions)

Source: own compilation

TOP	Popular fitness and sports applications	Monthly downloads (in millions)
1.	Home Workout	3 412 517
2.	Fitpro	3 062 954
3.	Sweatcoin	2 859 793
4.	Adm At Kazan	2 836 907
5.	Six Pack in 30 Days	2 648 175
6.	Pedometer, MStep	2 477 564
7.	FitCoach	2 404 215
8.	Keep	2 327 696
9.	Da Fit	1 742 377
10.	Workouts by Muscle Booster	1 701 678

Appendix 1

Leading health and fitness apps in the Google Play Store,
Worldwide in September 2022, by number of downloads to devices (in millions)

Source: own compilation

TOP	Leading health and fitness apps	Downloads to devices in millions
1.	Samsung Health	3,15
2.	Huawei Health	3,04
3.	Home Workout - No Equipment	2,43
4.	Feelsy: Stress Anxiety Relief	2,33
5.	Aarogya Setu	2,06
6.	Blood Pressure Pro	1,45
7.	Six Pack in 30 Days	1,41
8.	Sweatcoin	1,37
9.	Lucky Step	1,35
10.	Planet Fitness Workouts	1,08

Appendix 1

10 most popular fitness and sports applications in Google Play and Apple App Store,
In Hungary, in September 2022, by monthly downloads (in millions)

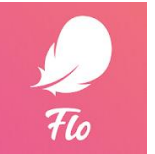
Source: own compilation

TOP	Free apps in Google Play Store	Free apps in Apple Store
1.	My Fitness	FitCoach
2.	MyStep	YAZIO
3.	Home Workout	Huawei Health
4.	FITAPP Run and Walk	Muscle Booster Workout Planner
5.	Six Pack in 30 days	Fitify: Fitness & Home Workout
6.	Yoga For Weight Loss	Sleep Cycle - Sleep Tracker
7.	YAZIO	Nike Run Club
8.	Fitify	My Fitness
9.	Mi Fit	Period Tracker Period Calendar
10.	iStep	Calorie Base - Calorie Counter

Appendix 2 The analyzed apps on Google Play Store

Sports and fitness activity tracking apps (6)	Pedometer	30 Days Fitness Challenge: Workout	Daily Workout Fitness	Garmin Connect	My Workout Plan	FitApp Run and Walk
						
number of evaluators	552,967	608,348	148,396	770,057	8,442	25,555
star rating	4.9	4.9	4.8	4.7	4.7	4.6
negative comment	Shows false values.	<i>I would use the app, but an ad pops up that cannot be removed. Annoying.</i>	<i>Does not correctly describe the muscles worked, no warm-up and stretching.</i>	<i>It has not worked for 2 days. I cannot log in. Server error.</i>	<i>Runs down the battery like a 3D game. Has a very limited set of exercises.</i>	<i>Paid but this isn't displayed correctly.</i>
neutral comment	<i>The system does not start automatically.</i>	<i>Good exercises, only short and with few tasks.</i>	<i>There could be more tasks, not just the same one, because after a while it gets boring.</i>	<i>There is no import function.</i>	no reviews	<i>It works fine, but unfortunately there is no audible indication of the mileage despite the setting.</i>
positive comment	<i>It's motivating to see how many calories I'm burning and the importance of increasing my speed.</i>	<i>Very easy to use, Hungarian and has everything you need. There is a pro version, but even without it you are perfectly fine.</i>	<i>Very good application. It is varied, everyone can find something to suit them.</i>	<i>The app is very fair, it does what I expect it to do.</i>	<i>Very useful app, with lots of exercises, workout plan sharing.</i>	<i>I really like it, it's a very good app, everything you need for running is there, time, mileage, calories.</i>
number of reviews	37	39	169	142	19	359
duration	30/12/2017 10/02/2022	01/01/2022 15/06/2022	01/01/2022 15/06/2022	02/01/2022 15/06/2022	06/10/2018 21/03/2022	02/01/2016 05/06/2022
male	12 (32.4%)	13 (33.3%)	27 (16.0%)	88 (62.0%)	10 (52.6%)	32 (8.9%)
female	13 (35.1%)	24 (61.5%)	108 (63.9%)	49 (34.5%)	6 (31.6%)	28 (7.8%)
not known	12 (32.5%)	2 (5.2%)	34 (20.1%)	5 (3.5%)	3 (15.8%)	299 (83.3%)
★	20 (54.0%)	0 (0.0%)	2 (1.2%)	16 (11.3%)	0 (0.0%)	30 (8.3%)
★★	0 (0.0%)	0 (0.0%)	1 (0.6%)	7 (4.9%)	2 (10.5%)	30 (8.3%)
★★★	2 (5.5%)	1 (2.5%)	6 (3.6%)	6 (4.2%)	0 (0.0%)	34 (9.4%)
★★★★	3 (8.1%)	0 (0.0%)	57 (33.7%)	13 (9.2%)	3 (15.8%)	49 (13.6%)
★★★★★	12 (32.4%)	38 (97.5%)	103 (60.9%)	100 (70.4%)	14 (73.7%)	216 (60.4%)
health aspects	3 (8.1%)	6 (15.4%)	4 (2.3%)	2 (1.4%)	2 (10.5%)	1 (0.2%)

	CalorieBase	Yazio	Water Reminder Daily Tracker	Water Time
Diet and nutrition apps (4)				
number of evaluators	4,806	455,687	395,000	147,433
star rating	4.8	4.7	4.7	4.4
negative comment	<i>Freezes and crashes after opening.</i>	<i>Very expensive. does not remember settings, so it is inconvenient to use.</i>	<i>Way too loud. Volume cannot be changed only if you upgrade and pay for it.</i>	<i>It has become a battery drainer recently.</i>
neutral comment	<i>For me, it often forgets the data entered at the end of the day, which is quite annoying</i>	<i>Morning and afternoon snacks are missed out, which would be important for insulin resistance people.</i>	<i>no reviews</i>	<i>The management of data input could be better. There is a lot of advertising.</i>
positive comment	<i>I've been using this app since March and have lost 7 kg so far. Not only does it help me see how many calories I eat a day, but it also helps me know what nutrients I need to increase or decrease to be healthier.</i>	<i>Absolutely useful application. The big advantage is that it has a lot more free features compared to other similar apps.</i>	<i>Perfect.</i>	<i>I find it very useful because it always helps me know when to have a glass of water.</i>
number of reviews	857	83	2	333
duration	20/10/2016 31/03/2022	03/01/2022 14/06/2022	03/01/2021 31/10/2021	04/05/2016 15/03/2022
male	308 (36.0%)	33 (39.7%)	1 (50.0%)	64 (19.2%)
female	475 (55.4%)	46 (55.5%)	1 (50.0%)	193 (58.0%)
not known	74 (8.6%)	4 (4.8%)	0	76 (22.8%)
★	125 (14.5%)	23 (27.7%)	1 (50.0%)	12 (3.6%)
★★	61 (7.1%)	9 (10.8%)	0 (0.0%)	9 (2.7%)
★★★	90 (10.5%)	6 (7.2%)	0 (0.0%)	13 (3.9%)
★★★★	124 (14.7%)	12 (14.5%)	0 (0.0%)	63 (18.9%)
★★★★★	457 (53.2%)	33 (39.8%)	1 (50.0%)	236 (70.9%)
health aspects	50 (5.8%)	4 (4.8%)	0 (0.0%)	0 (0.0%)

Mindfulness apps (3)	Forest	Yoga Challenge	Daily Yoga	Flo Ovulation and Period Tracker	Ladies Calendar	MyTherapy
Other health management apps (3)						
number of evaluators	491,774	2,654	143,192	2,628,383	704	134,937
star rating	4.9	4.6	4.4	4.6	4.2	4.8
negative comment	<i>I subscribed to the pro version, but it charged me without giving extra service.</i>	<i>no reviews</i>	<i>Insanely expensive</i>	<i>Advertising on the back of advertising.</i>	<i>For months I have been saving my data, which was very important, and now everything is lost, even though I exported the data to dropbox, the import back does not work at all! Everything is lost!</i>	<i>Apart from the day of the installation, I have never been told to take my medicine.</i>
neutral comment	<i>I am watching the ad, but do not get the bonus gold.</i>	<i>Moderately good.</i>	<i>In theory, the app is free, but practically everything you use within the app has to be paid for. What is available is quite sophisticated and well done (if you don't know English, you shouldn't download it, because you won't understand the instructions) The music is very good and the voice of the lady is soothing, the exercises are very well chosen, I like it very much!</i>	<i>Way too many commercial and ad breaks for an app that is one-purpose only: to quickly add a date and leave. I can tolerate ads, but not the pop-up ones.</i>	<i>Very good app, but it doesn't let you use the medicine reminder. I cannot set the pill type and it does not accept the pill name.</i>	<i>I cannot add customized times, like every 2.5 hours.</i>
positive comment	<i>This really is a great app! It helps you focus and with this app learning will be a piece of cake.</i>	<i>The best game in the world.</i>		<i>I absolutely love it.</i>	<i>Easy to use, accurate, very useful app.</i>	<i>I use it for dieting, very useful for me!</i>
number of reviews	215	5	106	167	171	128
duration	08/12/2014 27/04/2022	27/07/2016 05/07/2018	22/06/2012 25/04/2022	07/10/2017 07/06/2022	09/02/2013 03/05/2022	16/11/2018 12/05/2022
male	90 (41.8%)	1 (20.0%)	21 (19.8%)	1 (0.6%)	0 (0.0%)	69 (53.9%)
female	96 (44.7%)	2 (40.0%)	67 (63.3%)	166 (99.4%)	171 (100.0%)	48 (37.5%)
not known	29 (13.5%)	2 (40.0%)	18 (16.9%)	0 (0.0%)	0 (0.0%)	11 (8.6%)
★	18 (8.4%)	0 (0.0%)	4 (3.8%)	11 (6.6%)	36 (21.0%)	5 (3.9%)
★★	8 (3.7%)	0 (0.0%)	6 (5.7%)	5 (3.0%)	20 (11.7%)	3 (2.3%)

★★★	13 (6.1%)	1 (20.0%)	1 (0.9%)	9 (5.4%)	15 (8.8%)	6 (4.7%)
★★★★	36 (16.8%)	0 (0.0%)	3 (2.8%)	11 (6.6%)	24 (14.1%)	13 (10.2%)
★★★★★	140 (65.0%)	4 (80.0%)	92 (86.8%)	131 (78.4%)	76 (44.4%)	101 (78.9%)
health aspects	0 (0.0%)	0 (0.0%)	4 (3.7%)	5 (2.9%)	2 (1.1%)	0 (0.0%)

Source: based on Google Play data on 22 June 2022

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USING VIGNETTES IN QUALITATIVE RESEARCH TO ASSESS YOUNG ADULTS' PERSPECTIVES OF SEXTING BEHAVIOURS

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Abstract: *The purpose of this study was to compare attitudes toward sexting using vignettes. Participants were 49 university students (ages 19-26) who participated in five online focus group discussions and responded to five written vignettes describing sexting. The five vignettes about sexting were composed of five types of sexting experiences: 1) sexting under intimate partner pressure, 2) revenge sexting, 3) consensual sexting with intimate partner, 4) sexting under peer pressure, and 5) sexting to flirt with others. Students gave their opinions on the vignettes presented. Revenge sexting was perceived as a behaviour more negative than any other type of sexting experience. The vignette that depicted sexting with an intimate partner in a long-distance relationship was perceived as the least negative of all types of sexting. The results of this study aim to inspire future studies to use vignettes as a methodological tool to determine youths' attitudes, beliefs, and opinions about sexting.*

Keywords: *college students, attitude, sexting, vignette, qualitative research.*



INTRODUCTION

There has been considerable research conducted on sexting over the last ten years. Researchers have struggled to agree on a definition of sexting, with different emphases placed on particular aspects of sexting. In the most prevalent definitions, sexting is conceptualized as sharing personal sexually suggestive text messages or nude or nearly nude photographs or videos via electronic devices (Mori et al., 2020). Consensual sexting includes voluntary participation in sexting with the absence of pressure and blackmailing or forwarding the sext without the permission of the person who produces sexually explicit content (Döring, 2014; Morelli et al., 2016). Aggravated sexting involves the presence of harmful intention toward someone who shares sexts or forcing someone to share sexts (Wolak & Finkelhor, 2011). According to Morelli et al. (2016), sharing sexts without permission can be called non-consensual sexting, while peer pressuring someone to send sexts can be called pressured sexting. Although the sexting definitions vary considerably, there is consensus that sexting has increased in recent years among youth and increases as people age (Madigan et al., 2018). Sexting has been associated with a major impact on legal, sociological and psychological outcomes for the senders, receivers, and forwarders of sexts (O'Connor & Drouin, 2020).

Researchers have focused on identifying the reasons for participating in sexting. The most common theoretical model to describe a wide range of reasons that young people participate in sexting is a three-factor model for sexting motivations by Bianchi et al. (2018). The model shows that adolescents and young adults may sext for one of the following purposes: sexual purposes (sexting for sexual aims), instrumental/aggravated purposes (sexting for secondary aims – to obtain some benefit), and/or body image reinforcement purposes (sexting in order to obtain social reinforcement about the adequacy of one's own body). The authors noted that instrumental/aggravated purposes have the highest potential for harmful and coercive sexting that has been associated with dating violence (Bianchi et al., 2018). Other motivations to sext are to be fun and flirtatious, as a “joke” or attempt to bond and gain status among peers (Albury & Crawford, 2012; Burkett, 2015; Choi et al., 2016; Drouin et al., 2013; Englander, 2015; Kernsmith et al., 2018; Ringrose et al., 2012).

The present study empirically investigates how young adults differ in their evaluation of sexting behaviors driven by various motives and identifies factors that influence these judgments. Although there is considerable research on sexting attitudes, intentions (e.g. Hudson & Fetro, 2015; Liong & Cheng, 2017; Walrave et al., 2014) and behaviors (e.g. Ferguson, 2011; Strassberg et al., 2013; Wilson et al., 2021), to our knowledge there are no data available regarding the types of attitudes related to different motivational reasons for engaging in sexting. Existing cross-sectional research shows that consensual sexting is positively perceived and often occurs within an intimate relationship (Bianchi et al., 2016; Levine, 2013), while non-consensual sexting is focused on fun and excitement rather than the intimacy (van Oosten & Vandenbosch, 2020) and is a form of sexual harassment (Reed et al., 2016; Walker & Sleath, 2017). Recent qualitative research (e.g. Burkett, 2015; Burén et al., 2021; Harder, 2020; Le, 2016; Ringrose et al., 2012; Roberts & Ravn, 2019; Pérez Domínguez, 2020; Stanley et al., 2016; Van Ouytsel et al., 2017) and mixed methodological approach research (e.g. Currin et al., 2020a; Hasinoff & Shepherd, 2014; McGovern et al., 2016; Setty, 2019; Yeung et al., 2014) show that for young people sexting is not always a

positive enjoyable experience and can also be an uncomfortable or problematic activity. Though this qualitative or mixed-approach research contributes greatly to our understanding of the relationship between sexting motivations and the attitudes and beliefs about sexting, they nevertheless are limited to understandings of the perception, beliefs and meaning of sexting. All of the qualitative or mixed-approach studies, apart from one (Currin et al., 2020a), have been conducted using an in-person qualitative approach, where participants responded to open-prompts questions, individual interviews, or group focus interviews. However, insightful views of eliciting perceptions, opinions, beliefs and attitudes about sensitive issues that occur in the digital environment, such as sexting, may not be accessible through an in-person qualitative approach. We should use an internet-based qualitative context when seeking to produce a similar and realistic environment.

Utilizing vignettes is one way of effectively studying sensitive issues, especially when participants may not feel comfortable discussing personal challenges or when their answers may not be socially acceptable (Hess et al., 2016). Vignettes are short stories about hypothetical characters in specified circumstances in which the participant is invited to respond about the situation (Finch, 1987). This can be a less intrusive and non-threatening way of understanding individual cognitions (perceptions, beliefs, attitudes) about specific experiences, which are typically employed in conjunction with other qualitative methods such as interviews and focus groups (Azman & Mahadhir, 2017). With digital technology expansion, using vignettes within online focus groups could be an innovative methodological approach to examine individual cognitions about sexting. Given the limited research on understandings of individual cognitions about sexting in various motivational contexts using digital adaptations of qualitative approaches, this paper investigates the sexting experiences of young adults via online vignettes in combination with focus group discussions. The present qualitative study aims to compare attitudes toward sexting for three theoretically different motivational reasons (sexual purpose, instrumental/aggravated purpose, body image reinforcement purpose) and reasons for sexting for socializing purposes (fun, obtaining status, etc.). We expect that participants will display more positive attitudes toward sexting for sexual purposes and less positive attitudes toward sexting for instrumental/aggravated purposes.

METHODS

Participants

We conducted online synchronous focus groups from March 2021 to September 2021 using a website for online conferences. Participants from Bosnia and Herzegovina and Croatia took part in real-time online group discussion via text in which they were encouraged to express their opinions and comment on five vignettes featuring hypothetical examples of various motivational contexts for sexting behaviour. Ethical approval was obtained from the Department of Psychology in Bosnia and Herzegovina (Banja Luka and Mostar) and Croatia (Zadar). Hence, Croatian Ministry of Education and Science, Ministry of Education, Science and Youth of Sarajevo Canton and Herzegovina-Neretva Canton in Bosnia and Herzegovina approved this study.

Participants were 49 (41 female and 8 male) Croatian, and Bosnia and Herzegovina students who were entered into a drawing for a shopping centre voucher of a nominal value as a recognition for their participation in the study. Sixty-three percent identified themselves as Croat, 23% as Serb, and the remaining 14% as belonging to Bosnian nationality. Participant ages ranged from 19 to 26 years. Participants were recruited via direct advertising on university websites and announcements of the study in lectures at universities.

Designing the Vignettes

The set of five text vignettes (Supplemental Appendix 1) was designed specifically for this study which was part of a larger study project, "Nature and determinants of sexting among adolescents and youth: A cross-national study". When designing the vignettes, we drew upon the most common reasons for sexting noted in academic literature (sexual purpose, body reinforcement and instrumental/aggravated reasons, which is emerging as newest distinct motivational model for sexting; see in detail Bianchi et al., 2016; 2018). The guide was revised and approved by all authors and piloted with three focus groups.

Vignette 1 illustrated expression of instrumental/aggravated sexting that occurs when someone sexts, usually adolescent girls and young women, in response to being pressured by a partner (Drouin & Tobin, 2014; Klettke et al., 2014; Reed et al., 2020; Tobin & Drouin, 2013). This unwanted but "consensual" sexting (see Drouin & Tobin, 2014) occurs at concerning rate among youth probably due to motivation to maintain the relationship (Le, 2021). By Vignette 1 we tried to illustrate gender biases instrumental/aggravated forms of sexting since some studies show that girls are more often exposed to pressure, harassment and threats to sext (Bianchi et al., 2017, 2018; Choi et al., 2016; Englander, 2015; Kernsmith et al., 2018; Klettke et al., 2014; Ringrose et al., 2012, 2013).

Vignette 2 was also designed to illustrate form of instrumental/aggravated reasons of sexting but includes more harmful aims such as sexting coercion (Drouin & Tobin, 2014), and revenge toward an ex-partner (Drouin et al., 2015). However, due to findings suggesting that there are no gender differences for non-consensual sexting (see Madigan et al., 2018) we decided to provide more space for ambiguity and present a situation of a woman reporting instrumental/aggravated motivation with elements of harmful intention.

Vignette 3 depicts sexting for a sexual purpose which is the most commonly reported reason for sexting (Bianchi et al., 2016, 2017, 2019). It includes a situation of sexting in long distance relationship in order to improve passion and intimacy. According to the literature, sexting has been reported in relationships, especially in long-distance relationships, as an attempt to maintain or strength intimacy (Albury & Crawford, 2012; Bianchi et al., 2016, 2018; Currin et al., 2020b; Drouin et al., 2013).

Vignette 4 illustrated body reinforcement reasons for sexting which consists of sexting in order to obtain positive feedback and social reinforcement regarding one's own sexual attractiveness or appearance (Bianchi et al., 2016, 2017, 2019, Burkett, 2015; Currin & Hubach, 2019; Currin et al., 2022). As the literature has shown that that sexting motivations may be for fun, a "joke" or attempt to bond and gain status among peers (Burkett, 2015; Ringrose et al., 2012) we decided to incorporate these into these Vignette 4. We suspect that sexting for body image reinforcement involves sexting for social purposes (e.g., fun, peer status etc.). Hence, we wanted to explore young adults' views of sexting with strangers as it

relates to body reinforcement, since sexting with strangers has been perceived to have negative outcomes (Rice et al., 2014; Wolak et al., 2008).

Finally, Vignette 5 illustrated sexting for sexual purposes in an attempt to flirt with a potential partner (Albury & Crawford, 2012; Bianchi et al., 2016; Reed et al., 2020; Ringrose et al., 2013). Because recent findings have confirmed that LGBTQ individuals are more likely to engage in sexts for sexual reasons, e.g., to explore sexuality and meet partners/boyfriends, than heterosexual individuals (Bauermeister et al., 2014; Chong et al., 2015; Rice et al., 2012), we designed Vignette 5 to feature an individual with a gay/lesbian orientation.

Administering the Vignettes

Focus groups were conducted to explore participants' attitudes and opinions about the sexting experience. Each focus group lasted approximately 60 to 120 minutes and consisted of between six and eleven people. In total five groups were conducted in real-time using the web conferencing service by the facilitator and were recorded in digital format as text. After participants accessed the online focus groups via a username that did not indicate their identity, and gave their written informed consent, the facilitator gave the participants five brief hypothetical vignettes to explore. After each vignette was presented, the group was asked to discuss their initial thoughts about it. Prior to reading the vignettes, participants were asked to discuss ten open-ended questions that are not included in the analysis for this study.

Data Analysis

A thematic analysis, a method of qualitative data analysis that aims to describe the thematic categories that emerge from the data obtained (Howitt, 2010), was conducted to analyse the descriptive responses to the vignettes. In conducting the thematic analysis, Braun and Clarke's (2006) iterative approach to familiarising with the data, coding the data, and developing themes was followed. The data from the corresponding main themes developed through the thematic analysis were then quantified (by expressing them as a %) to determine the prevalence of positive, negative, neutral and mixed attitudes towards sexting underlying the different motives. An overview of the themes and codes based on analysis of focus-group data responses is presented in the Table 1. Data analysis was conducted using the qualitative software package QSR NVivo 10.

Table 1. Coding scheme with themes and codes with references in parentheses and examples.

THEMES	CODES		EXAMPLE OF CODED EXTRACT
Vignette 1			
Negative attitudes (66)	A partner's behavior is manipulation or blackmail (21)		„...if she wants to continue dating him indicates Robert's goal from the beginning, sexual gratification with Irene's pictures and/or their publication on the Internet (blackmail is also possible).“
	Content should not be sent under pressure from a partner (16)		„No, if it's something she doesn't want to do then she shouldn't do it.“
	Partner who put pressure is a bad person (or should seek help) (15)		„Robert is stupid and Irene deserves better.“
	End the relationship in case of pressure to sexts (6)		„Irene needs to block him and get him out of his life.“
	The partner should not exert pressure (6)		„If he loved her, he wouldn't ask for it.“
	A person should think before sending content under pressure (2)		„I think Robert is only with Irene to send her photos, but of course we do not see the whole story. We need to pay attention to the situation and then do what we can to make sure he does not do something we can borrow to get revenge.“
Vignette 2			
Negative attitudes (69)	The partner who blackmails is a bad person (should help) (27)		„Ana is trying to gain control over him. He is afraid of being hurt and losing someone. He's afraid of being lonely when he does not need her or feeling like she has a counter over him, so he does not want to be with her. She wants control, she wants to be above him. She might just be a psychopath and need a psychiatrist.“
	End the relationship in case of blackmail (and/or remove the content) (17)		„Took her phone away, forcibly deleted messages, and broke up with her.“
	Trust issues (lack of trust, breach of trust) (13)		„Luke gave Ana his trust, she played with him as seen on many occasions, unfortunately not the only case. He needs to be more careful and she needs to be more realistic because what she is doing is not sustainable.“
	Blaming (5)		„It's their own fault because they knew the negative consequences and could not be sure if the photos would be deleted.“
	Partner's behaviour is blackmail/criminal behaviour (4)		„Blackmail that is difficult to get out of.“
	Reporting to the police (3)		„...he would have contacted the police if I were in his shoes..“
Vignette 3			
Positive attitudes (31)	Consensual sexting in an intimate relationship (with a trusted person) is fine (23)		„Well done, I respect them. That means they are mature and trust each other.“
	Sexting in an intimate relationship can be good for an relationship (8)		„Sara and Allen have a healthy, trusting relationship. Sexting is a normal thing to do when you are in a long-term relationship and trust each other. It brings you closer together.“
Negative attitudes (25)	Sexting in an intimate relationship can be risky (14)		„It just brings them closer to blackmail if one of them decides to break up.“
	Sexting in an intimate relationship is wrong/bad (9)		„It's not the right way.“
	Sexting in an intimate relationship with minors is problematic (2)		„The problem here is that Allen is a minor.“
Neutral attitudes (2)	Sexting in an intimate relationship is own choice (2)		„If that's what they think, then let them.“
Vignette 4			
Negative attitudes (48)	Sexting under peer pressure is wrong/bad (17)		„Social pressure. It's the same as saying to yourself, if everyone jumps off a building, I'll go with them..“

	Sexting under peer pressure can be risky (14)	„Nora was certainly wrong at this point, because this acquaintance is in no way loyal to her, and it is almost certain that he will share her pictures with other people.“
	Content should not be sent under peer pressure (10)	„If you are not 100% sure at first, do not do it.“
	The person who has sext under peer pressure is a bad person (7)	„If she really sent it off, then she has some kind of disorder that needs to be treated.“
Neutral attitudes (8)	Sexting under peer pressure is own choice (8)	„She made her decision. No one told you to take her picture. She fell of her own volition, so let her get back up of her own volition.“
Vignette 5		
Negative attitudes (17)	Sexting for flirting purposes is wrong/bad (17)	„It's stupid of me to send such photos for flirting purposes.“
Neutral attitudes (13)	Sexting for flirting purposes is own choice and responsibility (13)	„I do If it's okay with him, who am I to judge.“
Positive attitudes (4)	A person who engages in sexting for flirting purposes is confident (4)	„Too much confident.“
Mixed attitudes (8)	Sexting for flirting purposes is acceptable if it is voluntary/consensual (5)	„If the other parties are okay with getting those pictures, that's fine.“
	Sexting for flirting purposes is acceptable if the person is aware of the consequences (3)	„If Sasha has thought through his choices and is aware of the consequences, that's fine, but you should be careful.“
Double standard on sexting for flirting purposes (7)	Double standard on sexting for flirting purposes (7)	„Comparing boys and girls in this situation is somehow not the same for me.“

RESULTS

The following sections present the results of dominant themes that were identified through the thematic analysis of participants' responses. Themes regarding each sexting vignette are presented first and include quotations from participants, then the participants' thoughts about the hypothetical situations in the vignettes are discussed.

Qualitative Data Analysis of Sexting Vignettes

Vignette 1: For the hypothetical scenario of pressure to sext participants expressed negative attitudes. Respondents perceived the partner's behaviour as manipulative (e.g., *“I think he's manipulating her and he does not really care about her.”*), blackmail (e.g., *“Everything was fine until the last part of the text where he says “If you want to continue with me, send me pictures,” that's blackmail, a red flag.”*), and/or sexual harassment (e.g., *“Irena should leave Robert and report him for sexual harassment.”*). According to one participant, pressuring someone into sexting can be a form of violence (e.g., *“Any further persuasion or pressure can be a form of “violence” and/or manipulation.”*). Respondents felt that the person being pressured into sexting should not participate (e.g., *“NO! I mean it's easy to say when you are not in their position, but that's a typical example of a man who does not need to have anything sent to him.”*) or even end the relationship (e.g., *“I think this relationship should end, toxicity, you can see there's no hope for this relationship in the future after Robert said he has to send photos when Irene goes out with him Robert is rude and does not deserve Irene...run Irene, run.”*). Some of the participants indicated that the partner who exerts pressure is a bad person and/or should seek help (e.g., *“I think Robert should seek*

professional help.”). Another reaction was that a partner who loves and respects the other person in the relationship should not put pressure on them (e.g., *“I think if Robert really likes her, he should not ask for something like that when she's not well.”*). Two participants mentioned that the person should think about it before deciding to sexts (e.g., *“I think she should think and wait because it's too early to ask for something like that.”*)

Vignette 2: Regarding sexting as revenge, participants thought that the person who revenge is a bad person who has serious problems (e.g., *“Ana has major emotional problems, keeping her partner this way requires a little more serious observation.”*) and should seek professional help (e.g., *“Ana needs professional help.”*). In addition, participants noted that the person subjected to such behaviour should end the relationship (e.g., *“I think you should definitely break up with her and try to delete the photos somehow.”*) or seek legal help (e.g., *“I think Luka should contact someone in the legal field and of course face the consequences if these pictures come to light.”*). One participant pointed to the need for professional psychological help, but emphasised the gendered double standard in seeking this type of help, as follows: *“Although I do not think Luka would seek professional help because he is a man, which is absolutely wrong.”* Participants believe that this sexting behaviour is related to a trust issue (e.g., *“In the case of Ana and Luka, I think Ana played trust in the first place and did not do the right thing.”*). Some participants indicated that those who decide to participate in sexting are at fault (e.g., *“Ana is clearly obsessed with him and it is her own fault that she decided to send such a picture.”*). For some participants, such behaviour is blackmail (e.g., *“I do not approve of Ana's opinion; it's blackmail, which is in no way correct or right towards the other side of the relationship, I mean Luka.”*) or criminal behaviour (e.g., *“It should be a criminal offence, certainly a form of rape/excessive consent.”*).

Vignette 3: For the vignette related to sexting within an intimate relationship participants most often expressed positive attitudes. Participants who viewed sexting within an intimate relationship positively most often viewed it as consensual and trusting behaviour (e.g., *“This is the story I can personally relate to the most because there is mutual trust and voluntary consent from both parties here.”*) that is also good for maintaining the relationship (e.g., *“There's nothing wrong with that, I am glad they found a way to be close even though they are physically far apart.”*). Those who viewed sexting in an intimate relationship as dangerous (e.g., *“I do not support it, you should always use a dose of caution and get to know the other person well.”*) and bad (e.g., *“But if the body is the only thing that connects them, then I do not think there's any point to the relationship.”*) were frequently expressed by those who held negative attitudes toward sexting in an intimate relationship. Two participants expressed that sexting in an intimate relationship can be problematic if the individuals are underage (e.g., *“Since Allen is underage, that means he's technically doing child pornography of himself, which would put him behind bars a little bit.”*). Finally, two participants expressed a neutral attitude toward sexting in intimate relationships, which they related to their own decision making, such as, *“Everyone reacts and makes decisions about their lives and is responsible for their behaviour.”*

Vignette 4: In the vignette about being pressured into sexting from others was viewed by participants as bad behaviour (e.g., *“Nora's ultimate procedure is very careless and reckless.”*). Participants in this vignette also talked about the risk of sexting with strangers/acquaintances. They expressed negative attitudes toward sexting with strangers due to the overall risk of negative consequences (e.g., *“I do not think it's good to send explicit*

photos with strangers, and it does not have any positive consequences, only negative ones.") or due to the risk of spreading content (e.g., *"Since it is only a superficial relationship (they are acquaintances), I would not advise her to do something like that, because even if she received such content indirectly, it is likely that these pictures will later circulate within and possibly outside this group."*). In addition to describing the negative risk of sexting, participants also described the person sexting under peer pressure as a bad person, usually described as unstable (e.g., *"Unstable person who does things they do not want to do just to please others."*) and/or immature (e.g., *"An unstable and immature person who does things just to fit in with their friends."*). Some participants noted that sexts should not have been sent under peer pressure (e.g., *"I do not support Nora, I think she lets peers influence her, she should not do that."*). For some participants, sexting in this vignette was not seen as personally acceptable, but was interpreted as their own choice and responsibility (e.g., *"If she did it, she was quite sure of her actions, regardless of the society, then that's fine, but it's not like this"*).

Vignette 5: Participants were most likely to perceive sexting as negative when done by individuals flirting with a same-sex potential partner, labelling it as wrong behaviour (e.g., *"Sasha is flirting in the wrong way."*). However, some participants pointed out that in the situation where women or men are involved in sexting, double gender standards become visible (e.g., *"In our society, a woman who sends such a photo is a 'whore', I apologise for this expression."*). The second most common opinion on this vignette was neutral, viewing sexting in this situation as a personal choice (e.g., *"He's an adult and can do what he wants, being aware of the consequences at his age."*). Finally, some participants held mixed attitudes, stating that it was only acceptable if another person wanted to receive sexts (e.g., *"That's fine if the boys want his photos and they voluntarily share them with each other, if he himself sends them without consent, then it's crazy."*) or if the person was aware of the consequences (e.g., *"If he's not interested in his photos being circulated, that's fine."*). One group of participants emphasised the positive qualities of the person participating in sexting to meet a potential same-sex partner, typically describing them as a confident person (e.g., *"I do not think Sasha would mind if his pictures end up showing up, he still says he's a really good looking guy."*).

Comparison of Attitudes Toward Sexting Depicted by Vignette

After categorization of qualitative data, the frequencies of responses across attitude categories were totaled. Table 2 provides the frequencies and percentages of the responses on attitudes across various sexting behaviors. Overall, more than 70% of students indicated that they had a negative attitude toward revenge sexting or sexting pressured by intimate partner. The majority of the participants expressed negative attitudes about sexting under peer pressure (63.65%) or for flirting with strangers by LGBTQ individuals (53.06%). The descriptive analyses yielded the most positive attitudes toward sexting within an intimate relationship. Due to an insufficient number of frequency responses on categories data have not been statistically tested by chi-square.

Table 2. Frequencies and percentages of positive, neutral, negative and mixed attitudes about various sexting motivational context by student participants.

Type of sexting behavior	Sexting attitudes			
	Positive <i>n</i> (%)	Neutral <i>n</i> (%)	Negative <i>n</i> (%)	Mixed <i>n</i> (%)
Sexting pressured by partner	0 (0%)	0 (0%)	36 (73.69%)	0 (0%)
Revenge sexting	0 (0%)	0 (0%)	40 (81.63%)	0 (0%)
Sexting within intimate relationship	26 (53.06%)	11 (22.45%)	8 (16.33%)	0 (0%)
Sexting under peer pressure with stranger for body reinforcement	0 (0%)	3 (6.12%)	31 (63.65%)	0 (0%)
Sexting by homosexual person in order to flirt with a potential partner	3(6.12%)	5 (10.20%)	26 (53.06%)	12 (24.48%)

DISCUSSION

The present study represents a first step toward qualitatively understanding beliefs, expectations and attitudes about sexting driven by various motives. Consistent with research focused on deviant sexting, hypothetical experiences of sexting under pressure (partner/peer) or blackmailing as revenge received the most negative reactions. Similar findings have been obtained in other sexting studies which conceptualized peer pressure, blackmailing, or unwanted forwarding of sexting as a risk and harmful behaviour (Benotsch et al., 2013; Gámez-Guadix & Mateos-Pérez, 2019; Houck et al., 2014; Morti et al., 2019; Rice et al., 2014). While discussing sexting as a risky behavior, some authors (Harris, 2011; O’Keeffe & Clarke-Pearson, 2011) have noted non-consensual sharing as the most often mentioned negative outcome of sexting, and have suggested abstinence from sexting as most helpful way to avoid this (Diliberto & Matthey, 2009).

Roberts and Ravn (2019) found that participants put significant emphasis on consent, mutuality, and respect to distinguish “appropriate sexting” practices as distinct from harassment or image-based abuse in their focus group study of undergraduate students. Our results are in line with those findings; participants perceived sexting as normative acceptable behaviour when done with a known and trusted person, preferably a romantic partner (Burén et al., 2021) and when used as a means of sexual gratification for the establishment of a long-term sexual relationship (Roberts & Ravn, 2019). The present study therefore confirmed that sexting within intimate relationships is viewed as a normal expression of sexual behaviour used to increase fun, intimacy or passion among partners (Anastassiou, 2017; Bianchi et al., 2018; Döring & Mohseni, 2018; Kosenko et al., 2017; Levine, 2013; Van Ouytsel et al., 2020; Yeung et al., 2014). Sexting for the purpose of flirting with a stranger (our fifth vignette) has been described as risky and parallels with finding that sexting outside of romantic relationships is associated with risk-taking behaviours (Van Ouytsel et al., 2018), as well as with those of consent and trust as the key to appropriate sexting practice (Roberts & Ravn, 2019). Sexting is separate from flirting as it is characterized by a stepwise build-up, where the next step of person is a reaction to the previous message of the interlocutor (Roberts & Ravn, 2019). Rather than focusing on the risk of sexting in order to flirt with the “potential” partner, future studies could examine how flirting can turn into appropriate

sexting practices. Further, considering the finding of double standard in sexting for flirting purposes, the gendered value on exchanging sexually explicit content comes to the forefront. Much research has found that the experience of sexting is highly gendered (Roberts et al., 2021) and positions boys and young men as sex-crazed and less judged for participating in sexting than girls or young women (Ringrose et al., 2013).

These findings may be of practical importance as they suggest that individual motives for sexting are crucial for understanding sexting behaviour. Specifically, sexting is perceived as more productive and acceptable when it serves sexual purposes, such as in an intimate relationship. However, this is not true for some harmful types of sexting, such as non-consensual sexting, where it may be more appropriate to promote prevention through education. Education should emphasise that any type of non-consensual sexting is wrong, regardless of the relationship with the recipient. Education efforts should emphasise that each partner, regardless of relationship status, should be respected and that it is not acceptable to share someone's sexts without explicit permission. It is clear that sexting is an important topic for young people and that education about this topic should be considered an important part of sexuality and relationship education.

Despite the strength of the results, there are some limitations with this study. First, the study population is limited to a single group, the majority of which is female. Therefore, young adults' attitudes, beliefs, and opinions about sexting were only validated in this female population. Moreover, due to the limitation of the study to the higher number of participants of Croatian nationality, the results cannot be generalized to all Serbian and Bosnian samples. Therefore, it is recommended that the results be replicated in future studies with different groups of girls and boys from different cultures, nationalities, religions, and regions. Another limitation is that the gender and sexual identity has not been evaluated in the study. Researchers should examine sexting behaviors in lesbian, gay, bisexual, transgender, and questioning (LGBTQ) populations as well. Although research on LGBTQ youth and sexting is sparse, it appears that identifying as LGBTQ is related to increased participation in sending sexts (Rice et al., 2012) and that LGBT women are more likely to send and receive sexting than heterosexual women (Wysocki & Childers, 2011). It could be that LGBTQ relationships do not operate according to a heterosexual script in which men are the sexual aggressors and women objectify themselves to gain some power in a romantic relationship (Kim et al., 2007). The third limitation is that while we attempted with the vignette scenarios to allow respondents to express their opinions in a non-threatening manner, the data collected and analysed were about hypothetical scenarios and may not accurately reflect or predict participant behaviour. A final limitation may be that by placing the vignette scenarios at the end of the survey we increased measurement error because the vignettes are particularly susceptible to fatigue effects (Sauer et al., 2011). Future studies will benefit from placing the vignettes in mixed order between questions.

CONCLUSIONS

In conclusion, we can say that sexting within intimate relationships is perceived as the most positive type of sexting behaviour in our study. Sexting pressured by a partner and revenge sexting are perceived as the most negative types of sexting behaviours. Furthermore, participants expressed negative attitudes toward sexting under pressure with strangers for the purpose of body reinforcement and sexting by LGBTQ individuals in order to flirt with a potential partner. In summary, sexting is perceived as acceptable only if it shared consensually between heterosexual young people, according to results of this research. The findings of this study suggest that professionals working with young people who sext should be aware of the nature of sexting motives and how these motives may influence behaviors.

IMPLICATIONS FOR RESEARCH AND PRACTICE

To our knowledge, the present study is one of the first to use vignettes to examine the relationship between attitudes toward sexting and the decision to participate in a particular sexting situation. Although vignettes cannot fully represent real-world situations and may be limited in their applicability to real-world situations, the use of case vignettes may be a good way to reconstruct sexting decision making in a controlled settings. By using vignettes, the study provides a nuanced understanding of how different types of sexting behaviors are perceived by university students.

Furthermore, the results of our study can explain not only why attitudes toward sexting are an important preventive target to reduce the risky aspects of sexting, but also why such a target is not always successful. Understanding how the different types of sexting are perceived can help professionals promote safe and responsible use of technology among youth. Future research should focus more on examining not only cognitive but also emotional and implicit attitudes toward sexting.

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Appendix 1

Vignettes about sexting

Vignette 1: Irena (24) has been dating Robert (25) for a couple of months. She really likes him, and she thinks he really likes her too. Lately Robert has been asking Irena to send him some of Irena's sexy pictures (sexts), but she has not done it. Irena is nervous about others finding out about the pictures or even possibly seeing them. Robert assured Irena that no one else would know about the pictures and explained that if she really liked him and wanted to keep dating him then she should send the pictures.

Vignette 2: Ana (23) and Luka (23) are in a relationship and have decided to share a few sexually explicit photos, but on the condition that both of them would delete the pictures upon their receipt and viewing. After viewing the sexy photos (sexts) from Ana, Luka immediately deleted them. Ana convinced Luka that she also deleted her 'sexy' pictures. After a while, Luka accidentally found his photos on Ana's cell phone. Clearly, she did not delete the pictures and lied to Luka! When Luka confronted Ana, she still refused to delete Luka's photos. She said she would forward the photos to others if Luka broke up with her.

Vignette 3: Sara (22) and Alen (21) have been in a relationship for more than 9 months. They are currently separated due to college attendance in different cities. They are really in love and talking about the future together. They both regularly exchange their sexually explicit photos and/or videos. In their opinion, the exchange of sexually explicit content (sexting) brings them closer to each other.

Vignette 4: Nora (23) has heard that some of her friends often receive nude/ half-nude photos and/or videos from other people. For some friends, this is funning, so they decide to reciprocate with their own nude/ half-nude photos and/or videos. She also received "sexy" photos from acquaintances several times with a request to forward her photos. So far, she has not responded to such messages and requests. Last night she again received from an acquaintance his sexually explicit photo with a request to send hers. She is standing naked in front of the mirror inspecting her body and wondering should she take own nude photo and sent to him. Although she is not very sure, she decides to have fun and send him her photo.

Vignette 5: Saša (24) is quite confident in his physical appearance and has a lot of his "sexy" photos in his mobile phone. He usually exchanges his photos with guys he likes. He sees this as a way to flirt with them.

THE IMPACT OF ARTIFICIAL INTELLIGENCE ON CONSUMER BEHAVIOUR AND CHANGES IN BUSINESS ACTIVITY DUE TO PANDEMIC EFFECTS

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Abstract: *The COVID-19 pandemic has impacted the world economy, and the restrictions have shaken business models. E-commerce has skyrocketed as the only way to purchase products and AI has received closer consideration as social distancing has become imperative. This research aims to find whether the COVID-19 has translated into an opportunity for the use of AI by companies. A survey incorporating consumers and companies was conducted to analyse the positioning of consumers regarding the use of AI, as well as the perception of companies regarding their possible use of AI. It was concluded that due to COVID-19 there was an increase in the relevance that companies give to AI, the main drivers being the companies' views on AI and the benefits from its use. Regarding consumer behaviour, consumers are more receptive to AI use, favouring a fully automated experience, with half of the sample preferring to buy online.*

Keywords: *COVID-19, consumers, companies, e-commerce, intelligent systems, artificial intelligence.*

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INTRODUCTION

With the emergence of the COVID-19 virus, the global economy was significantly impacted by restricted movement, social distancing, and mandatory containment measures. This has cut across all sectors, not only economically but also socially. Today, the business environment faces new challenges, especially in the way business is conducted. Consumption habits develop over time, but while consumption is habitual, it is also contextual and, given the current landscape, it is undergoing significant changes, putting enormous pressure on businesses. Customers have been prevented from going to their usual places of consumption and have been forced to change their habits. In addition, consumer attitudes have been changing due to the danger of the contagion.

As the pandemic reached its peak, individuals were forced into confinement, and many businesses and services were similarly forced to close. The duration of the pandemic caused many businesses to experience serious difficulties. Numerous enterprises were unable to operate, either because of a lack of customers or because of legal requirements that restricted their operations. The changes resulting from the pandemic challenged consumer perceptions and behaviour. The use and acceptance of digital have given way to the new reality where it is the only alternative that can keep people connected, so digital has become a necessity rather than an option (Sheth, 2020).

On the other hand, the implementation of AI in companies has taken on a clear importance today. The digital transformation fostered by the increasing leverage of artificial intelligence has been a critical influencing factor unleashing the next wave of enterprise business disruption (Chintalapati & Pandey, 2022).

AI is seen as an important aid in the development of various tasks, but more importantly these days, it can automate tasks and processes, and inevitably come to reduce contact, representing a key element in the course of containing the COVID-19 pandemic.

Coombs (2020) concluded that before the COVID-19 pandemic, individuals preferred a human element rather than a fully automated experience. However, after the pandemic situation, these preferences may change as contact became compromising. The current moment may represent the turning point in the massive use of AI by businesses, supported by the possible renewed consumer preference for automated interactions and the need for organizations to react and adapt to survive and overcome the current difficulties.

Therefore, this study aims to contribute to the progress in scientific knowledge in the area of business in conjunction with the area of AI, through the following general objectives: Contribute to the development of literature in the areas of business and AI in the pandemic situation COVID-19; Try to answer the gap in the literature relating these two topics; To understand if the COVID-19 pandemic can promote the use of intelligent systems by companies in a generalized way; Understand the impact and importance that AI may represent in the business environment as the pandemic progresses. To strengthen and deepen the study, a specific objective was defined: To understand how Portuguese companies evaluate the possibility of using AI to respond to situations caused by the COVID-19 pandemic.

This article, to achieve the proposed objectives and answer the research questions raised, is organized as follows: 1) a brief introduction to the article, 2) the literature review is elaborated, trying to understand which works and studies have been done in these areas, through the study and observation of the work of other authors in the area of AI and the impacts

of the COVID-19 pandemic on the behavior of companies, 3) the methodology used and the characterization of the sample used for the development of the work, 4) presents and discusses the results obtained with the authors who contributed to the formulation of each of the research questions, 5) the conclusion, where the final considerations of the research are described, followed by the contributions to academia, the limitations that the study presents, and suggestions for future research.

LITERATURE REVIEW

Innovation has always been the main driver of improvement throughout history. Internet-of-things (IoT), big data, artificial intelligence (AI) and blockchain are rising technologies all over the world, and the strong technological growth is awakening the ability of a machine to perform cognitive functions such as perceiving, reasoning, learning, and interacting through different AI approaches. Large amounts of data are currently produced, and according to Henke and Kaka (2018), it is this data that allows AI to assist an increasing number of companies in a wide variety of areas.

Similarly, Haenlein and Kaplan (2019) argue that derived from big data and improved computing power, these approaches have been increasingly used by businesses and the general public. Almost 60% of large companies have already adopted AI in at least one function or business unit in 2019 (Perrault et al., 2019), in which, most reported gaining benefits where it was used.

It was in 1950 that AI moved from science fiction to reality, through the publication of Alan Turing's paper, entitled "Computing Machinery and Intelligence." The Turing test was introduced, where it aimed to assess a machine's ability to mimic the behaviour of a human to determine whether or not it was intelligent. The test was simple, if a judge, when involved in an interaction with a computer, could not tell the machine from a human being, the machine would pass the test, which it eventually did. This historic achievement was considered the catalyst in the interest and further development in the field of AI.

The term artificial intelligence, as a respectable scientific term, was established at the Dartmouth conference in 1956. AI came to be seen as a broad branch of computer science, focused on building intelligent machines capable of performing tasks that normally required human intelligence. This topic is discussed and addressed by numerous authors, to which several definitions are attributed.

Authors such as Shabbir and Anwer (2015) argue that AI can be viewed as the use of machines and computer programs, to perform intellectual and imaginative tasks of humans. Panch et al. (2018), meanwhile, argue that AI exhibits certain behaviours that resemble human intelligence, and highlights planning, learning, reasoning, problem-solving, and knowledge representation. In turn, Güngör (2020) argues that AI is a generic term for various methodologies designed to provide computers with human-like abilities to see, hear, reason, and learn.

However, there is one common element mentioned by Patrick (2020), AI must exhibit intelligent human behaviours or be able to perform tasks that previously required human intelligence. In addition to the aforementioned, Pettersen (2019) further explains that currently,

AI focuses on the use of algorithms, these being a set of rules and procedures that a computer must perform when performing a given task.

Different approaches and practical applications of AI

By now it is clear that AI corresponds to a broad branch of computer science, and as such, includes several approaches and tools that companies should take into consideration when supporting decisions, whether to increase efficiency, reduce costs, or even to automate processes. Within this vast field of AI, it is usual to identify three distinct general categories: Narrow AI, general AI, and super AI.

Narrow AI, which according to Burgess (2018), corresponds to current techniques, applications, and algorithms that seek to address what is happening. General AI, concerning systems that can learn and behave intelligently, similar to a human being (Finlay, 2018). And Super AI, capable of being used in any situation, and delivering superior results to a human being (Haenlein & Kaplan, 2019).

Of the numerous AI approaches, the main ones stand out: Natural language processing, corresponding to the approach that supports text analysis, facilitating the understanding of the structure and meaning of sentences, through statistical and machine learning methods. It allows machines to understand the meaning of human language in a useful and intelligent way; Natural language generation corresponds to the AI approach used to process and generate text from computer data; And regarding speech recognition, it aims to translate human language, and convert it into a useful format for computer applications (Lu et al., 2017).

Machine learning refers to the use of algorithms for analyzing specific, structured data to recognize useful patterns, relationships or correlations, between different data inputs and learn from them. Once patterns are identified, it can make inferences about similar situations (Finlay, 2018).

Machine learning is typified into three categories, supervised learning, unsupervised learning, and reinforcement learning. Supervised learning algorithms according to Panch et al. (2018), are programs that learn associations by analyzing data, defined by a supervisor. Unsupervised learning algorithms correspond to programs that can learn associations in data, without an external definition. However, reinforcement learning algorithms seek maximization and can automatically identify optimal behavior.

Moving on to a subset of machine learning, we have deep learning where algorithms designed to match human neural networks are used. This approach can learn and complete its tasks through unstructured data, looking for correlations between the data through evolutionary testing. The deep learning approach makes it possible for machines to perform many tasks with little or no human intervention.

Finally, one AI technology that is very much in vogue today is robotic automation. Robotics resorts to the use of software and algorithms, in an attempt to automate human action to obtain more efficient processes in companies. Nowadays, these processes are used when it becomes too costly or inefficient for a human being to perform a certain task (Willcocks & Lacity, 2016).

There is a great deal of discussion about the importance of AI in today's times. With the introduction and successful implementation of AI solutions, many are the businesses that benefit from increased output and show significant growth rates (Shabbir & Anwer, 2015). The

different AI approaches that have been developed are characterized by having high levels of efficiency. These approaches both facilitate cost reduction, through waste reduction and better optimization of resources and also enable the increase of results and consequently the improvement in organizational performance.

There is enough evidence available in the literature that different AI approaches offer new opportunities that can lead to a remarkable transformation in business. AI is characterized by being transversal to any industry and can be used in several areas, whether in the industrial sector through the prediction of manufacturing processes, in planning processes, in repair forecasting, in quality control, in logistics, and even in optimization processes. Regarding the health area, it can become an important ally as detection tools and medical diagnosis, in performing surgeries through robotics or even in the development of vaccines, in the latter case, using machine learning to facilitate the observation of large samples during the process.

Even in the financial sector, these approaches have a place, whether in fraud detection in financial institutions and auditing firms or as automated trading tools in investment funds. Even in the agricultural sector, AI can have an impact, as today, farmers can get assistance in irrigation to make production more efficient.

Impact of AI on the pandemic COVID-19

The pandemic crisis is challenging all domains and consequently, causing huge changes in societies, be it consumers or companies, and the way they do business. There has been an increase in the demand and use of AI in several areas described by Naudé (2020). Recent studies identify AI and machine learning as promising approaches in combating the COVID-19 pandemic. According to Davenport and Kalakota (2019), it increases processing speed, reliability and can outperform people in certain healthcare tasks. Lalmuanawma et al. (2020), on the other hand, explain the advantages of their use in screening COVID-19 patients. According to studies conducted, some of the uses have an average accuracy of 95%.

Throughout the literature review conducted on this topic, it is apparent that the vast majority of recent research and studies that have been prepared by various authors focus on and target the medical field. However, there is already some work that focuses on the use of AI by companies as a way to deal with the pandemic crisis.

According to Sreeharsha (2020), there are companies currently concerned with developing new AI systems to control the social distance between employees in the workplace. This represents a way to overcome the obstacles and restrictions imposed by governments and will allow many companies to resume their activities.

Adapted AI approaches can bring unpredictable, unexpected, or even misleading results since they were initially developed for another purpose. This concept, however, can be important in the current context where it demands quick solutions. With the need to accelerate the development of promising technologies to COVID-19, adapting existing technologies may be a solution.

As an example, consulting firm PwC developed an AI-based automatic contact control tool by reusing an existing system that was used to control assets within a building (Sreeharsha, 2020). It has now been used to control contact between employees. Similarly, Smartvid has developed a business system using AI to detect the distance between two individuals, and whether they are meeting with more than 10 individuals. This system analyzes the images to

help enforce social distancing in a given location and can serve as a preventive measure in the fight and control of the COVID-19 pandemic, allowing companies to return to work safely.

Businesses need to react and adapt, identify new products, new customers, and shift operations to new markets to survive and remain competitive in the new economic environment (Kim & Mauborgne, 2005).

Strategic agility and market-shaping oriented strategies

According to author Ehiorobo (2020), strategic agility is not limited to a specific definition. While Denning (2018) sees it as the concern with creating new products or services aimed at new markets, Judeh (2014) understands it to be the ability of organizations to remain competitive by adjusting and adapting to innovations. In turn, Morton et al. (2018) consider strategic agility as a continuous practice of adapting and adjusting to the strategic direction in the core business, depending on strategic objectives and changing circumstances.

Although several authors speak on the topic, it is clear that strategic agility implies fluidity and a quick response to unstable market conditions. This will be necessary for the survival and continuity of any business. With the changes brought about by the COVID-19 pandemic, small and large retailers have had to adapt to cope with the current situation. The restrictions have been severely affecting companies and forcing them to react. Thus, alcoholic beverage companies have had to reconfigure their production to produce hand sanitizers, textile industries have changed their production to masks to protect against the COVID-19 virus, while food delivery companies have had to introduce contactless payment methods.

While the actions taken by companies to adapt and survive are working, in recent years, researchers such as Priem et al. (2013) have increasingly emphasized that markets are not deterministic contexts exogenous to the company in which they must adapt. Instead, a change of perspective is proposed whereby markets are seen as malleable complex adaptive systems (Suvi Nenonen et al., 2014), which are essentially the result of agent-driven efforts (Dew & Sarasvathy, 2016; Gavetti et al., 2017; Kjellberg et al., 2015; Nenonen et al., 2019).

According to Johnes (1999), an agent can choose to be a market leader by developing that market in the directions that are most favourable to it. Thus, instead of firms being required to be flexible and ready to adapt to the external environment, Patvardhan and Ramachandran (2020) suggest the need for model-oriented strategies, giving primacy to artificial evolution processes, i.e., interventions where a firm's leaders challenge what leverages the organization's internal ecology to drive the business model in a preferred direction.

Consequently, in addition to adapting value chains and work practices to the COVID-19 pandemic, companies must think more actively about the future, as Nenonen and Storbacka (2018) state that pushing an already disrupted market in a specific direction that is favourable to us is easier than setting a static market in motion. Therefore, the occurrence of crises gives rise to a deliberate formation of agents (Luksha, 2008). These agents aiming to shape the market to their advantage must time their efforts to coincide with periods of instability or discontinuity (McGrath, 2019; Nenonen & Storbacka, 2018). In this way, the COVID-19 crisis that has set in may be an ideal time for companies to impose themselves on the market, according to their guidelines, with new ways of doing business in an attempt to gain an advantage.

Changes in consumer behaviour

The profound changes resulting from the pandemic crisis are challenging consumer perceptions and behaviours. The increase in the use and acceptance of technology and digital, as well as online services, are giving way to the new reality, this being the only alternative capable of keeping people connected. Knowledge about digital has become a necessity rather than an alternative, and e-commerce has shown a significant increase (Sheth, 2020).

Consumers in rethinking their shopping habits recognized benefits in services they had never used before. Aging consumers have begun to turn to online shopping, discovering the safety and benefits of home delivery. Pantano et al. (2020) state that the internet presents itself as the main way to purchase essential products and services, and in the current landscape, online shopping and home delivery are classified as essential services.

A major impact on the elected shopping channel has been observed, while online shopping has been stable, albeit, with a slight growth in the last decade (Harris et al., 2017), it skyrocketed during the COVID-19 crisis. In addition, older consumers with less digital experience have begun to turn to online shopping. As an example, one online retailer, Miss Fresh, witnessed a 237% increase in users over the age of 40 (Nielsen, 2020). Similarly, distribution options are beginning to emerge where no physical interaction is required, such as home deliveries via robots and Amazon's Walkout Shopping technology.

Coombs (2020) during his research sought to understand the pros and cons of the massification of smart technologies are. He concluded that before the COVID-19 pandemic, people preferred a human element in their interactions rather than a fully automated experience. However, after the COVID-19 pandemic, these preferences may change as interpersonal contact has become compromised.

A clear change in consumer behaviour is becoming apparent, and consequently, questions arise as to how long these new habits will last. Are the new trends here to stay? Will traditional consumer habits return after the pandemic? Author Sheth (2020) argues that most habits will return to normal. However, some of the habits will inevitably disappear as the consumer, when confined, has discovered a more convenient and affordable alternative.

The importance that AI can represent in the business environment

Containment has generated a sharp increase in dependence on digital technologies to ensure continuity of life and work. This has forced many companies to reinvent their business models through digital technologies. According to Maritz (2020), online has become critical to obtaining sales, before the COVID-19 pandemic, e-commerce came from factors such as convenience and price, now it is a necessity.

The pandemic has increased the need for intelligent services. In the current scenario, customers have developed a renewed preference for contactless services supported by digital and smart technologies. Coombs (2020), on the other hand, argues that in addition to renewed customer interest, the COVID-19 pandemic may become the catalyst for the mass use of AI. As such, several brands have accelerated digital transformation to sustain competitiveness in the post-pandemic world.

Several hotels have decided to implement smart contactless services, including automatic or remote check-in, facial recognition, voice control in-room service, and robotic room service.

These services seek to avoid interpersonal contact and minimize stays in public areas, helping to reduce the risk of infection and transmission of the COVID-19 virus. Shabbir and Anwer (2015) argue that AI will transform the way companies compete around the world, which will ultimately drive corporate performance and bottom lines. Similarly, Ehiorobo (2020) describes AI and strategic agility as solutions applicable to any business allowing them to survive, grow, and meet customer expectations.

Dickson (2020) mentions that AI, internet-of-things (IoT), and big data are increasingly present, and business leaders are paying attention to this transformation. Furthermore, Ehiorobo (2020) explains that AI algorithms will be an important aid in predicting actual demand, reducing expenses, interpreting data on business dynamics, and new narratives of change to increase the prospects of business survival.

According to Hao et al. (2020), in addition to the advantages already mentioned, digital and intelligent tools make it possible to eliminate human error, increase service efficiency, and consequently, increase customer satisfaction. Nevertheless, the implementation of these technologies can also improve operational efficiency in terms of significant cost reductions, culminating in improved organizational performance.

According to Butzmann et al. (2017) and Scor (2018), AI has become the game-changer, and organizations that ignore this fact may be unable to withstand the competitive pressures in the post-COVID-19 global economy. Ehiorobo (2020) explains that using AI to leverage other organizational resources to transform them into organizational capabilities is what enables performance improvement and sustainable competitive advantage. Thus, we can say that AI corresponds to a technological resource used synergistically with other organizational resources to improve factor productivity.

Machines and equipment can be fully automated by implementing AI. In customer relationship management where it is often thought that the machine has no place because it involves the relationship and the more personal side through communication, AI can be implemented, since it can predict customer requirements, meet their needs, and provide the necessary information to guide them in their purchasing decisions using chatbots. Today, marketing means using biometrics, voice, and conversational user interfaces, that offer distinct ways in adding value for brands and consumers alike (Wang & Wang, 2022). At the marketing action stage, mechanical AI can be used for standardization, thinking AI for personalization, and feeling AI for improving relationships (Huang & Rust, 2021).

These AI applications can be considered examples of a new form of automation that Coombs et al. (2020) describe as Intelligent Automation. This is defined as the use of AI in such a way that it can learn, adapt, and improve over time to automate tasks that were formally performed by a human being.

Alongside this, the use of these technologies is seeing a rampant increase. Walmart has used robots to clean its stores, and Amazon is using robots in its warehouses to sort and ship orders. In Rwanda, robots are being used in response to the pandemic to monitor patients' temperatures, identify people not wearing masks, and deliver medicine to infected patients. However, some disadvantages may arise, including the need for large data sets, or limitations concerning data quality if the data is not accurate, leading to decisions based on faulty insights (Günther et al., 2017). Also, AI cannot deliver its promises in many domains, like in Marketing, if the challenge of moving tacit knowledge between AI models and organizations functions cannot be solved (De Bruyn, et al., 2020).

METHODOLOGY

Research Model

According to Tarski (1977), research methodology is a science that arises from logic to study the scientific method. The scientific method, in turn, corresponds to the procedures used and approved by the scientific community, capable of presenting and validating a theory. According to Vergara (2006) and Vilelas (2009), the classification of the methodology used in the development of research documents can be done as to the ends and as to the means. In this context, the ends correspond to applied and exploratory research, while the means translate field study and bibliographic research.

The present study assumes a pragmatic or inductive character and was supported based on a non-probabilistic sample by convenience, according to the availability and accessibility of the elements addressed (Carmo & Ferreira, 1998), in this case by professionals with some experience as senior management or middle management with some degree of decision-making and consumers. Thus, the questionnaires were sent to Portuguese companies by email and through the LinkedIn platform, and to consumers from the general public through email and dissemination in social networks. A total of 154 questionnaires were answered by companies and 333 by consumers.

In this context, in as much as the purposes of the research are concerned, an applied and an exploratory nature was implicit. Regarding the applied character, this results from the attempt to investigate a contemporary phenomenon in the context of real-life (Yin, 1994), assisted with an exploratory strand given the poor knowledge about the phenomenon of evaluation of the possibility of AI adoption by Portuguese companies to respond to situations caused by the COVID-19 pandemic, to create new theoretical knowledge on the subject, to gain new inputs on the consideration of the use of AI in response to the COVID-19 pandemic, answers that are only possible to find through the search for causes for the effects found (internal validity).

In terms of means, this study is based on a set of primary sources, the application of questionnaires to two distinct audiences, one aimed at Portuguese companies and the other at consumers in general, and secondary sources, corresponding to the bibliographic research and treatment of information, comprised in the study developed in books, journals, and scientific articles.

As for the methodology used, of the three possibilities in terms of research approaches, namely qualitative, quantitative, or a combined approach (Williams, 2007), a quantitative approach was used, to collect and work data statistically to support or deny hypothetical conclusions based on academically focused hypotheses (Williams, 2007).

Two quantitative analysis techniques were used, descriptive statistics and analytical statistics. Descriptive statistics involves the processing and disclosure of the results obtained using charts and tables, using techniques and rules that summarize the information collected from the questionnaires in a data dispersion in the form of frequencies, percentages, means, modes, medians, variances, standard deviations, and counts (Vilelas, 2009). Regarding analytical statistics, a theoretical model was built and structural equation modeling (SEM) was used to test it. Partial least squares (PLS) was used, which is a variance-based structural equation modeling technique using the SmartPLS 3 software (Ringle et al., 2015).

Regarding data collection, according to Vilelas (2009), it is a logical research procedure, in charge of defining the means for collecting and processing information, as well as controlling its use. The questionnaire survey was chosen, one of the most widely used techniques in social sciences (Provdanov & Freitas, 2013). This method is less prone to mistakes because it is implicit in primary knowledge and because it allows the possibility of grouping data in the form of statistical tables, facilitating the measurement of the variables under study.

Regarding the classification of the scaling techniques presented, in the presentation of the data, the non-comparative scaling technique of Likert assessment was used, which allows assessing the degree of agreement of the respondent in each statement from 1 (strongly disagree) to 5 (strongly agree).

Therefore, the study unfolded in four stages. The first consisted of bibliographic research and information treatment; the second phase, through the transfer of theoretical ideas to the field of observation, to obtain greater confidence in the results, a theoretical model was built; the third stage, corresponds to the fieldwork through the collection of data and information by the questionnaires and, finally, the fourth stage, which consisted in the quantitative analysis of the data, comparing the ideas and knowledge from the bibliographic research with the results generated by the information from the questionnaires, establishing new theoretical approaches in the field of the use of AI in Portuguese companies to respond to situations caused by the COVID-19 pandemic.

When preparing the literature review, four research questions emerged that will serve as the basis for this study. This chapter aims to show how each of the previously raised questions will be addressed and worked on. Table 1 shows the relationship between the objective of the study, the research questions, and the inherent literature review, as well as the method used to work on each of the research questions raised.

Table 1: Relationship between the study objective, research questions, literature review, and methodology used

Objective	Research Questions	Methodology	Literature Review
Understand how Portuguese companies evaluate the possibility of using AI to respond to situations caused by the pandemic COVID-19	(Q1). Has there been a change in companies' perception of how they can use AI to achieve competitive advantage under the COVID-19 pandemic? (Q2). Did the COVID-19 pandemic foster a shift in consumer attitudes toward AI? Will it be lasting in the post-COVID-19 era? (Q3). What is the true impact of using AI technologies on businesses during and after the COVID-19 pandemic? (Q4). Is the evaluation of the possibility of using AI by companies, impacted by their perception of the topic and its adjacent benefits?	Descriptive analysis through quantitative analysis of the questionnaires Descriptive analysis through quantitative analysis of the questionnaires Descriptive analysis through quantitative analysis of the questionnaires PLS-SEM - Analysis of Path Strength and Significance (betas)	(Coombs, 2020); (Priem et al., 2013); (Patvardhan & Ramachandran, 2020); Ehiorobo (2020); (Coombs, 2020); (Pantano et al., 2020); (Sheth, 2020); (Maritz, 2020); (Hao et al., 2020); Sreeharsha (2020); Pantano et al. (2020); (Coombs, 2020); (Patvardhan & Ramachandran, 2020); Ehiorobo (2020); Sreeharsha (2020);

To continue the study and answer Q1, Q2 and Q3, descriptive statistics were used by processing and disclosing the results obtained through charts and tables, using techniques and

rules that summarize the information collected from the questionnaires in a data dispersion in the form of frequencies, percentages, means, modes, medians, variances, standard deviations and counts (Vilelas, 2009). The method selected for data collection was the questionnaire survey, constructed through the Google Forms application. They were developed based on the literature review, where the factors that were most relevant to the study in question were analysed, giving rise to the blocks of questions. Two distinct surveys were built, directed to different target audiences. A first survey, directed to consumers, associated with Q2, and a second survey is directed to companies, associated with Q1, Q3, and Q4. The questionnaires were then tested to validate the wording and design of the questionnaire. Once circulated, data collection took place during the month of February 2021. After data collection was completed, they were imported from Excel into the statistical analysis program IBM® SPSS® Statistics, and the results were analysed and prepared.

Concerning the last research question, Q4, this was worked out through analytical statistics, where a theoretical model was built and structural equation modelling (SEM) was used to test it. Partial least squares (PLS), a variance-based structural equation modelling technique, was used using SmartPLS 3 software (Ringle et al., 2015). The analysis and interpretation of the results were phased, first, the reliability and validity of the measurement model were assessed, followed by the assessment of the structural model.

Statistically, the model reflects a set of equations where the parameters are established from statistical observation, and structural equations refer to equations that use analysis parameters from observable variables (El-Sheikh et al., 2017). That is, structural equation modelling is a viable statistical technique for exploring multivariate relationships among variables, allowing a comprehensive approach to the research question for measuring and analysing theoretical models (Anderson & Gerbing, 1988). Therefore, the measurement of latent constructs is done indirectly, mainly through the use of observable variables, and through the observation of causal effects in structural equation modelling between latent variables (Tarka, 2018).

Knowing that model evaluation using factor analysis alone does not determine causality relationships and path analysis despite establishing causality does not assess the error of the variables, structural equation modelling measures the total effect, direct and indirect, of the explanatory variable on the dependent one (Haque et al., 2019). It is thanks to the ability to offer a comprehensive approach to quantifying and testing theories, and the fact that structural equation models take into account measurement error, that this analytical statistical technique is frequently used.

To construct the theoretical model, two independent variables were identified; the view towards AI and the benefits of using AI. In addition, the dependent variable corresponding to the evaluation of the possibility of AI use by companies was identified, which reflects Q4. The evaluation of each of the variables was based on the items presented in the model, which comes from the literature review.

After the variables were identified, they were evaluated based on the pre-defined items arising from the literature review. Thus, the variables were measured by asking respondents to indicate their degree of agreement with the statements presented in the questionnaire on a five-point Likert-type scale (1 is equivalent to strongly disagree and 5 to strongly agree). Next, the developed conceptual model to be tested is shown in figure 1, and the relationship of the variables in the model to the questionnaire is shown in table 2.

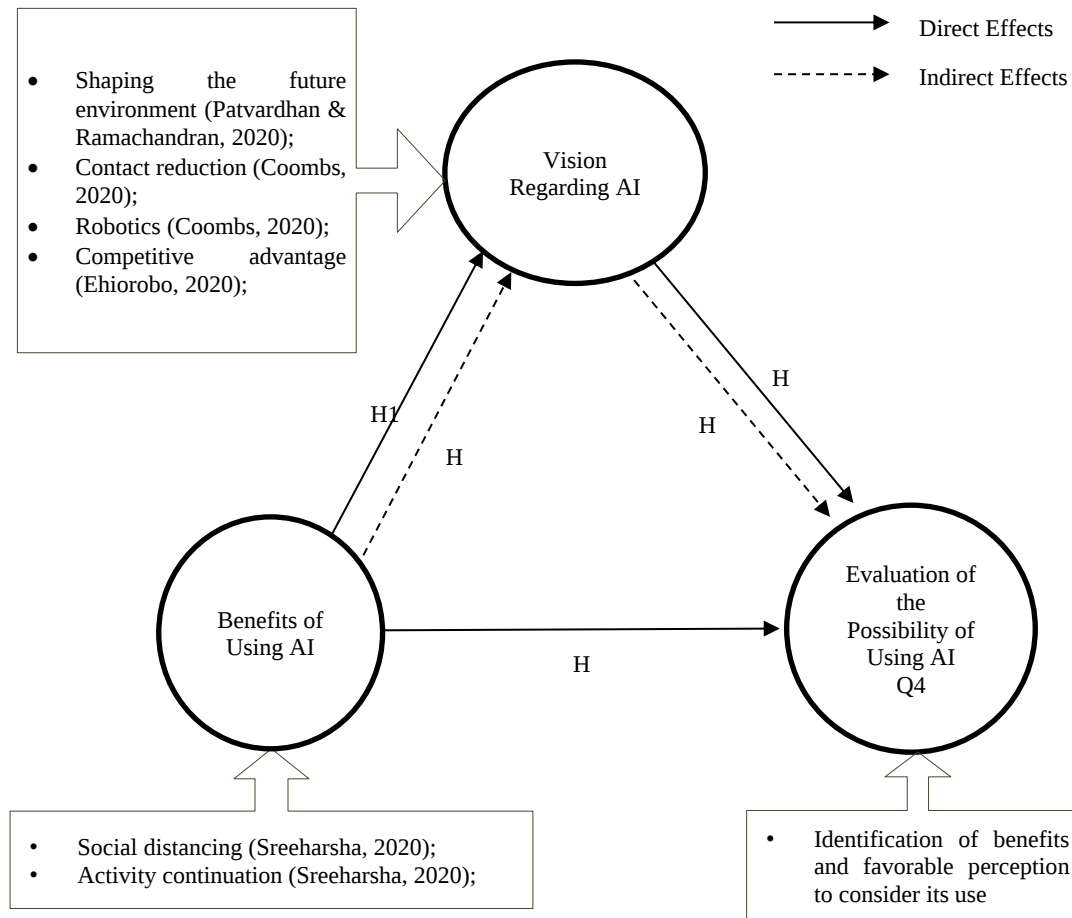


Figure 1: Conceptual model and hypotheses to be tested with SmartPLS 3.

Table 2: Relationship between the variables of the conceptual model and the questions in the questionnaire.

Independent Variable	Indicator	Questionnaire question (answers from 1 to 5)
Vision regarding AI	Shaping the future environment (Patvardhan & Ramachandran, 2020)	The different AI approaches represent the future, and the future will involve their massive use
	Contact reduction (Coombs, 2020);	The use of intelligent technologies enables the reduction of interpersonal contact
	Robotics (Coombs, 2020);	It may be relevant to use robots capable of performing tasks such as cleaning, destroying, and disinfecting any microorganisms within their reach, or delivering packages without human intervention All companies must have thermal security robots in their workspaces that can identify individuals within a radius of 30 meters with temperatures above 37.4 degrees It may be relevant to use intelligent systems that can monitor and detect the number of people gathered in a group, assess whether the safety distance is met, or check the wearing of the mask With the culmination of the COVID-19 pandemic, my view on the use of smart technologies in business has changed
	Competitive advantage (Ehiorobo, 2020)	By investing in AI technologies, I feel I am investing in the future and working in fields that could give me a competitive advantage given the COVID-19 pandemic
Benefits of using AI	Social Distancing (Sreeharsha, 2020)	The adoption of artificial intelligence systems capable of promoting social distancing, automatic temperature measurement of individuals, and controlling the wearing of masks to fight the

Activity Continuation (Sreeharsha, 2020)	COVID-19 pandemic may become essential and of utmost importance, impacting companies in a positive way
	The adoption of various measures using artificial intelligence is crucial for the continuity of various activities (security distance control systems, use of robots for disinfecting spaces, intelligent machines for contact reduction, etc.)

The following hypotheses emerged from the presented model: H1- The benefits arising from the use of AI positively influence firms' views towards AI; H2- Firms' views towards AI positively influence the evaluation of the possibility of using AI; H3- The benefits of using AI positively influence the possibility of using AI in firms' activities and H4- The view of the benefits of using AI in the decision to use AI is mediated by the view that firms hold towards AI.

Finally, concerning external validity, the study reinforces some of the little existing theory regarding these themes, allowing for contextual analyses to be performed by comparing results between different countries in this field of research.

Sample description

For the study, two different surveys were applied to different audiences, a first survey directed to Portuguese companies, and a second survey directed to consumers. The sample size of the consumer survey was 333, where the age of the respondents ranged from 16 to 77 years old. Still, the average age of the sample is 33 years old. As for the questionnaire addressed to companies, it sought to survey professionals with experience as senior managers or middle managers with some degree of decision-making - 155 responses were gathered. Concerning turnover, this figure is for 2019, since 2020 was an atypical year. Approximately 35% of the companies surveyed had a turnover of less than 1,000,000€ in 2019. Table 3 shows the sample information.

Table 3: Sample description.

Consumer Questionnaire	Category Class	Description	Total Number	Percentage
	Gender	Male	145	43,54%
		Female	188	56,46%
	Academic Qualifications	Basic Education	18	5,41%
		High School	136	40,84%
		Bachelor or Superior Degree	179	53,75%
Company Questionnaire (Senior management or middle management professionals)	Geographic Location	Northern Region	38	24,52%
		Center	5	3,23%
		Lisboa e Vale do Tejo	99	63,87%
		Algarve	13	8,39%
	Sector of Activity	Financial activities and insurance	65	41,94%
		Wholesale and retail	25	16,13%
		Accommodation, Restaurants and Similar Services	13	8,39%
		Health activities	3	1,94%
		Agriculture	2	1,29%
		Construction	5	3,23%
		Education	8	5,16%
		Manufacturing Industries	6	3,87%
		Transportation and Warehousing	9	5,81%
		Other	19	12,26%

ANALYSIS AND DISCUSSION OF THE RESULTS

Change in companies' perceptions regarding the use of AI and gaining competitive advantage in the pandemic COVID-19

Before ascertaining whether there was a change in the perception of companies concerning AI, we first tried to understand to what extent companies find the use of these technologies relevant through table 4.

Table 4: Table of descriptive statistics referring to the variables.

	AI represents the future, and this future will come through its massive use	The IS are important in predicting real demand and interpreting data in new business dynamics	Importance of using IS in several tasks without human intervention	The IS allows the reduction of interpersonal contact
N	155	155	155	155
Mean	4,45	4,24	3,88	4,29
Median	5,00	4,00	4,00	4,00
Mode	5	5	4	5
Srd. Deviation	,657	,850	,813	,837

Initially, the answers to questions such as the use of AI in the future, its importance in predicting and interpreting data concerning new business dynamics, and its ability to reduce human intervention and interpersonal contact were analysed. The answers of the surveyed companies show a mean and median value around 4 and a mode around 5, which reveals a high degree of agreement with the statements. Thus, we conclude that companies effectively attribute great relevance to the use of AI today.

Once it was perceived that companies value the use of AI, the possible change in their perception regarding AI and the achievement of competitive advantage in the context of a pandemic was analyzed. It was observed that more than 50% of the surveyed companies state that their idea about the use of AI has changed with the course of the pandemic, and about 80% of the sample agreed that the use of AI corresponds to the future and that it will bring them a competitive advantage in the context of the pandemic COVID-19.

To deepen the knowledge about the current change in the perception of the companies, we tried to understand if it presented differences according to the activity sector. By applying the ANOVA test, table 5, this analysis reveals whether there are discrepancies between averages by sector and allows us to investigate where these differences are found.

Table 5: ANOVA test on the change in firms' perceptions by sector.

	Sum of squares	df	Mean Square	Z	Sig.
Between Groups	7,617	9	,846	,805	,612
In the Groups	152,421	145	1,051		
Total	160,039	154			

When analyzing the ANOVA test, it shows a value of Sig. > 0.05, so it is possible to conclude that there were no differences in the means of the variable "change in perception" by

sector. This means that in the sample collected, the sector of activity had no influence on the change in perception of the companies, and this was transversal to all sectors.

Given that a good portion of the surveyed companies had changed their vision about the AI, a test was performed using Spearman's correlation coefficient to verify if the variables addressed were correlated with the change verified. As the COVID-19 pandemic progressed, social distancing and reduced contact became imperative. It was possible to verify that the fact that intelligent systems can reduce contact, predict actual demand, and interpret data in new business dynamics, show a moderate positive correlation with the change in companies' view on AI, and may explain this phenomenon.

Still, the fact that the correlation between the variables is moderate indicates that there may be other factors that contribute in the same way to this change. Some of the factors addressed in the literature are performance improvement, efficiency increase, cost reduction, human error reduction, and process optimization.

After analysing the data, we can conclude that, as Patvardhan and Ramachandran (2020) and Priem et al. (2013) state the need for companies to adopt strategies aimed at modelling the market through AI processes, a strong slice of the companies surveyed agree with this perspective, demonstrating their certainty in the potential of AI in the future and how it can be decisive in the context of the COVID-19 pandemic. Coombs (2020) argues that the COVID-19 pandemic can serve as a catalyst for the massive use of AI, which is corroborated with the companies' vision since they agree that the use of intelligent systems (e.g., robotics) allows for the reduction of human interactions, this being an essential factor as the pandemic progresses, which will drive the adoption of intelligent systems. Thus, with the use of these systems, it is possible to reduce contact and consequently obtain advantages in the course of the pandemic, since the distance has become imperative and that will inevitably improve performance and sustainable competitive advantage as described by Ehiorobo (2020).

The change in consumer behaviour regarding AI use during the COVID-19 pandemic

Through the questionnaire, the respondents were asked about their position on the use of intelligent systems given the current pandemic. After analysing the data in table 6 we can conclude, that in fact, the consumers present in the sample saw their attitude towards AI change with the onset of the pandemic COVID-19. They became more supportive of the use of intelligent systems, just as they confess that their sense of well-being and confidence in a commercial establishment increases if there are intelligent systems in place to combat COVID-19. In addition, respondents have come to prefer a fully automated experience given current circumstances. The mean value of respondents' agreement on these issues is approximately 3.5, with a mode and median of 4, on a scale of agreement from 1 to 5.

Table 6: Table of descriptive statistics referring to the variables.

	With the pandemic, I began to support the use of IS	With the COVID-19 pandemic, I started to value the IS in the purchasing process	I began to prefer a fully automated experience	I felt more comfort when using IS by being able to reduce personal contact	I felt more confidence and well-being in knowing that the establishment has IS
N	333	333	333	333	333
Mean	3,45	3,16	3,38	3,50	3,60
Median	4,00	3,00	4,00	4,00	4,00
Mode	4	4	4	4	4
Srd. Deviation	1,109	1,256	1,261	1,201	1,172

Once it was realized that the consumers surveyed came to support the use of AI during the course of COVID-19 pandemic, we sought to understand if there were differences for each categorization class of the sample. By applying the ANOVA test, reveals whether there are discrepancies between means according to age, gender, and educational attainment.

When applying the ANOVA test to assess the differences in support for the use of AI according to the age and gender of the respondents, both tests had a Sig. > 0.05, so it is possible to conclude that there were no differences in support for the use of IS by age and gender. This means that in the sample collected, the gender and age of the respondents did not influence the support shown for the IS.

However, regarding educational attainment, it can be observed that there were differences since Sig. < 0.05. Thus, in the sample collected, the academic qualifications influenced the evaluation of respondents regarding the support shown for the use of I.S. Thus, a Scheffe multiple comparisons test was performed, table 7, to compare each group of academic qualifications and understand the origin of such differences. It is possible to conclude that the degree of support for the use of IS differs between respondents who attended high school and those who attended college. This illustrates that support for the use of IS changes depending on the educational background of the group in question.

Table 7: Scheffe's Multiple Comparisons Test

(I) Academic Qualifications	(J) Academic Qualifications	Mean Difference (I-J)	Standard Error	Sig.	95% Confidence Intervals	
					Lower Limit	Upper Limit
Basic Education	High School	,231	,274	,702	-,44	,91
	Bachelor or Superior Degree	-,181	,271	,799	-,85	,48
High School	Basic Education	-,231	,274	,702	-,91	,44
	Bachelor or Superior Degree	-,412*	,124	,005	-,72	-,11
Bachelor or Superior Degree	Basic Education	,181	,271	,799	-,48	,85
	High School	,412*	,124	,005	,11	,72

*. The mean difference is significant at the 0.05 level.

Since respondents have come to support the use of intelligent systems as the pandemic has progressed, we sought to understand how this phenomenon is occurring, and what its implications are. After analysing the data, it can be concluded that there has been a greater

demand for online, serving as a refuge from physical purchases. Roughly 48% of consumers surveyed say they choose to buy online when compared to buying in person, and only 27% of respondents still prefer to buy in person. Consumers regularly use chatbots during the online shopping process, as more than 54% of consumers recognize advantages in the support provided to them. The growing number of consumers choosing to use intelligent systems in the purchase process is supported by the fact that a good portion of respondents, corresponding to more than 54%, identify value in the recommendations made to them by these systems.

By verifying that a significant part of the respondents avoided the physical purchase by opting for online shopping, we tried to understand if this phenomenon was constant in all age groups. Through the application of the ANOVA test, this presented a $\text{Sig.} > 0.05$. Thus, the age of the respondents did not influence the preference for online shopping, and this renewed preference occurred in a generalized manner regardless of age.

Once concluded that due to the pandemic situation, consumers started to support the use of intelligent systems, we tried to understand to what extent this attitude will remain after the regularization of the pandemic. After analysing the consumer responses, it can be concluded that the change in consumer attitude will continue post-COVID-19, and consumers will continue to support the use of intelligent systems. In addition, consumers show intentions to continue shopping online. Nevertheless, they say that after the situation is regularized, they will again seek physical shopping experiences, as can be seen in table 8 below.

After analysing the data, it is verified, as mentioned in the literature, although consumption is usual, it is also contextual, and due to the current situation, it has been undergoing significant changes. The authors Pantano et al. (2020) and Sheth (2020) highlight the increase in the use and acceptance of technology and the digital, registering an impact on the elected purchasing channel, with an exponential increase in e-commerce. The authors' perspective is confirmed through this research, as consumers have begun to support the use of intelligent systems thanks to COVID-19. Furthermore, the change in the shopping channel is clear, as approximately half of the sample, regardless of age, now prefer online shopping compared to in-person shopping, highlighting the importance of the internet today.

Table 8: Table of descriptive statistics referring to the variables.

	I will be looking for new physical purchasing experiences	I will look for new online shopping experiences	The change in my attitude will remain
N	333	333	333
Mean	3,35	3,24	3,46
Median	4,00	3,00	4,00
Mode	4	4	4
Std Deviation	1,136	1,176	1,157

Coombs (2020) throughout his research concluded that consumers preferred a human element in their experiences. However, the author states with the pandemic, this preference could change, giving rise to a renewed preference for a fully automated experience. Therefore, after analysing the results, it is possible to state that, due to the COVID-19 pandemic, consumers began to prefer a fully automated experience to reduce interpersonal contact, confirming the author's idea.

To conclude, Sheth (2020) when confronted with the duration in changing consumer habits, argues that most habits will return to normal, however it is inevitable that some of the old habits will disappear. From this research, it can be concluded that the change in consumer attitudes will continue post-COVID-19, and consumers will continue to support the use of intelligent systems. Consumers intend to continue shopping online, yet say that after the pandemic, they will again seek out physical shopping experiences.

The impact of AI use in enterprises on the COVID-19 pandemic

To answer this question a questionnaire was developed to try to assess the benefits of using intelligent systems in companies. Several variables were analysed, such as the AI's help in obtaining sales in the context of the pandemic, the increase in efficiency and the reduction of human error, the ability to predict the consumer's individual preference and offer a more personalized service, or even the importance of these intelligent systems in the continuity of activities in times of pandemic. Through the variables analysed it is possible to identify two distinct domains, one outside the company more focused on the customer, and an internal domain more directed towards the company.

By analysing table 9 it is possible to conclude that regardless of the domain, the companies surveyed showed a high degree of agreement with the variables. The trend of responses was coherent and uniform, with no significant differences by sector of activity and company size, since the mean, median, and mode values are above 4, on a scale of agreement from 1 to 5.

Table 9: Table of descriptive statistics referring to the variables.

	E-commerce and the I.S. are fundamental in obtaining sales today	The adoption of I.S. is crucial for the continuity of several activities	S.I in the fight against the pandemic can be essential, impacting positively the companies	With online commerce and S.I., it is possible to predict consumer preference by providing the most personalized and appropriate service	The use of intelligent systems can increase efficiency and reduce human error
N	155	155	155	155	155
Mean	4,25	4,06	4,07	4,19	4,31
Median	4,00	4,00	4,00	4,00	4,00
Mode	5	4	4	4	5
Std. Deviation	,776	,824	,831	,804	,726

Although the importance given by companies is very similar in both areas, the consumer sphere has a relatively higher average showing, even if the difference is small, that the companies surveyed give more importance to customers. With the onset of the pandemic, many companies were forced to close down due to the impositions of mandatory containment. This may be one factor explaining why the overwhelming majority of the companies surveyed, around 83%, consider online commerce and the use of intelligent systems to reduce contact essential in obtaining sales today. With the evident difficulty in making sales, companies are even more dedicated to customers, and about 82% of the sample considers online commerce and intelligent systems essential in predicting consumer preference, providing more personalized and appropriate service.

Still, although companies value a little more the advantages that intelligent systems can bring concerning consumers and obtaining sales, they also value the positive impacts they can have within the company itself. Examples of this are the improvement in internal processes and the increase in efficiency, the reduction in human error, the ability of intelligent systems to promote social distancing, the automatic temperature measurement of employees, the intelligent control in the use of masks to combat COVID-19, the use of intelligent systems in the cleaning and disinfection of spaces, or even the importance that these aspects represent in the continuity of activities.

By analysing the data in table 9, it is possible to conclude that the companies surveyed attribute great relevance to the points addressed in the previous paragraph since approximately 78% of the sample states that the adoption of measures using AI is crucial for the continuity of several activities and that intelligent systems will positively impact companies.

Through this research it is possible to conclude, similarly to what the authors Maritz (2020) and Pantano et al. (2020) stated, the online medium became fundamental to obtain sales with the course of the pandemic, confirmed by 83% of the surveyed companies. In this way, the mandatory confinement imposed and consequently the closure of several activities made the main way for consumers to purchase products to be through the digital medium.

The authors Hao et al. (2020) highlighted the ability of intelligent systems to eliminate human error and increase service efficiency, which was verified during this research, in which about 86% of the companies surveyed agreed on the ability of intelligent systems in reducing human error and increasing efficiency. Along with this, several measures were addressed using intelligent systems that allow companies to continue their activities. Some of the measures discussed included safety distance control systems, the use of AI in the disinfection of spaces, and the control of masks used in the fight against COVID-19. A good portion of the surveyed companies, approximately 78%, show interest in these measures and believe that these systems are capable of having a positive impact, which is in line with the idea of the author Sreeharsha (2020).

The evaluation of the possibility of using AI by companies is impacted by their perception of the subject and its adjacent benefits

To answer the last research question, a theoretical model was built, and structural equation modelling (SEM) was used to test it. Partial least squares (PLS) were used, and data analysis and interpretation followed two steps. First, the reliability and validity of the model were tested, followed by the testing of the structural model. To analyse the model, individual indicators of reliability, convergent validity, internal consistency reliability, and discriminant validity were assessed (Hair et al., 2017).

Concerning the reliability of the individual indicators, this is verified since the factor loadings of all items were greater than 0.6 and significant at $p < 0.001$ (Figure 2).

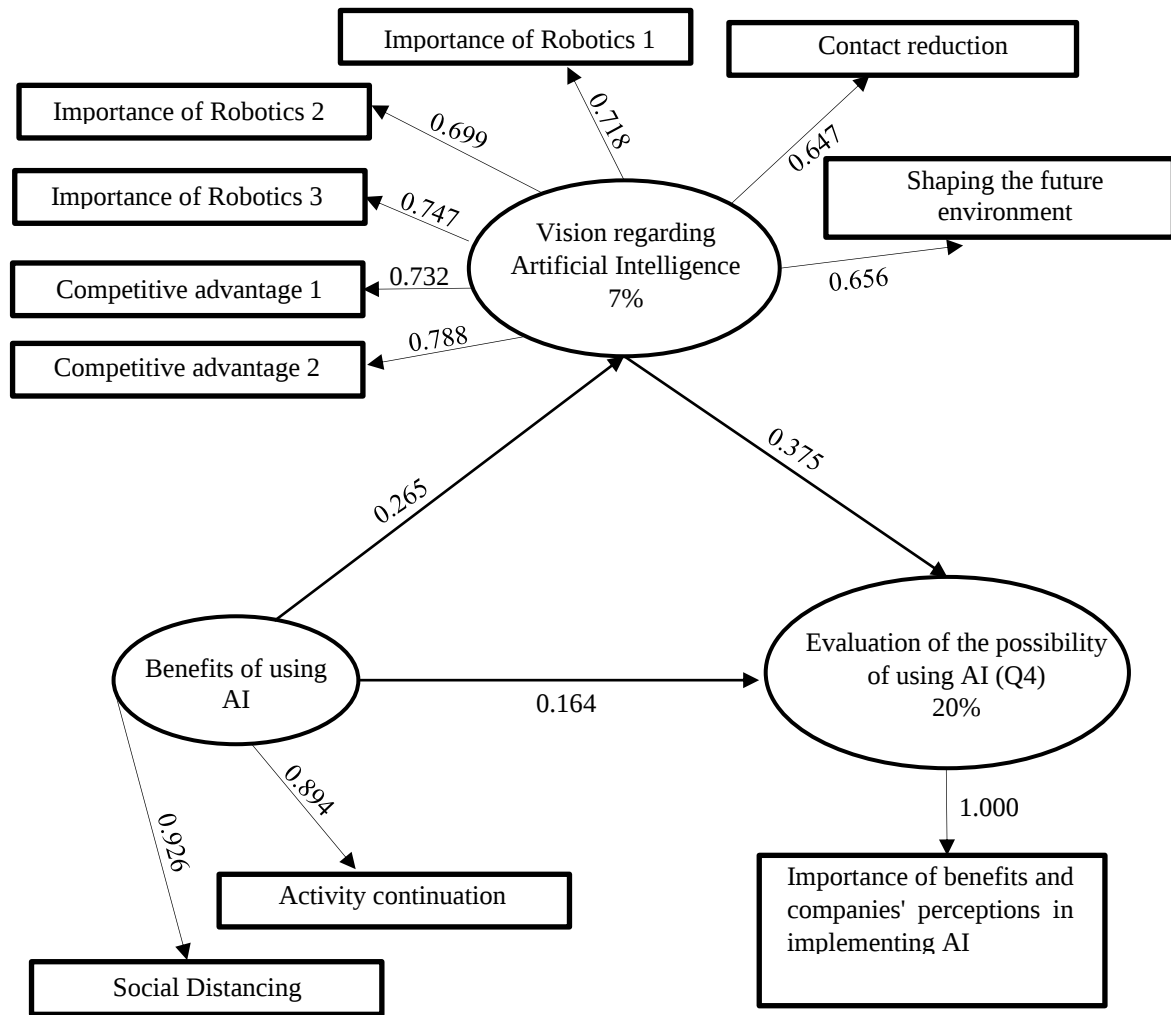


Figure 2: Tested model with the associated values from SmartPLS.

Regarding the reliability of the internal consistency, since Cronbach's Alpha and CR (composite reliability) values were always higher than 0.7 as shown in table 10, we can check its reliability.

Table 10: Checks for CR, AVE, correlations, and discriminant validity. Note: CR - composite reliability; AVE - average variance extracted. The numbers in bold are the square roots of the AVE. Below the diagonal elements are the correlations between the constructs. Above the diagonal elements are HTMT values.

	Cronbach's Alpha	CR	AVE	1	2	3
(1) Benefits of using AI	0.794	0.906	0.828	0.910	0.295	0.305
(2) Evaluation of the possibility of using AI	1.000	1.000	1.000	0.263	1	0.450
(3) Vision regarding Artificial Intelligence	0.840	0.879	0.510	0.265	0.419	0.714

Concerning convergent validity, as shown in table 10, since all items were positive and significant in the respective variables, and these presented CR values > 0.70 and AVE > 0.50 (Bagozzi & Yi, 1988), convergent validity was confirmed.

Discriminant validity was assessed based on two approaches. Initially, the Fornell and Larcker criterion was used, where the square root of the AVE (value on the diagonal of Table 10) must be greater than its highest correlation with any other variable (Fornell & Larcker, 1981). Looking at table 10 it can be seen that the criterion is satisfied for all variables. Next, the HTMT ratio criterion was used (Hair et al., 2017; Henseler et al., 2015), and as can be seen in the table above, all HTMT values are less than 0.85, providing evidence of discriminant validity.

To evaluate the structural model, we used the sign, magnitude, and significance of the structural path coefficients; the magnitude of the R^2 value for each endogenous variable as a form of predictive accuracy of the model, and Stone-Geisser's Q^2 values for the predictive relevance of the model (Hair et al., 2017). Before evaluating the structural model, collinearity was analysed. The VIF values ranged from 1 to 2.668, staying below 5 which shows that there is no collinearity. The coefficient of determination R^2 for the two endogenous variables of vision regarding AI, and the possibility of using AI, were 7% and 20%, respectively (Figure 2). The Q^2 values for the endogenous variables (0.028 and 0.167 respectively) are greater than zero, demonstrating the predictive relevance of the model (Hair et al., 2017). Table 11 shows the direct relationships present in the model.

Table 11: Direct model relationships.

	Path coefficient	Standard Errors	T Statistics	P Values
Benefits of using AI -> Evaluation of the possibility of using AI	0.164	0.082	1.993	0.046
Benefits of using AI -> Vision regarding AI	0.265	0.114	2.329	0.020
Vision regarding AI -> Evaluation of the possibility of using AI	0.375	0.075	4.990	0.000

Thus, through the results in table 11, we can verify that the benefits adjacent to AI and the use of intelligent systems have a positive relationship on the possibility of companies starting to use AI ($\beta = 0.164$, $p < 0.05$), as well as on the business vision regarding AI ($\beta = 0.265$, $p < 0.05$), and these results prove hypotheses H3 and H1, respectively. Nevertheless, the vision that companies have regarding AI has a significantly positive effect on the possibility that they started using AI ($\beta = 0.375$, $p < 0.001$), validating hypothesis H2.

Regarding hypothesis H4, a bootstrapping tool was used to assess indirect effects through a mediator variable (Preacher & Hayes, 2008). Table 12 demonstrates the result of the mediation effect.

Table 12: Specific indirect model relationships.

	Path coefficient	Standard Errors	T Statistics	P Values
Benefits of using AI -> Vision regarding AI -> Evaluation of the possibility of using AI	0.099	0.045	2.204	0.028

By analysing the results in table 12, it can be seen that the indirect effect of AI benefits on the possibility of using AI, through the mediator firms' vision towards AI, is significant with ($\beta = 0.099$, $p < 0.05$), validating the mediation hypothesis H4.

Thus, according to the model presented in the previous chapter, two main variables were identified, these being the vision regarding AI (Patvardhan & Ramachandran, 2020; Coombs, 2020; Ehiorobo, 2020), and the benefits of AI (Sreeharsha, 2020). Each of the variables presented a set of associated indicators, which were tested individually through a questionnaire, and all of these were confirmed to be relevant to the research, as they achieved scores above 0.6 and all were significant when $p < 0.001$, demonstrating their reliability (Hair et al., 2017).

Regarding the vision of companies regarding AI in the context of pandemic COVID-19, the results are aligned with the perspective of the authors studied, since the vision of companies is supported by the focus on the future environment (Patvardhan & Ramachandran, 2020), the reduction of contact (Coombs, 2020), the relevance of robotics (Coombs, 2020), and the competitive advantage they may gain (Ehiorobo, 2020).

Regarding the benefits of using AI as the COVID-19 pandemic progresses, we can conclude that these consist of the possibility of maintaining social detachment and inevitably, the continuity of various activities during the pandemic, as stated by the author Sreeharsha (2020).

After identifying the two main variables with potential impact on the possibility of AI implementation by companies during the COVID-19 pandemic, the hypotheses developed in the previous chapter were tested. According to the model developed, and regarding the direct effects, the results found that the benefits adjacent to AI and the use of intelligent systems, positively impact the possibility of companies starting to use AI, verifying hypothesis H3. In other words, as stated by the authors, given the current needs and the restrictions imposed, the greater the ability of intelligent systems to promote detachment, and in a way, allow activities to work, the greater the possibility of companies adopting this type of technology.

In addition, the benefits adjacent to AI and the use of intelligent systems positively impact companies' perceptions regarding these matters, confirming hypothesis H1. That is, the advantages that may result from the adoption of AI technologies and intelligent systems, cause the companies' view on these topics to be influenced, depending on the added value they may obtain from these technologies.

Interestingly, regarding the vision of companies regarding AI, this is the variable that has the most weight and significance in the possibility of using AI by companies in the context of pandemic COVID-19, significantly and positively impacting its implementation, confirming the hypothesis H2.

Regarding the indirect effects of the model, hypothesis H4 was formulated analysing the impact of the benefits of AI on the possibility of using AI, through the mediator vision regarding AI, where it was found to have a positive influence, confirming hypothesis H4.

CONCLUSION

The growing pressure on companies caused by the emergence of the COVID-19 pandemic has revealed a need for the business community to react. Many were the impositions and restrictions imposed that made life difficult for all citizens and, consequently, had a significant impact on companies. Therefore, this study sought to understand what changes occurred in the sphere of consumers and companies, seeking new alternatives using AI approaches and the use of intelligent systems to overcome the current difficulties. Following the literature review, and

after analysing the two questionnaires conducted with 489 responses, a set of conclusions about the proposed theme was obtained.

About the first research question concerning the perception of companies about AI and obtaining competitive advantage in the context of the COVID-19 pandemic, it was concluded that companies attribute great relevance to the use of AI nowadays and, more than half of the sample, regardless of activity sector, changed their perception derived from the current situation, assuming that by using AI they could obtain a competitive advantage.

About the second research question concerning the change in consumer behaviour, it was possible to conclude that consumers in the sample saw their attitude towards AI change with the onset of the pandemic, becoming more receptive to its use, preferring a fully automated experience, to prevent and mitigate COVID-19. This support by consumers was transversal to the age and gender of the sample. However, when analysed for educational attainment, there were differences between the high school and college education groups. In addition, it was possible to conclude that approximately half of the sample said they chose to buy online when compared to buying in person, and the age of the respondents did not influence the preference for online shopping. Attached, as to the duration of the change in the consumers' posture, it was concluded that this change will be maintained in the post-COVID-19 period.

As for the third research question, concerning the impact of the use of AI in companies during the pandemic, two distinct domains were identified, one outside the company more focused on the customer and related to obtaining and sales and concern with the customer, and another internal more directed to the company related to efficiency, error reduction, process optimization, AI's ability to promote detachment and control the use of masks, or be responsible for disinfection and cleaning of spaces. Although there are no significant differences, it was concluded that companies gave greater importance to customers, since with the pandemic, many companies felt serious difficulties in making sales, explaining the greater relevance given to the customer sphere when compared to internal benefits.

Regarding the fourth and last research question, we tried to understand how the companies' perceptions about AI and its benefits impacted their possibility of using it. It was concluded that the two main variables with potential impact on the possibility of AI use by companies are the companies' vision on these matters and the benefits of its use. It is concluded that the benefits positively impact the possibility of companies started using AI, in the same way, that they have a positive effect on the vision of companies regarding these topics. Interestingly enough, however, the companies' vision regarding AI was the variable with the most weight and significance on the possibility of use.

The present research allows us to conclude that the emergence of the COVID-19 pandemic has demanded new dynamics and strategies, which have to be adopted by the business fabric to overcome the current difficulties. Thus, the research intends to contribute to the development of management with the discussion of new AI approaches and implementation of intelligent systems, exploring the main ideas and applications, as well as the impacts that these can bring to companies.

Since the COVID-19 pandemic is a very recent topic and, to date, few studies have been conducted, and this being a pioneering study that aims to investigate the gap between the management of companies in the middle of the pandemic, with the implementation of intelligent systems and innovative AI approaches, this work represents a contribution to the scientific literature. More specifically, the research sought to understand what changes have

occurred in the sphere of consumers and companies in the face of AI, as well as the factors that lead companies to use AI and adopt intelligent systems in the context of the COVID-19 pandemic. However, the continuous development of studies and knowledge in this field is important, due to the rapid changes in the current reality, arising from the rapid evolution of the pandemic together with science, in an attempt to mitigate COVID-19.

As for the research limitations, it should be taken into account that the conclusions of the study should be read with due attention, given the sample size is considered small and reflects the context of the Portuguese reality, this being the main limitation of the study, given the impossibility of making generalizations.

Another limitation is that the coefficient of determination R^2 of the model developed corresponds to 20%, which means that the possibility of using AI by companies is only 20% explained by the benefits of AI and by the vision that companies have on this topic. However, assuming the exploratory and pioneering nature of the study, this factor is not a problem, being indicative of new avenues for future research, to identify new factors with potential impact on the evaluation of the possibility of AI use by companies, in the context of the COVID-19 pandemic. That said, these are the limitations that must be assumed, although they do not affect the importance and conclusions of the study.

Along with the limitation mentioned above, it is suggested that research be conducted to identify new variables and additional factors that can explain and impact the evaluation of companies in the implementation of AI in the context of the COVID-19 pandemic.

It would also be interesting to extend the study to other geographic regions, namely to other countries, to analyse and understand whether the attitude and behaviour of consumers and companies concerning these issues change depending on the countries and cultures in question.

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