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Sentiment Study of the Digitalization

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Abstract:

Digitalization often simplifies both our daily routines and work tasks, making them easier to manage and more efficient. On the other hand, some people may feel excluded due to low levels of digital literacy or fear digitalization because of job loss or the risks associated with new technologies.

The purpose of the study is twofold: first, to analyze individual sentiments toward digitalization, and second, to construct a measure based on levels of fear and satisfaction with digital transformation. To this end, we designed a survey to collect data on individuals' feelings about the development of digitalization. The survey included questions that addressed both satisfaction and concerns about digitalization. It was conducted in Poland and included participants from a variety of backgrounds in terms of age, education, and geographic location.

The empirical study involved two steps: analyzing the factors influencing satisfaction and fear of digitalization using correlation and Kruskal-Wallis tests, followed by building regression models and using machine learning tools (decision trees and logistic regression) to identify the key influences separately for satisfaction and fear.

We found that online services provided by the government have the greatest impact on satisfaction with digitalization, while the development of artificial intelligence, among others, has the greatest impact on respondents' fears. We also present a proposal for constructing a sentiment factor based on individuals' feelings.

Knowing individuals' feelings is important for the European Commission's actions regarding digitalization development plans in individual countries.

**Introduction**

Digitalization is one of the significant phenomena that captures the attention of researchers in various scientific disciplines. This term is commonly understood to encompass both the observed trend of shifting analog services to the online sphere and the development of modern information technologies capable of collecting and processing diverse datasets and enabling communication. The discussion about the impact of digitalization on organizations and society has intensified in recent years. The conclusions drawn from these considerations indicate that digitalization is not only about accessing better knowledge used by organizations and society (Deng et al., 2023; Ahmed et al., 2019; Lepore et al., 2021), but also a technology that enables a radical change in the way many functions and services are performed. In addition, digitalization has a positive impact on economic development and the improvement of people's well-being (Sabir et al., 2022). The other benefits of digitalization for the economy, for the society and for the daily life can be mentioned as well:

* improving the scale, access and availability of knowledge (Duan et al. 2020),
* the ability to leverage modern technologies such as artificial intelligence, big data, the Internet of Things, blockchain, and machine learning,
* improving business functions, processes, and business models,
* flexibility and scalability: digital solutions are typically easier to modify and scale, enabling faster adaptation to changing market conditions.

Digital technologies, both basic and advanced, as well as digital competences and skills can be important for the functioning of the economy and society. However, while digital transformation often makes life and work easier, it doesn't always match the skills of individuals. Some people may feel excluded due to low skill levels. Others may fear digitalization because of job loss or the risks associated with new technologies.

In March 2021, the European Commission published a document setting targets for digital skills, infrastructure, businesses and public services. One of the document's assumptions is that most services will be online by 2030. But while digital transformation often makes life and work easier, it can also leave some people feeling excluded, so this paper explores individual feelings about digitalization.

The purpose of the paper is twofold. First, to analyze sentiment related to digitalization. Second, to propose the construction of a factor based on the level of individual fear and satisfaction with digital transformation. To measure the level of sentiment toward transformation among individuals, we constructed a survey and conducted a study. Our proposed survey questions explore possible factors that influence the level of satisfaction and fear associated with digital transformation. The respondents were diverse in terms of age, education and location. Using machine learning tools, we find that online services provided by the government have the greatest impact on satisfaction with digitalization, while the development of artificial, intelligence, among others, has the greatest impact on respondents' fear.

Knowing individuals' feelings is important for the European Commission's actions regarding digitalization development plans in individual countries.

**Literature Study**

Digitalization is a term that has been used frequently in recent years, with many variants of the term: digitalization, digitization, digital transformation. Although the terms "digitalization" and "digitization" are often used interchangeably, they have different meanings.

Kohli and Johnson (2011) claim that digitization is commonly associated with the transformation of traditional processes into digital ones. Loske and Klumpp (2022) also point out that digitization is a “process of converting analog data into digital data sets.” In turn, digitalization is the socio-technical process of using digital technologies to increase the efficiency of economic transactions (Rubino et al., 2020). Gradillas and Thomas (2023) claims that digitalization is “the transformation of the socioeconomic environment through processes of digital artifact adoption, application, and utilization”

Digital transformation is defined as the “process that is used to restructure economies, institutions and society on a system level” (Unruh and Kiron, 2017). According to Zhu et al. (2021), digital transformation has human-oriented characteristics and usually involves the integration and innovation of technology and business. Although some definitions of digital transformation focus mainly on the technological aspect (Westerman et al., 2014; Karagiannaki et al., 2017), research has shown that the technology is only part of the digital transformation phenomenon (Vial, 2019), and more important aspect of digital transformation is to guide an organization to be more adaptive to change (Herbert, 2017; Kotarba, 2018).

The digitalization has been a frequent research topic across various disciplines, especially in the context of economic effects at the corporate level, and the opportunities that digitalization offers to economic development. Dąbrowska et al. (2022) extend the literature focusing mostly on the organizational level by proposing a broader definition of digital transformation as   
“a socioeconomic change across individuals, organizations, ecosystems, and societies that are shaped by the adoption and utilization of digital technologies”.

On the contrary to the economic effects, the social implications of digitalization are less explored in the literature (Grybauskas et al., 2022) although the social impact of the digital transformation relates to various aspects of daily life and work patterns (Makridakis, 2017) and makes digitalization an important issue for society (Peng and Tao, 2022). Digitalization is changing society by the increased connectivity and networking that digital technologies enable, such as enhancing communication, services, and trade. Digitalization also raises potential sustainability challenges pertaining to social and environmental wellbeing (Trump et al., 2018).

The literature on digital transformation in the context of individuals is quite limited and relates to selected issues. One of the most often studied problems is the cybersecurity, especially related to the use of autonomous vehicles. The study conducted by Khan et al. (2023) examined attitudes toward and barriers related to autonomous vehicles deployment. The authors analyzed six critical cyber impediments (data privacy, autonomous vehicles connectivity, intelligent transportation system infrastructure, lack of cybersecurity regulations, autonomous vehicles cybersecurity understanding, and autonomous vehicles cyber-insurance) in the context of gender, age, income, and geographic location, that influence the deployment of autonomous vehicles. The research revealed that main cyber barriers are: participants’ education level, understanding of autonomous vehicles, and cybersecurity knowledge, moreover the higher the level of education, the less significant the importance of this barrier in the deployment of autonomous vehicles; however, as autonomous vehicles comprehension and cybersecurity knowledge increase, the perception of a cyber barrier becomes significantly more important.

The cybersecurity knowledge of users of intelligent connected vehicles was also the subject of research conducted by Yu and Cai (2022). The authors studied the relationships between various data categories (including personal demographics/bioinformatics, usage habits, travel patterns, real-time location, audio, video, etc.), and perceived risk concerns around the data privacy and security of users. The study revealed that a key factor influencing users’ attitudes and behavioral intention towards in-vehicle infotainment data services is trust, affected by perceived security risk, perceived privacy risk, and perceived performance risk.

The similar study conducted Maeng et al. (2021). The authors analyzed the types of information security threats considered by users of connected and autonomous vehicles to be the most dangerous and consumer preference for the information security solution. The study showed that communication failure and the unauthorized collection of personal information are perceived by consumers as dangerous information security threats, and convenience of use, such as having automatic updates and a security dashboard are considered as important when purchasing an information security solution. Moreover respondents who have experienced privacy leakage have a higher preference for protecting systems from information security threats than those who have not (Maeng et al., 2021; Yu and Cai, 2022).

The progress of digital transformation is changing the social structure, the personal live, and is associated with inequalities in technology use. Factors having significant effects on individuals’ decisions regarding intelligent information technology acceptance were studied by Park et al. (2022). The research examined how five factors: psychological, technological, resource, risk perception, and value factors, influence the intelligent information technology acceptance. The authors found that the acceptance rate was generally very high, and the main factors determining technology acceptance were: voluntariness, positive image of technology, performance expectancy, relative advantage, radical innovation, and experience of use. In addition to technological factors, psychological factors and risk perception factors also played an important role in individuals’ decisions regarding intelligent information technology acceptance.

Inequalities in technology use are manifested especially in digital exclusion. Seifert (2023) studied subjective feelings of digital exclusion of various age groups. The research showed that older persons tend to belong to the group of persons with very strong feelings of digital exclusion because they cannot always master current everyday technologies; however the influence of age can be levelled out by other factors, like income and attitude toward technology.

Problems related to the perception and engagement of elderly people in the digital transformation were studied by Kinli and Kinli (2022). The study evaluated how digital access to private and public services alters social and everyday practices among older people. At the micro level of analysis, the research results demonstrated that socio-culturally privileged middle-class elders, regardless of their positive or negative attitude towards digital transformation, adopt more easily audio-visual tools, while they are more reluctant to use digital writing apparatuses, elderly people also demonstrate negative attitude where digitalization replaces face-to-face interactions. At the meso level digital network technologies and social media have radically altered elders’ socialization practices with family members and ways of participation to civil society activities. At the macro level, elders adapt to digital technologies in education, financial transactions, and government services as long as they facilitate and improve their quality of life. The research also revealed that the more elders engaged in the digital world, the more they felt alienated from new social dynamics.

The problems of society in a digital world were also studied by Liubinienė and Keturakis (2020). The research focused on identity transformation and the process of shaping one’s self in the contemporary world .The authors analyzed an individual’s perception, development and reinvention of identity in cyberspace and the link between the real cultural identity which is reinforced in one’s private life and real physical socio-cultural environment as opposed to   
a well-designed, constructed and reinvented virtual representation of self, being the simulacra of publicly announced “private life”.

Another aspects of analysis were the psychological factors and mechanisms determining personal resilience to sociocultural threats in the context of digital transformation of society (Kislyakov et al., 2021). The study showed that the greatest threat in relation to the individual are: reduction of live interpersonal communication and withdrawal from the real world; growth of aggression, cyberbullying; growth of information stress, and the psychological mechanisms that allow an individual to maintain resilience to socio-cultural threats in the context of digital transformation of society are: the mechanism of social tolerance, the mechanism of conformity (social adaptation), and the mechanism of psychological protection (coping).

An important element of the discussion on the digital transformation of society is the digitization of education, which has accelerated in the context of the pandemic and faces numerous implementation challenges. The study conducted by Zhang and Chen (2023) analyzed students’ perceptions of online learning in the post-COVID era in China. The results showed that students spend more time in university courses in the post-COVID era than in previous academic years and prefer to study alone and at individual times that are set by themselves, and study characteristics and the socio-economic situation of the students are not related to the acceptance and usage behavior of online learning. Another research was conducted to explore the role of e-learning in transforming the academic industry in the post-COVID-19 time in Jordan (Almajali et al., 2022). The findings revealed that the students were truly overwhelmed by joining online platforms, but a lack of immediate feedback discouraged them.

**Digitalization in Poland and European Union**

In March 2021, the European Commission presented the Communication "The 2030 Digital Compass: the European way for the Digital Decade", which outlines the European Union's vision for a successful digital transformation by 2030. It includes targets for digital skills, infrastructure, businesses and public services (EU Monitor, 2021). The Digital Compass Communication has been complemented by the Policy Program “Path to the Digital Decade” which sets out the governance framework to reach the 2030 digital targets. As a guide for Europe's digital transformation, the Digital Decade Policy Program sets out specific targets and objectives for 2030. These include (European Commission, 2023):

* + ICT Specialists: 20 million, gender convergence,
  + Basic Digital Skills: min 80% of population,
  + Tech up-take: 75% of EU companies using Cloud, AI, or Big Data,
  + Connectivity: Gigabit for everyone,
  + Key Public Services: 100% online,
  + e-Health: 100% of citizens have access to medical records online,
  + Digital Identity: 100% of citizens have access to digital ID.

The level of digitalization varies among the countries of the European Union (EU). One of the indicators used to measure this level is the Digital Economy and Society Index (DESI). The DESI summarizes indicators of Europe’s digital performance and tracks the progress of EU countries. The index is based on data on human capital, connectivity, integration of digital technologies and digital public services.

According to the DESI, Poland ranked 24th among EU Member States in 2022. Between 2017 and 2022, Poland's overall DESI score increased slightly more than the EU average. Compared to the EU average, Poland has particularly large gaps in the level of digital skills of its human capital. For example, only 43% of people aged 16-74 have at least basic digital skills (54% in the EU) and 57% have at least basic skills in creating digital content (66% in the EU). Additionally the share of an information and communications technology (ICT) specialist in Poland is slightly below the EU average (European Commission, 2022).

Eurostat provides a wide range of statistics related to the digitalization process in the European countries. Table 1 presents social statistics related to internet use by individuals. It shows the percentage of people who use the internet for selected purposes and the percentage of people who used the internet with a certain frequency during the last 3 months before the survey. The study of usage (of the internet) includes all locations and methods of access and for all purposes (private or work-related/business). To illustrate changes in internet use, data are provided for 2017 and 2022 years.

An analysis of the results presented in Table 1 shows that the level of internet use by individuals in Poland (86.94%) is lower than in the EU (89.98%). However, the number of internet users in Poland has increased more in the last 5 years (from 75.99% to 86.94%) more than in the EU (from 82.02% to 89.98%). Nevertheless, in 2022 more than 9% of people in Poland have never used the internet (compared to almost 7% in the European Union). The frequency of Internet use is also slightly lower in Poland than in the EU.

The statistics presented in Table 1 are for the total population. However, it is known that young people use the internet more often than older people. Focusing the analysis on the 16-29 age group, it was found that in 2022, 96% of young people in the EU used the internet every day, compared to 84% of the adult population. In all EU countries, the level of daily internet use among young people exceeded 94%. Although young people in each country reported very high rates of daily Internet use, the differences were greater among adult users. On average in the EU, the difference between the proportion of young people and adults using the internet daily was 12 percentage points. In Poland, the difference was as high as 18 percentage points.

Analyzing the activities of internet users, we can see that in Poland most people use the Internet to find information about goods and services (74.25%), to send and receive e-mails (69.25%), and to buy goods and services (64.58%). By comparison, in the EU in 2022, most people will use the internet to send and receive emails (76.97%), to find information about goods and services (69.59%), and to buy goods or services (67.98%). Individuals in Poland are very active in participating in social networks (60.61 compared to 58.14% in the EU). There was also a significant increase in the percentage of people using internet banking (from 39.77% to 55.55%, compared to 48.88% and 59.66% respectively in the EU) and for finding health-related information (from 45% to 52.02%, compared to 50.27% and 51.96% respectively in the EU).

Focusing the analysis on the 16-29 age group, it was found that in Poland in 2022, 84% of young people used the internet to participate in social media networks. Some of the other main uses were reading news online (68%) and internet banking (64%).

<< Table 1 >>

As mentioned above, the Digital Decade policy program, which includes specific targets and actions for 2030, assumes that at least 80% of the population will have basic digital skills. Table 2 shows the skills of the population in 2022 according to Eurostat's Digital Skills Indicator 2.0 (DSI). The DSI is a composite indicator based on selected activities related to internet or software use performed by individuals aged 16-74 in five specific areas (information and data literacy, communication and collaboration, digital content creation, security and problem solving). It is assumed that people who have performed certain activities have the corresponding skills. The indicators can therefore be seen as a proxy for individuals' digital skills.

Two levels of skills are calculated for each of the five areas ("basic" and "above basic") according to the variety of activities performed. Finally, based on the component indicators for each domain, an overall digital literacy indicator is calculated as a proxy for individuals' digital literacy ("no skills", "limited skills", "narrow skills", "low skills", "basic skills", "above basic skills" or "at least basic skills").

<< Table 2 >>

Table 2 shows that in 2022, 42.92% of individuals in Poland had basic or above basic overall digital skills, compared to 53.92% in the EU. Many people in Poland still lack at least basic digital skills, so this is an area that needs to be developed.

In Poland, the government has expanded its digital services in recent years. Based on the statistics in Table 3, we can see that the percentage of people interacting with public authorities via websites in Poland has definitely increased between 2017 and 2021 (from 30.81% to 47.50%). The increase was higher than in the European Union in the same period, but the percentage is still lower than the EU average.

Digital services provided by the government in Poland cover several areas. These include for example: Digital Platform for public services (to apply for an identity card, a copy of a civil document, to register the birth of a child, etc.), Trusted Profile (as a means of electronic identification that allows to confirm identity and sign the document with an electronic signature), E-Tax Office (to pay the PIT, CIT, VAT; to obtain tax information), Online Patient Account (for e-prescriptions, e-referrals) and Digital IDs (digital version of driver’s license, car registration certificate, etc.). E-government websites are better developed in Poland than in the EU. This is shown by the percentages of people who experienced certain problems when using these websites (Table 3). These percentages are lower in Poland than in the EU. Moreover in 2021, 41.89% of people in Poland reported no problems when using the website or application of public authorities, compared to 37.71% in the EU.

<< Table 3 >>

Eurostat statistics show that the level of digitization varies between EU countries. In some countries, there should be more improvement in the digitization transition. However, awareness of individual sentiments should be taken into account when introducing new online solutions.

**Methodology**

**Survey Description**

We designed a questionnaire to assess the factors that influence satisfaction and fear related to digitization. The questionnaire consists of four parts. In the first part, respondents were asked about some information, such as age (Age), gender (Gender), education (Education), type of education (EducType), region of residence (Region) and monthly income (Income).

The second part focuses on questions related to the positive side of digitalization. Respondents were asked to answer questions about the positive aspects of digitalization, related to the following topics:

* satisfaction with the speed and quality of the network connection (Yes/No);
* frequency of using the internet for entertainment purposes (streaming services, online games, web browsing) and assessment of online solutions for entertainment;
* importance of social media;
* frequency of using the internet to find information (global news, popular science, characteristics and opinions on products and services);
* assessment of existing solutions for learning/working online;
* frequency of using the internet and assessment of existing solutions for: shopping, buying tickets, travelling, making payments;
* assessment of existing online services provided by government (Digital Platform for public services, Trusted Profile, E-Tax Office, Online Patient Account, Digital IDs, Central register of vehicles and drivers);
* use of banking services (Yes/No) and preferred method of payment (ATM card/Cash/Other);
* assessment of availability of card payments;
* assessment of ability to use new technologies (0 – not experienced, 10 – very experienced);
* assessment of tendency to use new technologies (0 - prefer traditional solutions only, 10 - prefer new solutions).

Respondents were mostly asked to rate the issues listed on a scale from 0 (never / very unsatisfactory / not important) to 10 (very often / very satisfactory / very important).

The third part focuses on questions related to the negative side of digitalization. First, respondents were asked to rate their fear of the following on a scale from 0 (not afraid) to 10 (very afraid):

* + social manipulation, i.e. fake news, troll farms, etc;
  + addiction to computer games and social media;
  + exposure to hate;
  + stealing personal data and information;
  + exposure to criminalists;

They were then asked to rate whether they feared: losing their job (JobLoss), the development of artificial intelligence (AIdevelopment) and the internet surveillance and spyware (SurveillanceSpyware). In addition, they were also asked to give their assessment of the government's actions against cyber threats.

Finally the survey focuses on two main questions related to the subiective assessment of respondents' satisfaction and fears. Having answered questions about both positive and negative aspects of digitalization, the respondent was to some extent prepared for a subjective assessment of his or her fears and satisfaction with digitalization. Consequently, the last two questions in the survey were:

1. Please rate as a percentage your level of fear of digital transformation   
   (0% - no fear, 100% - high fear) – Fear
2. Please rate as a percentage your level of satisfaction with digitalization   
   in your country (0% - not satisfied, 100% - completely satisfied) – Satisfaction

**Data and Methods**

The survey included a diverse group of participants, as shown in Table 4. Almost equal numbers of women (47.50%) and men (52.50%) participated in the survey. A significant majority (66.25%) have a university degree and the remaining 33.75% are secondary school graduates. The respondents come from different locations, 62.50% from big cities, 17.50% from small towns and 20.00% from villages. The income distribution is also diverse, with 46.25% reporting incomes around the national average, 21.25% significantly above the average, and 15.00% significantly below the average. The survey included both young and old participants.

<< Table 4 >>

Based on the analysis of the respondents' answers, new variables were created that may be important for satisfaction or anxiety and that cover similar topics. Factor analysis and principal component analysis were used to construct these new variables due to the high correlation between respondents' responses.

The following variables were determined as part of the analysis of satisfaction with digitization:

1. OnlineServices indicator is composed of all responses related to online government services solutions,
2. NewTechnology indicator is created based on responses to questions regarding the ability and tendency to use new technologies,
3. Informationindicator is based on the frequency with which respondents use online solutions to find specific information (characteristics and opinions on products or services, news, popular science websites, etc.),
4. DailyLifeSolutionindicator is based on the assessment of existing online solutions related to daily life (shopping, traveling, making payments, etc.),
5. Entertainmentindicator is based on respondents' answers regarding their use of web browsing, streaming platforms, and ratings of entertainment solutions.
6. DailyLifeUsageindicator is based on the frequency of using online solutions related to shopping and paying bills,
7. TravellingUseindicator is based on the frequency of using online solutions related to travelling : buying tickets (entrance, bus, airplane) and travelling (GPS, accessing maps, timetables, taxi applications, etc.).

The other variables included in the analysis are:

1. PaymentAvailability – respondents' assessment of the availability of card payments,
2. WorkOnline – respondents' assessment of the existing online solutions for learning/working,
3. SocialMedia – respondents' ratings of how important social media is to them,
4. AIdevelopment – respondent's response (yes/no) to assess fear of AI development.

Similar to the previous case study, we used factor analysis and principal component analysis to construct variables related to the fear of digitalization. The following variables were constructed:

1. DangerousPindicator consists of all responses that assess the extent to which the respondent fears hatred and contact with dangerous people online (pedophiles, criminal groups, etc.),
2. GovActions indicator is based on responses to questions about government actions against cyber threats.

The rest of the variables in relation to the negative aspects of digitization are:

1. Manipulation – respondents' assessment of how much they fear social manipulation (fake news, troll farms),
2. Stealing – respondents' assessment of how much they fear stealing personal data and information,
3. Addiction – respondents' assessment of how much they fear addiction to computer games and social media,
4. SurveillanceSpyware – respondent's response (yes/no) to assess fear of internet surveillance and spyware,
5. JobLoss – respondent's response (yes/no) to assess fear of job loss.

The variables Fear and Satisfaction are analyzed in two cases, as respondents' responses (in percentages) and as responses aggregated into two states (Yes/No).

The empirical study was conducted in two steps. In the first step, we examined which factors influence satisfaction and which factors influence fear of digitalization. For this purpose, we performed correlation tests and the Kruskal-Wallis test. In the second step, we used regression models and machine learning approaches: a logistic regression model and a decision tree to identify the factors that have the greatest impact on satisfaction and fear, considered separately.

**Results and discussion**

**Satisfaction Factors**

The correlation tests carried out between Satisfaction and the given factors allow us to conclude that there is a significant correlation (at 5% significance level) for OnlineServices (r=0.36), NewTechnology (r=0.33), PaymentsAvailability (r=0.37), TravellingUse (r=0.27) and DailyLifeSolutions (r=0.28). The rest of the correlation coefficients between the analysis variables are insignificant.

<< Table 5 >>

Table 5 shows the mean and standard deviation of the indicators and the correlation coefficients between them. Analyzing the results, we find relatively strong relationships (r=0.59) between PaymentsAvailability and DailyLifeSolution and between NewTechnology and TravelingUse (r=0.59). In the following study, we only consider factors that are strongly correlated with Satisfaction and weakly correlated with each other. These were: PaymentsAvailability, OnlineServices and NewTechnology.

In addition to the quantitative variables obtained from the survey, qualitative responses were also considered. Therefore, the Kruskal-Wallis test was used to test the hypotheses that satisfaction differs by age (Age), gender (Gender), education (Education), type of education (EducType), region (Region), income (Income), and the respondent's answer (yes/no) to selected survey questions about job loss (JobLoss) and artificial intelligence development (AIdevelopment). Based on the results of the test, it was found that the level of satisfaction differs significantly between age groups (p-value = 0.07) and between groups of people who are afraid and not afraid of the development of artificial intelligence (p-value = 0.03). The obtained results are similar to those indicated by Xu and Du (2018), who analyzed factors influencing users’ satisfaction to digital libraries. The authors have found that user differences, including age, gender, and educational level, significantly affect digital libraries’ affinity, which further influence user satisfaction. Also, Laaber et al. (2024) indicated that self-determined use of digital technologies may support well-being, and therefore, user satisfaction as well. Similarly, a study conducted by Cheung et al. (2023) pointed out that information and communication technology, besides providing numerous benefits to the daily life of older adults, it also impacts respondents concerns about age-related losses and the fear of digital exclusion due to the ongoing digitalization of society.

In the next step we used a linear regression model to determine which factors among the quantitative variables: PaymentsAvailability, OnlineServices, NewTechnology and the qualitative variables: AIdevelopment, Age, have the greatest impact on Satisfaction.

Table 6 presents the results of the regression model. We observe a statistical significance (at 5% level of significance) of the parameters related to two indicators: Online services and AI development. Thus, we can conclude that online government services solutions have a positive impact on satisfaction and fear of the development of artificial intelligence has a negative impact on satisfaction. PaymentAvailability also has a significant impact on satisfaction, but less so than the others (p-value=0.09). Similar results were obtained by Alnaser et al. (2023), who analyzed whether artificial intelligence boost digital banking user satisfaction. This research has suggested that policy makers should pay attention in improving user expectation confirmation, perceived performance, visual attractiveness, communication quality and corporate reputation which in turn enhance satisfaction and boost digital banking user’s confidence to accept artificial intelligence enabled digital banking.

<< Table 6 >>

As a robustness check, we divided respondents into two groups: high satisfaction and low satisfaction. If the respondent's subjective rating was higher than 60%, we assigned a value of 1 (high satisfaction); if it was lower, we assigned a value of 0 (low satisfaction). We used logistic regression to examine the factors influencing high/low satisfaction. The results of the logistic regression confirmed the importance of the factors shown in Table 6. We confirmed significant parameters related to AIdevelopment: -1.38 (p-value=0.03), and OnlineServices: 0.40 (p-value=0.01). The significant parameter was also obtained for PaymentsAvailability: 0.54 (p-value=0.05), indicating that the availability of card payments also has an important impact on digital satisfaction.

Another research method used to classify satisfied and dissatisfied people was a decision tree. The CART algorithm was used as the classification method and the tree was validated using 10-fold cross-validation. Figure 1 shows a graph of the classification tree diagram. We can see that the respondents who are satisfied with digitalization are relatively young, highly rate government services, and are not afraid of the development of artificial intelligence. Older respondents who rate the availability of card payments in the country highly are also classified as satisfied with digitalization. Respondents who rate government solutions low and are pessimistic about their ability to adopt new technologies are classified as dissatisfied.

<< Figure 1 >>

Figure 2 shows the ranking of the variables that are important in the classification procedure. It can be seen that OnlineServices and PaymentAvailability have the greatest impact on the classification of satisfied and dissatisfied respondents. Similar to the logistic regression results, these two variables are shown to be important. In the classification procedure performed by the CART algorithm, Age has the smallest effect.

<< Figure 2 >>

The results show that online government services are one of the most important factors contributing to individual satisfaction. Digital Platform for public services, Trusted Profile,   
E-Tax Office, Online Patient Account, Digital IDs are all solutions that make everyday life easier. The relationship between satisfaction and e-government is also observed in other countries. Based on surveys in Sweden, Bernhard et al. (2018) showed that there is   
a relationship between the level of e-government in municipalities and the perceived satisfaction of their residents. According to their study, the level of digitalization is related to several dimensions of citizen satisfaction: satisfaction with life in the municipality, satisfaction with government performance, and satisfaction with transparency and influence. According to Ma and Zheng (2017), in European countries, highly ranked e-government is positively perceived by citizens. There, satisfaction is particularly related to e-service and e-participation. Thus, these analyses indicate that further development of online government services can contribute to citizens' satisfaction with digitalization.

**Fear Factors**

Some correlation tests performed between Fear and quantitative variables document   
a significant correlation for Stealing (r=0.31). Taking into account the qualitative variables, Kruskal-Wallis test results show that the level of fear is significantly different between men and women (p-value=0.01) and between two groups of people who are afraid and not afraid of: the development of artificial intelligence (p-value=0.00), job loss (p-value=0.04), internet surveillance and spyware (p-value=0.08).

When the dummy variables related to the Gender, JobLoss, SurveillanceSpyware and AIdevelopment are considered with Stealing in the linear regression model (Table 7), we document a strong impact of the AIdevelopment variable (p-value=0.00), JobLoss (p-value=0.06) and Gender (p-value=0.05) on the level of fear. The parameter related to Stealing is also statistically significant (p-value=0.04). Therefore, it can be concluded that the main impact on fear is due to stealing personal data and information (positive), fear of the development of artificial intelligence (positive), job loss (positive). A negative sign for the gender variable (Female-0, Male-1) indicates that the fear of women is significantly greater than the fear of men.

<< Table 7 >>

As a robustness check, we also divided the respondents into two groups: high fear and low fear. However, the division was done in a different way than in the case of the satisfaction study. If the respondent's subjective rating was higher than 40%, we assigned a value of 1 (high fear), if lower, 0 (low fear). This categorization was based on Fear values which were relatively low. Next, using the logistic regression model, we confirmed the statistical significance of only one of the indicators shown in the regression model. We obtained a significant parameter only for AIdevelopment: 1.48 (p-value=0.01).

Taking into account nonlinearity between variables (which is required in previous methodology), the CART algorithm was used to classify the respondents into two groups: people who are afraid of digitalization and those who are not afraid. Figure 3 shows a graph of the classification tree diagram. It can be seen that in the group of women who are afraid of the development of artificial intelligence and online spying and surveillance, there are more people who are afraid of digitalization.

On the other hand, respondents who are afraid of the development of artificial intelligence, but not afraid of surveillance and spyware, are classified in the group of respondents who are not afraid of digital transformation. All respondents who are not afraid of the development of artificial intelligence and are not afraid of stealing personal data and information are classified as not afraid of digital transformation.

<< Figure 3 >>

Figure 4 shows the ranking of the variables that are important in the classification procedure. It can be seen that Stealing and SurveillanceSpyware have the greatest impact on the classification of respondents who are afraid and not afraid of digital transformation.

<< Figure 4 >>

Analyzing the results presented in Figures 3 and 4, we notice that the variable AIdevelopment (whose importance was shown in the previous analysis) influences the choice of the classification path of the respondents. However, it is the Stealing and SurveillanceSpyware factors that are the most important in the classification process.

Studies on privacy concerns related to digital transformation, referring to specific digital solutions, were also conducted by Tronnier et al. (2022) and Kumar et al. (2023). Tronnier et al. (2022) analyzed the influence of privacy concerns and different dimensions of currency-related trust on individuals’ willingness to use Central Bank Digital Currency (a digital euro). Empirical results of this study indicate that multiple antecedents are associated with privacy concerns regarding the use of digital euro that in turn influence intention to adopt it. Kumar et all. (2023) have investigated how the adoption of digital conferencing tools relates to user information privacy concerns against security incidents and coping appraisal. The authors found that perceived benefits, trusting beliefs, and personal Internet interest increase intention to use digital conferencing software while risk beliefs decrease behavioral intentions. Thus, these analyses indicated that privacy concerns such as information stealing or spyware and surveillance, are perceived as the key fear factors related to digital transformation.

**Sentiment Indicator**

In this study, we propose the construction of a sentiment factor derived from individuals' subjective assessment of fear and satisfaction with digital transformation. Based on survey data, we can build the sentiment indicator as:

where: - satisfaction of i-th respondent, - fear of i-th respondent; – number of respondents.

This indicator provides an overall assessment of attitudes toward digitalization. The higher the value of the SI indicator, the more satisfied people are with digital transformation and the less they fear it. The results of the study show that the value of the SI index in Poland is about 37 percentage points.

**Conclusions**

The objective of the study was to validate indicators that influence an individual's sentiment and fear towards digital transformation. We created a survey where the questions explored possible factors that influence the level of satisfaction and the level of fear with digital transformation. Based on the survey data, we proposed the Sentiment Indicator (SI) to assess attitudes towards digitalization.

The study conducted in Poland includes a sufficiently diverse sample of respondents. Using machine learning tools, we found that online services provided by the government, the availability of card payments, and not fearing the development of AI have the greatest impact on satisfaction with digitization. On the other hand, fear of the development of AI is one of the factors with the greatest impact on the level of fear of digitization.

Taking into account the non-linearity between variables, the CART algorithm was used to classify the respondents into two groups: people who are afraid of digitalization and those who are not afraid. The results indicate that the factors related to stealing of personal data and surveillance with spyware are the most important in the classification process.

The conducted study shows that most people who are afraid of digitalization are in the group of women who are afraid of the development of artificial intelligence and online spying and surveillance.

In summary, based on the data from the study, we can conclude that there are some factors that influence satisfaction with and fear of digital transformation. Knowing the level of satisfaction and fear, in turn, allows for an overall assessment of people's attitudes towards digitalization, which can be important when making decisions about the adoption of new solutions. For this purpose, the creation of sentiment indicators is proposed. In Poland this indicator is about 37 points.

When creating plans for the development of digitalization in individual countries, it is important to take into account the sentiments of individuals in these countries. These sentiments provide valuable insights into the unique preferences, concerns, and expectations of the population. By aligning digitalization strategies with people's sentiments, policymakers and planners can increase the effectiveness and acceptability of initiatives and foster a more inclusive and responsive approach to technological development. Digital transformation should resonate with the needs and aspirations of local populations.

Different countries have different levels of digitalization. There is still room for improvement, but it is important to consider people's feelings about digital transformation. Our plan for the future is to conduct a survey in other countries. After all, it is important to understand individual perceptions of digitalization for the European Commission's initiatives on national digitalization development plans.

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#### **Table 1**

#### Social statistics related to internet use by individuals

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Individuals | EU (%) | | Poland (%) | |
|  | 2017 | 2022 | 2017 | 2022 |
| using the internet | 82.02 | 89.98 | 75.99 | 86.94 |
| frequently using the internet | 70.63 | 83.97 | 61.13 | 81.32 |
| regularly using the internet | 79.17 | 88.59 | 72.66 | 85.71 |
| who have never used the internet | 14.25 | 6.96 | 19.62 | 9.42 |
| using the internet for sending/receiving e-mails | 70.12 | 76.97 | 59.76 | 69.25 |
| using the internet for participating in social networks | 51.80 | 58.14 | 48.02 | 60.61 |
| using the internet for finding information about goods  and services | 64.05 | 69.59 | 58.35 | 74.25 |
| using the internet for seeking health-related information | 50.27 | 51.96 | 45.00 | 52.02 |
| using the internet for internet banking | 48.88 | 59.66 | 39.77 | 55.55 |
| using the internet for selling goods or services | 18.28 | 18.46 | 15.51 | 13.39 |
| using the internet for buying goods or services | -- | 67.98 | -- | 64.58 |
| using the internet for looking for a job or sending a job application | 15.83 | 13.42 | 11.63 | 5.96 |
| using the internet for taking part in online consultations  or voting | 7.97 | 8.41 | 4.18 | 4.96 |
| using the internet for doing an online course | 6.53 | 16.44 | 3.83 | 8.39 |

Source: own study

#### **Table 2**

#### Percentage of individuals with selected digital skills in 2022

|  |  |  |
| --- | --- | --- |
| Individuals | UE (%) | Poland (%) |
| with above basic overall digital skills | 26.46 | 20.64 |
| with basic overall digital skills | 27.46 | 22.28 |
| with low overall digital skills | 17.14 | 18.82 |
| with narrow overall digital skills | 9.47 | 11.45 |
| with limited overall digital skills | 5.42 | 7.31 |
| with no overall digital skills | 3.04 | 4.88 |
| for whom the digital skills could not be assessed | 11.00 | 14.63 |

Source: own study

#### **Table 3**

#### Statistics about E-government activities of individuals

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | UE (%) | | Poland (%) | |
| 2017 | 2021 | 2017 | 2021 |
| E-government activities of individuals via websites | 48.76 | 58.15 | 30.81 | 47.50 |
| Problems experienced when using e-government websites: | | | | |
| unable to access on smartphone or tablet | -- | 6.43 | -- | 1.32 |
| no issue when using a website or app of public  authorities | -- | 37.71 | -- | 41.89 |
| technical problems (last 12 months) | -- | 15.35 | -- | 8.88 |
| problems using electronic signature or identification | -- | 6.82 | -- | 1.94 |
| website or app was difficult to use | -- | 12.82 | -- | 4.29 |

Source: own study

#### **Table 4**

#### Survey respondents characteristics

|  |  |
| --- | --- |
|  | Percentage of respondents |
| Gender |  |
| Female | 47.50 |
| Male | 52.50 |
| Education |  |
| Higher | 66.25 |
| Secondary | 33.75 |
| Region |  |
| Big city | 62.50 |
| Small town | 17.50 |
| Village | 20.00 |
| Income |  |
| Not applicable | 17.50 |
| Significantly lower than the national average | 15.00 |
| About the national average | 46.25 |
| Significantly higher than the national average | 21.25 |

Source: own study

#### **Table 5**

#### The summary statistics and correlation coefficients

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Mean | SD | 1 | 2 | 3 | 4 |
| 1. OnlineServices | 7.24 | 2.14 |  |  |  |  |
| 2. NewTechnology | 7.31 | 2.10 | 0.32\*\* |  |  |  |
| 3. PaymentsAvailability | 8.70 | 1.28 | 0.44\*\*\* | 0.26\* |  |  |
| 4. TravelingUse | 7.47 | 2.56 | 0.26\* | 0.59\*\*\* | 0.31\*\* |  |
| 5. DailyLifeSolutions | 8.08 | 1.58 | 0.49\*\*\* | 0.39\*\*\* | 0.59\*\*\* | 0.50\*\*\* |

Source: own study

\*p < .05. \*\*p < .01. \*\*\*p < .001.

#### **Table 6**

#### Estimates of linear regression model parameters for satisfaction

|  |  |  |  |
| --- | --- | --- | --- |
|  | parameter | t Statistic | p-value |
| Intercept | 20.51 | 1.31 | 0.19 |
| OnlineServices | 2.34 | 2.15 | 0.04 |
| NewTechnology | 1.13 | 0.96 | 0.34 |
| PaymentsAvailability | 3.04 | 1.70 | 0.09 |
| Age | -2.95 | -0.88 | 0.38 |
| AIdevelopment | -8.97 | -2.14 | 0.04 |

Source: own study

**Figure 1**

*Classification of people satisfied with digitalization*

Source: own study

**Figure 2**

*Ranking of indicators for classification of satisfied and dissatisfied respondents by the CART algorithm*

Source: own study

#### **Table 7**

#### Estimates of linear regression model parameters for fear

|  |  |  |  |
| --- | --- | --- | --- |
|  | parameter | t Statistic | p-value |
| Intercept | 14.38 | 2.23 | 0.03 |
| Gender | -8.30 | -1.96 | 0.05 |
| Stealing | 2.01 | 2.11 | 0.04 |
| JobLoss | 13.15 | 1.92 | 0.06 |
| AIdevelopment | 14.08 | 3.10 | 0.00 |
| SurveillanceSpyware | -1.84 | -0.32 | 0.75 |

Source: own study

**Figure 3**

*Classification of people who fear digitalization*

Source: own study

**Figure 4**

*Ranking of indicators for classification of feared and not feared respondents by the CART algorithm*

Source: own study