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The Use of Binomial Models to Increase Digital Competence of Seniors in the City of Czestochowa

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Abstract:

Purpose: *The aim of the research conducted as part of the presented article is an attempt to determine the competence in the use of new technologies by the seniors of the city of Czestochowa, contributing to the improvement of their quality of life.*
Design/Methodology/Approach: *The research task was carried out on the basis of the literature on the subject and the results of the survey conducted in the third quarter of 2020, among 174 seniors living in the housing stock of the Department of Housing Management - Social Housing Association LLC in Czestochowa (in Poland abbreviated and known as ZGM "TBS" Sp. z o.o.). In the empirical analysis, probit models were estimated, in which determinants belonging to 5 categories were considered. On this basis, using the Gretl program, 14 probit models (7 full and 7 reduced) were built, showing the relationships between the studied variables.*
Findings: *The conducted analyzes showed that all estimated models are characterized by a matching correctness, as evidenced by the value of the likelihood ratio test. Moreover, the obtained research results show that older people living in the housing stock managed by the Social Housing Association "TBS" in Czestochowa are interested in using modern technologies, in particular in developing their competence in the field of finance and online transactions.*
Practical Implications: *Thanks to the conducted research, it was found that seniors show a gap in terms of digital competence related to finance and online transactions. The gap covers both the skills and concerns of fraud in this area. Bearing in mind the conducted study, ZGM TBS implemented the information campaign called „Be safe, senior," which aims to raise the knowledge in the field of counteracting financial frauds against the elderly. Regardless of this, employees contacting clients have been trained in competence assistance for seniors in the field of digital financial transactions.*
Originality/value: *The study conducted by the authors can be considered original as it constitutes the basis for taking appropriate steps to reduce digital exclusion by seniors. On the other hand, it is the basis for increasing the necessary skills in the use of new technologies, especially needed in the time of the COVID-19 pandemic.*

Keywords: *Goldberger model, logit model, probit model, competence, seniors, digital divide / digital exclusion.*

JEL classification: *J14, O14, O15.*

Paper Type: *Research study.*

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1. Introduction

Modern technologies are a permanent element of the environment in which the contemporary man functions. This is due to the fact that these technologies, especially during the COVID-19 pandemic, have become the basis for the normal functioning of a number of enterprises, government and local government organizations, including schools and universities, or individual units. It can be said that these technologies, in the period of the imposed limitations and restrictions, have become a way of participation in economic and social life along its various paths: remote work, online sales channels, customer service, electronic document circulation, distant learning or communication (Dębkowska *et al.,* 2020). Unfortunately, the use of these technologies requires appropriate conditions and competence. In practice, this means that people using them should have appropriate knowledge and conditions related to it (having a computer, Smartphone, tablet, access to the Internet). This, on the other hand, means that many people, in particular the elderly, do not use them, becoming more and more socially excluded people (Charmarkeh, 2017). Obviously, this problem is the result of a number of other factors, resulting mainly from personal circumstances and barriers that the individual (an elderly person) encounters or has imposed on himself/herself, or restrictions that have been subconsciously imposed by the entire society (Ruppel *et al.,* 2016). Additionally, social and cultural isolation, including a sense of loneliness, leads to the fact that seniors are largely distanced from them (Fernandez *et al.,* 2017).

Taking all the above aspects into account, the purpose of the considerations in the presented article is an attempt to define competence in the use of new technologies by the seniors of the city of Czestochowa, contributing to the improvement of their quality of life. The consequence of the defined article's objective was the formulation of a set of research questions:

- RQ1: Do seniors have access to new technologies?
- RQ2: Are seniors interested in using new technologies?
- RQ3: Do seniors feel the need to increase their skills in the use of new technologies?
- RQ4: Which skills are they interested in developing?

2. The Problem of Digital Divide among the Elderly

One of the potential factors contributing to the socio-economic development is the intensification and then popularization of modern technologies. This is due to the fact that these technologies significantly affect the increase in efficiency, revenues, and hence, GDP growth, virtualization of money and transactions, growth of digital and network services, shortening the investment cycle, popularization and democratization of social communication or universal access to knowledge and information, and many others (Wielki, 2012). It can therefore be said that the Internet and related modern technologies have become an essential part of everyday life, affecting, among other things, education, work, employment and free time.

Unfortunately, the use of modern technologies is related to two basic factors. Firstly, it requires having the right conditions, and secondly, having the appropriate knowledge and competence. This, in turn, affects the fact that not everyone has access to them and uses them. Such a situation makes them become more and more excluded from social life (Polat, 2012). The digital exclusion (also referred to as digital divide), because that's what we are talking about, is a multi-layered concept that covers many dimensions of infrastructure, access, applications and results (Park *et al.*, 2015). This is the gap that exists between individuals, households, businesses and geographic areas at different levels of socioeconomic development in terms of their ability to access information and communication technologies (Koss, 2001). To simplify the presented definition, it is the gap between those who benefit from new technologies and those who are unable to do so (Wilson *et al.*, 2003). Therefore, digital divide is recognized as one of the major policy challenges, with the national aim of providing access to infrastructure in all areas of the country and providing access to disadvantaged groups (Park *et al.*, 2013). As indicated by Brännström (2012) or Mossberger (2009), there are significant inequalities in the field of digital exclusion in developed and developing countries, depending on age, income, education, gender, geography, race or ethnicity.

Municipal flats are inhabited by people with a diverse demographic structure, however, a significant part of these flats are inhabited by elderly people. It is a group that is increasingly exposed to digital exclusion, especially during the COVID-19 pandemic, in which the imposed restrictions and recommendations force the isolation of these people. As a result of the pandemic, activities that were previously facilitated by digital technologies, such as access to online banking or the ability to settle administrative matters in offices via the Internet, often turned out to be impossible to perform in the traditional way - an example was the closure of cashier's windows to pay the rent during lockdown. This is due to the fact that seniors have difficulty keeping up with the pace of change and technological progress (Helsper, 2008). On the other hand, elderly people are more reluctant to use new technologies and all that is associated with it. This attitude makes them increasingly isolate themselves from society and from the place where understanding various forms of communication has become necessary (Saracchini *et al.*, 2015).

Juncos *et al.* (2006) argue that modern technologies have a positive effect on the functioning of the elderly. In their research they show that during the aging process, access to the Internet can help them establish new social contacts, ensuring access to culture and education, as well as stimulating them cognitively. A similar position is presented by the studies of He *et al.* (2020), according to which these technologies:

- are an effective digital means of participating in social life,
- connect elderly people with family and friends,
- help them engage in social activity,
- gain social support,
- have a positive effect on physical and mental health,
- strengthen social ties,

- allow them to share information with family members and friends through various digital means such as text, photos, voice and video,
- reduce social isolation and loneliness.

Fernandez *et al.* (2017) point to a number of benefits from their use. They indicate that these technologies have a positive impact on the seniors' quality of life, improve their psychosocial state, reduce depressive symptoms and use them to search for information and expand knowledge. It should be noted here that digital exclusion is related to its negative aspects. According to van Dijk (2006), this is related to a number of barriers in this respect, which result from:

- motivation to use new technologies,
- physical access (having a computer, access to the Internet),
- skills (strategic, informational, operational),
- use (different ways to use).

A similar position is presented by Stern *et al.* (2009), who distinguished three such groups, covering the following with their scope: access, which can be largely achieved through interventionist policies, as well as skills and opportunities.

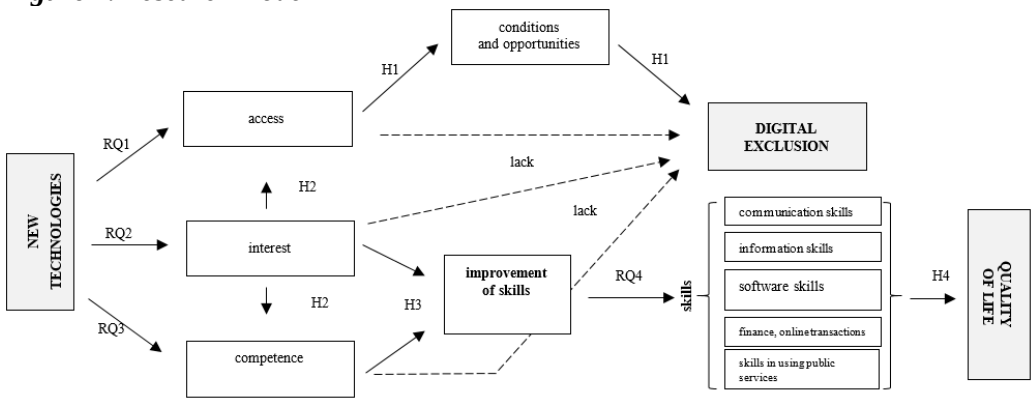
3. Empirical Results

The first step in searching for an answer to the main objective of the research along with the set of research questions identified in the introduction was to formulate hypotheses adequate to them and to build a research model (Figure 1). And so, for the purposes of the study, it was determined that:

1. Seniors show a low degree of access to new technologies, including the inability to apply new technologies.
2. Learning to use new technologies effectively motivates the elderly to intensify their competence in this area.
3. There is an increased need to broaden the range of skills in the use of the Internet by seniors.
4. Expanding skills in the use of modern technologies contributes to an increase in their quality of life.

The constructed research model is a graphic reflection of the selected RQs 1-4, along with the H1-4 hypotheses corresponding to them, requiring static testing. For this purpose, the instruments for econometric modeling in the form of binomial models were used.

Figure 1. *Research model*



Source: *Own study.*

4. Analytical Aspects of Binomial Models

Binomial models, otherwise known as dichotomous models, are the basic models used to describe qualitative endogenous variables. These models provide the basis for the analysis of the relationship between one (or more) independent (exogenous) variable and a binomial (binary, dichotomous) dependent variable. In other words, these models present the relationships that exist between the exogenous explanatory variables that describe the features of possible alternatives and the probability of choosing one of the two possible variants (conventionally marked as 0 and 1) (Osiewalski and Marzec, 2004; Fávero and Belfiore, 2019). In practice, this variable takes one of the two values, e.g. yes/no, good/bad, implemented/not implemented, and takes the following form (McCullagh and Nelder 1989; Rodríguez, 2007; Kufel, 2007):

$$y_i^* = \beta_0 + \sum_{j=1}^{k} \beta_j x_{ij} + u_i \quad (1)$$

Where:
y_i^* - hidden variable, taking:

$$y_i = \begin{cases} 1 \ for \ y_i^* > 0 \\ 0 \ for \ y_i^* \leq 0 \end{cases}$$

In this sense, the variable takes the value 1 when the desired event occurs and the value 0 when the desired event does not occur.

In binomial models it is assumed that the probability -P_i, is a function of the vector of exogenous variables x_i and the parameter vector β having the following form (Cramer, 2004; Suchecki 2012):

$$P_i = P(y_i = 1) = F x_i \beta \quad (2)$$

Where:

$x_i\,\beta$ - indicator defining the i-th unit of observation (linear combination of variable and parameter values)
F - is an increasing function of this indicator.

According to M. Gruszczyński (2002), binomial modeling is mainly used for:

- verification of the adopted hypothesis (hypotheses) regarding the mechanism generating the variable Y, i.e. determining the set of variables X that are important for determining the probability value P in a given community,
- prediction $P(y_i = 1)$ of the probability of an event or state that the Y variable takes the $y_i = 1$ value, or a prediction of a change in probability P caused by a change in the value of one of the exogenous variables X.

In practice, the most popular and, at the same time, the most frequently used binomial models are logit and probit models. These models are also referred to as Goldberger or probability models and are used to analyze the relationship between one or more independent (explanatory) variables and a dichotomous dependent variable (assuming the two values mentioned). And so (Kufel 2007):

- the logit model takes the following form:
-

$$y_i^* = ln\frac{P_i}{1-P_i} = \beta_0 + \sum_{j=1}^{k}\beta_j x_{ij} + u_i \tag{3}$$

where:
y_i^*- is called logit
P_i- is referred to as the probability of the dependent variable y_t, determined on the basis of the logistic distribution from the following equation:

$$P_i = \frac{P_i}{1-P_i} = e^{y_i^*} = e^{\beta_0+\sum_{j=1}^{k}\beta_j x_{ij}+u_i},$$

$$P_i = \frac{P_i}{1-P_i} = \frac{P_i}{1+e^{-(\beta_0+\sum_{j=1}^{k}\beta_j x_{ij}}} \tag{4}$$

If:
$y_i^* \to \infty$, then $P_i \to 1$
$y_i^* \to -\infty$, then $P_i \to 0$
$y_i^* = 0$, then $P_i = 0{,}5$

- the probit model is:

$$P_i = F\left(\beta_0 + \sum_{j=1}^{k}\beta_j x_{ij}\right) = \int_{-\infty}^{\beta_0+\sum_{j=1}^{k}\beta_j x_{ij}} \frac{1}{\sqrt{2\pi}} e^{\left(-\frac{t^2}{2}\right)} dt \tag{5}$$

It should be noted here that in the selected models (logit and probit models), the following relationship exists between the β parameters:

$$\beta_{logit} = 1.6\beta_{probit} \tag{6}$$

In practice, these models are similar to each other, therefore one of them is selected to determine the studied phenomenon. And so, for the purposes of the study, a probit model was used for H2-4, assuming the following assumptions:

- $y_i = 1$, if i-th elderly people are interested in using new technologies, including the intensification of competence in this area
- $y_j = 0$, if j-th elderly people are not interested in using new technologies, including the intensification of competence in this area.

When considering the binomial models, including the selected probit model, it should be noted that each of the estimated models requires a qualitative assessment of their correctness. The most frequently used statistical measures include:

- Likelihood Ratio Test:

$$LR = -2(I_n\widehat{L_R} - I_n\widehat{L_{UR}}) \tag{8}$$

Where:
$\widehat{L_R}$ - the maximum value of the logarithm of the likelihood function for a model containing only the intercept
$\widehat{L_{UR}}$ - value of the likelihood function for the complete model.

- McFadden's R-squared:

$$R^2_{McFadden} = 1 - \frac{I_n L_{UR}}{I_n L_R} \tag{9}$$

- Akaike Information Criterion*:

$$AIC = -2lnL(\hat{0}) + 2K \tag{10}$$

- Bayesian Information Criterion*:

$$BIC = -2lnL(\hat{0}) + K\ln(n) \tag{11}$$

- Hannan-Quinn Information Criterion*:

$$HQC = -2lnL(\hat{0}) + 2K\ln(\ln n) \tag{12}$$

Where* (for AIC, BIC and HQC):
$l(\widehat{0})$ – logarithm of the likelihood function for the estimated vector
K – number of model parameters,
N – number of observations.

Number of cases of 'correct prediction'; on the basis of counting the appropriate numbers of n_{ij}, the predicted value of the dependent variable (0) or (1) can be calculated. The cut-off point is 0.5 by default.

All of the selected statistical measures were used to verify the assumptions made (research model), as well as the probit models estimated in the further part of the study.

5. Research Material

Only zero-one variables were used to estimate probit models, coded on the basis of the respondents' (i.e. subjects') responses to selected research problems from the study on the digital activity of seniors living in the municipal housing stock managed by the Department of Housing Management "TBS" LLC in Czestochowa (ZGM TBS). This study was conducted at the beginning of 2020 in a group of 174 seniors living in the housing stock managed by ZGM TBS in Czestochowa[1]. And so, the dependent variables (y) were coded on the basis of the respondents' answers to nine research questions, defined for the purposes of this scientific study as:

- y_1 - having a computer, including Internet access,
- y_2 - having a mobile phone with Internet access,
- y_3 – interest in using new technologies,
- y_4 – interest in expanding competence in using the Internet,
- y_5 – interest in improving communication skills,
- y_6 – interest in developing information competence,
- y_7 – interest in mastering software-related skills,
- y_8 – interest in developing competence in the field of finance and online transactions,
- y_9 – interest in developing competence in the use of public services.

The input set of independent variables (x) included the variables characterizing seniors living in the housing stock managed by the ZGM TBS in Czestochowa. For the purposes of the study, the following exogenous variables were selected: gender, age, professional activity status, type of occupied premises, ZGM TBS branch. The answer options, along with the reference group, are presented in Table 1.

As can be seen (Table 1), a set of explanatory (exogenous) variables (x) includes 5 categories, containing 15 explanatory variables, on the basis of which the research sample can be characterized. And so the sample is made up of 52.3% of women and 47.7% of men who were selected as the reference group. Taking into account age, the dominant group (i.e. 60.9%) of respondents are people in the range of 50-60 years, while people over 60 years old make up 39.1% of the surveyed group (reference group). Most of the subjects are employed under a contract of employment - 46% (reference group), the next group from the point of view of professional activity are retirees and pensioners - 25.3% of the respondents, then the unemployed - 16,% and casual workers - 12.1%. 41.4% of the respondents are people who rent housing resources managed by ZGM TBS in Czestochowa, 31% of the respondents are people who own premises (reference group), and 27.6% are people who have social housing.

Table 1. *List of exogenous variables* (x)

Statistical data of the respondents		*Independent variable*	*Value (%)*
Gender	Female	x_1	52.3%
	Male	x_2	47.7%*
Age	50-60	x_3	60.9%
	Over 60	x_4	39.1%*
State of professional activity	Contract of employment	x_5	46.0%*
	Casual work	x_6	12.1%
	Retired/pensioner	x_7	25.3%
	Unemployed	x_8	16.7%
Type of occupied premises	Proprietary	x_9	31%*
	Social	x_{10}	27.6%
	Rented	x_{11}	41.4%
ZGM TBS branch	OE 1	x_{12}	27.6%
	OE 2	x_{13}	29.9%
	OE 3	x_{14}	28.2%
	OE 4	x_{15}	14.4%*

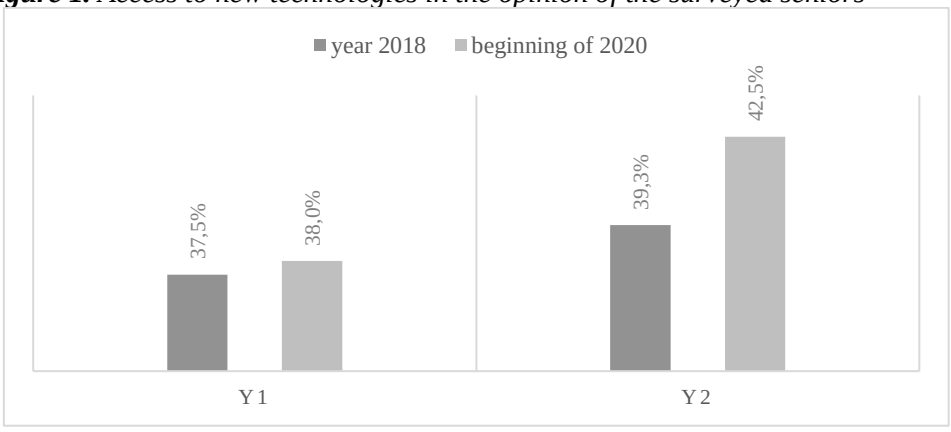
Note: ** Reference group*
Source: *Own study.*

The last category of variables was related to the ZGM TBS branch. The dominant group in this category are people living in OE 2 (29.9% of indications), then in OE 3 (28.2% of indications). The third group in this category were people living in OE 1 (27.6% of indications). The smallest group that was selected as the reference group was the group of people living in OE 4 (14.4% of responses).

6. Research Results and Discussion

Searching for answers to RQ1 for y_1 and y_2, the authors of the research compared the results of the current survey study (beginning of 2020) with the results obtained in 2018 (Figure 2).

Figure 1. *Access to new technologies in the opinion of the surveyed seniors*



Source: *Own study.*

As can be seen (Figure 2), the elderly still show a low level of access to new technologies, including the inability to use them. Admittedly, it can be noted that at the beginning of 2020, compared to 2018, the number of people with a mobile phone with Internet access increased (from 38% to 42.5%), nevertheless, these people are still largely exposed to digital divide. This situation is related not only to the lack of a computer or access to the Internet, but above all, low competence in this area. In order to solve this problem, ZGM TBS in Czestochowa took the initiative to support seniors, engaging in the process of increasing their competence in this area, contributing to the improvement of their quality of life.

However, looking for the answers to RQ2-4, twelve probit models were estimated using the Gretl program, two models for the endogenous (dependent) variables $y_3 - y_9$, of which:

- 7 full models, taking into account all the variables (x),
- 7 reduced models taking into account only those variables (x), that show features of significance.

The results of the estimation of probit models for the variables $y_3 - y_9$ are presented in Table 2.

Table 2. *The results of the estimation of probit models for* $y_3 - y_9$.
* used observations 1-174

variable	Coefficient	Standard deviation	z	p-value	Marginal effect
MODEL 1 full probit model for y_3					
$const$	−0.101756	0.579383	−0.1756	0.8606	
x_1	0.421675	0.280923	1.501	0.1333	0.0837327
x_3	−0.0461678	0.293166	−0.1575	0.8749	−0.00898229
x_5	1.42030	0.427053	3.326	0.0009 ***	0.269507
x_6	0.345387	0.457481	0.7550	0.4503	0.0575359
x_7	−0.204352	0.375263	−0.5446	0.5861	−0.0424502
x_{10}	−0.621246	0.339740	−1.829	0.0675 *	−0.142419
x_{11}	0.204007	0.326494	0.6248	0.5321	0.0391257
x_{12}	−0.542242	0.375779	−1.443	0.1490	−0.122002
x_{13}	1.90836	0.579029	3.296	0.0010 ***	0.260936
x_{14}	0.447283	0.397535	1.125	0.2605	0.0779654
MODEL 2 reduced probit model for y_3					
$const$	0.0950211	0.178416	0.5326	0.5943	
x_5	1.37317	0.285719	4.806	1.54e-06 ***	0.282838
x_{10}	−0.687710	0.267615	−2.570	0.0102 **	−0.172729
x_{13}	1.93299	0.472110	4.094	4.23e-05 ***	
MODEL 3 full probit model for y_4					

const	0.407844	0.469133	0.8694	0.3847	
x_1	0.0321414	0.219896	0.1462	0.8838	0.0122241
x_3	−0.341623	0.232516	−1.469	0.1418	-0.127774
x_5	0.884209	0.327235	2.702	0.0069 ***	0.323031
x_6	0.607577	0.402915	1.508	0.1316	0.207214
x_7	−0.0686513	0.339785	−0.2020	0.8399	-0.0262339
x_{10}	−0.687461	0.286023	−2.404	0.0162 **	-0.265836
x_{11}	−0.594523	0.251638	−2.363	0.0181 **	-0.226271
x_{12}	−0.554117	0.344380	−1.609	0.1076	-0.214632
x_{13}	0.487378	0.340656	1.431	0.1525	0.177455
x_{14}	0.261370	0.342380	0.7634	0.4452	0.0972460
		MODEL 4			
		reduced probit model for y_4			
const	0.299718	0.213256	1.405	0.1599	
x_5	0.829213	0.211277	3.925	8.68e-05 ***	0.304510
x_{10}	−0.653305	0.264398	−2.471	0.0135 **	−0.252924
x_{11}	0.469489	0.235666	−1.992	0.0464 **	−0.179258
		MODEL 5			
		full probit model for y_5			
const	-0.446205	0.480665	-0.9283	0.3532	
x_1	0.189857	0.212160	0.8949	0.3709	0.0710389
x_3	-0.174748	0.226456	-0.7717	0.4403	−0.0659249
x_5	-0.336735	0.312443	-1.078	0.2811	−0.125233
x_6	-0.0232630	0.393794	-0.05907	0.9529	−0.00870174
x_7	-0.963837	0.335369	-2.874	0.0041***	−0.315396
x_{10}	-0.268539	0.273850	-0.9806	0.3268	−0.0982414
x_{11}	-0.438208	0.246405	-1.778	0.0753*	−0.161061
x_{12}	1.42248	0.389866	3.649	0.0003***	0.522850
x_{13}	0.819437	0.380355	2.154	0.0312**	0.312875
x_{14}	0.436146	0.389296	1.120	0.2626	0.167201
		MODEL 6			
		reduced probit model for y_5			
const	−0.502142	0.188413	−2.665	0.0077 ***	
x_7	−0.753128	0.252208	−2.986	0.0028 ***	−0.257102
x_{11}	−0.319490	0.213072	−1.499	0.1338	−0.118660
x_{12}	1.16152	0.254197	4.569	4.89e-06 ***	0.437331
x_{13}	0.547194	0.248692	2.200	0.0278 **	0.210078
		MODEL 7			
		full probit model for y_6			
const	-0.601179	0.461349	-1.303	0.1925	
x_1	-0.184421	0.202967	-0.9086	0.3635	−0.0707755
x_3	-0.174920	0.216468	-0.8081	0.4191	−0.0674036
x_5	0.0450742	0.302167	0.1492	0.8814	0.0173080

x_6	0.0884081	0.380433	0.2324	0.8162	0.0342213
x_7	-0.189517	0.317622	-0.5967	0.5507	−0.0716260
x_{10}	-0.113277	0.263164	-0.4304	0.6669	−0.0431380
x_{11}	-0.353550	0.237188	-1.491	0.1361	−0.133863
x_{12}	1.11457	0.364534	3.058	0.0022***	0.422516
x_{13}	0.943998	0.358795	2.631	0.0085***	0.361768
x_{14}	0.464223	0.367967	1.262	0.2071	0.180760
		MODEL 8			
		reduced probit model for y_6			
$const$	−0.653377	0.157580	−4.146	3.38e-05 ***	
x_{12}	0.758010	0.240181	3.156	0.0016 ***	0.294088
x_{13}	0.605154	0.234658	2.579	0.0099 ***	0.235484
		MODEL 9			
		full probit model for y_7			
$const$	0.706299	0.444102	1.590	0.1117	
x_1	-0.0604542	0.215332	-0.2807	0.7789	−0.0215612
x_3	-0.217395	0.227081	-0.9573	0.3384	−0.0782259
x_5	0.000132494	0.311460	0.0004254	0.9997	4.72289e-05
x_6	-0.161333	0.402063	-0.4013	0.6882	−0.0557153
x_7	-0.554350	0.337131	-1.644	0.1001	−0.181975
x_{10}	-0.256074	0.276843	-0.9250	0.3550	−0.0885079
x_{11}	-0.248849	0.251708	-0.9886	0.3228	−0.0876157
x_{12}	0.0303999	0.322198	0.09435	0.9248	0.0108709
x_{13}	-0.969594	0.328863	-2.948	0.0032***	−0.302528
x_{14}	-1.42823	0.355609	-4.016	<0.0001***	−0.404434
		MODEL 10			
		reduced probit model for y_7			
$const$	0.189992	0.147655	1.287	0.1982	
x_{13}	−0.864482	0.239811	−3.605	0.0003 ***	−0.278664
x_{14}	−1.35282	0.273987	−4.938	7.91e-07 ***	−0.395118
		MODEL 11			
		full probit model for y_8			
$const$	0.506459	0.463043	1.094	0.2741	
x_1	0.535649	0.222606	2.406	0.0161**	0.206472
x_3	-0.528685	0.238869	-2.213	0.0269**	−0.206367
x_5	0.0799979	0.330255	0.2422	0.8086	0.0312805
x_6	0.190651	0.424039	0.4496	0.6530	0.0753072
x_7	-0.319300	0.347417	-0.9191	0.3581	−0.121967
x_{10}	-0.589653	0.282231	-2.089	0.0367**	−0.219613
x_{11}	-0.424616	0.252835	-1.679	0.0931*	−0.163473
x_{12}	0.785339	0.346777	2.265	0.0235**	0.305336
x_{13}	-0.778437	0.336588	-2.313	0.0207**	−0.284903
x_{14}	-1.03510	0.346757	-2.985	0.0028***	−0.363441
		MODEL 12			
		reduced probit model for y_8			

$const$	0.439194	0.373545	1.176	0.2397	
x_1	0.490998	0.216503	2.268	0.0233 **	0.189601
x_3	−0.461413	0.228332	−2.021	0.0433 **	−0.180372
x_{10}	−0.612243	0.274194	−2.233	0.0256 **	−0.227342
x_{11}	−0.400095	0.248938	−1.607	0.1080	−0.154192
x_{12}	0.772842	0.336330	2.298	0.0216 **	0.300685
x_{13}	−0.721061	0.330643	−2.181	0.0292 **	−0.265655
x_{14}	−0.999639	0.341719	−2.925	0.0034 ***	−0.352748
		MODEL 13			
		full probit model for y_9			
$const$	-7.19510	2074.05	-0.003469	0.9972	
x_1	-0.135778	0.250622	-0.5418	0.5880	−0.0117569
x_3	-0.415342	0.274824	-1.511	0.1307	−0.0391527
x_5	1.14765	0.448282	2.560	0.0105**	0.117509
x_6	1.46425	0.506611	2.890	0.0038***	0.294283
x_7	0.424568	0.474839	0.8941	0.3713	0.0441877
x_{10}	0.0982799	0.328898	0.2988	0.7651	0.00878764
x_{11}	-0.167364	0.300838	-0.5563	0.5780	−0.0140642
x_{12}	5.90577	2074.05	0.002847	0.9977	0.993848
x_{13}	6.07642	2074.05	0.002930	0.9977	0.993758
x_{14}	5.51282	2074.05	0.002658	0.9979	0.985916
		MODEL 14			
		reduced probit model for y_9			
$const$	−1.39048	0.211864	−6.563	5.27e-011 ***	
x_5	0.635064	0.262906	2.416	0.0157 **	0.160005
x_6	0.959751	0.353453	2.715	0.0066 ***	0.308832

Note: *The level of significance of the parameters:* *** $\alpha = 0.01$, ** $\alpha = 0.05$, * $\alpha = 0.1$

Source: *Own study.*

Looking at the obtained results of the estimation of probit models (Table 2), it can be concluded that two groups of variables, i.e. gender and age, are not statistically significant factors determining the probability of occurrence of the phenomena defined as y_3, y_4, y_5, y_6, y_7 and y_9. Such significance, at the level of $\alpha = 0.05$, was shown by these variables, both in the case of the full model and the reduced model, only in the case of y_8 (model 11 and 12, respectively). It can therefore be concluded that elderly people (both men and women) are mainly interested in developing competence in the field of finance and online transactions.

In the case of data analysis in groups distinguished according to the criterion of professional activity, where the reference group was made up of unemployed people, a statistically significant relationship can be observed for the variable x_5 (full and reduced model), in three cases, i.e. and y_9(model 1, 2, 3, 4 as well as 13 and 14). Therefore, it can be concluded that professionally active elderly people are interested in using new technologies, including the development of competence in this area, in

particular competence in the use of public services. A significant statistical relationship (significance level $\alpha = 0.01$) can also be observed in the case of models 5 and 6 (full and reduced model) for the variable x_7. In view of the obtained results of the selected models' estimation, it can be concluded that people who are retired or on a pension are primarily interested in the improvement of communication skills. Statistical significance can also be noticed in the case of models 13 and 14 (full and reduced model) for the variable x_6. Therefore, casual workers are largely interested in developing competence in the use of public services.

When analyzing another category of variables, i.e. the type of the premises occupied, it can be noticed that the variables characterizing this category showed statistical significance in the case of four endogenous (i.e. dependent) variables. And so, for y_3, significance at the level $\alpha = 0.1$ was demonstrated by the variable x_{10} in the case of the full model - model 1, and at the level $\alpha = 0.05$ in the case of the reduced model - model 2. At a similar level, this variable showed statistical significance in the case of models 3 and 4 (for y_4), as well as 11 and 12 (for y_8).

Apart from the variable x_{10}, statistical significance at the level $\alpha = 0.05$was demonstrated by the variable x_{11} in the case of models 3 and 4 (for y_4). This variable also showed statistical significance in the case of model 5 and model 11 (full models). In the case of reduced models, this variable did not show any significant statistical relationships. In view of the above, it can be concluded that elderly people living in social premises are interested in using new technologies, including increasing their skills in this area, in particular in the field of finance and online transactions. On the other hand, persons occupying rented premises are interested in intensifying competence in the field of communication skills as well as finance and transactions on the web.

Taking into account the last variable category, i.e. the ZGM TBS branch, it can be noted that elderly people living in OE2 (x_{13}) are most interested in using new technologies, including the development of communication, information and software skills as well as skills in the field of finance and online transactions. The selected variables show statistical significance in both the full model (model 1, 5, 7, 9, 11) and the reduced model (model 2, 6, 8, 10, 12).

The conducted research shows that the improvement of communication and information skills as well as competence in the field of finance and online transactions is noticeable among people living in OE1 (x_{14}). Statistical significance is also noticeable in x_{14} in two cases, namely the intensification of competence related to software (model 9, 10 - full and reduced) and in the field of finance and online transactions (model 11, 12 - full and reduced).

In order to qualitatively assess the estimated models, Table 3 presents measures of fitting data to individual models.

Table 3. *Data fit measures for the estimation of logit models 1-14*

	MODEL 1	MODEL 3	MODEL 5	MODEL 7	MODEL 9	MODEL 11	MODEL 13
				FULL MODELS			
Likelihood Ratio Test	82.4273 [0.0000]	50.9161 [0.0000]	37.4817 [0.0000]	18.5286 [0.0467]	37.7835 [0.0000]	54.3752 [0.0000]	28.7102 [0.0014]
McFadden's R-squared	0.414374	0.217857	0.161603	0.079004	0.167602	0.229126	0.176060
Adjusted R-squared	0.303777	0.123725	0.066750	-0.014802	0.070013	0.136423	0.041149
Akaike Information Criterion	138.4927	204.7968	216.4553	238.0000	209.6515	204.9403	156.3603
Bayesian Information Criterion	173.2423	239.5464	251.2049	272.7496	244.401	239.6899	191.1099
Hannan-Quinn Information Criterion	152.5892	218.8934	230.5519	252.0966	223.748	219.0369	170.4568
Log likelihood	−58.24634	−91.39839	−97.22767	−108.0000	−93.82577	−91.47017	−67.18013
Number of cases of 'correct prediction'	148 (85.1%)	134 (77.0%)	127 (73.0%)	110 (63.2%)	121 (69.5%)	132 (75.9%)	145 (83.3%)
	MODEL 2	MODEL 4	MODEL 6	MODEL 8	MODEL 10	MODEL 12	MODEL 14
				REDUCED MODELS			
Likelihood Ratio Test	68.1689 [0.0000]	28.7649 [0.0000]	32.3404 [0.0000]	12.0035 [0.0025]	30.9824 [0.0000]	51.7202 [0.0000]	9.55351 [0.0084]
McFadden's R-squared	0.342695	0.123078	0.139436	0.051182	0.137434	0.217938	0.058585
Adjusted R-squared	0.302478	0.088848	0.096321	0.025598	0.110819	0.150518	0.021791
Akaike Information Criterion	138.7511	212.9480	209.5966	228.5251	200.4525	201.5954	159.5170
Bayesian Information Criterion	151.3873	225.5842	225.3919	238.0022	209.9297	226.8678	168.9941
Hannan-Quinn Information Criterion	143.8771	218.0740	216.0042	232.3696	204.2971	211.8475	163.3615
Log likelihood	−65.37555	−102.4740	−99.79832	−111.2625	−97.22627	−92.79770	−76.75848
Number of cases of 'correct prediction'	145 (83.3%)	118 (67.8%)	128 (73.6%)	108 (62.1%)	124 (71.3%)	128 (73.6%)	143 (82.2%)

Source: *Own study.*

By analyzing the measures of fitting data to probit models presented in Table 4, it can be concluded that all the measures estimated by the authors of this study showed statistical correctness. As a result of the modeling, high x^2test statistics were obtained (in all estimated models), which justifies the rejection of the null hypothesis about the total irrelevance of the analyzed model parameters. On the other hand, this allows for the adoption of an alternative hypothesis that at least one explanatory variable in the model 1-14 is statistically significant, which also means the significance of the estimated models.

The comparison of the parameters for assessing the quality of the estimation models of the undertaken modeling shows that model 1 is more econometrically correct, as evidenced by the largest number of correct prediction cases, at the level of 85.1%. This means that in the case of the variable $y3$, the prediction is consistent with the actual state of affairs to the greatest extent. Equally high quality of the estimated models can be noticed in the case of models 2, 13 and 14. In these models, the number of 'correct prediction' cases is at the level of 83.3% (model 2 and 13) and 82.2% (model 14). In the remaining models, it can be observed that the correctness of the estimated models is above 62%, which can be considered a satisfactory result.

7. Conclusion

The global COVID-19 pandemic has made people realize how important a role modern technologies and competence in this area play. The group that manifests the greatest problems in this respect are the elderly. This is mainly due to the lack of access to them, as well as the predispositions they have. For this reason, the authors of the study have made an attempt to define competence thanks to which seniors will not be affected by digital exclusion. It should be emphasized that the issues discussed

by the authors do not exhaust the full list of areas of its analysis. Nevertheless, it indicates the need to develop the basic competence in the use of modern technologies (mainly communication skills as well as those related to finances and online transactions). This fact is evidenced by the results of the estimated probit models, which showed statistical significance, as evidenced by the results of the measures of fit. It should also be noted that the factors influencing the willingness to increase one's competence are the professional status and the area of residence in the city of Czestochowa.

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Notes:

1 It should be emphasized that an attempt to assess the digital activity of seniors as well as other residents of the housing stock managed by the ZGM TBS in Czestochowa was made in 2018. It was then noticed that the problem of digital exclusion among seniors was the result of the lack of access to modern technologies, including appropriate knowledge. Due to the interest in increasing competence in this area, the manager of the ZGM TBS in Czestochowa decided to re-conduct the study only in the group of people over 50 years of age.