The GNG neural network in analyzing consumer behaviour patterns: empirical research on a purchasing behaviour processes realized by the elderly consumers

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Received: 17 July 2019 / Revised: 29 May 2020 / Accepted: 31 July 2020 / Published online: 30 August 2020
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Abstract

The paper sheds light on the use of a self-learning GNG neural network for identification and exploration of the purchasing behaviour patterns. The test has been conducted on the data collected from consumers aged 60 years and over, with regard to three product purchases. The primary data used to explore the purchasing behaviour patterns was collected during a survey carried out among the elderly students at the Universities of Third Age in Slovenia, the Czech Republic and Poland, in the years 2017–2018. Finally, a total of six different types of purchasing patterns have been identified, namely the ‘thoughtful decision’, the ‘sensitive to recommendation’, the ‘beneficiary’, the ‘short thoughtful decision’, the ‘habitual decision’ and ‘multiple’ patterns. The most significant differences in the purchasing patterns of the three national samples have been identified with regard to the process of purchasing a smartphone, while the most repetitive patterns have been identified with regard to the purchasing of a new product. The results significantly support the GNG network’s validity for identification of consumer behaviour patterns. The application of this method allowed quick and effective to identify and segment consumers groups as well as facilitated the mapping of the differences among these groups and to compare the consumption behaviour expressed by consumers on different markets. The identified consumer purchase patterns may play a basic role for marketers to understand consumer behaviour and then propose tailored strategies in international marketing.

Keywords GNG neural network · Consumer behaviour · Consumer purchasing pattern · Consumer 60 and over · Elderly · Smartphone

Mathematics Subject Classification 68T07 · 91B42 · 90B60

1 Introduction

Contemporary global society is different from all the previous generations. This can be observed i.e. comparing the demographic structure of the world over the past hundred years. This first meaningful dissimilarity refers to the generation structure. Currently, the senior citizens have already marked their appearance on it significantly. For the first time in history, persons aged 65 or above outnumbered children under five years of age globally and by 2050, one in six people in the world will be over age 65 (16%) (UN 2019). Furthermore, for the first time in human history, we have to deal with as many as two generations of seniors, i.e. people over 60 years of age and in many cases still living their parents at the age of 80 and over. The growing number of senior citizens has also become a real challenge for the global economy. On the one hand, there increase burdens due to the costs of maintaining the quality of life of these people under the existing socio-economics systems (Bloom et al. 2010). On the other hand, their specific consumption has created a new market—the so-called silver market (Vernai et al. 2018) with emerging unique consumer segments with different consumption needs and life goals. It is important to understand the behaviour patterns of older consumers, as well as the evaluation criteria that older people use in market decision-making processes, which enables for a general understanding of the broad changes in consumer behaviour observed in the silver market (Ong et al. 2008). What's more previous research pointed out that both theoretical and methodological models to explore the consumption pattern of the elderly are insufficient (Moschis 2012).

Purchasing and using some new technological solutions are becoming more and more evident also among elderly consumers (Eurostat 2019; Orlov 2020). For example, the ageing market is a large and important market with high potential for digital products and services (Perez et al. 2019). Previous research still does not illustrate the brand new experiences of the older generations that spend the later part of their lives in the digital world. Among the elderly, some new consumer behavioural patterns expressed, but they haven't been recognized yet quite thoroughly and finally well-understood. All of the above issues results in a significant cognitive gap in the consumer behaviour field. Understanding of the needs and desires of older customers is key to a successful marketing strategy (Fregolente et al. 2019), particularly in international terms, business runs nowadays.

Globalization of markets and international competition force business to operate in a multicultural environment (Luna and Gupta 2001). In a global context, cultural and local factors play a significant role (Schumann et al. 2014). It is thus principally critical to define the role the culture plays in shaping consumer behaviour, in the context of international marketing. Moreover, academic literature tends to focus on consumer behaviour of particular populations, without considering the range of the nationalities and the cultures making up consumer groups (Lichy and Pon 2013). But, most aspects of consumer behaviour are culture-bound, while the concept that all consumers engage in shopping with specific fundamental decision-making modes or styles seems to be problematic (De Mooij and Hofstede 2011). The consumer patterns existing on foreign markets are far more complex and challenging than the domestic ones (Majić Jurković and Kuštrak 2013). International marketers, therefore, need to cognize the cultural differences to develop effective global marketing (De Mooij 2015). An understanding

of the reasons behind consumer behaviour provides additional information on how to be successful in the market (Jamalova 2018).

Current contemporary marketing strategies are developed based on in-depth and detailed research on consumer behaviour, substantially in the context of international marketing. To be familiar with such behaviours thoroughly marketing research needs to be carried out in detail. The results can be applied to determine the similarities and differences among the consumer groups. Presently in marketing, data collections are supported by the dynamic development of techniques and instruments dedicated, and managers have to cope with increasingly expansive multidimensional data sets. Such a process leads to the necessity of using increasingly advanced analytical methods, especially when the goal is to obtain comparative results. Among many methods to improve the analysis of large consumer data sets, artificial intelligence tools as neural networks may be proposed. Neural networks are powerful alternative tools and a complement to statistical techniques when data are multivariate with a high degree of interdependence among factors, when the data are noisy or incomplete, or when many hypotheses are to be pursued and high computational rates are required (Venugopal and Baets 1994). One example of those techniques is the GNG neural network that can search for specific repetitive patterns. The analysis of consumer purchasing behaviour may result in observations on consumer purchasing patterns, for instance. Strong evidence shows that the GNG network appears to be an efficient tool for analysis of multidimensional data sets and applied for grouping, classifying and searching for different patterns widely (Decker and Monien 2003; Decker 2005; Migdal-Najman and Najman 2013; Najman et al. 2018). What is more, neural networks can, for example, predict the consumers' shopping behaviour with greater accuracy than regression (Flynn et al. 1995).

Despite the many attempts to use neural networks to identify some specific patterns, such a solution has not been applied often in the field of consumer behaviour in recent years. Other methods dominate in literature, such as: Naive-Bayes classification, a modelling approach (Furaiji et al. 2012), a simulating approach (Ben Said et al. 2005), market basket analysis (Utami and Prajitno 2017), cluster analysis, which have many limitations. With the contemporary technological development and the resultant increase in computational capabilities of computers, such solutions as e.g. artificial intelligence enable faster and more accurate examine large data sets. These, in turn, constitute the basis for multi-criteria analysis in modern marketing. Such multidimensional data sets have become the principal source of the data used to determine, segment and vary the similarities and the differences in the complex consumer behaviours in various markets. This paper, therefore, constitutes an answer to the information gap regarding the practical application of neural networks for market-data analysis and identification of consumer behaviour patterns.

The research, therefore, sheds light on the use of a self-learning GNG neural network for the identification and exploration of the purchasing behaviour patterns expressed by elderly. The purpose of the study is to empirically investigate the national-level of cross-country differences in consumer purchasing behaviour, using samples from three selected Central European states. The test has been conducted on the data collected from consumers aged 60 years and over, concerning three product purchases: a new product; an innovative product; a smartphone. The scientific issue addressed involved

finding answers to the following questions: Are there any specific product-purchase-related consumer behaviour patterns expressed by consumers aged 60 years and over? And, are there any differences among the populations examined, in terms of the product purchase? To explore the purchasing behaviour patterns, the primary data collected during a survey carried out among the participants of Universities of Third Age in Slovenia, the Czech Republic and Poland, in the years 2017–2018.

This paper is organized as follows: the brief literature review was presented in Sect. 2; the research methodology was described in Sect. 3; the results were illustrated in Sect. 4; discussion and conclusions, with practical implications, were presented in Sect. 5.

2 Literature overview

2.1 Consumer behaviour patterns

Consumers are individuals oriented, in their decisions and actions, at maximization of their satisfaction and play the role of the most important agent in the marketing impact of enterprises (Bartosik-Purgat 2011). Consumption behaviour is observed in the consumption processes broadly defined as the human behaviour related to economic activity (Jachnis 2007). It is a field concerning the processes associated with acquisition of goods, services, experiences and ideas as well as with their consumption and disposal (Mowen 1987). Consumption behaviour is defined as the mental and the physical activities—behaviour—combining the motives and the causes that drive individuals and small groups, in terms of the the purchase, the use and maintenance as well as disposal of products or goods and services from the market, the public and the household sectors, enabling consumers to function and achieve goals as well as to realize the value of those goods and services (Antonides and van Raaij 2003). Consumer behaviour is recognized as the study of how individuals select, buy, use and dispose of products, as to satisfy their needs and wants (Solomon 2011). It is an activity stimulated by external factors that directly depend on the person's psycho-emotional status, former experience and the resources at one's disposal (Andersone and Gaile-Sarkan 2008).

Consumer purchasing behaviour is influenced by many factors: social and personal (Kotler and Keller 2012), demographic, technological, economic (Kusińska 2000) and cultural ones (Kusińska 2000; Kotler and Keller 2012).

For both academicians and practitioners, the elderly/ageing market is still in the initial stage of more comprehensive knowledge. In recent years, the number of studies on the elderly and their consumption behaviour from various perspective and different sectors has been steadily increasing worldwide (Angell, et al. 2012; Moschis 2012; Steffen et al. 2012; Köroğlu 2014; Roy 2017; Tańska et al. 2017; Bae et al. 2018; Ford et al. 2019; Fregolente et al. 2019; Jimon et al. 2019; Kim and Jin 2019; Krivosikova et al. 2020; Moschis et al. 2020). Elderly consumers present unique characteristics caused by physical and psychological ageing what can result in changes in their desires and demands (Kohlbacher and Herstatt 2011). The idea of a 'typical' older adult consumer does not exist, but some common traits, characteristics, and physical

realities can be observed among this age group in comparison with younger populations (Arensberg 2018). People age 60 or above tend to have different needs and different behaviours than younger generations (Bloom et al. 2010). Older consumers appear to be different from younger consumers (Moschis et al. 2004; Rizal 2003) due to various motives and behaviours of elderly people. Older consumers can express a broad spectrum of diverse identities whose understanding is desirable to create better marketing activities (Szmigin and Carrigan 2001).

Temporary, one of the research fields that has received much academic attention is the relations between the older generation and technology (Vermeir and Loock 2010; Villarejo-Ramos et al. 2014; González-Oñate et al. 2015; Chou and Liu 2016; Díaz-López et al. 2016; Wang et al. 2017; Wong and Leung 2016; Lüders and Gjevjon 2017; Choudrie et al. 2018; Rashmi et al. 2018; Perez et al. 2019; Rahman et al. 2019; Vahedi et al. 2019). Regarding the elderly and technology, a stereotyped profile of older persons is used (Mattila et al. 2003). The older adults demonstrate an interest in technologies when it seems to be useful, and the older adults' decisions to purchase and use technologies are related to personal and social factors (Huber and Watson 2014).

A growing body of empirical research has demonstrated the impact of culture on consumer behaviour and decision making (Hofstede 1991, De Mooij 2010, 2013, 2014, 2015, 2017; De Mooij and Hofstede 2002, 2010, 2011). Several models (see: Hofstede 2001; Schwartz 2006; GLOBE House et al. 2004) of national culture are available, which can be used for cross-cultural research on international marketing, as to find explanation for the differences in consumer behaviour (De Mooij 2017). Consumer behaviour results from certain culture-related decisions and factors (Jamalova 2018). Culture is one of the most important determinants affecting consumer behaviour (Henry 1976; De Mooij 2010; De Mooij and Hofstede 2010). It is understood as 'collective programming of the mind that distinguishes the members of one group or category of people from another' and is not a characteristic of individuals, but presents a group of people, who share the same education and life experience (Hofstede 2001). Culture can be recognized as cultivated behaviour that results from the learning and the social experience of individuals (Rana and Sharma 2013), and is learned rather than inherited (Hofstede 1991). It affects consumer behaviour, which itself may reinforce the manifestation of culture (Peter and Olson 1998). Culture could affect the general goals of consumers and their responses to marketing activities (Yang et al. 2015; Shavitt and Cho 2016). Cultural differences affect consumer responses and behavioural decisions (Ng and Lee 2015). Cultural diversity is evident on markets both in the sense of product offerings and the consumers themselves (Torelli and Stoner 2019). What is more, cultural differences, which account for the differences in consumer behaviour, are stable and unlikely to disappear, even if national income levels converge (De Mooij and Hofstede 2002). Deeper-level cultural differences in consumer behaviour across countries are persistent: even though the needs are universal, the core values, the attitudes and the motivations vary (De Mooij 2010). It is difficult to gain insight on and to recognize the consumer behaviour patterns existing on the domestic market and even more difficult to identify them on foreign markets, because these patterns are far more complex and challenging (Majić and Kuštrak 2013). Culture only exists by comparison (Hofstede et al. 2010), while examination of culture at a country level can

provide better understanding than analysis of the within-country factors to determine why individuals from a given country behave the way they do (Hassan et al. 2016). Even though the research on the role of culture in international marketing has been expanding, the still-limited existing studies indicate the effects of culture on consumer behaviour, in particular concerning the diffusion of innovations, product adoption, the purchase of new products or innovations (Arnould 1989, Steenkamp et al. 1999, 2001, 2002; Dwyer et al. 2005; Tellis et al. 2003, 2009).

Cultural factors are essential for correct explanation of the consumption and consumer behaviour patterns existing on various external markets (Gherasim and Gherasim 2018). The consumer portrait affects consumer behaviour directly, because it is straightway related to any of the factor groups (Andersone and Gaile-Sarkan 2008). Consumer purchasing patterns are well-established market behaviours of individuals (Szwacka-Mokrzycka and Letkowski 2018). Through making choices, consumers create independent consumption/consumer patterns (Dąbrowska and Ozimek 2010), which then are translated into patterns of entire societies. Recognition of the changes taking place in the consumers' purchasing patterns is connected with the need to conduct market research of various types (Szwacka-Mokrzycka and Letkowski 2018), whereas technological innovations have enabled collection of data on various aspects of the shopping process (Nakahara and Yada 2012).

Many various methods are used for identification of consumer behaviour patterns, while selection of an approach is determined, among others, by the nature of both the qualitative and quantitative data and the features. Out of these methods, the following ones can be used: e.g. Naïve-Bayes classification (Pornpimon et al. 2019), a modeling approach (Furajji et al. 2012), a simulating approach (Ben Said et al. 2005), basket analysis (Utami and Prajitno 2017), or clustering analysis (Govindasamy et al. 2018).

2.2 Artificial neural networks type GNG

Flynn et al. (1995) noted that the neural network is a computer based technology that mimics the properties of brain neurons. Neural networks models can be used to determine relationship between large numbers of input and output variables (Flynn et al. 1995). In 1990, Bernd Fritzke propounded three constructions of variable structure networks: Growing Grid (GG), Growing Cells (GC) and Growing Neural Gas (GNG) (Fritzke 1992, 1993a, b, c, 1994; Fritzke 1995a, b). Variable-structure networks can change many of their parameters during the self-learning process. They are a more developed form of permanent structure networks, in which a priori assumption of the number of neurons and of the network size is required. B. Friedrich, in the artificial neural networks of GNG type (1994 1995a,b, 1997), assumed that the simplest network can consist of two neurons only. The network should not have a fixed structure and should be modified as necessary. New neurons should appear in the network only if addition of such significantly reduces the error of pattern recognition. They should be inserted in the place of the network's largest error. At the same time, the neurons that do not participate in the process of the network's self-learning should be removed. To distinguish the existing clusters, the network can be divided into as many parts as the number of clusters. All connected neurons would create a single-focus image (Cheng

and Zell 2000; Marsland et al. 2002). The GNG network finds application in various fields of science today: i.e. medical diagnostics (Ogura et al. 2003; Netto et al. 2012), analysis of shopping habits (Decker and Monien 2003; Decker 2005; Migdał-Najman and Najman 2013), pattern recognition (Datta et al. 2001; Frezza-Buet 2008; Sun and Yang 2010; Viejo et al. 2012), the device control process (Pucci 2010; Zapater et al. 2015), and social sciences (Memmert and Perl 2009). In recent years, the research on the development of GNG networks was focused on algorithm optimization (Chávez et al. 2011; Aljobouri et al. 2018) application in large data systems (parallel algorithms) (Vojáček and Dvorský 2013; Fliege and Benn 2016), model construction algorithms (supervised GNG) (Duque-Belfort et al. 2017).

Construction of a network begins with establishment of the value of the parameters controlling the process of the network's self-learning. On the one hand, they have to ensure optimization of the mapping obtained, and on the other, interrupt the process, under certain a priori conditions. There are five parameters:

- The maximum number of iterations ($it_{\max}$), beyond which the network-construction process is interrupted;
- The level of acceptable error (Mean Quantisation Error, $MQE_{\max}$), after which the process of the network's self-learning is interrupted. The network, at the time of its creation, extremely misdiagnoses the units. For this reason, the initial value of the quantization error is set at $+\infty$. In the network construction process, this value decreases, and when the $MQE_{\max}$ value is reached, the network's self-learning process is interrupted;
- The maximum number of neurons composing the network ($k_{\max}$). When this value is reached, the network's self-learning process is interrupted;
- The maximum number of iterations in which the neurons do not participate in network learning (the so-called maximum age of the neuron, $age_{\max}$). After this number is exceeded, the neuron, whose age exceeds this value, will be deemed unnecessary and removed from the network.
- Constant rate of the winning neuron's learning at the level of ϵ_b and of the connected neurons' learning at the level of ϵ_n . These parameters indicate how far the winning neuron and the adjacent ones can be overcome in a single iteration. These are usually small fractions, at the level of: $\epsilon_b = 0.5$ and $\epsilon_n = 0.1$.

Its essence can be presented as follows:

Let D be M —an element of a set of objects in n -dimensional space:

$$D = \{\xi_1, \dots, \xi_M\}, \xi_i \in \mathbb{R}^n. \quad (1)$$

Each object $\xi \in D$ is described by an n -element of the set of data vectors (data vectors).

Let A be k —an element, n -dimensional set of neurons:

$$A = \{c_1, c_2, \dots, c_k\}, c_i \in \mathbb{R}^n. \quad (2)$$

To each $c \in A$ neuron, a reference vector w_c is connected, which can be considered as a vector of neuron coordinates in the input space.

The initial set of neurons is composed of two elements, $k = 2$. The self-learning process starts with an initiation of neurons c_1 and c_2 with random weights (spatial co-ordinates of the objects analysed):

$$A = \{c_1, c_2\}. \quad (3)$$

The connection between neurons and the age of the connection is set to 0.

One object ξ (data vector) is randomly selected from the D set. The following neurons are sought among the existing ones: the neuron closest and the second closest to the object selected:

$$s_1 = \arg \min_{c \in A} \|\xi - w_c\| \quad s_2 = \arg \min_{c \in A \setminus \{s_1\}} \|\xi - w_c\| \quad (4)$$

Neuron s_1 is called the winning neuron. To measure the distance of the objects from the neurons (data vectors and reference vectors), it is necessary to adopt appropriate metrics, correspondingly to the measurement scales used in the study. If these neurons are not connected, such connection should be created at the age set to 0. The age of the connection is the number of consecutive iterations in which the neuron is not the winning neuron. Then, the learning stage of neurons s_1 and s_2 is initiated. In the first step, a local measure of the network error for neuron s_1 is determined:

$$\Delta E_{s_1} = \|\xi - w_{s_1}\|^2. \quad (5)$$

It is a classical quantisation error. All the neurons connected to neuron s_1 are then sought and their coordinates are updated:

$$\Delta w_{s_1} = \varepsilon_b (\xi - w_{s_1}) \quad \Delta w_i = \varepsilon_n (\xi - w_i) \quad (\forall i \in N_{s_1}) \quad (6)$$

where: 'i' is the i-th neuron connected with the winning one (Jirayusakul and Auwatanamongkol 2007). The winning neuron's speed of learning (the moving of neurons s_1 and s_2 toward object ξ) is determined by ε_b and the speed of the other connected neurons by ε_n . The age of the connections between the neurons, the coordinates of which have been updated, is increased by 1. All the neuron connections older than the maximum set for $\text{age}_{\max}$ are removed. It is then checked whether neuron s_1 remained connected to any other neuron. If it lost all its connections, it is removed.

The above procedure is repeated for successively drawn objects ξ . If the number of random objects continues to be equal to a multiplicity of parameter λ , insertion of a new neuron begins. If connections exist, the procedure of new neuron insertion is initiated. The neuron with the maximum quantisation error q and the one closest to neuron f are sought. The new neuron r is placed between neurons q and f , forming its coordinates by interpolation of the coordinates of neurons q and f :

$$A = A \cup \{r\}, \quad w_r = (w_q + w_f)/2. \quad (7)$$

At the same time, the connections between the neurons are modified by removal of the connection between q and f , and then by linking neurons q with r and f with r .

Table 1 The GNG network parameters

λ	$\text{age}_{\max}$	ε_b	ε_n	$k_{\max}$	$\text{MQE}_{\max}$	$\text{it}_{\max}$
90	88	0.005	0.003	60	0.0001	30,000

The age of those connections is set at 0. The quantisation error for the new neuron is also determined:

$$E_r = (E_q + E_f)/2. \quad (8)$$

where:

$$E_q = \|\xi - w_q\|^2, E_f = \|\xi - w_f\|^2. \quad (9)$$

This is the last stage of the algorithm, after which the stopping conditions are tested in the following manner: achievement of the assumed maximum number of iterations $\text{it}_{\max}$, achievement of the network's assumed minimum learning error $\text{MQE}_{\min}$ (Mean Quantisation Error), and achievement of the assumed maximum number of neurons $k_{\max}$. Fulfillment of any of these conditions ends the algorithm. One drawback of the algorithm entails identification of a number of parameters that have to be experimentally predetermined, such as: the maximum number of iterations, the maximum number of neurons and the maximum age of connections, the minimum network error and the frequency of the new neuron iteration λ . It is difficult to determine these parameters a priori, due to the lack of simple formal dependencies between them and the quality of cluster reconstruction.

For the purpose of this study, the values of the above parameters were selected experimentally, by observing the level of the MQE changes in the network's self-learning process. The GNG network parameters for all three countries were set at the following levels (see Table 1).

The application of the GNG networks has several benefits, in opposition to easier and more numerous exceeding recognised methods, such as the k-medium method. Inappropriate, the k-means method requires a prior determination of the number of clusters k , which usually is unknown. Furthermore, that method distinguishes spherical and well-separable clusters solely. GNG networks do not possess such limitations. The number of clusters is self-determined by the network in the process of self-learning (Palomo and López-Rubio 2017). The network can also detect clusters of any spatial configuration. The learning process for larger data sets is more agile than other commonly used cluster examination techniques. It does not require significant RAM resources (Migdał-Najman and Najman 2013; Boulbazine et al. 2018).

The disadvantages of the GNG network include, to a large extent, the subjective manner of selecting the network operating parameters (Chávez et al. 2011). It seems that the most important practical limitation of the GNG network entails the lack of universally available software that researchers and practitioners may use. In this paper, all the analyses presented based on proprietary software (Migdał-Najman and Najman 2013, Appendix 3, GNG Software).

In marketing, the advantages of neural networks entail: their use as a part of the total set of statistical options, their application as scanner data to predict product purchase,

their use to determine which attributes may predict purchase (Quaintance and Franke 1991) as well as their ability to recognize patterns in data and use that information to predict the outcomes (Flynn et al. 1995). As Flynn's et al. study (1995) results show, neural networks can predict consumer purchasing behaviour with greater accuracy than regression, due to a better prediction rate (R^2). Following Flynn et al. (1995) 'the weaknesses of neural networks are threefold: its inability to explain and describe relations (Eastminger 1990; Rumelhart and McClelland 1986); and it does not provide a significance test statistic'.

Previous studies show some useful applications of neural networks in marketing e.g., for predicting shopping behaviour (Flynn et al. 1995), database marketing (Rao and Ali 2002), analysis of market basket data (Decker and Monien 2003; Decker 2005; Migdał-Najman 2012); for repeat purchase modelling in direct marketing (Baesens et al. 2002), for decision support (Cui and Wong 2002, 2004; Olson and Chae 2012), and a model selection for direct marketing (Cui et al. 2008), in analysis of customer satisfaction; for a micro segmentation (Ali and Rao 2001), for targeting direct marketing campaigns (Guido et al. 2011), in an exploration of the relationship between marketing and operations (Marques et al. 2014) and identifying consumption behaviour patterns (Migdał-Najman 2012; Najman et al. 2018).

3 Methodology

The article sheds light on the prospective usefulness of GNG networks in a market data analysis in identifying and exploring consumer purchase patterns. The purpose of the study is to empirically investigate the national-level of cross-country differences in consumer purchasing behaviour, using samples from three selected Central European states. The test was conducted on the data collected from consumers aged 60 years and over, and concerned three product purchases. The scientific problem aimed to answer the following questions:

- Are there any specific product-purchase-related consumer behaviour patterns expressed by consumers aged 60 years and over?
- And, are there any differences among the populations examined, in terms of product purchase?

The specific objectives of the study refer to:

- the general consumer behaviour pattern while buying a new product;
- the general consumer behaviour pattern while buying an innovative product;
- the general consumer behaviour pattern while buying a smartphone.

The survey was complex. To identify the consumer behaviour associated with the acquisition of new products under international conditions, the construct of consumer innovativeness [see: Szmigin and Carrigan (2000), Truong (2013)] and specific constructs of the unified theory of acceptance and use of technology (see: Venkatesh's et al. (2003, 2012)) were taken into account and adapted for this cross-country study. For this analysis, however, only the survey questions concerning the respondent characteristics and the consumer innovativeness construct were examined, ultimately providing 108 variable features (Appendix).

The entire questionnaire thus consisted of 2 parts: the first one concerned the respondent characteristics (6 questions) and the second referred to the objects examined (47 questions and statements). Bearing in mind the research goal set for this analysis, only the respondent characteristics, as well as 16 questions and statements (the last 10 of which were measured on a five-point Likert scale, ranging from (1) strongly disagree, to (5) strongly agree), were taken into further consideration. After the linguistic adaptation of the questions and statements to the local conditions, the questionnaires were prepared. Quota sampling was applied. The characteristics (quotas) covered by the research were: gender and age.

To collect the primary data, a paper-and-pencil interview was applied to target the smartphone users aged 60 years and over in the three selected Central European countries: Slovenia, the Czech Republic and Poland. The reason for the selection of those national populations derived from the fact that those nations share many common characteristics: they are becoming the oldest societies in the world (the average age ratio in 2015 shows 39.6 for Poland, 41.4 for the Czech Republic and 43.1 for Slovenia, and in 2050 will amount to 52.2, 47.9 and 49.7 respectively) (UN 2017); they belong to the Slavic cultural circle; they have a post-communist and transformative experience.

Based on Sekaran’s (1983) approach, to collect comparable samples, selection of samples matched, based on a certain set of the characteristics under examination, was applied. The questionnaires were distributed among the participants of the selected 27 Universities of the Third Age (12 in Poland, 8 in Czech Republic and 7 in Slovenia). The elderly university participants constitute the most homogeneous segments of consumers in the three countries under examination. Furthermore, some cultural differences could be amplified, if the data are collected employing a more inclusive respondents’ group (Erdem et al. 2006).

Only the participants who attended lectures on the days of the survey were tested. Ultimately, 1834 questionnaires were collected (322 in Slovenia in 2017; 531 in the Czech Republic in 2018; 981 in Poland in 2018). For further analysis, only the respon-

Table 2 Samples characteristics by national samples

Item	National samples		
	Czech Republic	Poland	Slovenia
The year of data collection	2018	2018	2017
No. of respondents	531	981	322
No. of the smartphone users	279	617	142
The smartphone users’ gender (%)			
Male	12	14	11
Female	88	84	88
Lack of data	0	2	1
The smartphone users’ age (%)			
60–69	64	55	75
70–79	32	38	23
80 and over	4	7	2

dents who declared their age at 60 years and over and admitted to smartphone usage were taken into account, which resulted in a total of 1038 questionnaires. The samples' characteristics are presented in Table 2.

4 Results

The scales assigned to the neurons in the GNG network (neuron coordinates) were used to assess the purchasing behaviour patterns. Each GNG-network neuron, more precisely its coordinates, reflect the patterns of purchasing behavior of the consumers at the age 60 and over. The components of the weight vector range from 0 to 1. A weight-vector value equal to one means that such behavior occurs in all the mapped behaviors of a given GNG neuron. The most important purchasing behavior patterns of these customers are presented in Fig. 1. The 'thicker' the simple combining of product groups, the more often the products are co-bought together (there are more neurons that are responsible for such a pattern of behaviour). To facilitate visualization (especially when many variants are examined), it is also possible to eliminate those variants that are least related to other variants (appropriate restrictions or connections are marked with a 'thin' line) or those that have no connections.

To illustrate the consumer behaviour of the elderly consumers surveyed, network graphs have been applied (Fig. 1). They enable identifying the links between all the analyzed variants of the features examined (108 variants (dots) per the grid graph, Fig. 1). Digit 1, for example, is assigned to the gender variant: female, digit 2 illustrates another gender variant: male(...), digit 13 represents the respondents' education: higher education with a master's degree, etc. (Appendix).

As the data shows, the primary user of an innovative product (i.e. smartphone), identified among the students at the Universities of the Third Age in the countries examined, is a female aged 60–69 years, who has a university degree (Poland, Slovenia) or non-baccalaureate secondary education (Czech Republic). In general, she is an administrative employee (Czech Republic, Slovenia) or a white-collar worker (Poland)

Fig. 1 Most frequent connections among the variants analysed and the features examined, obtained on the basis of the GNG network

Table 3 Characteristics of typical smartphone users by the national samples

Item	National samples		
	Czech Republic	Poland	Slovenia
Gender	Female	Female	Female
Age	60–69	60–69	60–69
Education	Secondary	Higher	Higher
Occupation	Administration	White collar	Administration
Income by household	350–460 Euros	460–600 Euros	600–1000 Euros

Fig. 2 Consumer purchasing patterns associated with a new, innovative product (i.e. a smartphone) by national samples

with a monthly per capita income of 350–460 Euros (Czech Republic), 460–600 Euros (Poland) and 600–1000 Euros (Slovenia) (see Table 3).

4.1 Purchasing behaviour patterns while buying a new product (see Fig. 2)

One main pattern of behaviour can be indicated among the respondents. Let us call it: Pattern A. It has been identified in all the three national samples examined. The pattern belongs to the individuals, whose decisions to acquire new, unknown products, require a long interval, are headed by deliberations and discussions family and or colleagues. These people are used to look for information in a variety of sources, including press, radio, TV and the Internet. Pattern A can be defined as the ‘thoughtful decision’ pattern (see Table 4).

4.2 Purchasing behaviour patterns while buying an innovative product (see Fig. 2)

Among the three national samples examined, the pattern A1 can be distinguished, with the extra pattern A2 in Slovenia. The respondents expressing the pattern A1 declared that, in terms of innovative products, the decision to purchase a smartphone is made by the elderly only after their friends, acquaintances, and or family have already bought, tested and recommended to these seniors a given product. As such, the pattern A1 is a

Table 4 Types of the patterns identified among the respondents by the national samples

Item	National samples		
	Czech Republic	Poland	Slovenia
Purchasing behaviour patterns while buying a new product	Thoughtful decision (A)	Thoughtful decision (A)	Thoughtful decision (A)
Purchasing behaviour patterns while buying an innovative product	Sensitive to recommendation (A1)	Sensitive to recommendation (A1)	Sensitive to recommendation (A1) Thoughtful decision (A2)
Purchasing behaviour patterns while buying a smartphone	Thoughtful decision (A11) Beneficiary (A12)	Thoughtful decision (A11) Beneficiary (A12) Habitual decision (A13)	Thoughtful decision (A11) Multiple (A21)

typical ‘sensitive to recommendation’ pattern. The pattern A2 is characteristic of the people who usually buy innovative products quite swiftly, as exhibited on the market, but its purchase precedes a period of reflection. This pattern can be defined as a ‘short thoughtful decision’ one (Table 4).

4.3 Purchasing behaviour patterns while buying the smartphone (see Fig. 2)

Four behavioural patterns can be distinguished among the respondents: pattern A11 (P A11), pattern A12 (P A12), pattern A13 (P A13) and pattern A21 (P A21). The pattern A11 has been observed in all three countries examined. It represents the respondents that choices to obtain an innovative product (i.e. a smartphone) require a longer time. The process of acquiring precedes deliberations, discussions with the family and or friends, and exploration for information in various sources: i.e. press, radio, TV and the Internet. This variant can be called a ‘thoughtful decision’ pattern (see Table 4). Its specificity for all the national samples is presented in Table 5. What is more, pattern A12 can be identified for both the Czech and the Polish respondents, that were the users who received an innovative product (a smartphone) as a gift and did not bear the cost of buying it. This type of pattern can be defined as a ‘beneficiary’ pattern (see Table 4). The specificity of this pattern, for both national samples, is presented in Table 6. Additionally, pattern A13 has been noted in the group of Polish respondents. The decision on a smartphone purchase is declared as a result of those consumers’ regular purchasing attitudes, e.g. the desire to own the latest version of a product.

This group is generally interested in the technological novelties in the mobile phone industry. This type of patterns can be called a ‘habitual decision’ one (see Table 4). Its specificity for this national samples is presented in Table 7. Another pattern—A21—is characteristic for the Slovenian respondents. In this case, no unique behaviour pattern has been distinguished concerning the smartphone purchase. These consumers present many different consumption modes referred to as a ‘multiple’ pattern, thus exhibiting a non-dominant pattern in the population (Table 4). The specificity of this pattern for the Slovenian national sample is presented in Table 8.

For the ‘thoughtful pattern’ (Table 5), on the one hand, the Czech and Polish respondents did not consider themselves to be the last in their social circles to reach for a smartphone and its latest versions. On the other hand, the Slovenian respondents had the opposite opinions. They agreed that they were the last ones, who started using the smartphone, as well as its latest version. Among the above respondents of those nations, the most numerous similarity in admitting a shortage of knowledge about mobile phones and their latest versions was recognized. The elderly declared a rare purchase of the latest versions of phones and visiting the store with this product, and no planning of the smartphone purchase. What’s more, if the respondents considered buying the latest version of the smartphone, they would become familiar with its new features, appearance and a way of use.

For the ‘beneficiary pattern’ (Table 6), both the Czech and Polish respondents agreed they were not the last one among their social circle who used the latest version of a smartphone. They were also not the last one who had bought such a phone. Those respondents rarely visited sales departments with smartphones and had no plans to

Table 5 Specificity of the ‘thoughtful decision’ pattern (A11) of smartphone purchase by the national samples

Statements pattern A11	1	2	3	4	5
In general, I am among the last ones in my circle (family/friends/acquaintances) to buy/start using a touch mobile phone called a “smartphone”	CZECH REP	POLAND		SLOVENIA	
If I heard that a new version of a touch mobile phone called a “smartphone” was available in shops, I would be interested in buying it	CZECH REP	POLAND SLOVENIA			
Compared to my friends/family/acquaintances I seldom buy/use a newer version of a touch mobile phone called a “smartphone”				CZECH REP POLAND SLOVENIA	
I would consider buying a new version of a touch mobile phone called a “smartphone”, even if I haven’t known its new functions, look and way of using	CZECH REP POLAND	SLOVENIA			
In general, I am the last in my circle (family, friends, acquaintances) to use the latest/newest version of a touch mobile phone called a “smartphone”		CZECH REP POLAND		SLOVENIA	

Table 5 continued

Statements pattern A11	1	2	3	4	5
I know about new versions of touch mobile phones before other people of my circle (family, friends, acquaintances) do		CZECH REP POLAND SLOVENIA			
Overall, I'm interested in the latest technology of touch mobile phones			CZECH REP POLAND	SLOVENIA	
I often visit a section with touch mobile phone products in a department store or supermarket	POLAND	CZECH REP SLOVENIA			
I know more about touch mobile phones than other people do		CZECH REP POLAND SLOVENIA			
If I needed to use a touch mobile phone called a "smartphone", I would buy the latest one available		CZECH REP POLAND SLOVENIA			

Legend: Likert scale: 1—strongly disagree, 5—strongly agree

Table 6 Specificity of the ‘beneficiary’ pattern (A12) while buying an innovative product for the Czech and the Polish samples

Statements PATTERN A12	1	2	3	4	5
In general, I am among the last ones in my circle (family/friends/acquaintances) to buy/start using a touch mobile phone called a “smartphone”		CZECH REP POLAND			
If I heard that a new version of a touch mobile phone called a “smartphone” was available in shops, I would be interested in buying it	CZECH REP POLAND				
Compared to my friends/family/acquaintances I seldom buy/use a newer version of a touch mobile phone called a “smartphone”				CZECH REP POLAND	
I would consider buying a new version of a touch mobile phone called a “smartphone”, even if I haven’t known its new functions, look and way of using	POLAND	CZECH REP			
In general, I am the last in my circle (family, friends, acquaintances) to use the latest/newest version of a touch mobile phone called a “smartphone”		CZECH REP POLAND			
I know about new versions of touch mobile phones before other people of my circle (family, friends, acquaintances) do	POLAND	CZECH REP			
Overall, I’m interested in the latest technology of touch mobile phones	POLAND	CZECH REP			
I often visit a section with touch mobile phone products in a department store or supermarket	CZECH REP POLAND				
I know more about touch mobile phones than other people do	POLAND	CZECH REP			
If I needed to use a touch mobile phone called a “smartphone”, I would buy the latest one available	CZECH REP	POLAND			

Legend: Likert scale: 1—strongly disagree, 5—strongly agree

Table 7 Specificity of the ‘habitual decision’ pattern (A13) of smartphone purchase for the Polish sample

Statements PATTERN A13	1	2	3	4	5
In general, I am among the last ones in my circle (family/friends/acquaintances) to buy/start using a touch mobile phone called a “smartphone”	POLAND				
If I heard that a new version of a touch mobile phone called a “smartphone” was available in shops, I would be interested in buying it		POLAND		POLAND	
Compared to my friends/family/acquaintances I seldom buy/use a newer version of a touch mobile phone called a “smartphone”		POLAND			
I would consider buying a new version of a touch mobile phone called a “smartphone”, even if I haven’t known its new functions, look and way of using		POLAND			
In general, I am the last in my circle (family, friends, acquaintances) to use the latest/newest version of a touch mobile phone called a “smartphone”		POLAND			
I know about new versions of touch mobile phones before other people of my circle (family, friends, acquaintances) do			POLAND		
Overall, I’m interested in the latest technology of touch mobile phones				POLAND	
I often visit a section with touch mobile phone products in a department store or supermarket			POLAND		
I know more about touch mobile phones than other people do		POLAND			
If I needed to use a touch mobile phone called a “smartphone”, I would buy the latest one available				POLAND	

Legend: Likert scale: 1—strongly disagree, 5—strongly agree

Table 8 Specificity of the ‘multiple’ pattern (A21) of smartphone purchasing for the Slovenian sample

Statements PATTERN A21	1	2	3	4	5
In general, I am among the last ones in my circle (family/friends/acquaintances) to buy/start using a touch mobile phone called a “smartphone”		SLOVENIA			
If I heard that a new version of a touch mobile phone called a “smartphone” was available in shops, I would be interested in buying it		SLOVENIA			
Compared to my friends/family/acquaintances I seldom buy/use a newer version of a touch mobile phone called a “smartphone”				SLOVENIA	
I would consider buying a new version of a touch mobile phone called a “smartphone”, even if I haven’t known its new functions, look and way of using		SLOVENIA			
In general, I am the last in my circle (family, friends, acquaintances) to use the latest/newest version of a touch mobile phone called a “smartphone”		SLOVENIA			
I know about new versions of touch mobile phones before other people of my circle (family, friends, acquaintances) do		SLOVENIA			
Overall, I’m interested in the latest technology of touch mobile phones				SLOVENIA	
I often visit a section with touch mobile phone products in a department store or supermarket		SLOVENIA			
I know more about touch mobile phones than other people do		SLOVENIA			
If I needed to use a touch mobile phone called a “smartphone”, I would buy the latest one available		SLOVENIA			

Legend: Likert scale: 1—strongly disagree, 5—strongly agree

buy its latest version. The Polish respondents more regularly highlighted their explicit attitudes. They expressed a definite lack of interests in technological innovations in mobile telephony, knowing more about the latest versions of phones earlier. They would definitely not consider a purchase without getting acquainted with its new features, appearance and way of the usage of a smartphone. The Czech respondents shared a similar opinion, but with a lower intensity of expression.

For the ‘habitual decision’ pattern (Table 7), the respondents would be interested in buying a smartphone shortly after they were informed about that availability of the latest version for sale. They belonged to people being interested in technological innovations in mobile telephony. They buy the latest versions of phones more often in comparison with their friends and acquaintances. The heading information collected of the Polish respondents about the latest versions of smartphone phones compared with their social circle was neither greater nor less. The frequency of the respondents’ visits to sales departments should be considered average. Their awareness of the smartphone was not more extensive than their social circle. Despite that, they were also not the last people who started using the latest version of a smartphone. The respondents would not consider buying the latest version of the phone without familiarizing themselves with the smartphone’s new features, appearance and the way of use in advance.

For the ‘multiple’ pattern (Table 8), the Slovenian respondents infrequently bought the latest versions of smartphones in comparison with their social circle. However, the elderly were interested in technological innovations in mobile telephony. They did not refer to people who recently reached for a smartphone and its latest versions. The respondents would not consider buying the latest version of the phone without familiarizing themselves with its new features, appearance and the way of use in advance. Their awareness of smartphones and the latest versions wasn’t advancing as well, and their visiting in sales departments offering smartphones were occasionally. If they demanded to use a smartphone, they wouldn’t obtain the latest version of that which would be available for purchase.

5 Discussion and conclusions

As both the theory and the practice indicate, a broader understanding of consumer behaviour is a key to successful marketing today. Consumption behaviour concerns processes of searching, purchasing, disposal and utilization goods and services. Repetitive purchasing behaviour displays in some specific patterns which recognition enables developing proper marketing strategies. Such a process is especially notable in terms of international expansion when a company needs to deal with previously unfamiliar behaviour of foreign consumers.

The consumer patterns existing on foreign markets are far more complex and challenging than the domestic ones (Majić Jurković and Kuštrak 2013). Consumer behaviour may be influenced by cultural factors, which differentiate buyers on those distinct markets. Most aspects of consumer behaviour are culture-bound (De Mooij and Hofstede 2011). The impact of cultural factors first and foremost patterns consumption and consumer behaviour on different international markets (Gherasim and Gherasim 2018). Awareness of the existence of cultural differences in international

markets as well as respect for those differences is very important for the development of marketing strategies (Majić Jurković and Kuštrak 2013). Before developing those strategies, it is critical to identify and segment the consumer groups as well as to map the differences between them (based on socio-demographic or other characteristics, such as e.g. decision making) and to compare the consumption behaviour, attitudes or motives of these groups. Behaviour patterns research on the purchase of new and innovative products has been carried out for several decades worldwide. Despite of that, in international marketing, managers are forced to use mostly buying patterns developed for Anglo-Saxon markets or Western Europe ones. For Central and Eastern European countries, such an approach seems to be insufficient or even improper due to significant differences between i.e. economic conditions, historical heritage, cultural habits and norms shared by these nations. It is especially crucial for an elderly living most of their lives in socialist times, transformative and post-transformative conditions. But for these nations, such comparative cross-country studies are not available yet, and the gap of knowledge exists in this field. Therefore, it is worth identifying and exploring such patterns among these European nations.

Concerning the results obtained, the GNG network used has enabled the acquisition of various and complex purchasing behaviour patterns for different national samples. Bearing in mind the research objective, a total of six different types of purchasing patterns have been identified, namely the 'thoughtful decision', the 'sensitive to recommendation', the 'beneficiary', the 'short thoughtful decision', the 'habitual decision' and 'multiple' patterns. Thus, some specific product-purchase-related consumer behaviour patterns expressed by consumers aged 60 years and over have existed. Furthermore, among the populations examined, some differences in terms of the product purchase have existed as well. Firstly, a higher number of patterns (four different ones and one recurrent pattern) has been observed for both the Polish and the Slovenian samples of elderly consumers. The Polish sample includes: the 'thoughtful decision' pattern of new product purchase; the 'sensitive to recommendation' pattern of innovative product purchase; as well as the 'beneficiary', the 'habitual decision' and again the 'thoughtful decision' patterns of the smartphone purchase.

Secondly, the Slovenian elderly respondents expressed the following purchasing patterns: the 'thoughtful decision' pattern of new product purchase; the 'sensitive to recommendation' pattern, as well as the very unique 'short thoughtful decision' pattern of innovative product purchase, which is specific for this national sample only. Moreover, the 'thoughtful decision' and the 'multiple' patterns of the smartphone purchase (again specific for this national sample only) have been noted.

Thirdly, the Czech elderly respondents expressed four patterns (three different ones and one recurrent): the 'thoughtful decision' pattern of new product purchase; the 'sensitive to recommendation' pattern of innovative product purchase; as well as the 'beneficiary' and again the 'thoughtful decision' patterns of the smartphone purchase.

The present research provides three managerial implications at least. First, elderly consumers are not a homogeneous group with one indiscrete behavioural pattern. The patterns identified present distinct attitudes and behaviours of the elderly people towards the domain. The patterns can provide some critical criteria for classifying the appropriate segments of the elderly consumers concerning a purchase of selected categories of products, i.e. innovations.

As the outcomes show, even for the product like a smartphone in this peculiar case, some separate specific types of patterns were recognized. They enable drawing out supplementary microsegments within some more substantial consumer segments. In modern marketing based on the micro philosophy, i.e. building an offer for narrower purchasing groups, such a separation of microsegments is the basis for responding to this type of specific behaviour and needs. The multiplicity and diversity of purchasing behaviour patterns is the basis for developing separate marketing activities that take into account the differences between individual consumer groups. Referring to the research, the elderly people that purchase a new product are consumers guided with a scheme like 'thoughtful decisions'. Such a process demands the elderly people an interval to get to know the offer, to compare values, analyze the advantages and disadvantages of some solutions proposed. Therefore, marketers should include a longer elderly customer journey in their marketing activities for a better response to the purchasing process of the seniors. Secondly, in the case of an innovative product, it is necessary to consider the influence of third parties on the decision-making process. In all the countries, the seniors appeared to be sensitive to external recommendations while buying an innovation. They required searching for support to obtain information on solutions among their social groups. Such behaviour can be a course of action for marketers so that people from the circle of the elderly may become a part of the process of communicating innovation to older groups. However, the more behaviour relates to a particular object, the more different patterns identified in the individual country. Moreover, in the case of the selected product, one pattern was common for all the countries, two the same in two countries and two different ones. Therefore, when developing marketing activities in various geographical markets, it is necessary to take into account the specificity of consumer behaviour towards a particular product. Referring only to general consumer attitudes seems to be insufficient or improper.

Considering the level of consumer innovativeness expressed as the pattern of 'thoughtful decision' occurring in all the countries, the most conservative group turned out to be the Slovenes, then Poles and finally Czechs. Then, in the case of the 'beneficiary pattern', the Poles seem to show a lower level of innovativeness than the Czechs. Therefore, it seems that differences between the countries in the types of patterns should be determinants of specific market activities of the business in international markets. Than in this case, taking the cultural factor into account should be a must.

Thus, resuming managerial implications, a business should take into account the following perspectives: the elderly market is not homogeneous and specific segments and microsegments may be identified due to selected purchasing behaviour; the specificity of elderly consumers' behaviour towards a particular product should be recognized and taken into account, not only the seniors' general attitudes towards a general product category; within the same patterns, significant differences in the level of consumer innovativeness among various countries exist. Such a situation requires the adaptation of a specific marketing strategy for a single market each time. Finally, while developing marketing strategy, two factors should be taken into consideration: a specific behavioural attitude towards a product and national culture.

Referring to the method of the analysis, the GNG neural network used has allowed easily to identify the connections between the variants of the features examined. As a result of the clustering of the items with similar characteristics, the problem scale was

reduced to the most common patterns. The very high speed of the GNG network will enable equally effective analysis in further research, covering not hundreds, but thousands of respondents. In future research, based on much larger samples, the Authors will attempt to explore the sensitivity of the results obtained to the network's learning parameters. The observations to date show that results do not have an influential impact on the network's ability to distinguish dominant clusters and thus to distinguish the most important patterns. Nevertheless, in-depth research into this problem seems necessary.

Furthermore, the stochastic nature of the GNG network algorithm can cause some problems. Firstly, the network is randomly initiated, and secondly, a sequence of learning by individual objects is random, as well. After having the network learning parameters established, both factors can lead to some instability in the structures found. After several launching, the network with identical parameters may usually get slightly different properties, and as well as classifications may vary. These problems typically affect objects that exist on the edge of the clusters. These objects are relatively the least similar to the overall cluster profile to which they were classified. The above problem does not seem to have much practical significance in the present research due to the goal that the network should have achieved. The aim is to find the most common relationships, mostly explicit structures in the data. Furthermore, all weak and few connections between objects rejected, and most of them concerned objects placed the furthest from the centre of the cluster. These units have no impact on the final result.

Summing up, this study may contribute, both theoretically and practically, to international marketing as well as has its enrichment in analysis methodology. First, it provides a new insight into the field of cultural differences in consumer behaviour as well as sheds light on individual differences existing across countries. The outcomes show that the behaviour patterns expressed when consumers acquire, innovative and or specific products may be unique for different countries. These patterns may be affected by socio-demographic factors as well as by consumer attitudes and shopping motives. Second, the findings may entail essential practical consequences for marketing practitioners, providing more beneficial knowledge on the way cultural differences rationalize and interpret consumer behaviour differences. In terms of managerial implications, it is worth emphasizing that successful international marketing requires more extensive market research, carried out on every single foreign market, which would define the similarities and the differences among those markets. Consumer purchasing patterns seem to be dependent on local cultural features and specific consumer characteristics. This national-level exploration can support the macrolevel view, which may enhance the insight into the issue via individual-level studies. The findings provide international businesses with national-level outlines, which may improve the individual-level studies. The paper additionally provides a noteworthy practical contribution to market-data analysis. The results significantly support the GNG network's validity for the identification of consumer behaviour patterns. The application of this method enabled to identify and segment consumers groups quickly and efficient as well as facilitated the mapping of the differences among these groups (based on socio-demographic or other characteristics, e.g. decision making) and comparing of the consumption behaviour expressed on different markets.

Concluding, based on the exploration of the three processes of buying a new product, an innovative product and a smartphone, as declared by consumers aged 60 years and over, in three selected Central European countries: Slovenia, the Czech Republic and Poland, it can be stated that the verification of the application of a self-learning GNG neural network to identify consumer purchasing patterns has been conducted positively. Ultimately, the analysis results in the observation of the purchasing behaviour patterns that are specific for these national groups. In general, the most significant differences in the purchasing patterns of the three national samples have been identified and concerned the purchase process of a smartphone, while the most repetitive patterns have concerned the purchase of a new product. The consumer purchasing patterns recognized may be of primary significance for marketers, in terms of the understanding of consumer behaviour.

Finally, it should be stressed that this study has its limitations, considering the samples used and the size of the respondent groups. The results obtained seem to be specific for the groups surveyed only. The matching of the samples was preceded by recruitment of survey participants at the Universities of the Third Age—institutions run by public or private universities and or non-profit organizations, providing intellectually and physically stimulating courses for the elderly, who mostly are the retired members of the community. The elderly participants constitute the most homogeneous segments of consumers in the three countries under examination. They seem to possess characteristics that can affect their attitudes towards new products, i.e. smartphones. They are intellectually fit, courageous, curious about the world, ready for new challenges. They are also open to new acquaintances and teamwork. It seems that these features are universal, which enabled the respondents to be treated as a proper representation of the users of new technologies in this age group, even though, in a statistical sense, it is not a representative sample. Several assumptions exist that the results might have been different if the respondents surveyed had been selected among other consumer groups. These limitations, however, can lead to particular directions of future research. It is worth examining consumer behaviour on more heterogeneous samples or and other product categories, which would expand the generalizability of the results obtained. The research can also be expanded to nationally representative samples in all those countries. What is more, the studies may be conducted in other countries of Central Europe, such as Slovakia or the Baltic Sea region countries, as to compare the results with the data obtained.

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Appendix: Variants of the examined features

1. Gender / Female
2. Gender / Male
3. Age/50–59
4. Age/60–69
5. Age/70–79
6. Age/80–89
7. Age/90 or over
8. Education/primary school complete
9. Education/non degree professional trade or technical tertiary qualification/vocational
10. Education/secondary/higher school without certificate
11. Education/secondary/higher school with certificate
12. Education/undergrad university degree
13. Education/postgrad university degree
14. Education/PhD
15. Last occupation before retirement/skilled occupation
16. Last occupation before retirement/service or trade occupation
17. Last occupation before retirement/professional, managerial or technician occupation
18. Last occupation before retirement/secretary/administration occupation
19. Last occupation before retirement/own homestead/farmer occupation
20. Last occupation before retirement/sole trader enterprise
21. Last occupation before retirement/non-employed
22. Present residence/farm/home in the country
23. Present residence/country village (city/town up to 19.999 citizens)
24. Present residence/a small city/town (from 20.000 to 49.999 citizens)
25. Present residence/town/city from 50.000 to 99.999 citizens
26. Present residence/town/city from 100.000 to 499.999 citizens
27. Present residence/the big town/city (from 500.000 citizens or over)
28. Economic position/income: Monthly household income gross/to 500 PLN gross per member of household
29. Economic position/income/from 501 PLN to 999 PLN per member of household
30. Economic position/income/from 1000 PLN to 1499 PLN per member of household
31. Economic position/income/from 1500 PLN to 1999 PLN per member of household
32. Economic position/income/from 2000 PLN to 2499 PLN per member of household
33. Economic position/income/from 2500 PLN to 2999 PLN per member of household
34. Economic position/income/from 3000 PLN to 4999 PLN per member of household
35. Economic position/income/from 5000 PLN or/and over per member of household

36. Assessment of general behavior while purchasing new product/In general, I make decisions about purchasing new products under the influence of emotions.
37. Assessment of general behavior while purchasing new product/In general, the decision about purchasing new products requires a long consideration and using numerous different sources of information (asking my family and/or friends, looking for information in the press, radio, on TV, internet, etc.).
38. Assessment of general behavior while purchasing new product/In general, decisions about buying new, unknown products are for me the result of the purchase of common - the purchase is driven by habit e.g. I always desire to have a newer version of a product.
39. Assessment of general behavior while purchasing new product/no answer/none of the answers above.
40. Assessment of an attitude towards new products/In general, I buy innovative/new products soon after they appeared for sale. I like having new products.
41. Assessment of an attitude towards new products/In general, I quickly buy innovative products but after earlier consideration.
42. Assessment of an attitude towards new products/In general, I buy innovative products after they have been bought and tested by my acquaintances, friends, family and recommended to me.
43. Assessment of an attitude towards new products/In general, I reluctantly buy new products. I have my favorite ones and do not want to change them.
44. Assessment of an attitude towards new products/no answer/none of the answers above
45. Do you use a mobile phone/Yes
46. Do you use a mobile phone/No
47. Assessment of behavior while purchasing your touch phone called a “smart-phone”/I make the decision about purchasing my touch mobile phone under the influence of impulse/instantaneous emotions.
48. Assessment of behavior while purchasing your touch phone called a “smart-phone”/The decision about the purchase of my touch mobile phone took me a long consideration and using numerous different sources of information (asked my family and/or friends, looked for information in the press, radio, on TV, internet, etc.).
49. Assessment of behavior while purchasing your touch phone called a “smart-phone”/The decision about buying my touch mobile phone was for me the result of the purchase of common - the purchase is driven by habit e.g. I always desire to have a newer version of the product.
50. Assessment of behavior while purchasing your touch phone called a “smart-phone”/I got my mobile phone e.g. as a gift/present and I didn’t bear costs of purchasing it
51. Assessment of behavior while purchasing your touch phone called a “smart-phone”/no answer/none of the answers above.
52. Assessment of an attitude towards your touch mobile phone called a “smart-phone”/I bought my touch mobile phone called a “smartphone” soon after it appeared for sale. I like having new products.

53. Assessment of an attitude towards your touch mobile phone called a “smart-phone”/I bought my mobile phone called a “smartphone” but after earlier consideration.
54. Assessment of an attitude towards your touch mobile phone called a “smart-phone”/I bought my touch mobile phone after they have been bought and tasted by my acquaintances, friends, family and recommended to me.
55. Assessment of an attitude towards your touch mobile phone called a “smart-phone”/I bought my touch mobile phone called a “smartphone” when others had been having the newer version of this product.
56. Assessment of an attitude towards your touch mobile phone called a “smart-phone”/I don’t have a touch mobile phone called a “smartphone”.
57. Assessment of an attitude towards your touch mobile phone called a “smart-phone”/I got my mobile phone e.g. as a gift/present and I didn’t bear costs of purchasing it.
58. Assessment of an attitude towards your touch mobile phone called a “smart-phone”/no answer/none of the answers above.
59. In general, I am among the last ones in my circle (family/friends/acquaintances) to buy/start using a touch mobile phone called a “smartphone”./strongly disagree
60. In general, I am among the last ones in my circle (family/friends/acquaintances) to buy/start using a touch mobile phone called a “smartphone”./disagree
61. In general, I am among the last ones in my circle (family/friends/acquaintances) to buy/start using a touch mobile phone called a “smartphone”./neither disagree nor agree
62. In general, I am among the last ones in my circle (family/friends/acquaintances) to buy/start using a touch mobile phone called a “smartphone”./agree
63. In general, I am among the last ones in my circle (family/friends/acquaintances) to buy/start using a touch mobile phone called a “smartphone”./strongly agree
64. If I heard that a new version of a touch mobile phone called a “smartphone” was available in shops, I would be interested in buying it./strongly disagree
65. If I heard that a new version of a touch mobile phone called a “smartphone” was available in shops, I would be interested in buying it./disagree
66. If I heard that a new version of a touch mobile phone called a “smartphone” was available in shops, I would be interested in buying it./neither disagree nor agree
67. If I heard that a new version of a touch mobile phone called a “smartphone” was available in shops, I would be interested in buying it./agree
68. If I heard that a new version of a touch mobile phone called a “smartphone” was available in shops, I would be interested in buying it./strongly agree
69. Compared to my friends/family/acquaintances/I seldom buy/use a newer version of a touch mobile phone called a “smartphone”./strongly disagree
70. Compared to my friends/family/acquaintances/I seldom buy/use a newer version of a touch mobile phone called a “smartphone”./disagree
71. Compared to my friends/family/acquaintances/I seldom buy/use a newer version of a touch mobile phone called a “smartphone”./neither disagree nor agree
72. Compared to my friends/family/acquaintances/I seldom buy/use a newer version of a touch mobile phone called a “smartphone”./agree

73. Compared to my friends/family/acquaintances/I seldom buy/use a newer version of a touch mobile phone called a “smartphone”./strongly neither disagree nor agree
74. I would consider buying a new version of a touch mobile phone called a “smartphone”, even if I haven’t known its new functions, look and way of using./strongly disagree
75. I would consider buying a new version of a touch mobile phone called a “smartphone”, even if I haven’t known its new functions, look and way of using./disagree
76. I would consider buying a new version of a touch mobile phone called a “smartphone”, even if I haven’t known its new functions, look and way of using./neither disagree nor agree
77. I would consider buying a new version of a touch mobile phone called a “smartphone”, even if I haven’t known its new functions, look and way of using./agree
78. I would consider buying a new version of a touch mobile phone called a “smartphone”, even if I haven’t known its new functions, look and way of using./strongly agree
79. In general, I am the last in my circle (family, friends, acquaintances) to use the latest/newest version of a touch mobile phone called a “smartphone”./strongly disagree
80. In general, I am the last in my circle (family, friends, acquaintances) to use the latest/newest version of a touch mobile phone called a “smartphone”./disagree
81. In general, I am the last in my circle (family, friends, acquaintances) to use the latest/newest version of a touch mobile phone called a “smartphone”./neither disagree nor agree
82. In general, I am the last in my circle (family, friends, acquaintances) to use the latest/newest version of a touch mobile phone called a “smartphone”./agree
83. In general, I am the last in my circle (family, friends, acquaintances) to use the latest/newest version of a touch mobile phone called a “smartphone”./strongly agree
84. I know about new versions of touch mobile phones before other people of my circle (family, friends, acquaintances) do./strongly disagree
85. I know about new versions of touch mobile phones before other people of my circle (family, friends, acquaintances) do./disagree
86. I know about new versions of touch mobile phones before other people of my circle (family, friends, acquaintances) do./neither disagree nor agree
87. I know about new versions of touch mobile phones before other people of my circle (family, friends, acquaintances) do./agree
88. I know about new versions of touch mobile phones before other people of my circle (family, friends, acquaintances) do./strongly agree
89. Overall, I’m interested in the latest technology of touch mobile phones./strongly disagree
90. Overall, I’m interested in the latest technology of touch mobile phones./disagree
91. Overall, I’m interested in the latest technology of touch mobile phones./
92. Overall, I’m interested in the latest technology of touch mobile phones./agree

93. Overall, I'm interested in the latest technology of touch mobile phones./strongly agree
94. I often visit a section with touch mobile phone products in a department store or supermarket./strongly disagree
95. I often visit a section with touch mobile phone products in a department store or supermarket./disagree
96. I often visit a section with touch mobile phone products in a department store or supermarket./neither disagree nor agree
97. I often visit a section with touch mobile phone products in a department store or supermarket./agree
98. I often visit a section with touch mobile phone products in a department store or supermarket./strongly agree
99. I know more about touch mobile phones than other people do./strongly disagree
100. I know more about touch mobile phones than other people do./disagree
101. I know more about touch mobile phones than other people do./neither disagree nor agree
102. I know more about touch mobile phones than other people do./agree
103. I know more about touch mobile phones than other people do./strongly agree
104. If I needed to use a touch mobile phone called a "smartphone", I would buy the latest one available./strongly disagree
105. If I needed to use a touch mobile phone called a "smartphone", I would buy the latest one available./disagree
106. If I needed to use a touch mobile phone called a "smartphone", I would buy the latest one available./neither disagree nor agree
107. If I needed to use a touch mobile phone called a "smartphone", I would buy the latest one available./agree
108. If I needed to use a touch mobile phone called a "smartphone", I would buy the latest one available./strongly agree

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Affiliations

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