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RESEARCH ARTICLE

Adaptation of the middle class to innovation: perception of new technologies and openness to them

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Abstract

In the modern world, a key skill is the ability to adapt to changing conditions, including mastering new programs, devices, technologies, ways to search for information, and sometimes new professions. With the outbreak of the pandemic – in the context of restrictive measures and transition to remote forms of employment – the problem of adaptation to innovation has become even more relevant. A quick switch to programs ensuring work in remote conditions (for example, Zoom, MSTeams) has become a necessary requirement for keeping the job for some of the employed. Residents of large cities had to switch over to digital public services, QR codes, online order of goods, etc. Obviously, not all groups of the population had a shared reaction to changes, including due to different perception of new technologies and attitudes towards them.

The middle class has been traditionally regarded as a change provider in society, as a layer most open to non-groundbreaking, yet sustainable transformations and new ideas. Testing validity of this statement becomes especially interesting in light of the new reality, that has challenged the middle class (due to peculiarities of employment and lifestyle) with mastering new technologies.

The purpose of this article is to analyze specific features of perception of new technologies by the middle class. Based on data of the specialized survey «Middle class: willingness to invest in human capital development», innovation openness index has been constructed comprising components of attitude, acceptance and use of innovations. On the basis of the technology acceptance model, a set of factors for perception of technical innovations has been identified, taking into account opinion of the middle class about usefulness, ease of use, reliability and safety, and elitism of innovations. In conclusion, relationship between perception of innovations and openness to them has been analyzed and determinants of openness to new technologies have been identified.

The study shows that the middle class has a positive attitude towards introduction of new technologies into various areas of life, is experienced in using them and is rather interested in innovative goods and services. However, the key study conclusion is related to heterogeneity of the middle class in terms of perception of innovations and openness to them. A statement that these categories are independent stratifying features both at the level of the middle class and the entire population has been suggested to stimulate further expert discussion.

Keywords

adaptation, perception of innovation, diffusion of innovations, index method, new technologies, progress, middle class

JEL codes: O330, Z130

Introduction

One of the basic processes in the modern world is a rapid technological progress. It has become an integral part of reality both in terms of employment, leisure and recreation. Today, it is difficult to imagine a person's life without expanding the range of innovative devices. For example, the global Internet connectivity, associated with many of the latest state-of-the-art solutions, is currently estimated at 65.6% of the population exceeding 90% in some countries (World Internet... 2021). In Russia, according to the 2020 data, 78.1% of the population aged over 12 has access to the Internet (Internet audience... 2020).

In fact, everyone is increasingly having to use new technical products, both voluntarily and under the circumstances related, for instance, to transition of the service sector to greater automation or employer's decision to increase efficiency of labour time or performance quality.

The COVID-19 pandemic has developed a special request for accelerated introduction of digital technologies into economy, social sphere and everyday life. Lockdown and the associated transition to remote work and study, internet shopping and contact-free delivery of purchases have stimulated both the demand for new technical solutions and their supply.

Although, in general, a movement towards an innovative economy is the predominant imperative of the Russia's development (Gokhberg, Kuznetsova 2011), the process of mastering technologies is not unified: some individuals are on the edge of their seats waiting for the new gadgets' release, others are stressed when they have to use a messenger or simplest digital terminal for payment.

Actually, innovativeness is becoming a new stratifying feature.

In this context, discussion about characteristics of the middle class is being increasingly built around the topic of innovative consumption associated with the use of new technologies. The income level allows the middle class to be more free in choosing goods and services (Pishnyak et al. 2020), while socio-professional characteristics contribute to accepting the innovator model, resulting in the middle class assuming the image of the development driver including a technological one as well as its positioning as a class prepared for the sixth technological mode (Grinin, Grinin 2015) and «smart economy» (Ansong, Boateng 2019; Negrea et al. 2019; Nepelski 2019). However, this happens mainly at the level of pseudoexpert discourse, which does not emply research data focused on the middle class.

This article covers the topic based on data from a specialized survey of representatives of the Russian middle class «Middle class: willingness to invest in human capital development». The purpose of the study is to analyze both perception of new technologies[1] and openness of the middle class to them as well as to identify differences in behavior of the middle class and public at large in this respect.

1 Within the framework of this paper, the terms «new technologies», «new technical devices», «technological innovations», etc. are used synonymously.

What does an innovation mean and what is the role of the middle class in adoption of innovation?

Innovation as one of the drivers of the economic growth has long been in the focus of scientific attention. Interpretations of this concept vary and subject to changes over time. At first, innovations were considered from the economic standpoint. In early definitions, the emphasis was on breaking the established routine practices, either creating something, or developing a new sales market, a new source of raw materials, etc. (Schumpeter 1982). In general, innovation was associated with the development of production that could facilitate the economic growth through the use of new technologies, inventions and developments. Over time, understanding of the essence of innovation has been expanded with the focus shifting from a pure economic aspect to a social one, since innovations create new consumer properties of goods and, as a result, attractiveness for the end user (Drucker 1992). The focus shifts to the process of creating the best technologies and ultimate benefits for economic gain (Santo 1990). Subsequently, a transition was made to other objects in the context of studying the role of innovation – the media space, management and organizations. A separate area of research has focused on social innovations.

As a result, one may talk of multidisciplinary of innovation studies that go beyond individual industries, countries and scientific approaches. In general, studies on development and dissemination of technologies and innovations currently follow two major directions – innovation studies and science and technology studies. The former focus on systems of production and diffusion of innovations, impact of social structure on innovation activity, while the latter study the mere processes of knowledge development, artifacts and their transfer (Zemnukhova 2018).

One of the key papers on early directions of innovation studies that is worthy of attention within the framework of this study is Rogers' work on diffusion of innovations (Rogers 2003). According to this paper, diffusion of innovations is a process that unfolds over time and uses certain communication channels among different elements of the social system. Due to the fact that time is measured both at the individual and social level, it is assumed that the period for adopting innovations by an individual and the system as a whole may not coincide. Since it takes users a different amount of time to accept an innovation, a classification by time required for a relative adoption of innovation has been introduced.

Innovation itself is defined as an idea, practice, or an object that is perceived by an individual or an element of the system as something new. The paper is primarily focused on technological innovations. The main characteristics of innovation, in the form they are perceived by end users, determine the level of innovation acceptance. Major attributes of innovations that contribute to their diffusion: 1) relative advantage over the previous form (here we are talking not only about cost-effectiveness, but also subjectively perceived prestige of possession and ease of use); 2) compatibility, which implies linkage with past experience, needs and values of the end user; 3) complexity, related to understanding and adopting the technology; 4) triability, trial use; 5) observability by those who neither have adopted the innovation nor have access to it.

Based on empirical data, Rogers (2003) has proposed a classification dividing the society into the following five groups[1]. Among the first to adopt innovations are the most educated,

1 Rogers refers to five groups: innovators (the first 2.5% to adopt the innovation); early adopters (13.5%) and early majority (34% – accepting the innovation only after it has been adopted by others due to unwillingness to take risks); late majority (34%) and laggards (16% – the very last to adopt the innovation) (Rogers, 2003).

most affluent or those with access to vertical social mobility, this group is characterized by rationality and a predisposition to abstract thinking. According to the author, it takes 50% of the population adopting the innovation to make a new product or technology a success.

It should be noted here that the social structure and networks greatly influence the sources of innovation and the process of diffusion of innovations (Granovetter 2005; Rogers 2003). A number of academic sources consider the middle class as one of the most promising social groups in the social structure capable of bringing new things to the broad strata of society. It is believed that value attitudes of this group correspond to attitudes of the modern society, including nonconformism, initiative, independence, rationality, etc., and the Russian middle class is no exception (Mareeva 2015). In the process of diffusion of innovations, the elites are the first to adopt, then at the stage of cost reduction innovations become the middle class' domain, and only after that they become wildly used (Radaev 2003). The middle class is a kind of a mediator, its representatives, as a broader and more open group than the elites, are put forward for the role of an innovative subject, an actor of modernization transformations, meaning that its representatives are likely to bemore receptive to innovations

The Russian academic publications also analyze predisposition of the middle class to innovative practices (Radaev 2003; Golovlyanitsina 2009).

Innovative practices are defined as such actions of an individual that are not widespread at a certain point in time, but have been already accepted in certain circles. Yet they are new ways of acting – until recently they did not exist at all. Innovative practices can be as follows: ability to make decisions and bear responsibility, readiness for creative activity and non-routine work, which makes an individual to independently set specific tasks and find ways to solve them bypassing the execution of the prescribed procedures (Golovlyanitsina 2009). Representatives of the Russian middle class use many innovative practices in various everyday areas including starting own business, generating savings, organizing leisure and recreation, using paid services, including those related to investments in human capital. Representatives of the middle class are distinguished by innovative job search practices (Radaev 2003), and also tend to choose innovative jobs and, in general, demonstrate commitment to innovative labour values (Golovlyanitsina 2009).

Given the role assigned to the middle class, it is important to present not only innovativeness of its practices in the context of employment and consumption, but also openness to innovation in general, as well as the ability to be a mediator for further diffusion of innovations to common people, especially during crisis periods.

Research methodology

Technology acceptance model

An integral part of this paper is testing the technology acceptance model (hereinafter referred to as TAM). This model, first published in 1989, showed how perception of IT technologies affects willingness of the end user to use them in their work. It was assumed that the way an individual perceives information systems (within the scope of this paper, we are talking about the use of computers in the workplace) further influences the adoption, and hence the actual use of these systems. Perception of an information system and intention to use it is determined by perceived usefulness and perceived ease of use. Perceived usefulness is the degree of confidence that the innovation can improve individual's performance, while perceived ease of use is the degree of confidence that adopting or using the innovation does

not require any effort on the part of the individual. As a result, it is assumed that these two factors explain differences in adopting and using new technologies (Davis 1989).

Subsequently, TAM has been repeatedly tested and over time the scope of its application has been expanded: adoption and use of information technologies in education, banking and financial services, etc., became a focus of research. Implementation of the model for assessing the use of digital services in the financial sector and e-commerce has raised the issue of trust in new technologies, since such services touch on the topics of risk and uncertainty. In this regard, a number of researchers have started to include trust factor in the TAM model that affects the user's intention to use a new technology (Gefen et al. 2003).

Expansion of the scope of TAM application has also attracted attention to the social aspects of the use of innovations. One of the papers proposed a version of TAM with a social influence variable included. It was argued that the intention to use a new development or technology is mediated, among other things, by social pressure implemented through subjective norms. It was assumed that behaviour of an individual is often largely based on expectations of the immediate environment: opinion of others can dictate certain actions to a person. The work has identified impact of subjective norms on people's intention to use a new technology (Venkatesh, Davis 2000). Thus, variations of this model make it possible to evaluate perception of some major characteristics of innovations, indicated in Rogers' work.

One of the latest variations of the model is the Unified Theory of Acceptance and Use of Technology (UTAUT), suggesting that the user behaviour is influenced by self-assessment of performance (through perceived usefulness), possible efforts (through ease of use), social influence and working conditions (Venkatesh et al. 2003).

In the context of the middle class, recognizing its heterogeneity, openness to innovation and attitudes towards technical innovations are another stratifying feature. Therefore, the paper is structured as follows: 1) assessment of openness to innovation (through index construction); 2) assessment of innovation perception (by identifying factors of perception of new technologies); 3) study of openness to innovation and perception of innovation in different socio-demographic groups of the middle class (including the core and those outside); 4) testing of the relationship between openness to innovation and perception of new technologies.

Information base and index construction

The study is based on data from a specialized survey of the middle class in Russia «Middle class: willingness to invest in human capital development» (2018)[1]. This unique survey, focused on characteristics of life, preferences and attitudes of representatives of this stratum of the Russian society, was carried out on the basis of mixed searching and survey techniques: some information was gathered during face-to-face interviews, while the other – online. Since the total number of the respondents is rather big – 2,715 respondents (1,346 interviews and 1,369 online questionnaires), we are privileged to analyze individual subgroups of the middle class[2].

1 Conducted by GfK-Rus company by order of the National Research University Higher School of Economics in 2018 using the tools developed by the authors.

2 This study is based on a multi-stage stratified zoned (cluster) representative sample, which enables projecting the study results to the target group of the adult population of Russia aged 18 years and older, meeting the specified selection criteria: higher education; income above average; status of a manager of any level, entrepreneur, self-employed, specialist with higher education, highly qualified worker and employee with higher education (at least two criteria out of three). The sampling error does not exceed 1% with a confidence interval of 0.95.

Methodologically, this paper defines the middle class according to the three-criteria principle, taking into consideration education, socio-professional status and well-being assessment. In fact, all the survey respondents can be attributed to the generalized middle class. Since the middle class is heterogeneous, within the framework of the study, we additionally focus on the core of the middle class, including those self-identified as the middle class. This approach is borrowed from the «Middle Classes in Russia» (Avraamova et al. 2000) study.

It should also be noted that the estimates of the middle class in Russia vary depending on the accepted assessment methodology. Within the framework of multi-criteria approaches, these estimates are fixed within 28-36% for the generalized or aggregate middle class and 6-11% for the core. (Mareeva 2021; Pishnyak 2020, Tikhonova 2020). In this paper, 43% of the respondents belong to the core, however this so overestimated at first glance indicator is associated with the specifics of the survey per se, which included representatives of the generalized middle class only.

The methodology is also based on the authors' previous study on evaluation of openness to innovation among the entire population (Pishnyak, Khalina 2021), which also enables comparing the middle class with the entire population.

The survey questionnaire included a block of questions about introducing new technologies and innovations in various areas of life, and a set of questions to develop and test the technology acceptance model (TAM), which makes it possible to identify attitudes of the middle class in relation to new technological devices.

1) the *index method* is used to analyze openness to innovation. This tool has been developed on the basis of works related to the assessment of level and quality of life of the population (Hallerod 1994; Decancq, Lugo 2013), however it is quite applicable to serve purposes of this study.

A multi–domain indicator – a comprehensive assessment of openness to innovation – is determined for each respondent in accordance with formulas 1 and 2.

$$I_n = \frac{\sum a_i x_i}{\sum a_i} \times 100 \quad (1)$$

I_n is the component of the index of innovativeness (index by domain), x_i – components of the domain (they take the value «1» if the individual is characterized by innovativeness, and «0» if innovativeness is not characteristic of the individual), a_i is the weight of the constituent part of the domain (the share of individuals who are not characterized by innovativeness), i is the number of constituent parts of the component (domain).

$$I = \sum b_n I_n \quad (2)$$

I is the index of innovativeness, I_n – components of the index of innovativeness (indexes by domains), b_n is the weight of the component (domain) calculated based on the one–factor analysis, and n is the number of components (domains).

2) Analysis of attitudes towards innovation is carried out on the basis of *identification of factors* of perception of new technologies according to the methodology of the Davis Technology Acceptance Model (TAM) and is based on a specialized questionnaire block of 17 judgments (factor analysis by the method of principal components).

3) To analyze the relationship between openness to innovation and attitudes towards new technologies, the method of *linear regression model* is used. The index (reduced

to a dichotomous form) acts as a dependent variable. Along with socio-economic and demographic characteristics, independent variables include the identified factors of perception of technologies in the form of variables reflecting the level of manifestation of certain factors in the middle class.

The study also uses data of the «Public pperception of socio-economic changes in modern Russia» (VNSEI – 2017) survey[1] to compare attitudes towards innovation among the middle class and public at large.

How to identify openness to innovation?

To analyze openness of the population (including representatives of the middle class) to innovation, it is necessary to keep the following three focuses of attention:

1. analyze attitudes towards new technological solutions and devices;
2. analyze acceptance of new technological solutions and devices;
3. pay attention to the experience of using new technological solutions and devices.

The survey data of the middle-class representatives provide an opportunity to consider the respondents' attitude towards introduction of innovations in education, medicine, transport, construction, agriculture, production of goods, household services and trade. In the context of innovation acceptance, one can analyze attractiveness of innovative options of various products and services (from clothing and footwear to smartphone applications) to each individual respondent. Finally, the use of innovations will be tested on the basis of questions related to the experience of receiving different services via the Internet (for example, educational and legal services or medical consultations).

It is these three aspects that determine design of the innovation openness index –we compose an individual index domain for each (according to formula 1). Combination of these domains (according to formula 2) gives a final assessment of an individual's openness to innovation or a personal index value. Let's sequentially consider which variables serve basis for each domain.

Attitude towards innovation

A specialized block of research questions aimed at evaluating innovations in software products, technological devices, techniques, etc. used in various fields helps to analyze attitudes of the middle-class representatives towards innovation (Figure 1). It is assumed that the respondents can rate their attitude towards introduction of such new solutions on a five-point scale (from «completely negative» to «completely positive»).

As the survey data demonstrate, in general, representatives of the middle class give an upbeat assessment of innovations in all these areas – the average score on a five-point scale varies within 4.2-4.4 across different items. Innovations in medicine are more welcomed – about 86% of the respondents indicate that they have a positive attitude towards innovations in this area.

Innovations in education give rise to much concern, however, even in this case, the number of those with a negative attitude towards the use of new technologies (software, new

1 An all-Russia representative study, including a survey of 5087 respondents using a mixed technology method (face-to-face interviews in combination with online survey), conducted by GfK-Rus by order of the National Research University Higher School of Economics in 2017 using the tools developed by the authors.

devices, scientific research results, etc.) is insignificant adding up to less than 10% of the Russian middle class representatives.

It is interesting to compare results of the survey of the middle class representatives and attitudes towards innovations among public at large[1]. Such a comparison has a number of limitations, including those related to the periods of data collection, so we will consider this plot only as an additional one to assist in developing assumptions for future research.

In the middle class, there is a higher share of those who are completely positive about introduction of innovations in all eight areas under study (from education to trade). Yet, the most significant gap in the corresponding indicators for the middle class and the entire population of Russia is registered in transport innovation assessment, while the most consistent results are documented in regard to innovations in agriculture (Figure 1).

In general, this is consistent with the concept of the middle class as a more technology-oriented layer of society.

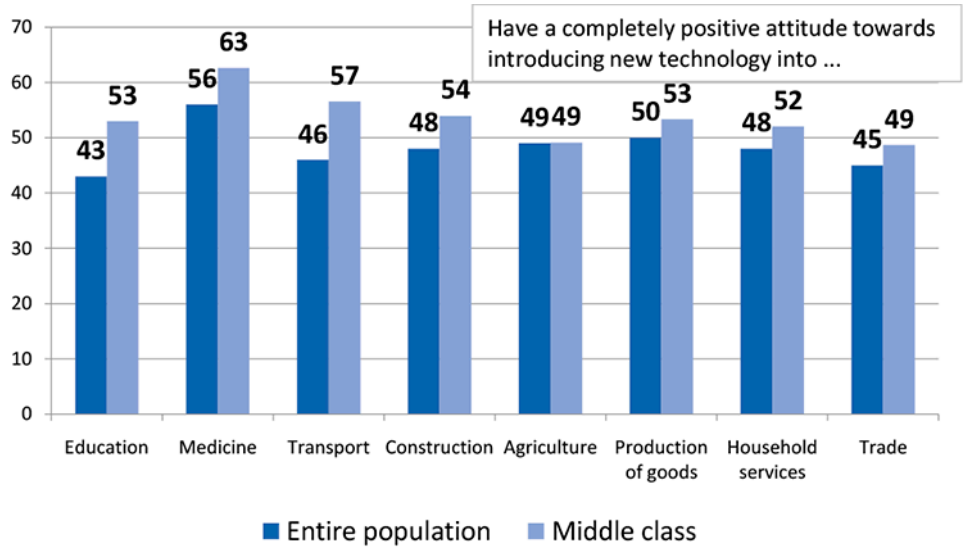

Figure 1. Attitudes of the Russian middle class representatives and public at large towards introduction of innovations into …, %. *Sources*: 1) «Middle class: Willingness to invest in human capital development» survey (2018); 2) «Public perception of socio-economic changes in modern Russia» (2017).

Before combining all the listed items into one domain of the innovation openness index, we have undertaken assessment of internal consistency of responses based on reliability of the scale analysis according to the Cronbach's Alpha model[2]. After this step, it is necessary to determine the weight each component will have in the index domain. For this purpose, we use the weighing method of neutral-negative responses. In other

1 To serve this purpose, we use data of the «Public perception of socio-economic changes in modern Russia» survey (VNSEI – 2017) – an all-Russian representative study, including a survey of 5087 respondents by the method of mixed technologies (face-to-face interviews in combination with an online survey).

2 The Cronbach's Alpha test method is a test of correlation between ranks of each component (variable) from the group and the sum of ranks of other components (variables) of the tested group. The final «Alpha» indicator with simultaneous consideration of eight items of the domain equals to 0.939, while the indicator for each variable ranges from 0.927 to 0.935.

words, we determine significance of a positive attitude towards innovations in a certain area based on assessment of the share of the respondents who are completely negative, more of negative or neutral about introduction of innovations into this area. The highest weight will be given to the components reflecting a positive attitude towards innovations in the area where innovations are least welcomed (for example, the maximum weight has a positive attitude towards innovations in agriculture, since, characterizing their attitude towards innovations in this area, the respondents more often chose the option «completely negative», «more of negative» or «neutral» compared to assessment of innovations in other areas).

Acceptance of innovations

The survey questions related to attractiveness of innovative options of goods and services help to analyze acceptance of new technical solutions and devices by representatives of the middle class. In this context, the survey focused on the following seven different types of goods – Figure 2.

The middle-class representatives showed the greatest personal interest in technical innovations related to household appliances and electronics – more than 68% of the respondents find such innovations attractive.

This result may seem quite expected, since sellers of household appliances and electronics have long been exploiting innovation as an attractive characteristic in advertising goods and thereby have formed a concept of the latest developments as one of the greatest advantages that such products can have.

However, acquisition of the latest technological device often requires developing skills to use it, which, according to expert data, can put breaks on the decision to buy an innovative product. We reserve this remark here, because we are going to address perception of ease of use of new products in sections devoted to attitudes towards innovation.

New developments in the field of medical procedures and operations, medicines and medications turned out to be attractive to the respondents as well. Over half of the middle class representatives show a personal interest in innovative solutions in these areas.

On the contrary, clothing and footwear made of innovative materials, as well as food products produced using the latest developments and discoveries turned out to be the least attractive to the respondents. According to the data obtained, the former arises personal interest among 30% of the middle class respondents, while the latter attracts less than a quarter of the respondents.

Let us again turn to the comparison of the survey results of the middle-class representatives and public at large. In this context, such a comparison is even more interesting, because according to the above-presented data, it is difficult to determine how advanced the middle class is in accepting new technical solutions.

There are rather unexpected results out here. If we are talking about attitudes towards innovation, the middle class shows a much greater support for introducing new technologies into medicine, transport, and production of goods, etc., compared to the remaining population. However, when discussion turns to attractiveness of such products and services for personal use, the middle class representatives show certain concern: both the latest solutions in medical procedures and operations, and advanced technologies in food production and even clothing are less accepted by the middle class compared to the remaining population.

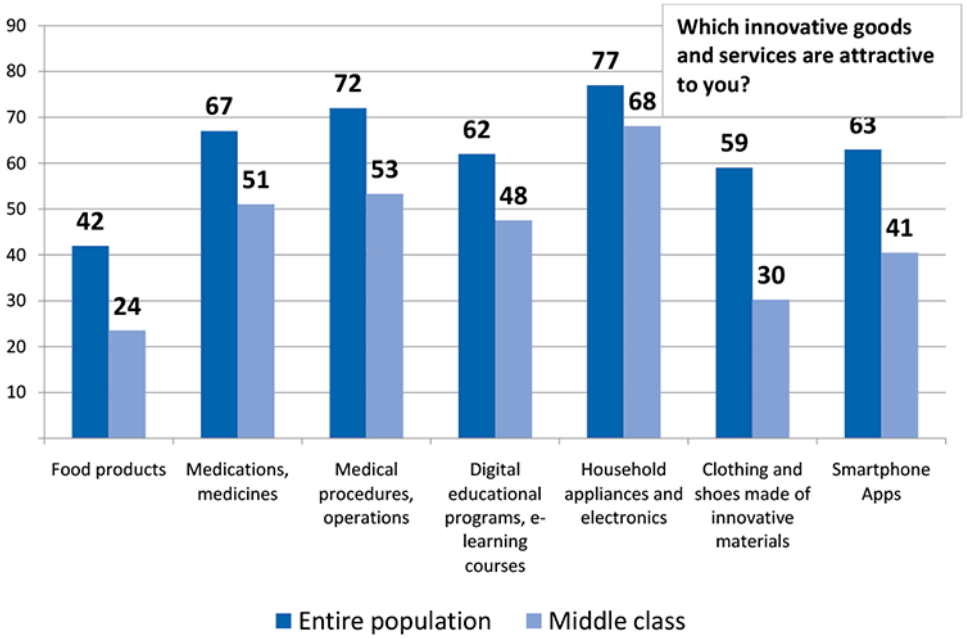

Figure 2. Attractiveness of innovative options of goods and services to representatives of the Russian middle class and public at large, %. *Sources*: 1) «Middle class: Willingness to invest in human capital development» survey (2018); 2) «Public perception of socio-economic changes in modern Russia» (2017).

It can be assumed that public at large view these options of goods and services as something desirable, yet hardly affordable, while the middle class is facing a real consumer choice and, therefore, is more cautious in judgments.

Before combining information on individual components into a single innovation acceptance domain, we again turn to consistency testing using the Cronbach's Alpha model. In this case, the value of the indicator for combining seven items equals to 0.640, while removing any of the items does not allow to increase consistency of the domain components[1]. The weight of each component in this domain is determined by the share of the respondents who don't' find innovative options of certain goods and services attractive (this decision is accounted for by dichotomous-type variables included in the block under study).

Use of innovation

The domain of innovation use is also based on dichotomous-type variables within the framework of constructing the innovation openness index. In this case, we turn to experience of the middle class representatives in obtaining a number of services via the Internet. The types of services we are interested in are usually offered in the form of a personal, indirect appeal to a specialist. However, the latest communication technologies make it possible to receive a service in a different form, which can save time, reduce cost of treatment, allow consulting with a specialist located at a considerable distance, etc. Moreover, the coronavirus

1 The value of the Cronbach «Alpha» if the component is excluded ranges from 0.578 to 0.640.

pandemic has increased the need for remote access to services, leaving a certain part of the population with no choice. In the context of innovativeness, it was important to take into account the experience of applying for services as an indicator of openness to innovation in general. Subsequently, this may not lead to switching to online consultations with specialists, but the mare fact indicates a predisposition to try something new.

The survey data document experience of using the Internet to receive various services (Figure 3).

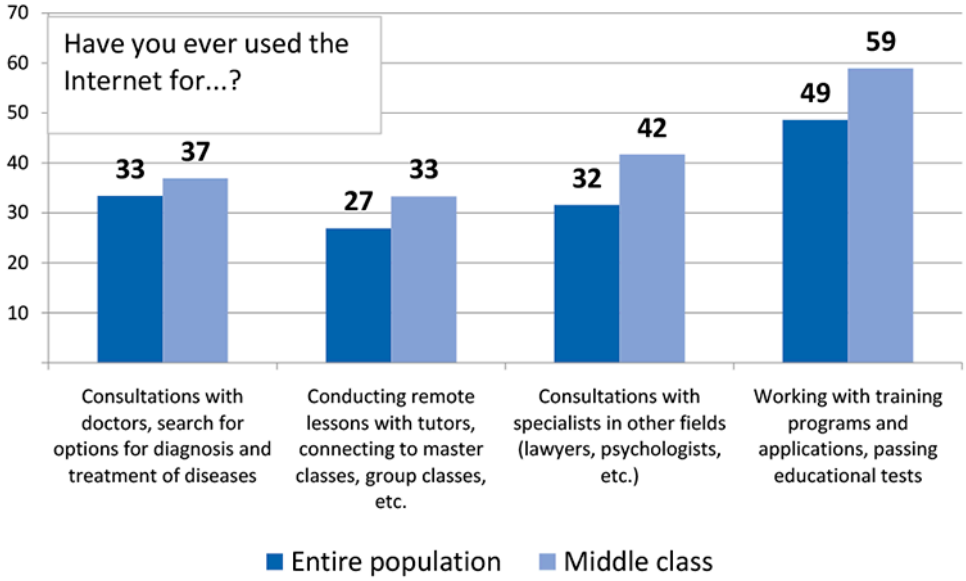

Figure 3. Experience of the Russian middle class representatives and public at large in using the Internet, %. *Sources*: 1) «Middle class: Willingness to invest in human capital development» survey (2018); 2) «Public perception of socio-economic changes in modern Russia» (2017).

Of the listed options, the most common is the experience of using the Internet to work with training programs and applications, passing educational tests, etc. – almost 60% of the middle class representatives claim doing so. Less than half of the respondents mention other types of online consultations. Moreover, those who have experience of distant classes, master classes, etc. are least numerous accounting for only a third of the respondents.

How prevalent this kind of experience is among the middle class and public at large? In this context, the middle class is significantly ahead of representatives of other strata, as indirectly evidenced by Figure 3.

When referring to data on the entire Russian population, it should be noted here that less than half of the Russians have experience of online consultations in respect to each type of services. The most common is the use of training programs, applications, tests – almost 49% of the respondents say that they have such experience. However, this is almost 1.2 times less than among the middle class.

The smallest gap between the middle class and public at large is registered in the share of those who consulted doctors online, as well as the share of those who searched the Web for options for the diagnosis and treatment of diseases (37% versus 33%, respectively). However, the

difference here is vanished due to the fact that turning to online reference books, instructions for the use of medicines, etc. may be considered as search for diagnostic and treatment options.

The most significant difference – 1.3 times – is found in experience of online consultations with specialists in other fields (lawyers, psychologists, etc.). However, in this case, it is necessary to mention the lack of information about differentiation of the demand for such consultations among different segments of the population – this plot remains outside the scope of this study. It should be taken into account that this kind of differentiation may also be due to the fact that the middle class has the opportunity to purchase paid services.

Returning to the composition of the innovation use domain in relation to constructing the innovation openness index, we present results of the component consistency testing according to the Cronbach's Alpha model. For four items, the indicator equals to 0.607, and if any of them are excluded from the index, the indicator becomes only smaller[1], suggesting a possibility of combining the listed components into one domain. The weights of the components, like for the previous domain, are set here according to the principle of prevalence of alternative response options, i.e. by the share of the middle class representatives without any experience in obtaining relevant types of services via the Internet.

Total index of openness to innovation

At the stage of compiling an index with three domains, testing components for consistency is not necessary, since the attitude, acceptance and use of innovations are heterogeneous phenomena, and the degree of manifestation of one component at the individual level does not necessarily imply manifestation of the other two.

Nevertheless, this does not cancel the task of determining weights, that will be used to combine domains into one indicator. To meet this purpose, a method of selecting coefficients based on a one-factor model is used (such a solution is substantiated by, for example, (Jacobs et al. 2004; Popova, Pishniak 2017)).

The use of the maximum likelihood factor model gives reason to believe that the most significant contribution to the index should be made by the innovation acceptance domain, while the weight of the innovation attitude domain should be lower than the weight of the innovation use domain – Figure 4.

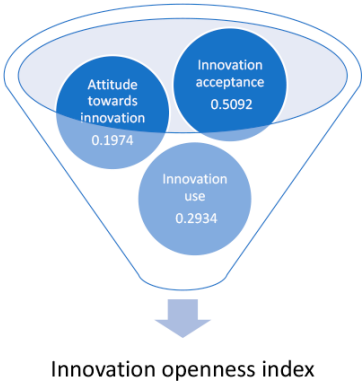

Figure 4. Domain weights (factor load) as part of the innovation openness index

1 The value of the Cronbach «Alpha» if the component is excluded ranges from 0.578 to 0.640.

The innovation openness index is formed in such a way that its value minimum equals to 0, while its value maximum adds up to 100. The actual distribution of the index values is close to normal with the mean equaling to 45.9.

However, these characteristics are not actually of any interest per se. It is important to analyze differentiation of the index values for individual subgroups of the middle class. This is the greatest value added in using this tool, and will be presented after description of the process of identifying attitudes of the middle class towards innovations.

How does the middle class perceive new technological devices?

In order to evaluate attitudes of the middle class representatives towards new technological devices, a set of affirmations consisting of 17 statements was used. The classic list of statements reflecting perceived ease of use and perceived usefulness has been expanded with statements characterizing perception of reliability and safety of new technologies, as well as statements characterizing perception of social aspects related to the use of new technologies.

First, let's turn to the distribution of responses to all 17 statements. Almost all statements are evaluated as more of positive – the share of those who agree on almost all items equals to 50% and over, while the average scores on a scale from 1 to 5 are over 3.48. The statement «*New technological devices are needed for well-off people only*» stands out against the general background[1] – here the majority (58%) did not agree with this statement, however, this statement has a rather negative connotation, therefore, such distribution of the responses looks only logical against the general background. The most approved statements included «*New technological devices open up new opportunities for people*» (84% agreed with the statement) and «*New technological devices help to faster cope with tasks*» (83% agreed). In general, it can be noted that statements in the group of perceived usefulness and social attitudes enjoy higher acceptance. A little more «questionable» for the respondents are statements about reliability and safety of technological devices related to trust in new technologies. 50% of the middle class representatives agreed with the fact that «*the use of new technological devices is safe*», another 27% are neutral about it, and 55% of the respondents agree that «*the problem of safety of new technological devices does not bother me enough to reject them*», however, 18% do not agree with this statement, which means they can potentially stop using technical innovations if they consider their safety and reliability questionable[2].

We assumed that the proposed statements describe four attitudes regarding the use of new technological devices. Factor analysis showed that they can be defined as follows (Table 1)[3].

We will specially focus on the obtained results in relation to perceived usefulness of new technological devices. In this factor, four basic statements describing perceived usefulness in accordance with the technology acceptance model were supplemented with statements capturing the social component of the innovation use. However, scale reliability test shows

1 The only statement with the average score less than 3 (2.48).

2 For a full list of statements, see Table 1.

3 Factor analysis was carried out by the method of principal components. The number of factors is set in accordance with the study main hypotheses. In aggregate, the factors obtained explain 74% of the variance. According to «Measure of sampling adequacy and the Bartlett's test» table, it is determined that the Kaiser-Meyer-Olkin measure of sampling adequacy is 0.960, indicating a presence of dense clusters of correlated variables. The factor components include statements with factor loading values over 0.5. These values are indicated in parentheses after the statement.

Table 1. Factors characterizing attitudes towards the use of new technology

Perceived usefulness	New technological devices open up new opportunities for people (0.822)
	New technological devices help to faster cope with tasks (0.784)
	New technological devices make our life easier (0.714)
	New technological devices are used by modern, advanced people who move with the times (0.713)
	I believe that, in general, new technological devices benefit society and a human being (0.652)
	New technological devices are used by people like me (0.632)
	It is prestigious to use new technological devices (0.625)
	New technological devices help me to better control my life. (0,567)
Perceived reliability and safety	The use of new technological devices is safe (0.754)
	In general, I trust manufacturers of new technological devices (0.751)
	Basically, new technological devices are reliable (0.747)
	The problem of safety of new technological devices does not bother me enough to reject them (0.664)
Perceived ease	I think it's easy to master new functions of modern technological devices (0.831)
	It's easy for me to become an advanced user of new technological devices (0.795)
	New technological devices are usually easy to use (0.771)
	In general, it is easy for me to learn how to use new technological devices that appear in our lives (0.708)
Perceived elitism	New technological devices are needed for well-off people only (0.960)

that there are no grounds for excluding these statements from the obtained factor[1]. This result makes it possible to conclude that assessment of usefulness by the middle class is by large socially constructed. Usefulness of innovations and technological devices is defined by the opportunities those innovations open up to the user, social characteristics (prestige, modernity, advancement) of the new technologies, and whether technological devices act as an identification tool for affiliation with a certain social circle.

Is the middle class homogeneous in terms of innovativeness and attitudes towards new technical solutions?

As noted above, we adhere to a three–criteria approach to define the middle class and distinguish a special group within the generalized middle class – the core – that differs by all three identification features (level of well-being, socio-professional status and self-identification as the middle class).

1 Reliability test of the Cronbach's Alpha scales equals to 0.921, which is a good result per se. In each case, testing the Cronbach's Alpha value if any of the individual items is removed gives reason to believe that such combinations do not require any changes.

Taking the middle-class heterogeneity for granted, we will analyze how the core and the rest of the representatives of the generalized middle class differ in terms of openness to innovation, as well as attitudes towards new technological devices.

The analysis results indicate that the representatives of the core and the remaining middle class are not differentiated in terms of their openness to innovation – the index average values in these two subgroups are almost the same. Regarding the domains that make up the index, there are small statistically significant differences out there (Figure 5). Thus, the core of the middle class demonstrates higher indicators in the domain of attitude towards innovation, while the rest are characterized by a little higher index in the domain of the innovation use.

It can be said that the core in general shows a more positive attitude towards innovations, yet less often uses the possibilities of new technologies, perhaps both due to the lack of necessity, and a more rational and skeptical attitude to the opportunities that new technologies provide.

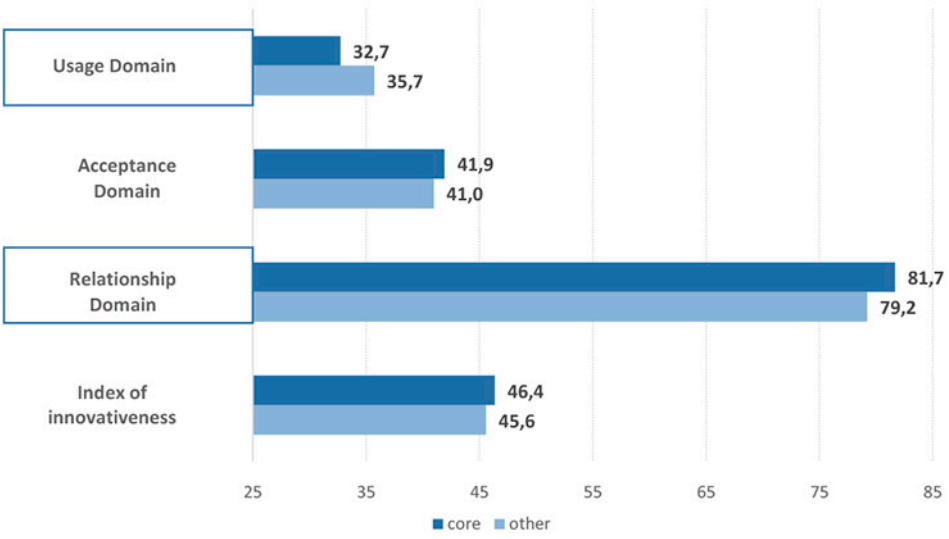

Figure 5. Average values of the innovativeness index and its individual domains for the core and other representatives of the middle class. *Source*: «Middle class: willingness to invest in human capital development» survey (2018). *Note*: Here and in Figure 6, a rectangle highlights domains/factors with statistically significant difference in averages.

While the difference between the core and the rest of the middle class representatives is minimum with regard to openness to innovation, there is a significant difference in terms of attitudes towards new technological devices between the two groups (Figure 6). Despite the fact that both groups are neutral in perceiving usefulness of new technologies, factor loadings among the core representatives are clearly positive in terms of all other selected attitudes, while the other representatives of the middle class are mainly negative. For the core representatives, the new technological devices are easy to use, safe and reliable and, therefore, can be trusted, and they also have a certain characteristic of elitism, the core representatives can associate themselves with. For everyone else, new technologies are rather an everyday thing, necessary for everyone regardless of income, yet not always easy to use, which reliability and safety are questionable.

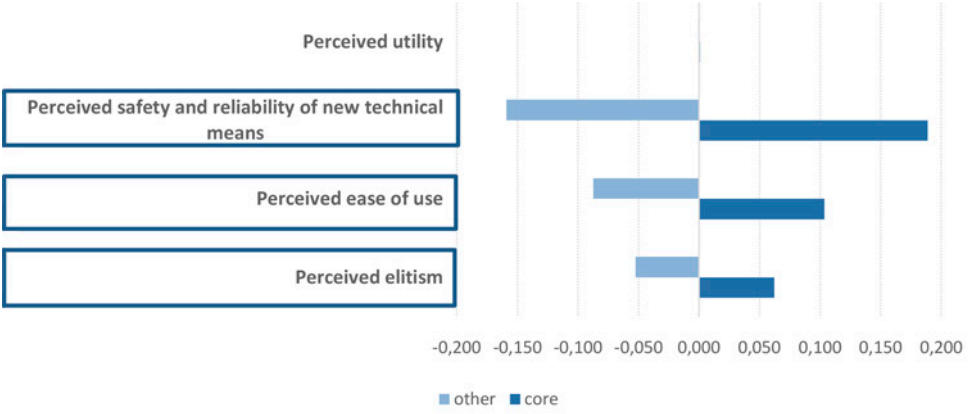

Figure 6. Levels of factor manifestation characterizing attitudes towards the use of new technologies among the core representative and other representatives of the middle class. *Source*: «Middle class: willingness to invest in human capital development» survey (2018). *Note*: Here and in Figure 5, a rectangle highlights domains/factors with statistically significant difference in averages.

What determines openness to innovation?

Concluding the study, we will analyze the relationship between innovation perception and openness to innovation. This task is implemented on the basis of a logistic regression model.

Here we turn again to Rogers' concept of diffusion of innovations. Acceptance of innovation by «innovators», «early adopters» and «early majority» (in total, they make up 50% of society) is a signal to others that the innovation should be used (Rogers 2003). Based on the fact that it is possible to move from the index value distributions to the classification proposed by Rogers, let's define the group of those predisposed to innovation the most by the index value exceeding the median[1] – i.e. 50% of the middle class[2]. Groups of innovators are characterized by a high degree of openness to innovation measured on the basis of the index.

Then the dependent variable takes the value «1» if the index value for the individual exceeds the median value, and «0» if the value is lower.

Figure 7 summarizes results of the regression analysis.

The analysis shows that, those representatives of the middle class who perceive innovations as easy to use and consider them useful can be regarded as more open to innovation. The group of innovators includes younger people, while older people are more often characterized by the index value below the median. Women are more predisposed to innovativeness than men. The larger the household size, the higher the likelihood of innovative behaviour. Finally, the larger the settlement type, the more open to innovation the middle class representatives. And if, in the context of comparing the average values of the index, the core of the middle class representatives turns out to hardly differ from the rest of the middle class in mean index values while the model indicates a lower predisposition to innovativeness among representatives of the core of the middle class.

1 The median value halves the distribution.

2 The assumption is as follows: the middle class group (with higher innovativeness than in general population) include the same groups as the Rogers classification does.

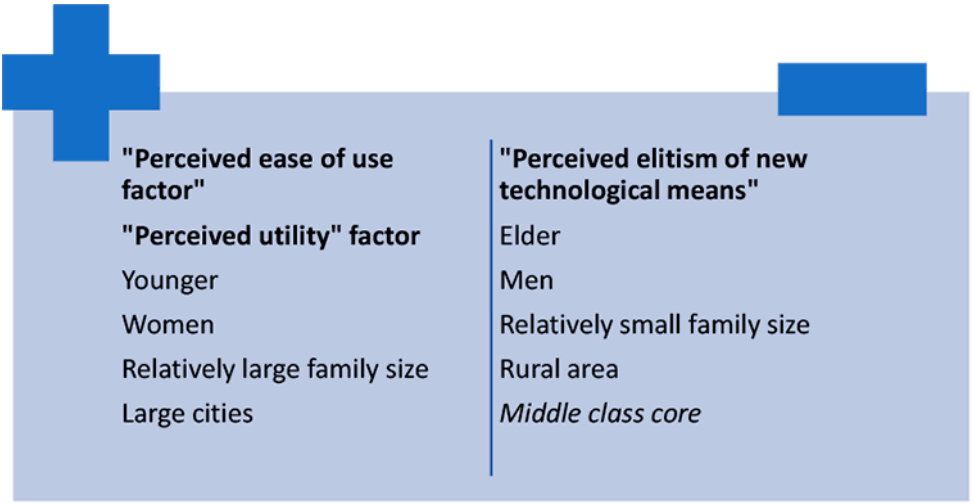

Figure 7. Determinants of high openness to innovation. *Note*: The model used four factors of perception of new technologies as independent variables: age, gender, family size, settlement type and affiliation with the core or the rest of the middle class. The factor of perceived safety and reliability of new technologies turned out to be insignificant. The 2-Log-likelihood ratio equals to 2729,830. Appendix A provides additional characteristics of the model.

Thus, having all characteristics of the middle class: socio-professional status, material security and the corresponding self-identification is not a guarantee of higher openness to innovation than affiliation with the generalized middle class with a different combination of identification features. This may be due to the fact that the core of the middle class has already participated in the race for progress and takes a moderate position, having experience in consuming everything innovative, and the need to master new things to achieve higher professional, educational, income and other statuses, which is more relevant to those who are yet to enter the middle class by any criteria.

Discussion and conclusion

In the world of constantly improving technologies, the leading role in adoption and further dissemination of innovations is often attributed to the middle class, expecting it to act as a driver of socio-economic development and a conductor of novelty into society. Interest in the topic is growing within the framework of achievability analysis of the national goals, with a special focus on digital transformation.

There are scarce empirical data to explore the topic. In these circumstances, «Middle class: willingness to invest in human capital development» survey provides a unique opportunity to analyze innovativeness of the stratum of society we are interested in – to analyze perception of new technologies and openness to them by the middle class.

This article is devoted to solving several problems. Openness to innovation is evaluated through constructing a three-component index (attitude towards innovation, acceptance of innovation and use of innovation). The analysis of perception of innovations was based on identification of attitudes towards new technological devices using a factor model. The

relationship between openness to innovation and factors was further investigated. Thus, attitudes towards innovation, along with other individual characteristics and group socio-economic peculiar features have been analyzed as determinants of openness to innovation.

The middle class demonstrates a positive attitude towards innovation and welcomes introduction of the latest technological developments into various fields (education, medicine, agriculture, production of goods, etc.). Moreover, representatives of this stratum of society turn out to be more advanced in this context than other segments of the population.

There is a somewhat different picture with regard to personal interest in innovative goods and services: although representatives of the middle class note that they are interested in such goods, public at large demonstrates a higher interest. Probably, the difference is due to the fact that public at large views their interest as an abstract one with a low actual availability of innovative goods (at least due to their higher cost compared to alternatives), while the middle class shows a real consumer choice.

The practice of using innovations has been studied within the framework of the paper on the example of accessing different services via the Internet. In this context, the practices are more common among the middle class than public at large in general. The smallest differences are registered in relation to online doctor appointments and searchers for options for the diagnosis and treatment of diseases, while the highest differences relate to the experience of online consultations with specialists in other fields (lawyers, psychologists, etc.).

Using the TAM methodology, the following four attitudes towards new technologies have been identified through a factor analysis: 1) perceived usefulness of new technological devices; 2) perceived safety and reliability of new technologies; 3) perceived ease of use of new technologies; and 4) perceived elitism of new technological devices. The fact that the identified attitude «perceived usefulness of use» differs from the classical one and takes into account a social aspect of using innovations can be considered as a separate result. This attitude can be correlated with the perceived attribute of innovation, considered by Rogers as a relative advantage, which includes not only economically calculated usefulness, but also a subjective assessment of usefulness and prestige of using the innovation.

Respondents differ in various concentrations of characteristics of the middle class, therefore, differences in openness to and attitudes towards innovation among representatives of the middle-class core and others become a separate issue. Thus, the analysis of means shows that the core and the rest of the middle class do not differ in innovativeness, while they do differ in perceiving ease, reliability and safety, as well as elitism of new technologies.

In the long run, the study results show heterogeneity of the middle class in the context of innovation acceptance, which, in the context of a request for identification of social groups that are locomotives of the country's development, gives grounds to use innovativeness as an additional or even independent stratification characteristic. At the same time, one can expect increased inequality in this regard, since not all categories of the population are ready to equally respond to the request for a rapid adoption of new technological solutions (similar to the one during the period of the COVID-19-related restrictive measures).

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Appendix A. Main characteristics of the binary logistic regression model

Table 1A. Summary of the regression model

Step	-2 Log-likelihood	Cox-Snell R-square	Nagelkerke R-square
1	2729.830[a]	0.142	0.189

a. The evaluation was discontinued at iteration number 4, since the parameter estimates changed by less than 0.001.

Table 2A. Regression classification table[a]

			Forecasted		
			The index is above the median		Percentage of correct
			0	1	
Step 1	The index is above the median	0	612	429	58.8
		1	292	888	75.2
	Total percentage				67.5

a. The cutoff value is 0.500.

Table 3A. Regression model statistics

	B	Root-mean-square error	Wald	deg. freed.	Significance	Exp (B)
Factors of perception of new technical devices						
Perceived usefulness of new technical devices	0.463	0.050	84.288	1	0.000	1.589
Perceived safety and reliability of new technical devices	0.021	0.048	0.201	1	0.654	1.022
Perceived ease of use of new technical devices	0.227	0.050	20.838	1	0.000	1.255
Perceived elitisms of new technical devices	-0.405	0.047	73.727	1	0.000	0.667
Age						
Number of full years	-0.025	0.004	34.976	1	0.000	0.975
Gender						
Women (compared to men)	0.318	0.094	11.327	1	0.001	1.374
Family composition						
Number of people in the family	0.142	0.040	12.881	1	0.000	1.153
Place of residence						
Compared with those residing in rural areas						
City of 1 million or more	0.903	0.151	35.898	1.000	0.000	2.468
City of 500 thousand – 999 thousand	0.589	0.189	9.708	1.000	0.002	1.802
City 250 thousand – 499 thousand	0.509	0.190	7.130	1.000	0.008	1.663
City of 100 thousand – 249 thousand	0.468	0.193	5.859	1.000	0.015	1.597
City of less than 100 thousand	0.293	0.168	3.033	1.000	0.082	1.340
Middle-class structure						
Core (compared to the rest)	-0.227	0.095	5.728	1.000	0.017	0.797
Constant	0.108	0.259	0.172	1.000	0.678	1.114

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