Personnel Typologization and Barriers to Innovative Activity in the Course of Introducing Digital Technologies (by the Example of Healthcare Sector)

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Abstract. The research attempts to identify types of personnel depending on the level of their preparedness to innovations and demand for them, as well as behavioral features in the course of digital technologies introduction in medical establishments. The information basis for the research is a representative sample of polling 1004 employees of 17 medical establishments in the Republic of Tatarstan. The analysis was carried out with SPSS Statistics software. The obtained results allow identifying four types of personnel and determining differences in their concepts about their role and position in innovative processes in an organization, their preparedness for the introduction and use of digital technologies, and the stimuli for innovative activity. Also, the authors identified barriers to innovation-oriented behavior of the personnel when introducing and using digital technologies in medical practice. These barriers are technical failures in software functioning, unstable access to the Internet, and the low level of the employees' digital literacy.

Keywords: Structure of the personnel; Personnel; Using digital technologies; Information technology; The efficiency of digitalization; Innovative behavior of employees.

1 Introduction

The vectors of digital healthcare development today are medical information systems and systems supporting doctors' decision-making, including with artificial intelligence. Due to the comprehensive automation of all business processes, the use of modern digital services, etc., the efficiency of medical establishments' functioning increases, as well as the quality and accessibility of medical care and the level of satisfaction of the population.

Proceedings of the 10th International Scientific and Practical Conference named after A. I. Kitov "Information Technologies and Mathematical Methods in Economics and Management (IT&MM-2020)", October 15-16, 2020, Moscow, Russia

However, despite the promising character of digitalization as the global trend of medical sector development, in the Russian economy this process unwinds rather slowly [1], unsystematically, and, which is the worst of all, extremely unevenly across the regions. In particular, according to the data of the Russian Chamber of Accounts, the number of telemedicine services differs by 10 thousand times across the Russian regions [2].

According to the "Future Health Index", an annual research carried out by Philips Company, the main obstacle for development of telemedicine services in Russia is the "human factor" [3]. Many promising projects in the sphere of distant consulting failed due to the doctors' unwillingness to work in a new way. The currently existing platforms provided for doctor-patient communication do not suit both of the parties [4].

Thus, the institutional and legal changes in the organization functioning of medical establishments, introduced by digitalization, determine the importance of the personnel in this process. That is why it is essential to assess the capability and preparedness of the personnel to changes and to permanent mastering of new software products and technologies.At the same time, we reveal the interaction between innovative preparedness of the personnel and the efficiency of digitalization at medical establishments.

The role and significance of personnel in innovative processes in an organization is often researched from the viewpoint of the main structural characteristics. These are creativity, knowledge generation, initiative, learning abilities; this allows interpreting personnel asthe innovative capital [5].

This approach is rather widely spread in economic science. For example, L.K. Shamina identified innovative potential of an organization with its provision with highly-qualified specialists and academic staff.[6]An innovation-oriented employee is the one possessing the following traits: creative approach to work, orientation towards result, participation in team work, initiative in promoting new ideas, open exchange of experience and knowledge, orientation towards training and self-development, etc. [7]

A similar approach is developed by T. M. Amabile and S. J. Kramer, who group the factors of employees' innovative behavior into catalysts and inhibitors [8]. The former promote innovation-oriented conduct: setting distinct goals, autonomy of actions, providing resources, assistance at work, generating ideas, etc. The latter factors impede innovative activity: lack of distinct goals, micromanagement, lack of the necessary resources, isolation, and communication blocks.

Developing this view, A. A. Merkusheva proposed a four-cluster matrix, in which various factors of innovative behavior were united into the following groups: personal catalysts and personal inhibitors, organizational catalysts and organizational inhibitors [9].

The unique combination of individual and organizational components of employees' innovative behavior is used by I. D. Subramaniamto explain their desires and abilities to implement them. The former category includes age, initiative, desire to learn, etc. The latter –organizational structure, motivation system, organization size, etc [10].

The model of employees' innovative behavior by B.W. Amo also contains an opinion that under the influence of certain factors an employee turns to innovation-oriented conduct [11]. Such factors are interaction between an administrator and personnel and personnel characteristics of an employee.

In general, one should note that the various combinations of individual and organizational factors, influencing the innovative activity of the personnel, is the issue widely analyzed in foreign literature [12,13,14,15]. Researchers come to similar conclusions regarding the importance of combining these factors in stimulating innovative activity of the employees. At the same time, the scholar diverge in substantiating what factors have the largest impact on the innovative activity of the employees – individual [16,17,18,19] (in the recent years this factor is often considered from the viewpoint of psychological capital) or organizational [20,21,22,23, 24].

In particular, S.D. Tsai, Ch.-Yu Pan и H.-Q. Chiang characterize employees' innovative behavior through its orientation towards elaboration and implementation of new ideas. It is viewed as a carcass formed by organizational culture or mentality at all administrative-managerial levels [25]. A similar opinion can be found in the works by the Russian economists. In their works, the ability and willingness of employees to participate in the processes of innovative development is associated not only with the creation of learning environment and stimulating, but also with forming a certain mental level [26, 27], as well as social-psychological environment [28].

A close opinion is shared by J. Barshand M. M.Capozzi, for whom a significant factor of innovations in companies is behavioralmodels of interaction between administrators and the personnel, based on initiative and involvement into the processes of organizational development [29]. At that, the managerial accent on incentives system and external control may undermine the natural disposition of a person to find something new, develop and search through overcoming difficulties [30].

Preparedness of the personnel for change is interpreted by the researchers not so much as desire but as action revealed in additional labor effort and expenditures at the working place [31]. M.Al-Hussami, S. Hammad, and F. Alsoleihat analyzed this aspect in accordance to such factors as subjective career success of personnel of healthcare institutions, their loyalty to organization and support of administration. The authors suggest that the greatest preparedness and perceptivity of change are demonstrated by the employees with high levels of their estimation of organizational loyalty, organizational support, and subjective career success. The latter was the strongest predictor of the medical personnel preparedness for implementing the institutional-organizational changes. Other factors included behavior of administration and age of employees.

Thus, most of the foreign researchers come to the conclusions that innovative labor conduct id determined by the inner self-motivation – creative thinking of the employee. Being creative is one of the types of innovative behavior [32]. In a subsequent research, F. Yuan and R. Woodman suggested that through innovative activity employees try to demonstrate their efficiency [33].

Later, economists showed the importance of theinternal environment created in the organization, which promote or impede the generation of innovative ideas by the personnel [34].

2 Materials and Method

The main technique of information collection was questioning. It was carried out from February to May 2019 in the medical establishments of the Ministry of Healthcare of the Republic of Tatarstan. We polled 1004 employees of 17 medical establishments. As of 1 January 2019, the average yearly number of employed doctors and paramedical personnel in the medical establishments of the Ministry of Healthcare of the Republic of Tatarstan was 45966 people [35]. The sample with a minimal probability of statistical error (under confidence probability of 99% and error of 5%) is 656 people. Thus, our sample is representative.

The research was carried out in the form of questioning. The questionnaire contained both close and open questions, and ranking tasks. Questioning was anonymous. The data were integrated into a single massif and analyzed as a single base with STATISTICA 12 and SPSS Statistics software.

3 Results

Women (85.6%) have the largest unit weight in the structure of the polled personnel (Table 1). The categories of doctors (35.4%) and paramedical personnel (51.9%) prevail.

We are interested above all in the success of domestic production of software and hardware. Here is an example of a table with planned results for the main goal of the DE Program - to develop our own production called “Ensured unity, sustainability and security of the information and telecommunications infrastructure of the Russian Federation at all information space levels. It should be noted that, in accordance with the DE Program, the main task of the information and telecommunication infrastructure is access to the Internet.

Table 1. Structure of the personnel.

	n	**%**
Gender		
male	145	14.4
female	859	85.6
Type of work		
Administrative-managerial personnel	28	2.8
Doctors	355	35.4
Paramedical personnel	521	51.9

No answer	100	9.9
Type of innovative behavior		
Type I “Prepared and demanded”	635	63.2
Type II “Prepared and not demanded”	282	28.1
Type III “Not prepared and demanded”	23	2.3
Type IV “Not prepared and not demanded”	47	0.05
Not defined	17	1.7
Total	1004	100

Based on the combination of two classification indicators (willingness to participate in activities aimed at improving the efficiency of the organization functioning and capability to make proposals to improve the organization functioning), we extinguished four typological groups of employees, showed in Table1. Employees of type I (63.2%)and type II(28.1%) prevail. These groups are represented differently among different categories of employees (Table 2).

Table 2. Quantitative composition of the typological groups of employees, number of people (% in the row).

	Total	I	II	III	IV
Administrative-managerial personnel	27(100)	19(70.4)	7(25.9)	0(0)	1(3.7)
Doctors	354(100)	246(69.5)	83 (23.4)	13(3.7)	12(3.4)
Paramedical personnel	511(100)	301(58.9)	171(33.5)	7(1.4)	32(6.3)
Total	892	566	261	20	45

The difference in the number of personnel in Tables 1 and 2 (12 people) is due to the people not giving answers to the questions. Most of the personnel of medical establishments belong to type I. this is true not only for doctors and paramedical staff, but also the administrators and managers. From 25 to 33%, depending on the category, belong to type II.

4 Discussion

At the next stage of the research, we identified the differences in conceptions of the separate groups of personnel about their place and role in innovative processes in the organization (Table 3).

Table 3. Self-conception of the personnel in the innovative processes within the medical establishment*, number of people (% in the row).

	Total	I	II	III	IV
Administrative-managerial personnel	27(100)	18(66.7)	4(14.8)	0(0)	1(3.7)
Doctors	354 (100)	193(54.5)	53(14.9)	1(0.3)	3(0.8)
Paramedical personnel	511(100)	272(53.2)	106(20.7)	2(0.4)	7(1.4)
Total	892	566	261	20	45

* Do you have a distinct conception about your place and role in the innovative processes in your organization? (question v7)

Not all employees who are ready to take part in introducing innovations understand their role and functions in their implementation. This is true for all categories of personnel.

The processes of digitalization in healthcare system are also ambiguously perceived by various categories of personnel (Table 4).

Table 4. Preparedness of the personnel to introduce and use digital technologies**, number of people (% in the row).

	Total	I	II	III	IV
Administrative-managerial personnel	27(100)	14(51.8)	7(25.9)	0(0)	0(0)
Doctors	354(100)	214(60.5)	78(22.0)	6(1.7)	2(0.6)
Paramedical personnel	511(100)	288(56.4)	156(30.5)	4(0.8)	12(2.3)

** Assess your personal preparedness to introduce and use digital technologies (question v6)

Administrative-managerial personnel of type I demonstrate lower preparedness to take part in introducing digital technologies (51.8%) than in introducing innovations (66.7%). On the contrary, personnel of type II are more apt to introduce digital technologies (25.9%) than innovations in general (14.8%). However, doctors and paramedical personnel of all types expressed their willingness to introduce digital technologies.

Let us consider the preparedness for introducing and using digital technologies of the personnel of various age groups (Table 5).

Table 5. Preparedness of the personnel to introduce and use digital technologies (age) ***, number of people (% in the row).

Age categories of staff	Total	I		II		III		IV	
		Total	Ready	Total	Ready	Total	Ready	Total	Ready
Up to 30 years	132 (100)	84 (63.6)	77 (91.7)	34 (25.8)	34 (100)	5 (3.8)	3 (60.0)	9 (6.8)	4 (44.4)
31 to 40 years old	240 (100)	160 (66.7)	156 (97.5)	71 (29.6)	68 (95.8)	3 (1.3)	3 (100)	6 (2.5)	2 (33.3)
41 to 50 years old	320 (100)	208 (65.0)	202 (97.1)	92 (28.8)	84 (91.3)	6 (1.9)	2 (33.3)	14 (4.4)	3 (21.4)
51 to 60 years old	220 (100)	137 (62.3)	116 (84.7)	66 (30)	56 (84.8)	4 (1.8)	1 (25.0	13 (5.9)	5 (38.5)
Over 61	48 (100)	33 (68.8)	25 (75.8)	12 (25)	10 (83.3)	2 (4.2)	0 (0)	1 (2.1)	0 (0)

*** Assess your personal preparedness to introduce and use digital technologies (question v6)

First of all, we accessed the distribution of the personnel by the types in age aspect. There were no significant differences in distribution by types between various age groups. Thus, from 62.3 to 68.8% of the employees of each age group refer to type I, from 25 to 30% – to type II. That is, innovative activity of the personnel is not related to age.

In the aspect of each type, we determined the share of employees who expressed preparedness for introducing and using digital technologies. Analysis showed the following features. In employees of both type I and II, the desire to implement digital technologies in professional activity steadily reduces with age. Personnel of type III aged under 40 y.o. demonstrates a rather high level of readiness, but after 41 y.o. almost all employees reject digitalization processes. The low value of this indicator is also seen in all employees of type IV of innovative activity (from 0 to 44.4 in various age groups).

Thus, there is a reverse dependence between the age of the personnel and their readiness to introduce and use digital technologies and solutions in professional activity.

It is essential to understand the stimuli of using digital technologies for the personnel (Fig. 1). The need for personal professional growth, the objective necessity to know, to use digital technologies when rendering medical services are the main stimuli for the majority of the personnel.

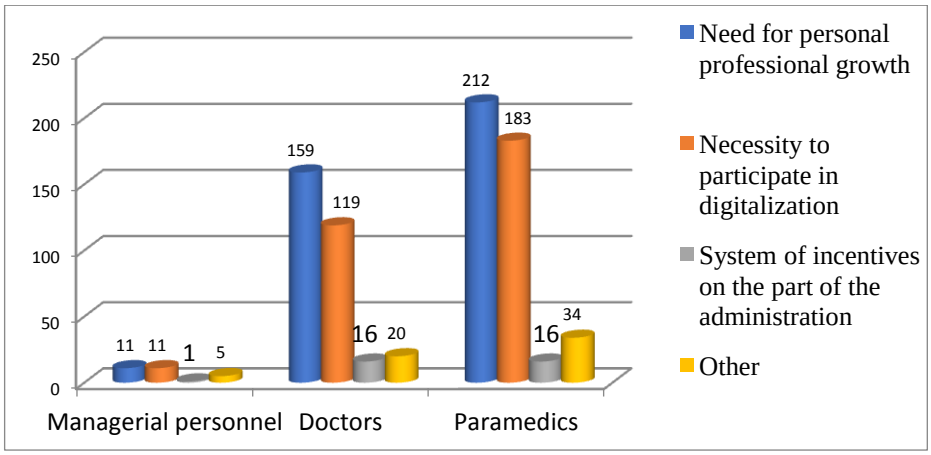

Fig. 1. Stimuli for using digital technologies by various categories of personnel

When introducing and using digital technologies, the employees of medical institutions face certain problems, both depending and not depending on themselves (Fig. 2).

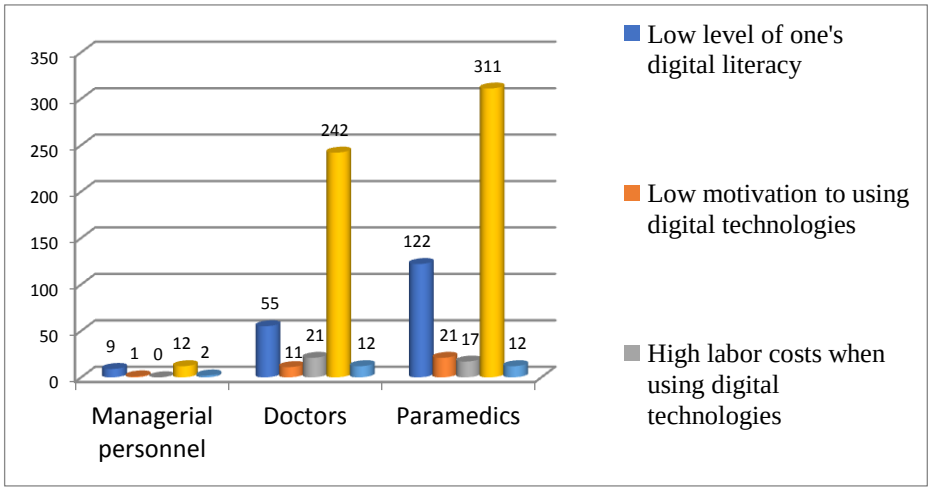

Fig. 2. Problems in introducing and using digital technologies by the personnel of medical institutions

The desire of personal professional growth, the objective need to know and use digital technologies when rendering medical services are the main stimuli for most of the personnel.

When introducing and using the digital technologies, the personnel of medical establishments face certain problems, both depending and not depending on them.

The data show the presence of problems with the stable, fail-free functioning of software and access to the Internet. Another important factor is the employee's own

level of digital literacy. Such structure of the answers is characteristic both for the administrative-managerial and paramedical personnel, and for the doctors.

At the next stage of analysis, we built regression linear models (Table 6).

Table 6. Regression analysis of the efficiency of digitalization of a medical establishment.***

	B	SE	β	t	Tolerance
Model–personnel of type I (n=635)					
Constant	7.488	5.383		1.391	0.165
Is the level of applied modern digital and innovative technologies higher in the private medicine than in the state one? v47	0.239	0.036	0.258	6.551	0.000
Does the level of medical instrumental examinations in your organization comply with the requirements of today? v35	0.253	0.041	0.231	6.133	0.000
Is the population ready for the introduced digital technologies in healthcare (digital medical records, online registering, telemedicine)? v42	0.210	0.038	0.228	5.582	0.000
R^2=0.331, ΔR^2=0.338, F=104.058, p< 0.001					
Model – personnel of type II (n=282)					
Constant	3.099	4.759		0.651	0.515
Is the population ready for the introduced digital technologies in healthcare (digital medical records, online registering, telemedicine)? v42	0.739	0.045	0.739	16.565	0.000
Is the level of applied modern digital and innovative technologies higher in the private medicine than in the state one? v47	0.153	0.034	0.215	4.499	0.000
is your organization interested in your probation in the leading Russian and foreign clinics? v44	-0.065	0.028	-0.110	-2.280	0.023
R^2=0.659, ΔR^2=0.655, F=178.744, p< 0.001	511(100)	288(56.4)	156(30.5)	4(0.8)	12(2.3)

*** Has implementation of digitalization program in healthcare increase the quality of medical services in your organization? (question v34)

The model quality is determined by a p-value. In the constructed models, p-value is low, which testifies to the high quality of the models. Heteroscedasticity in the regression model may lead to negative consequences: there is a high probability that the values of standard deviations of the regression model coefficients would be calculated inaccurately, which may finally result in stating the wrong hypothesis about the significance of the regression coefficients and the significance of the regression model in general. The zero hypothesis (no heteroscedasticity) was confirmed in all models. Also, the test for normal distribution of errors in all models showed that the errors are normally distributed.

The dependent variable was the question "Has implementation of digitalization program in healthcare increased the quality of medical services in your organization?" This allowed us to summarize the subjective estimations of the personnel of types I and II, and to identify the most important factors. Personnel of types III and IV, which is innovation-passive, was not considered.

5 Conclusion

The present research proposes and tests the approach to personnel typology, which links the organizational culture of involving employees to introducing innovations and the innovative activity of the personnel, assessed by the employees themselves. The following types of personnel were proposed: type I "prepared and demanded", type II "prepared and not demanded", type III "not prepared and demanded", and type IV "not prepared and not demanded". The high level of preparedness to introduce and use digital technologies was found in personnel of type I. The stimuli are the willingness for personal professional growth, the objective need to know and use digital technologies when rendering medical services. The barriers for introduction and use of digital technologies are failures in software functioning, unstable access to the Internet, and, to a much less extent, low level of their own digital literacy.

The work proposes and test the model linking the estimation of efficiency of a medical establishment's digitalization by personnel of types I and II with the factors determining the conditions of its implementation. The research results confirm the important role of preparedness of the population to the introduced digital technologies (0.739 for personnel of type II), competition between state and private medicine, quality of medical instrumental examinations, and interest of medical establishments in probation of their personnel. Consequently, medical establishments should make efforts aimed at developing their employees in order to improve the efficiency of their organizations' functioning. The results obtained confirm the role of organizational culture, which will either stimulate the innovative and creative activity of the employees or, vice versa, limit its manifestations. Besides, the medical authorities should pay

special attention to the topical task of implementing comprehensive measures to increase the digital literacy of not only the personnel, but also their own.

6 Acknowledgments

The reported study was funded by RFBR according to the research project No. 19-010-00251 A.

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