

# Digital transformation of management system of program apparatus complex based on correlation-regression analysis

N. A. Safiullin<sup>1</sup>, F. T. Nezhmetdinova<sup>1\*</sup>, R. I. Zinurova<sup>2</sup>, F. F. Gatina<sup>1</sup>, and A. R. Tuzikov<sup>2</sup>

<sup>1</sup>Kazan State Agrarian University, 65, K. Marx St., Kazan, 420015, Republic of Tatarstan, Russian Federation

<sup>2</sup>Kazan National Research Technological University, 68, K. Marx St., Kazan, 420015, Republic of Tatarstan, Russian Federation

**Abstract.** The paper is devoted to the study of the modern state and development of the system for the provision of electronic public services in the Volga Federal District. The data on the dynamics of the number of users on the portal of public services are given. The rating of the regions of the studied district in terms of the quality of the provision of electronic public services is presented. The factors affecting the score-rating system are outlined. A correlation-regression analysis is carried out, which reveals the correlation between the resultant and factor characteristics. It is proved that the quality of the electronic provided services can be brought to the level of 67.7 points by changing the degree of influence of these factors. The experience of digital transformation of state and municipal government in the Udmurt Republic, as the leader of the Volga Federal District in terms of the quality of the provision of electronic public services, is described.

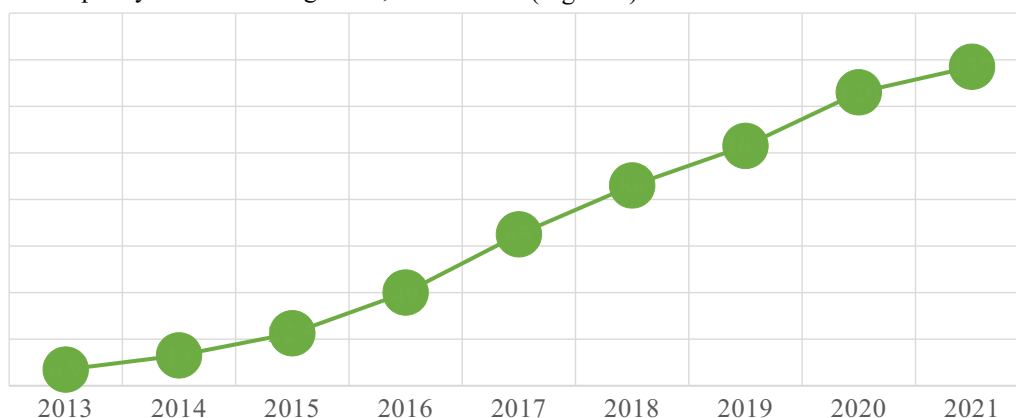
## 1 Introduction

The process of digital transformation of state and municipal government includes deep transformations in the provision of public services to the population and organizations based on information and communication technologies. The virtual interaction of citizens with the authorities allows improving the quality of life in the country and the efficiency of managerial decision-making.

The scientific community supports the priority of the improvement of the quality of services in general, but the

authors especially emphasize the role of public sector services as special forms of service that ensure the socio-economic stability of national economy [1].

Nowadays, public services in electronic form are provided through the federal and regional portals of public services, as well as on the basis of multifunctional centers. Citizens can receive about 80% of basic services and services remotely. By the beginning of 2022, more than 93 million Russians had registered a verified account on the Unified Portal of Public Services [2]. The total number of registered users reached 137 million (Figure 1).



**Fig. 1.** Dynamics of the number of registered users of Unified portal of state and municipal services of the Russian Federation, million users.

According to the Decree of the Government of the Russian Federation since 2022, the list of state services, which were previously provided either on regional portals or in the traditional form, is significantly expanding [3]. The resolution approved 212 services,

including a number of benefits for children, technical inspection of self-propelled vehicles and other types of equipment, registration of rights to real estate, acceptance of tax returns on income of individuals,

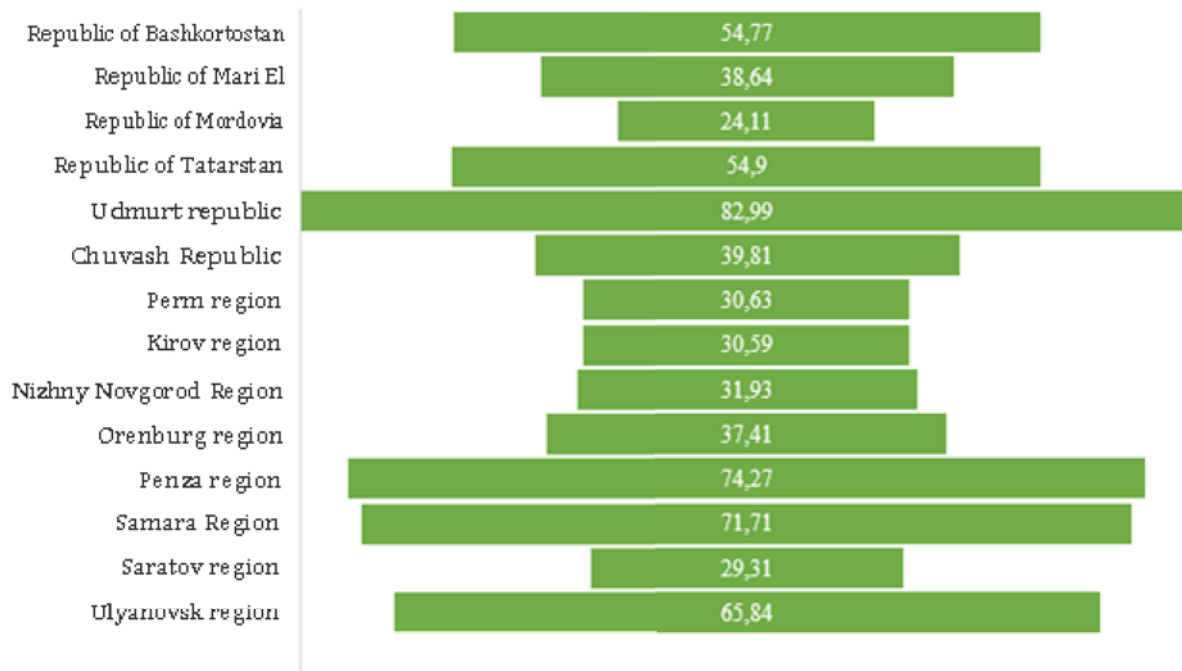
\* Corresponding author: [nadgmi@mail.ru](mailto:nadgmi@mail.ru)

extracts from state forest register, various licenses and permits, etc.

Thus, the importance of the quality of the provision of public services increases, since the level of satisfaction of citizens and organizations of state and municipal government, as well as the level of trust in the authorities, depends on this.

The assessment of the quality of electronic public services can also be carried out from the point of view of the internal environment, that is, a performer in the form of a set of quality of internal processes for the provision of services [4].

The main target indicators of the quality of public and municipal services are enshrined in the Decree of the President of the Russian Federation, including the satisfaction of citizens with the quality of public services [5]. By 2018, it was planned to reach the indicator value of at least 90%. In accordance with this decree, the Ministry of Economic Development of the Russian Federation annually monitors the quality of public services. In 2019 and 2020, monitoring began to be carried out on the basis of a score, the maximum value of which was 120 points.



**Fig. 2.** Rating of the regions of the Volga Federal District in terms of the quality of the provision of electronic public services in 2019, points.

As we see from the presented data, the leaders of the Volga Federal District were the Udmurt Republic, the Penza and Samara regions. The quality of the provision of public services is reasoned by many factors, especially the socio-economic development of individual regions, the technical condition of the infrastructure and the attitude of citizens to regional authorities.

## 2 Materials and Methods

The adoption of rational managerial decisions is based primarily on the results of a factor analysis of socio-economic phenomena. In economic practice, the ability to manage the factors of socio-economic phenomena makes it necessary to measure their interrelations. The quality of the provision of electronic public services and services depends on many factors.

In order to assess the degree and nature of the relationship between the rating of regions in terms of the quality of electronic services and the factors that determine it, we conducted a correlation-regression analysis solving problems of multiple correlation. For this purpose, two multifactorial correlation-regression models of the state and development of the state system

for the provision of electronic services to the population in the regions of the Russian Federation for 2019 were created. It covers the totality of the subjects of the Volga Federal District (14 units) [6].

In these models, effective ( $y$ ) and factor ( $x$ ) features are distinguished.

In socio-economic processes, performance factors include indicators that directly or indirectly reflect the results of socio-economic activities. In this regard, an indicator that characterizes the score-rating assessment of the regions in terms of the quality of the provision of electronic services acts as an effective factor.

In turn, factor indicators should reflect the level of their impact on the score-rating system:

$y$  – rating of regions in terms of the quality of electronic services, points;

$x1$  – the average monthly subscription fee for Internet access, rub.;

$x2$  – the share of people employed in the ICT sector in the total number of employed population, %;

$x3$  – the share of public authority (PA) and local public authority (LPA) that had a data transfer rate over the Internet of less than 2 Mbps, in the total number of surveyed organizations of PA and LPA, %;

$x_4$  – the share of healthcare institutions using the Internet in the total number of healthcare institutions, %;

$x_5$  – the average number of personal computers per 100 households, pcs.

Multivariate correlation-regression analysis allows estimating the degree of influence on the studied performance indicator of each of the factors included in the model with a fixed position of the remaining factors, as well as with any possible combinations of factors with a certain degree of accuracy. In this case, the important condition is the absence of a functional relationship between the factors.

The assessment of the parameters of the solution results is reduced to the comparison of the obtained parameters with the norms of mathematical statistics. If the parameters meet the standards, then they proceed to the interpretation of the results of the solution.

Otherwise, the correlation-regression model is corrected by screening out observations that have gross (anomalous) errors and excluding or replacing factor features.

A feature with insufficient variation range is excluded from the model. If the coefficient of variation is higher than 30%, the model can be corrected by dropping observations with critical (highest and lowest) values of the feature. However, economic studies are characterized by a high level of variation range. Therefore, in practice, a variation range level of 50–60% is allowed. In our case, the values of the coefficients of variation reflect the normal spread (the maximum value of the coefficient of variation is  $v_{x2} = 33.048\%$ ), therefore, they do not require adjustment of the correlation-regression model.

**Table 1.** Results of correlation and regression analysis for the Volga Federal District (compiled by the author).

Result and factors	$Y$	$X_1$	$X_2$	$X_3$	$X_4$	$X_5$
Errors of correlation ratios	0.070	0.214	0.180	0.222	0.242	0.212
Reliability coefficient ratio	12.235	-2.072	3.167	-1.854	-1.266	2.155
Arithmetic averages	47.636	495.417	1,490	64.336	98.121	117,000
Standard deviations	18.778	56.143	0.492	4.277	1.406	11.778
Variation ratio, %	39.419	11.333	33.048	6.649	1.433	10.066
Regression ratio	277.074	-0.038	18.502	-1.669	-2.178	0.710
Beta ratio		-0.114	0.485	-0.380	-0.163	0.445
Determination ratios,%	73.739	19.747	32.568	16.935	9.392	20.804
Individual Definitions ratio	73.739	5.086	27.693	15,650	4.997	20.312
Multiplier Correlations ratio	0.859					
Paired correlation ratio	$Y$	-0.444	0.571	-0.412	-0.306	0.456
	$X_1$		-0.548	-0.002	-0.081	-0.175
	$X_2$			-0.075	-0.027	-0.023
	$X_3$				0.162	0.070
	$X_4$					-0.175

According to the results of the solution of the five-factor model, the correlation ratio between the resultant and factor characteristics selected in the correlation model is very strong in the Volga Federal District ( $R = 0.859$ ), as evidenced by the numerical value of the multiple correlation coefficient. At the same time, the error of the correlation ratio ( $ORI = 0.070$ ) and the reliability of the correlation ratio ( $TR = 12.235$ ) confirm the existence of a connection between the effective and factor signs and indicate sufficient reliability of the multiple correlation coefficient. If the value of the multiple correlation ratio, as well as the pair correlation, is below 0.2 and the absolute value of the reliability of the correlation ratio is below  $t = 2.0$  (with a probability value of  $P = 0.95450$ ), then this indicates the absence of a significant and reliable relationship between the

effective and factor traits. In this case, further analysis of the results of the solution of the problem is not important.

The assessment of the problem solution parameters shows that two factor signs  $x_3$  and  $x_4$  ( $t_3 = -1.854$ ,  $t_4 = -1.266$ ) should be excluded from the correlation – regression model. At the same time, the composition of indicators in the new, corrected model will be as follows:

$y$  – the rating of regions in terms of the quality of electronic services, points;

$x_1$  – the average monthly subscription fee for Internet access, rub.;

$x_2$  – the share of people employed in the ICT sector in the total number of employed population, %;

$x_3$  – the average number of personal computers per 100 households, pcs.

**Table 2.** Results of a three-factor correlation-regression analysis for the Volga Federal District (compiled by the author).

Result and factors	Y	X1	X2	X3
Errors of correlation ratios	0.121	0.214	0.180	0.212
Reliability coefficient ratio	6.143	-2.072	3.167	2.155
Arithmetic averages	47.636	495.417	1,490	117,000
Standard deviations	18.778	56.143	0.492	11.778
Variation ratio, %	39.419	11.333	33.048	10.066
Regression ratio	-57.716	-0.022	20.787	0.729
Beta ratio		-0.066	0.545	0.457
Determination ratio, %	54.879	19.747	32.568	20.804
Individual Definitions ratio	54.879	2.919	31.112	20.847
Multiplier Correlations ratio	0.741			
Paired correlation ratio	Y	-0.444	0.571	0.456
	X1		-0.548	-0.175
	X2			-0.023

The assessment of the parameters of the repeated solution is satisfactory.

According to the results of the solution of the three-factor model, the correlation ratio between the resultant and factor features selected in the second correlation-regression model remains quite strong ( $R = 0.741$ ,  $TR = 6.143$ ).

Paired correlation ratio –  $r_{yxj}$  – a parameter that reflects the correlation ratio (strength) between a separate factor and resultant feature. The coefficient takes values ranging from -1 to +1. A positive value of the coefficient means a direct relationship between features, a negative value means feedback.

Absolute values  $r_{yxj}$  reflect the following bond strength:

$r_{yxj} = 0$  – no connection;

$0.00 < r_{yxj} < 0.20$  - insignificant, unreliable correlation;

$0.20 < r_{yxj} < 0.40$  – weak correlation;

$0.40 \leq r_{yxj} < 0.60$  – average correlation;

$0.60 \leq r_{yxj} < 0.80$  – strong correlation;

$0.80 \leq r_{yxj} < 1.00$  – very strong correlation;

$r_{yxj} = r_{,00}$  – functional linear correlation

Thus, the obtained values of the paired correlation coefficients allow concluding that in the Volga Federal District the quality of electronic services is most influenced by the factor  $x_2$  – the share of those employed in the ICT sector in the total number of employed population ( $r_{yx2} = 0.571$  at  $t = 3.167$ ). At the same time, the factors  $x_1$  (subscription fee for accessing the Internet) and  $x_3$  (the number of personal computers per 100 households) are almost equally dependent on the

effective feature ( $r_{yx1} = -0.444$ ,  $r_{yx3} = 0.456$ ). It is necessary to note that the correlation between  $x_1$  and  $y$  is average, inverse; and the correlation between  $x_3$  and  $y$  is medium, straight line.

The interpretation of the solution results involves the study of regression coefficients, determination coefficients and coefficients of a separate determination.

The ratio of the regression equation are the coefficients of the regression dependence equation (VFD):

$$Y = -57.716 - 0.022x_1 + 20.787x_2 + 0.729x_3$$

If we substitute the arithmetic mean values of factor features –  $x_1, x_2, \dots, x_5$  into the equation, then the calculated value of the effective feature –  $Y$ , will also be the arithmetic mean.

The parameters of the linear regression equation with a factor feature show what change in the average value of the resultant values leads to a change in the factor value by one unit.

That is, if the share of people employed in the ICT sector in the total number of employed population is increased by 1%, then the quality of electronic services to the population of the Volga Federal District will increase by 20.787 points in the rating of regions. If the number of personal computers per 100 households is increased by 1 unit, the rating will increase by 0.729 points. However, the growth of such a factor as the average monthly subscription fee for accessing the Internet causes a decrease in the quality of electronic services, that is, if the subscription fee is increased by 100 rubles, then the rating will decrease by 2.2 points.

Thus, changing the values of factor attributes, it is possible to achieve the maximum (or minimum) possible value of the effective attribute. However, it is legitimate to change factor values in the direction of decrease or increase only within the variation range or coefficient of variation from their arithmetic mean:

$$Y_{\max} = -57.716 - 0.022x_1 - \min + 20.787x_2 - \max + 0.729x_3 - \max = -57.716 - 0.022 * 433.14 + 20.787 * 1.98 + 0.729 * 128.78 = 67.7 \text{ points}$$

The results of the solution show that the value of the effective feature - Y grows with the increase in the values of the factor features x2 and x3 and the decrease in the value of the factor feature x1. Therefore, in order to determine the maximum possible value of Ymax, the maximum allowable values of factor signs x2 and x3 and the minimum allowable value of factor value x1 should be substituted into a certain regression equation.

This means that changing the degree of impact of these factors, the quality of the provided electronic services can be brought to the level of 67.7 points on the rating scale of the regions of the Volga Federal District, which is 20.1 points or 42.2% higher than the average regional value.

Thus, the parameters of the developed regression equations can be used to predict the results of the activities of state authorities in the field of the provision of electronic services to the population of the Russian Federation.

According to Figure 2, the Udmurt Republic occupies a leading position in the ranking, so it makes sense to consider the experience of this region in the digitalization of state and municipal government.

### 3 Results and Discussion

The Udmurt Republic has a fairly developed digital infrastructure. The compact location of settlements allowed covering 95.4% of the population with 3G network and 93.1% with 4G network. More than 400

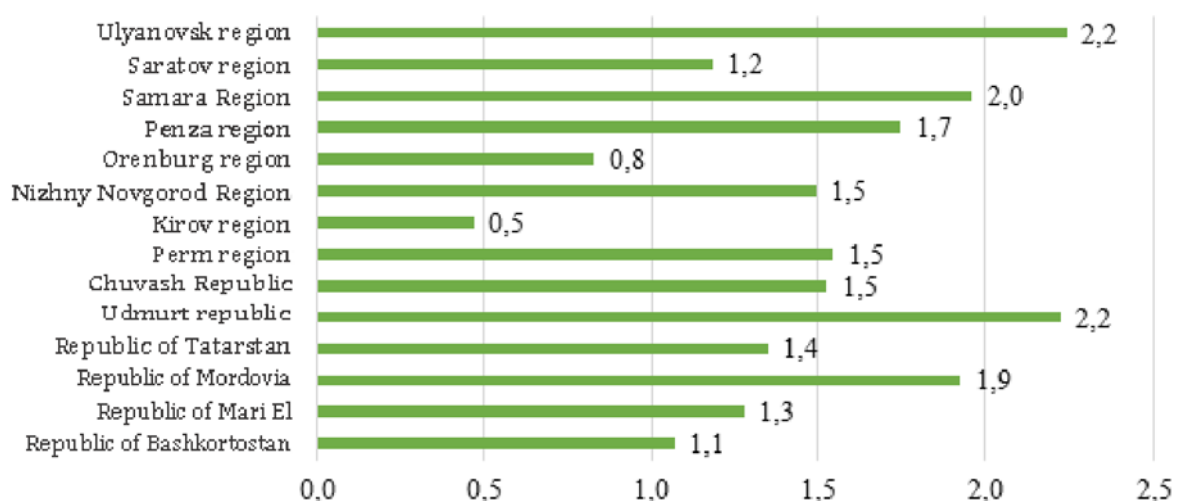
settlements in the region are covered by fiber-optic networks, the length of which exceeds 7.800 km. In 2021, it is planned to provide high-speed Internet to all schools and feldsher-obstetric stations in the region. As a part of the elimination of the digital gap, it is planned to build 47 mobile base stations. This fact allowed decreasing the subscription fee for Internet access to a minimum value in the Volga Federal District (436.95 rubles) which is a key factor in the conducted correlation-regression analysis.

In 2020, the Udmurt Republic entered the top ten constituent entities of the Russian Federation in terms of the quality of the provision of electronic public services. The share of services received electronically by the population has not fallen below 75% for several years.

The regional portal of state and municipal services [uslugi.udmurt.ru](http://uslugi.udmurt.ru) includes about 200 services [8]. In 2020, more than 8 million services were provided. During the coronavirus pandemic, electronic services for registering self-isolation and returning to work were added to the portal. In 2021, it is planned to add regional super services Healthy Citizen, Tourist, Driver and others.

There are 33 offices of Multifunctional centers (MFC) for the provision of state and municipal services in the republic, in which 238 regional and 3545 municipal services are provided. In 2020, 934,307 services were provided to individuals, 8,200 of them were provided to legal entities. A single call center was created on the basis of the MFC, in which more than 2,600 calls are processed daily. In this case, the response of the operator is 4 seconds. Due to the callback service and 52 operators, the call center covers 100% of applicants. In 2021, it is planned to expand the network of windows, introduce Lean MFC tools and offer the population a mobile application, as well as expand the range of services.

By 2030, the Republic of Udmurtia plans to bring the indicator of digital maturity of economic and social sectors to 100%. In 2020, the value of this indicator was 28 % (the planned one was 4%).

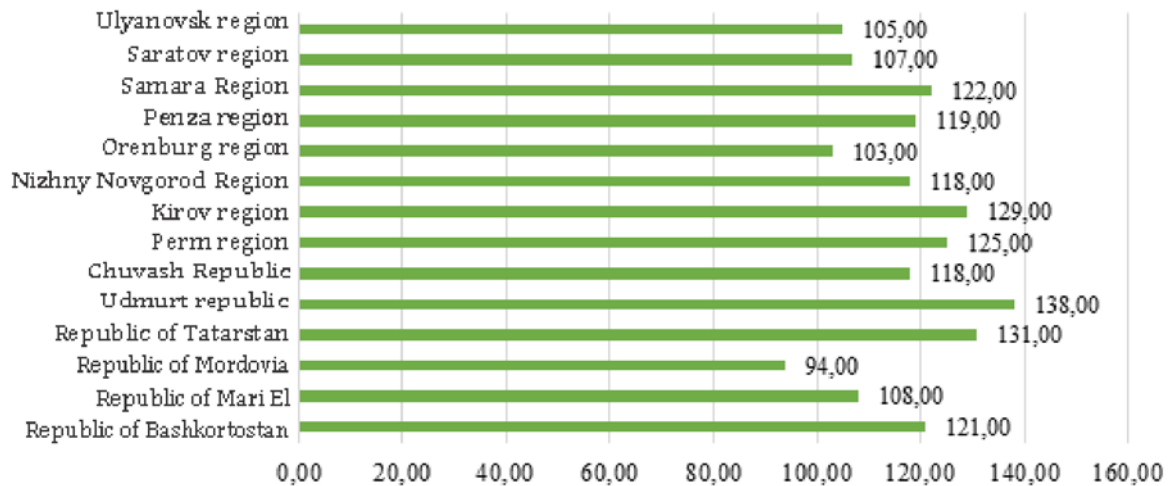


**Fig. 3.** Share of people employed in the ICT sector in the total number of employed people in the Volga Federal District in 2019, % (compiled by the author).

According to the conducted correlation-regression analysis, one of the factors affecting the quality of the public services in electronic form is the share of those employed in the ICT sector in the total number of employed people. The Udmurt Republic has the highest value of this indicator.

In 2020, the annual turnover of organizations engaged in the field of information and communication technologies in the republic exceeded 58 billion rubles, which was 19.5% higher than last year level. The average level of wages in the industry amounted to 46,589 rubles, which was 14.1% higher than in 2019.

The leadership of the region actively supports the enterprises of the ICT sector. They have the opportunity to receive subsidies for loans, as well as to arrange a mortgage for young professionals with a preferential rate of 2.9%. The participation of organizations involved in the field of information and communication technologies in competitions and grants attracted 232 million rubles to the Republic of Udmurtia, which was 58.9% more than last year.



**Figure 4.** Number of personal computers per 100 households (compiled by the author).

The level of satisfaction with the quality of the provision of electronic public services based on the results of the correlation and regression analysis is influenced by the provision of the population with technical means, including the availability of personal computers. The Udmurt Republic ranks first in the Volga Federal District in terms of the number of personal computers per 100 households (138). Due to this, in 2020, about 70% of citizens over the age of 14 of this Republic had a verified ESIA account [9. 10.11].

At the same time, the digital transformation of the agro-industrial complex is facing many problems, which include not only the backwardness in the digital competencies of a significant part of the personnel of the agricultural sector, but also the risks posed by digital technologies related to living systems [12, 13,14].

## 4 Conclusion

The results of the study indicate the existing reserves for the improvement of the quality of the provision of electronic public services. Carrying out digital transformation, executive authorities need to use end-to-end technologies such as artificial intelligence, big data and the Internet of things. The Internet of Things technology is recognized as a priority in the development in terms of the potential to change business models. The development of such technologies in state and municipal administration will significantly expand the capabilities of state bodies and increase the level of confidence of

citizens and organizations in the system of public services.

The experience of the Udmurt Republic in the field of informatization and communications can be used in the digital transformation of public services in other regions of the country. It will also improve the quality-of-service provision and rise in the corresponding rating.

## References

1. M. V. Vasilyeva, V. A. Budasova, Perspective directions for assessing the quality of public services implemented in electronic form, *Intellect. Innovation. Investments* **6** 24–36 (2021)
2. Gosuslugi, *Interesting and useful*, retrieved from: <https://www.gosuslugi.ru/help/news> (2022)
3. The Decree of the Government of the Russian Federation of September 1, 2021 N 1458 “On Amendments to the Regulations on the Federal State Information System” Unified Portal of State and Municipal Services (Functions) (2021)
4. N. A. Safiullin, S. S. Kudryavtseva, Management of digital transformation of state and municipal services at the mesolevel, *Economic Bulletin of the Republic of Tatarstan* **1**, 19–24 (2021)
5. The Decree of the President of the Russian Federation of May 7, 2012 No. 601 “On the main directions for improving the system of public administration” (2021)
6. Rosstat, *Russian statistical yearbook 2020* (Moscow, 2020)

7. A. K. Subaeva, N. R. Aleksandrova, State support for the digitalization of agriculture, *Bulletin of the Kazan State Agrarian University* **16-4 (64)** 130–135 doi: 10.12737/2073-0462-2022-130-135 (2021)
8. Public Services of the Udmurt, *On the Regional Portal of State and Municipal Services of the Udmurt Republic*, retrieved from: [https://uslugi.udmurt.ru/about\\_portal](https://uslugi.udmurt.ru/about_portal) (2021)
9. E. F. Amirova, O.V. Kirillova, M. G. Kuznetsov, Sh. M. Gazetdinov Internet of things as a digital tool for the development of agricultural economy, *BIO Web of Conferences* **17**, 00050 doi: 10.1051/bioconf/20201700050 (2020)
10. E. F. Amirova, M. G. Kuznetsov, E. Khakimova, A. Tolmacheva, Integrated development of digital agribusiness platform to support import substitution of food products, *BIO Web of Conferences*, **27**, 00055 doi: 10.1051/bioconf/20202700055 (2021)
11. G. Krupina, et al. Main directions of popularization of electronic state and municipal services among rural population *BIO Web of Conferences* **27** (2020)
12. F. T. Nezhmetdinova, N. S. Barabash, Transformation of education in the context of the formation of the digital economy *Innovation and expertise: scientific works* **2 (23)**, 120–131 (2018)
13. F. T. Nezhmetdinova, M. E. Guryleva, N. Kh. Sharypova, R. I. Zinurova, A. R. Tuzikov, Risks of modern biotechnologies and legal aspects of their implementation in agriculture, *BIO Web of Conferences* **17**, 00227 (2020)
14. F. T. Nezhmetdinova G. R. Fassakhova, L. R. Shagivaliev, N. Kh. Sharypova, R. I. Zinurova, Transformation of personnel training for the agro-industrial complex in digital economy. In the collection: *Agriculture and food security: technologies, innovations, markets, personnel. Scientific works of the international scientific-practical conference dedicated to the 100th anniversary of agricultural science, education and enlightenment in the Middle Volga region* pp 721–725 (2019)