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Marketing ensuring of the competitiveness of the Republic of Kazakhstan regions in the transition to the digital economy

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A B S T R A C T

Transition to the digital economy determines the readiness of the national economy complex for the emergence of new industries, forms of economic cooperation, and general development of the regional economy on the whole, both for a separate region and for the entire country. Authors determine the possibility of application of digital transformations in regional development. This is due to the fact that the Republic of Kazakhstan is a country with widely differentiated regional development. This means that regional development should be proceed not only from the application of digital technology directly within the regional economy, but also from the introduction of digital technology in certain sectors of the industrial complex. The novelty of the study lies in the determination of the possibility of implementing digital technology as an integral part of the economy and the possibility of clustering individual industries on the basis of digital platforms and communication technology. The authors provide mathematical justification of the integration model for digital complexes within various economy sectors of individual regions. Authors propose using the developed mechanism for structuring the current situation of regional economic development. The practical significance of the study is determined upon designing regional development programs. This will facilitate the increase of position of Kazakhstan in the ratings of world development and economic comfort of living in the state.

1. Introduction

Economy digitalization is regarded as a fundamental factor of economic growth, innovation and competitive environment, employment creation and social progress in general. The key factor of digital economy is the digital data, which multiply the scope of processed information, reduce the time for its analysis and significantly boost its efficiency for the production of technology, goods, and service enhancement (Hoontrakul, 2018). The digital economy ecosystem has several aspects of transformation of the traditional processes, namely:

- reorientation of economic structure, transformation of market concepts and market relations, change of understanding of managerial and social environment, penetration into each of the given aspects of new information technology;

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- fundamental change of the economy structure due to more efficient virtual structures and consequential modernization of economic processes;
- the leading part in the economy management belongs to the institutions based on the innovative digital models and information processes.

The economy digitalization facilitates many positive social and economic effects. The main economic advantages of the digital economy include more rapid economic growth, advancement in SME development, increased efficiency of business processes, increased employment in the information technology industries. The social effects of the economy digitalization are: increased availability of financial services, education cost reduction through its virtualization, healthcare quality improvement through patients' data digitalization, reducing the negative impact on the environment.

2. Literature review

The defining trend of the world economy development in the 21st century is the spread of information and communication technology, resulting in formation of the so-called "digital economy" and introduced such concept as "digitalization" into scientific discourse (Bogoviz *et al.*, 2019). Application of digital technology had the most significant impact on the financial sector, in particular, it made significant changes in the organizational process of circulation and trade of financial instruments (Braccini *et al.*, 2011). Despite significant advantages facilitated by technological progress and fintech innovations, the economy digitalization bears risks and threats of its own (Bounfour, 2016). A comprehensive study of the impact of digitalization on the functioning of the financial sector, identification of potential threats and their consideration upon designing an economic development strategy will ensure the stable functioning of the financial system (Rebiazina, 2018).

Factoring in the potential positive impact of digitalization on national economies and public welfare, ICT development issues are considerably addressed by the global community (Kusakina, 2019). The development of digital technology plays an important part in strategic documents of the European Union such as Europe 2020 and Digital Agenda for Europe (Novikov & Belov, 2019). Digital Agenda for Europe is to be implemented in four main areas: digital society (training and employment, healthcare and pension protection, utilities, cyber security and confidentiality, emergency support line, "smart" solution for quality of life, Internet-trust); research and development (innovation, digital infrastructure, new technology, components and systems, open science, robotics, consultants in scientific research); access and communication (broadband access in Europe, telecommunications and open Internet); digital economy (start-ups, databases, cloud technology, the future of the Internet, consultants) (Fedotova *et al.*, 2019). Horizon-2020 (2014-2020) is a European Programme aimed at achievement of similar goals and focuses research and development financing on the following three complementary priorities of Europe-2020 Programme, including frontier science, industrial leadership and societal challenges (Przhedetsky, 2018).

The volumes of the EU digital economy in 2017 amounted to over 285 billion EUR, i.e. almost 2% of EU GDP (Hanna, 2018). Over the year, the cost created by this sector increased by 5%, amounting to 300 billion EUR in 2018. Provided that political and legislative conditions are favourable, including encouragement of ICT investment, the digital economy in the EU is forecast to grow to 739 billion EUR in 2020, or up to 4% of the entire EU GDP. According to the experts, by 2025, over 30-50% of the GDP of most countries, which entered the information age, will be implemented within the digital economy ecosystem. In other words, the bulk of all economic and business processes will be implemented through cutting-edge information tools and virtual platforms (Filatova, 2018). For the Republic of Kazakhstan, the economy digitalization is significantly connected with the necessity of reducing the regional development differences (Mizintseva and Gerbina, 2018). This is due to the continual historical development of the central regions only (Ismagilova *et al.*, 2017). At the same time, subsequent to the collapse of the USSR, the tendencies only rose (Benzerga *et al.*, 2018). Hence the necessity of digitalization of regional economic systems.

3. Material and Methods

From the standpoint of methodology for analysis of digital economy enterprise clustering efficiency and digital economy cluster performance, the use of economic and mathematical modelling is of considerable interest (Breznitz, 2011). The cluster of the digital economy objects, as a modelling object, represents a system, the complexity of which is determined by the number of its elements (enterprises, organizations, subjects of socio-economic, scientific and technical purposes, etc.), relations between them, including relations with the external environment (Berg and Wilts, 2018). Associative integration of elements in the cluster implies common goals and interests. With that, cluster elements have their own goals and strive to achieve them (Pang *et al.*, 2014). The composition of the cluster elements, the ways of their association and their correlation determine the cluster structure as an economic system, including its performance (Kozlova, 2019). A key element in cluster forming for the digital economy objects is the justification of the optimal composition of cluster members and, particularly, the participation of certain enterprises as the key element of the cluster's "core" (Blaschke *et al.*, 2017). Subsequently to the study of analytical methods, which help to model the enterprise clustering efficiency, it appears prudent to employ precisely the simulation modelling for the solution of the specified issue (Cyberspace Studies…, 2019). The stages of modelling the digital economy clustering efficiency and the digital economy cluster performance are provided in the main part of the study.

4. Results and discussion

To highlight the indicators of digital economy clustering efficiency and digital economy cluster performance, the author selected tasks to determine the said indicators, according to which a questionnaire was designed and a survey was carried out among experts. Analysis and data grouping were performed for 89 questionnaires, proceeding from which four groups of indicators of digital economy clustering efficiency and digital economy cluster performance were singled out. Each group contains five indicators most often pointed by respondents, with similar indicators being merged (Table 1). Expert assessment of the singled out indicators of digital economy clustering efficiency and the digital economy cluster performance. On the basis of the first survey, a second survey was carried out among experts to assess the importance of the specified indicators, and to forecast their dynamics for three years. The survey specified 20 indicators of enterprise clustering and digital economy cluster performance mentioned by the overwhelming majority of respondents of the previous survey. The experts were to assess each of the indicators on the scale from 0 to 9 points in ascending order of priority. Furthermore, upon taking the current value of the indicator for 1 (100%), the respondents could predict its expected growth (decrease) over the first three years after the creation of the digital economy clusters.

Table 1
Indicators of digital economy clustering efficiency and digital economy cluster performance

Group indicators	Single indicators
1. Economic efficiency indicators	x_{11} – income growth from service implementation; x_{12} – development of labour productivity; x_{13} – capital investment growth; x_{14} – reduction of expenditures from service implementation; x_{15} – growth of profitability (ratio of total income to total expenditures).
2. Environmental efficiency indicators	x_{21} – reduction of emissions to the environment by using cleaner modes of transport; x_{22} – reduction of impact of transport on the environment through innovative technology; x_{23} – increase of compliance of vehicles with international environmental standards (environmental safety of transport); x_{24} – reduction of taxes and fees (environmental tax); x_{25} – reduction of fines for violation of environmental legislation.
3. Innovative efficiency indicators	x_{31} – return on assets; x_{32} – formation of new technology transfer channels; x_{33} – increase of the number of developed and/or introduced information-managerial innovation; x_{34} – increase of the number of developed and/or introduced logistic innovation; x_{35} – increase of the number of developed and/or introduced transport innovation.
4. Social efficiency indicators	x_{41} – creation of employment; x_{42} – improvement of working conditions; x_{43} – increasing the number and improving the quality of social communications; x_{44} – growth of the wage level among workers; x_{45} – advanced training of employees, growth of social status and opportunities for personal fulfilment.

23 survey results were obtained and processed using statistical methods of evaluation. 100% of responses single out the indicators characterizing the economic efficiency of enterprise clustering and digital economy cluster performance, 19 respondents (82.6%) singled out the indicators of innovative efficiency of enterprise clustering and digital economy cluster performance, 15 respondents (65.2%) singled out the indicators of social efficiency of enterprise clustering and digital economy cluster performance, 9 respondents (39.1%) singled out the indicators of environmental efficiency of enterprise clustering and digital economy cluster performance. The results of consistency check, carried out for the expert assessment of importance of indicators, were obtained by the rank correlation method with Student criterion. The experts were awarded the corresponding ranks. For the sequence of ranks, the coefficients of rank correlation were calculated and their significance was assessed using the Student criterion. Since the empirical values of the rank correlation coefficients for all indicators and all expert groups are statistically significant with the level of probability, there are no grounds to reject the hypothesis on consistency of expert assessment. The tables of the initial type display the probabilities of adopting the corresponding hypothesis on the consistency of expert assessment for each indicator and each pair of experts (we should note that in case when the table displays the value of 1 it means that the corresponding probability is close to 1 with accuracy to 0.00001 at least). Identification of the group integral are indicators of digital economy clustering efficiency and digital economy cluster performance.

As the calculations confirmed the consistency of the expert assessment, on the basis of the results of the expert assessment of the weight coefficients and the expected dynamics of digital economy clustering efficiency, we shall determine the average values of the following assessment indicators: p_{ij} are weight coefficients of each single indicator; $d_{ij}^{(t)}$, t=1,2,3 are predicted values of the x_{ij} indicator growth coefficient for three years. The dynamics of the studied indicators of digital economy clustering efficiency and digital economy cluster performance are displayed in Table 2.

Table 2
Expected dynamics of the studied indicators of digital economy clustering efficiency and digital economy cluster performance

Group indicator	Single indicator	Years of functioning		
		t = 1	**t = 2**	**t = 3**
1. Economic efficiency	x_{11}	$1.02x_{11}$	$1.1016x_{11}$	$1.2118x_{11}$
	x_{12}	$1.02x_{12}$	$1.1220x_{12}$	$1.2903x_{12}$
	x_{13}	x_{13}	$1.1x_{13}$	$1.32x_{13}$
	x_{14}	$1.0101x_{14}$	$1.0413x_{14}$	$1.0961x_{14}$
	x_{15}	$1.02x_{15}$	$1.0812x_{15}$	$1.1677x_{15}$
2. Environmental efficiency	x_{21}	$1.0204x_{21}$	$1.0741x_{21}$	$1.1935x_{21}$
	x_{22}	x_{22}	$1.0204x_{22}$	$1.0741x_{22}$
	x_{23}	$1.0200x_{23}$	$1.0710x_{23}$	$1.1460x_{23}$
	x_{24}	x_{24}	$1.0101x_{24}$	$1.0636x_{24}$
	x_{25}	x_{25}	$1.0204x_{25}$	$1.0629x_{25}$
3. Innovative efficiency	x_{31}	x_{31}	$1.04x_{31}$	$1.1024x_{31}$
	x_{32}	$1.1x_{32}$	$1.232x_{32}$	$1.4168x_{32}$
	x_{33}	$1.1x_{33}$	$1.265x_{33}$	$1.518x_{33}$
	x_{34}	$1.01x_{34}$	$1.0605x_{34}$	$1.1666x_{34}$
	x_{35}	x_{35}	$1.02x_{35}$	$1.0608x_{35}$
4. Social efficiency	x_{41}	x_{41}	$1.03x_{41}$	$1.0918x_{41}$
	x_{42}	$1.01x_{42}$	$1.0504x_{42}$	$1.1134x_{42}$
	x_{43}	$1.01x_{43}$	$1.0403x_{43}$	$1.0923x_{43}$
	x_{44}	x_{44}	$1.02x_{44}$	$1.0710x_{44}$
	x_{45}	$1.04x_{45}$	$1.1232x_{45}$	$1.2355x_{45}$

We shall note that p_{ij} values must satisfy the following condition:

1) $0 \le p_{ij} \le 1$;

2) $\sum_{j=1}^{n}\sum_{i=1}^{4} x_{ij} = 1$,

where i is the number of the group indicator, and j is the number of the single indicator.

To satisfy these conditions, we shall apply the natural normalization method to the matrix of averaged expert assessments:

$$p_{ij}^{`} \to p_{ij} = \frac{p_{ij}^{`} - \min\limits_{i,j}(p_{ij}^{`})}{\max\limits_{i,j}(p_{ij}^{`}) - \min\limits_{i,j}(p_{ij}^{`})} \tag{1}$$

where p'_{ij} is an expert assessment, p_{ij} is a normalized assessment. Using this approach, we obtain the following normalized matrices:

$$p_1 = \left\| p_{1j} \right\| = \begin{pmatrix} 0,67 \\ 0,56 \\ 0,67 \\ 0,44 \\ 0,67 \end{pmatrix} \to \begin{pmatrix} 0,0652 \\ 0,0543 \\ 0,0652 \\ 0,0435 \\ 0,0652 \end{pmatrix} \tag{2}$$

$$p_3 = \left\| p_{3j} \right\| = \begin{pmatrix} 0,67 \\ 0,56 \\ 0,44 \\ 0,22 \\ 0,56 \end{pmatrix} \to \begin{pmatrix} 0,0732 \\ 0,0610 \\ 0,0488 \\ 0,0244 \\ 0,0610 \end{pmatrix} \tag{4}$$

$$p_2 = \left\| p_{2j} \right\| = \begin{pmatrix} 0,56 \\ 0,56 \\ 0,33 \\ 0,22 \\ 0,22 \end{pmatrix} \to \begin{pmatrix} 0,0610 \\ 0,0610 \\ 0,0396 \\ 0,0244 \\ 0,0244 \end{pmatrix} \tag{3}$$

$$p_2 = \left\| p_{2j} \right\| = \begin{pmatrix} 0,67 \\ 0,22 \\ 0,67 \\ 0,67 \\ 0,67 \end{pmatrix} \to \begin{pmatrix} 0,0732 \\ 0,0244 \\ 0,0732 \\ 0,0732 \\ 0,0732 \end{pmatrix} \tag{5}$$

We shall identify the integral indicators for each group indicator of digital economy clustering efficiency and digital economy cluster performance:

$$I_1 = \left\| p_{1j} \right\| \times x_{1j} = 0,0652x_{11} + 0,0543x_{12} + 0,0652x_{13} + 0,0435x_{14} + 0,06524x_{15} \tag{6}$$

$$I_2 = \left\| p_{2j} \right\| \times x_{2j} = 0,0610x_{21} + 0,0610x_{22} + 0,0396x_{23} + 0,0244x_{24} + 0,0244x_{25} \tag{7}$$

$$I_3 = \left\| p_{3j} \right\| \times x_{3j} = 0,0732x_{31} + 0,0610x_{32} + 0,0488x_{33} + 0,0244x_{34} + 0,0610x_{35} \tag{8}$$

$$I_4 = \left\| p_{4j} \right\| \times x_{4j} = 0,0732x_{41} + 0,0244x_{42} + 0,0732x_{43} + 0,0732x_{44} + 0,0732x_{45} \tag{9}$$

The resulting formulas for calculating the integral indicators have the following properties: upon substitution of the normalized relative x_{ij} values, which can vary from 0 to 1, into the corresponding formula, we shall obtain the normalized value of the integral indicator. Moreover, when all x_{ij} gain maximum values, the corresponding value of the integral index equals 1. This allows to use the obtained formulas for:

- comparison of relative digital economy clustering efficiency and digital economy cluster performance for different groups of indicators;
- identification of the impact from development, financing, support, etc. of each of the selected single indicators and their influence on the general digital economy clustering efficiency and digital economy cluster performance;
- analysis of the dynamics of changes in the economic, environmental, social and innovative fields in the process of digital economy clustering and digital economy cluster performance for certain time periods.

Modelling the dynamics of the studied indicators of digital economy clustering efficiency and digital economy cluster performance.

We shall set the recurrence relations to identify the dynamics of the studied indicators of digital economy clustering efficiency and digital economy cluster performance:

$$f^t(x_{ij}) = g(d_{ij}^1)x_{ij} + g(d_{ij}^2)g(d_{ij}^1)x_{ij} + g(d_{ij}^3)g(d_{ij}^2)g(d_{ij}^1)x_{ij} \tag{10}$$

where $g(d^t_{ij})$ is a function of the predicted value of the x_{ij} indicator growth coefficient for t year which constitutes a linear function when the factor is an indicator with a positive value and is inverse for the factor with a negative value. We shall display the implementation of the above formulas for the cases when $g(x^+) = x^+$ and $g(x^-) = 1/x^-$. The results of modelling the dynamics of integrated indicators of digital economy clustering efficiency and digital economy cluster performance are displayed in Table 3 and illustrated in Figure 1.

Table 3
Integral indicators of the expected digital economy clustering efficiency and digital economy cluster performance by group indicators

Integral indicator	Years of digital economy cluster performance			
	t=0	**t=1**	**t=2**	**t=3**
Economic efficiency	0.2935	0.2976	0.3203	0.3591
Environmental efficiency	0.1848	0.1865	0.1929	0.2068
Innovative efficiency	0.2826	0.2920	0.3128	0.3470
Social efficiency	0.2391	0.2423	0.2253	0.2696

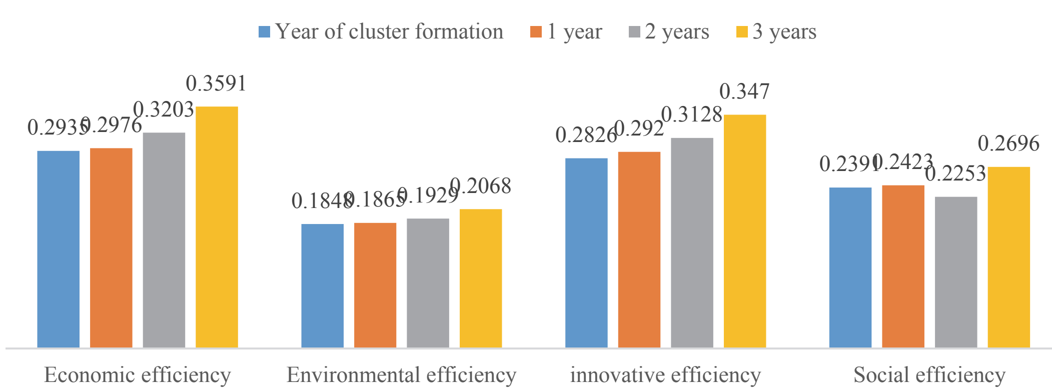

Fig. 1. Dynamics of integrated indicators of digital economy clustering efficiency and digital economy cluster performance

Calculation of the functionality of assessment of digital economy clustering efficiency and digital economy cluster performance and justification of the choice of the strategy type for digital economy cluster development.

The developed economic and mathematical model of digital economy clustering efficiency and digital economy cluster performance suggests using four types of digital economy cluster development strategy:

1) economic strategy, which involves changes in the technological complex, and production, innovation, organizational and management activities of the digital economy objects, aimed at profit enhancement and profitability of digital economy enterprises, competitive growth, the best possible use of resources available, service quality increase, full customer satisfaction in rendering services, expanding the range of services offered by enterprises, increase of the share and development of new market segments, introduction of modern technology, attraction of investments, management system improvement, widespread introduction of information and communication technology, introduction of partnerships with scientific institutions and governmental structures, increase in the level of security and availability of digital services for the population;

2) environmental strategy, which involves the implementation of ecological and economic interests by reducing polluting emissions through the use of green production, reduction of the impact of activities on the environment through innovative technology implementation, achievement of compliance of the digital economy objects to the international environmental standards and improvement of environmental consciousness of the population;

3) social strategy, which involves achieving common welfare and collective security on the basis of mutual responsibility, transparency, ethical behaviour, compliance with legal provisions, compliance with international standards of human rights protection, creation of employment, improvement of working conditions, ensuring continuous improvement of the educational and professional level of employees, decent wages and access to social benefits;

4) innovative strategy, which involves the effective development and introduction of management innovation, logistics innovation and transport innovation on the basis of strategic marketing, R&D, modern ICT, available scientific, technical and intellectual potential of the enterprise, production and technical facilities of the digital economy objects, substantial investment, use of technology, knowledge transfer channels, development of intellectual wants of personnel, encouragement of the creative approach to task performance, and consistent knowledge building of employees in the course of professional activity. We shall model the efficiency assessment matrix on the basis of Table 3. In the model example, we shall assume that all x_{ij} obtain a single value. We shall obtain the assessment functionality with a positive value of the following form Eq. (11):

$$F^{+}=\begin{pmatrix} 0,0665\,0,0718\;\,0,790 \\ 0,0554\,0,0610\,0,0701 \\ 0,0652\,0,0717\,0,0816 \\ 0,0439\,0,0453\,0,0477 \\ 0,0665\,0,0705\,0,0762 \\ 0,0555\,0,0584\,0,0649 \\ 0,0543\,0,0555\,0,0584 \\ 0,0333\,0,0349\,0,0374 \\ 0,0217\,0,0220\,0,0231 \\ 0,0652\,0,0672\,0,0712 \\ 0,0549\,0,0571\,0,0605 \\ 0,0439\,0,0452\,0,0475 \\ 0,0217\,0,0222\,0,0233 \\ 0,0565\,0,0610\,0,0671 \\ 0,0652\,0,0678\,0,0719 \\ 0,0239\,0,0268\,0,0308 \\ 0,0717\,0,0825\,0,0990 \\ 0,0659\,0,0692\,0,0761 \\ 0,0652\,0,0665\,0,0692 \\ 0,0241\,0,0398\,0,0156 \end{pmatrix} \tag{11}$$

After the convolution operation, factoring in the weight coefficients, we shall obtain the assessment matrix for the indicator groups:

$$F=\left\|f_{ij}\right\|=\begin{pmatrix} 0,297613 & 0,186544 & 0,242283 \\ 0,320350 & 0,192898 & 0,252709 \\ 0,359053 & 0,206828 & 0,269639 \\ 0,297613 & 0,186544 & 0,242283 \end{pmatrix} \tag{12}$$

For the research of the obtained assessment matrix we shall apply the approaches of selecting the best possible strategies in the decision theory, that are similar to the criteria of Wald, Bayes, and Savage, that is, we shall solve the optimization problems of the following types:

1. Optimization when distribution of environmental conditions is unknown and is supposed to be antagonistic (the most unfavourable) for the subject of decision-making

$$z=V\rightarrow \max, \tag{13}$$

subject to

$$\begin{cases} \sum_{j=1}^{4} f_{ij} w_i \geq V \\ \sum_{i=1}^{20} w_1 = 1 \\ 0 \leq w_{\min} \leq w_i \leq w_{max} \end{cases} \tag{14}$$

where w_i is a relative share of resources available for the digital economy cluster development, aimed at the implementation of i^{th} strategy, w_{min} and w_{max} are, respectively, the least and most expected values, which in practice should be identified by expert assessment, f_{ij} is F matrix elements, V is an integral indicator of digital economy clustering efficiency and digital economy cluster performance. Having reduced the model to an equivalent form:

$$g = \sum_{i=1}^{4} t_i = \frac{1}{V} \rightarrow \min \tag{15}$$

$$\begin{cases} \sum_{j=1}^{4} f_{ij} t_i \geq 1 \\ t_i = \dfrac{w_j}{V} \\ 0 \leq t_{\min} \leq t_i \leq t_{\max} \end{cases} \tag{16}$$

we shall solve the problem and obtain the result: w_1 =0.2847, w_2 =0.2293, w_3 = 0.2563, w_4 =0.2297, V=0.2834. Thus, per Wald criterion, to ensure the digital economy clustering efficiency and digital economy cluster performance in the amount of 28.34%, it is advisable to allocate 28.47% of resources available to the implementation of the economic strategy, 22.93% – to the environmental strategy, 25.63% – to the social strategy, 22.97% – to the innovative strategy of digital economy cluster development.

2. The optimization when the empirical expected distribution of environmental conditions is known, in our case this is the average expected level of performance for each indicator group. We shall denote this distribution $\lambda = (\lambda_1;\lambda_2;\lambda_3;\lambda_4), 0 \leq \lambda_1 \leq 1, \sum_{i=1}^{4} \lambda_1 = 1$. In this case, the Bayes criterion is applied. We shall obtain the following model:

$$z=V\rightarrow \max, \tag{17}$$

subject to

$$\begin{cases} \sum_{j=1}^{4} \lambda_1 f_{ij} w_i \geq V \\ \sum_{i=1}^{20} w_i = 1 \\ 0 \leq w_{\min} \leq w_i \leq w_{\max} \end{cases} \tag{18}$$

In practice, application of such model is advisable only after a certain time period elapsed since the start of the activity in the cluster, in such case there is a possibility to assess the value λ=(λ1;λ2;λ3;λ4) empirically.

3. The optimization when the expected distribution of priorities of the decision-making subject is known, in our case this is the average expected level of financial (organizational, etc.) support for a certain indicator group. We shall denote this distribution $\mu=(\mu_1;\mu_2;\mu_3;\mu_4)$, $0\le\mu_i\le 1$, $\sum_{i=1}^{4}\mu_i=1$. We shall obtain the following model:

$$z=\sum_{i=1}^{4}\frac{\mu_1 w_1}{v}\rightarrow \min, V\rightarrow \max \tag{19}$$

subject to

$$\begin{cases} \sum_{j=1}^{4} f_{ij}\mu_i w_i \ge V \\ \sum_{i=1}^{20}\mu_i w_i = 1 \\ 0\le w_{\min}\le w_i\le w_{\max} \end{cases} \tag{20}$$

This study proposes the analysis of the influence of the binary and trinary combination of various strategies of digital economy cluster development on the expected digital economy clustering efficiency and digital economy cluster performance using the developed economic and mathematical mod with the Savage criterion. The developed economic and mathematical model of enterprise clustering efficiency and digital economy cluster performance facilitates a large number of combinations of types of development strategies for digital economy clusters by taking economic, environmental, social and innovative measures that influence various groups of efficiency indicators. We shall consider the influence of all possible variations of the binary combination of different types of development strategies on the digital economy clustering efficiency and digital economy of cluster performance:

1. Economic and environmental development. In this case, the following values are assigned: $\mu_3=\mu_4=0$, $\mu_1>0$, $\mu_2>0$, $\mu_1+\mu_2=1$. We also considered the values of weight coefficients as variables. Subsequent to the implementation of the model, we obtained the following result: $w_1=0.6802$, $w_2=0.3198$, $w_3=0$, $w_4=0$, V=0.2621.
2. Economic and social development. In this case, the following values are assigned: $\mu_2=\mu_4=0$, $\mu_1>0$, $\mu_3>0$, $\mu_1+\mu_3=1$. Subsequent to the implementation of the model, we obtained the following result: $w_1=0.6599$, $w_2=0$, $w_3=0.3401$, $w_4=0$, V=0.2788.
3. Economic and innovative development. In this case, the following values are assigned: $\mu_2=\mu_3=0$, $\mu_1>0$, $\mu_4>0$, $\mu_1+\mu_4=1$. Subsequent to the implementation of the model, we obtained the following result: $w_1=0.6394$, $w_2=0$, $w_3=0$, $w_4=0.3606$, V=0.2957.
4. Social and environmental development. In this case, the following values are assigned: $\mu_1=\mu_4=0$, $\mu_2>0$, $\mu_3>0$, $\mu_2+\mu_3=1$. Subsequent to the implementation of the model, we obtained the following result: $w_1=0$, $w_2=0.2768$, $w_3=0.7232$, $w_4=0$, V=0.2269.
5. Social and innovative development. In this case, the following values are assigned: $\mu_1=\mu_3=0$, $\mu_2>0$, $\mu_4>0$, $\mu_2+\mu_4=1$. Subsequent to the implementation of the model, we obtained the following result: $w_1=0$, $w_2=0.3156$, $w_3=0$, $w_4=0.6844$, V=0.2587.
6. Innovative and environmental development. In this case, the following values are assigned: $\mu_1=\mu_2=0$, $\mu_3>0$, $\mu_4>0$, $\mu_3+\mu_4=1$. Subsequent to the implementation of the model, we obtained the following result: $w_1=0$, $w_2=0$, $w_3=0.4358$, $w_4=0.5642$, V=0.2753.

Study results of the influence of binary combination of cluster development strategy types on digital economy clustering efficiency and digital economy cluster performance are displayed in Table 4.

Table 4
Study results of the influence of binary combination of cluster development strategy types on digital economy clustering efficiency and digital economy cluster performance

Variants of digital economy binary development	General efficiency indicator	Relative frequency, w_i			
		w_1	w_2	w_3	w_4
Economic and innovative	0.2957	0.6394	0	0	0.3606
Economic and social	0.2788	0.6599	0	0.3401	0
Innovative and environmental	0.2753	0	0	0.4358	0.5642
Economic and environmental	0.2621	0.6802	0.3198	0	0
Social and innovative	0.2587	0	0.3156	0	0.6844
Social and environmental	0.2269	0	0.2768	0.7232	0

Comparison of influence of binary combination of various cluster development strategy types revealed that the combination of economic and innovative strategy types influences the enterprise clustering efficiency and digital economy cluster performance the most. This will provide for the expected integrated efficiency in the amount of 29.57% after three years of digital economy cluster performance.

We shall consider the influence of all possible variations of the trinary combination of different types of development strategies on the digital economy clustering efficiency and digital economy of cluster performance:

1. Social and economic and environmental development. In this case, the following values are assigned: $\mu_4=0$, $\mu_1>0$, $\mu_2>0$, $\mu_3>0$, $\mu_1+\mu_2+\mu_3=1$. Subsequent to the implementation of the model, we obtained the following result: $w_1=0.3964$, $w_2=0.3010$, $w_3=0$, $w_4=0.3026$, $V=0.2475$.
2. Economic and social and innovative development. In this case, the following values are assigned: $\mu_2=0$, $\mu_1>0$, $\mu_3>0$, $\mu_4>0$, $\mu_1+\mu_3+\mu_4=1$. Subsequent to the implementation of the model, we obtained the following result: $w_1=0.4010$, $w_2=0$, $w_3=0.2993$, $w_4=0.2997$, $V=0.2455$.
3. Social and innovative and environmental development. In this case, the following values are assigned: $\mu_1=0$, $\mu_2>0$, $\mu_3>0$, $\mu_4>0$, $\mu_2+\mu_3+\mu_4=1$. Subsequent to the implementation of the model, we obtained the following result: $w_1=0$, $w_2=0.3333$, $w_3=0.3333$, $w_4=0.3333$, $V=0.2732$.
4. Economic and innovative and environmental development. In this case, the following values are assigned: $\mu_3=0$, $\mu_1>0$, $\mu_2>0$, $\mu_4>0$, $\mu_1+\mu_2+\mu_4=1$. Subsequent to the implementation of the model, we obtained the following result: $w_1=0.3643$, $w_2=0.3178$, $w_3=0$, $w_4=0.3178$, $V=0.2605$.

Study results of the influence of trinary combination of cluster development strategy types on digital economy clustering efficiency and digital economy cluster performance are displayed in Table 5.

Table 5
Study results of the influence of trinary combination of cluster development strategy types on digital economy clustering efficiency and digital economy cluster performance

Types of cluster development strategy	Average value	Relative frequency, w_i			
		w_1	w_2	w_3	w_4
Social and innovative and environmental	0.2732	0	0.3333	0.3333	0.3333
Economic and innovative and environmental	0.2605	0.3643	0.3178	0	0.3178
Social and economic and environmental	0.2475	0.3964	0.3010	0	0.3026
Economic and social and innovative	0.2455	0.4010	0	0.2993	0.2997

Comparison of influence of trinary combination of various cluster development strategy types revealed that the combination of social, innovative and environmental strategy types influences the enterprise clustering efficiency and digital economy cluster performance the most. This will provide for the expected integrated efficiency in the amount of 27.32% after three years of digital economy cluster performance. The developed economic and mathematical model facilitated the identification of the influence of binary and trinary combination of different development strategy types for digital economy clusters on the expected integral efficiency of digital economy clustering and digital economy cluster performance (Fig. 2).

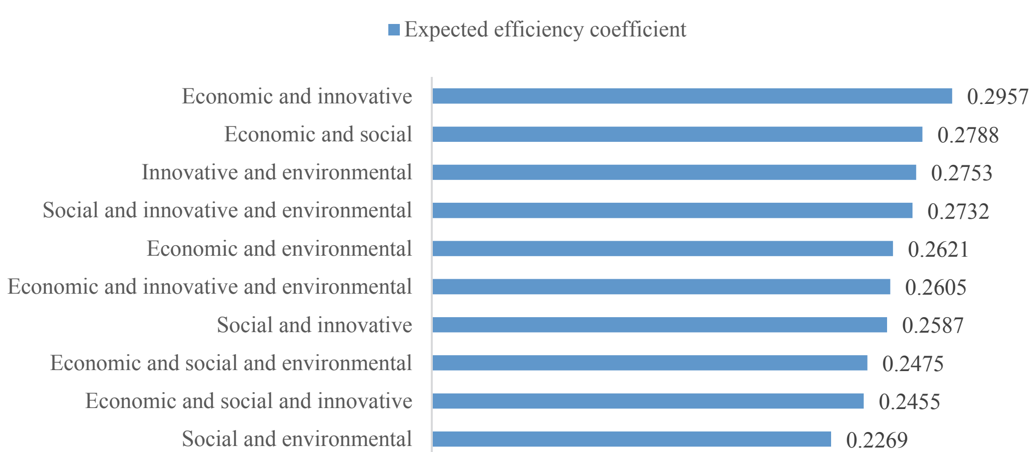

Fig. 2. Results of comparison of the influence of binary and trinary combination of different development strategy types for digital economy clusters on digital economy clustering efficiency and digital economy cluster performance

Comparison of impact of binary and trinary combination of various development strategy types for digital economy clusters revealed that the combination of economic and innovative strategies influences the digital economy clustering efficiency and digital economy cluster performance the most. This will provide for the expected integrated efficiency in the amount of 29.57% after three years of digital economy cluster performance.

For obvious reasons, Kazakhstan also strives to jump on the bandwagon. "Digitalization is not a goal, it is a means of achieving the supremacy of Kazakhstan. A self-respecting country cannot do without it. If we do not win the competition, we will lag behind and eat the dust fed to us by the advancing countries," said President Nursultan Nazarbayev.

For the implementation of the assignments of the Head of state, at the end of 2017, the Digital Kazakhstan State Program was adopted. The program envisages the increase in the share of e–commerce to 2.6%, and in electronic public services – up to 80%. With that, it is planned to create 300 thousand new jobs by means of digitalization. All this should be done by 2022. As Nursultan Nazarbayev noted, "the digitalization should facilitate the increase of Kazakhstani economy by 30%, in monetary terms, it will be over 2 billion tenges" ("Digital Kazakhstan"…, 2017).

Informational Kazakhstan-2020 State Program, approved in 2013, became the foundation for the digital transformation of the country's economy and contributed to the development of the following factors: transition to the information society, improvement of public administration, creation of institutions of "open and mobile government" and growth of availability of information infrastructure not only for corporate structures, but also for the citizens of the country. Informational Kazakhstan-2020 State Program includes 83 target indicators and 257 activities. As per results of three years of implementation of Informational Kazakhstan-2020 State Program, 40% has already been achieved. However, the rapid development of information technology on a global scale dictates its own rules and requires an adequate and timely response on the part of our government. Thus, it is necessary to take the next step – to timely initiate the process of transformation for the key sectors of the national economy, education, healthcare, including the sphere of interaction of the state with society and business. The purpose of Digital Kazakhstan State Program (hereinafter referred to as “the Program”) is to improve the quality of life and competitiveness of the economy of Kazakhstan through progressive development of the digital ecosystem. The program is aimed at development of the following areas:

1. Digital Silk Road – creation of a high-tech digital infrastructure by providing broadband Internet access in rural settlements; development of telecommunication hub; information security; construction of data processing centres, etc.

2. Creative society – development of human capital by improving digital literacy, advanced training for specialists in the field of information and communication technology, creative thinking development, etc.

3. Digital transformations in the economy sectors – development of the digital industry by automating the transport and logistics system of the country; implementation of digital technology in the agriculture and industry; implementation of analytical systems in the field of energy saving and energy efficiency; development of e-commerce; improvement of the mineral resources accounting systems; ensuring the preservation and accessibility of digital geological information; implementation of technology for creating smart cities, etc.

4. Proactive state – formation of digital government by further development of electronic and mobile government; increase of public services provided in electronic form; formation of open government; development of national spatial data infrastructure, etc.

The Program is developed in accordance with the Address of the President of the Republic of Kazakhstanб Nursultan Nazarbayev, to the people of Kazakhstan, Kazakhstan Way – 2050: One Goal, One Interest, One Future, 100 Steps Short-Term Anti-Crisis Strategy, Nurlyzhol Infrastructure Development Program and Laws of the Republic of Kazakhstan "On Electronic Document and Electronic Digital Signature", "On Communication", and "On Informatization". According to these documents, improvement of the quality of life of citizens, the development of economic, socio-political and cultural spheres of society, including improvement of the system of public administration are the main principles and vector of digital transformation development proposed by this Program.

To date, Kazakhstan has achieved steady progress towards the increase in the capacity of traditional telecommunications. In providing the shortest route for information flows between Europe and Asia, Kazakhstan strengthens its competitive advantage in the international traffic transit market. Acting as a coordinator of interregional initiatives, for example, the TASIM network project –Trans-Eurasian Information Super Highway, Kazakhstan contributes to the integration of data exchange centres in Western Europe and Asia. Analysis of the UN Economic and Social Commission for Asia and the Pacific (UN ESCAP) indicated that Kazakhstan has a leading position in terms of the capacity of international communication channels in the region. The current share of Kazakhstan in Europe – Asia land transit is 10%. With that, traffic in this direction currently reaches 75 Gb/s.

The main underdeveloped areas in the development of BBA are still the rural settlements (hereinafter referred to as “the RS”). If the density of urban Internet users at the end of 2015 was 76.4%, in RS this indicator amounted to 68.3%. Overcoming the information inequality of the regions is complicated by the size of the country (about 6723 villages and townships at the beginning of 2016), the presence of a large number of settlements located in the distant and inaccessible areas.

Overcoming the information inequality of the country's regions will be at the expense of further development of digital terrestrial television and promotion of BBA development in the rural areas of the Republic of Kazakhstan. In accordance with the regional frequency plan of the Republic of Kazakhstan, it is planned to complete the construction and reconstruction of 827 regional transport systems that will provide 95% coverage of the population of the Republic of Kazakhstan with digital terrestrial television by 2019. The use of different support mechanisms for the construction of BBA infrastructure in the RS will make the Internet accessible for 72% of rural residents by 2020.

To improve the digital literacy of the populationб within the framework of the Program, a complex of training materials will be developed and the process of training for all segments of the population in all regions of Kazakhstan will be organized.

The transport and logistics system is the main tool for the implementation of economic relations between the regions of Kazakhstan, including the main conductor of the export of the Kazakh goods to the world markets.

Currently, the e-commerce market in Kazakhstan is regulated by the Rules of e-commerce, approved by the Order of the acting Minister of National Economy of the Republic of Kazakhstan No. 720 dated November 25, 2015. With that, it is noteworthy that in Kazakhstan the transactions, concluded in the process of e-commerce, are regulated by the same documents as conventional transactions. One of the recent developments in the e-commerce was the President's signing of the Law of the Republic of Kazakhstan "On Payments and Payment Systems" aimed at protecting the interests of consumers of payment services. As for the delivery of goods, to date, the internal logistics matches international standards and competition in this market is present in big cities. The greatest necessity is in qualitative logistics in the remote regions of Kazakhstan.

In this regard, to date, large Internet-shops deliver their goods by their own efforts or establish their courier services to develop the level of service and build trust. However, courier services of Internet-shops are focused only on the urban population and it is difficult to refer to qualitative service in the rural areas. To this end, within the framework of the Program, the development of transport and logistics infrastructure in the distant regions will increase the level of goods delivery service.

An important aspect of development is the establishment of a financial centre with the aim of accessing larger markets in the region. The development of the international financial centre, by means of a highly efficient digital infrastructure, will facilitate the entrance into larger markets in the region, the transaction cost reduction for investors, will provide opportunities for investment diversification and efficient capital allocation and attract large enterprises from Central Asia.

Given that each city struggles with its own problems (specifics of the economic structure and the needs of cities) and their solutions for the implementation of the goal on the development of "smart cities" in the Republic of Kazakhstan, it is necessary to create the Smart City Concept for each city or region of Kazakhstan, which should contain all the factors determining the direction of urban development, strategic priorities, business principles and technology of documentation and clarification of tasks and projects.

5. Conclusions

Methodological framework for modelling the digital economy clustering efficiency and digital economy cluster performance was developed, providing for the identification of integral indicators of economic, social, environmental, and innovative efficiency. And which are based on the economic and mathematical model that facilitates the implementation of a large number of combinations of development strategy types for digital economy clusters, in particular through binary or trinary combination, by means of carrying out an action plan of economic, environmental, social, and innovative nature, which influence the level of integrated efficiency. According to the comparison results for the influence of binary and trinary combination of various development strategy types for digital economy clusters, it was established that the combination of economic and innovative development strategy types influences the digital economy clustering efficiency and the digital economy cluster performance. This will provide for the expected integrated efficiency of digital economy clustering in the amount of 29.57% after three years of digital economy cluster performance.

In the 1990s, the state program on forced industrial and innovative development was launched, the Bolashak International Education Program was initiated. In 2005, the formation of e-government began. In addition, Kazakhstan has already created a number of elements of the innovative ecosystem with a special economic zone – the Alatau Park of Innovative Technology, and Nursultan Nazarbayev University. Astana Hub International Technopark is being launched. Per preliminary calculations, the direct effect from the digitalization of the economy of Kazakhstan by 2025 will allow to create an added value in the amount of 1.7-2.2 billion tenges, thus yielding 4.8-6.4 times the return from investment to the total investment by 2025, private investment included.

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