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Article

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Prospects for Digitalization of Energy and Agro-Industrial Complex of Kazakhstan

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ABSTRACT

The goal of this paper is to analyze the management efficiency of the energy industry and the agro-industrial complex based on the introduction of digitalization to stimulate economic growth in Kazakhstan. When writing the work, the following research methods were used - bibliometric, statistical, factorial, grouping and generalization, regression, comparative. Results - an economic assessment of the development of the electric power industry and the agro-industrial complex was carried out. It is noted that the economy of Kazakhstan is quite energy-intensive and costly. It is shown that the increasing level of agricultural production exceeds the demand for electricity consumption. The serious deterioration of electrical equipment and agricultural machinery has been identified, which is a barrier to the promotion of digital technologies. The stimulation of the growth of electricity generation from renewable energy sources based on the use of innovative and digital technologies is analyzed. The modeling of the development of the agro-industrial complex is carried out on the basis of the use of information, communication and digital technologies of smart farms on the example of the Almaty region. Presented and summarized measures for the implementation of innovative projects in digital energy and smart agriculture. The problems and recommendations are given for accelerating the implementation of digitalization in the energy sector and the agro-industrial complex. The role of digital and electronic technologies in agriculture and the energy complex in promoting the economic growth of Kazakhstan has been substantiated.

Keywords: Electricity, Agro-industrial Complex, Digitalization, Renewable Energy Sources, Smart Farms, Information and Communication Technologies, Kazakhstan
JEL Classifications: L94, M15, P28, Q12, Q13, Q16

1. INTRODUCTION

At the end of 2019, a dangerous COVID 19 infection appeared all over the world. Let us highlight that the pandemic has accelerated and stimulated the introduction of ICT. In 2022, some positive trends in the recovery of the global economy can be predicted. This will obviously lead to an increase in demand for energy resources and consumption of agricultural products.

According to international organizations, the economic growth of Kazakhstan in 2021 will be equal approximately - 3.8%, 2022. - 4.2%, 2023 - 5%. While in 2020 there was an economic downturn to minus 2.6%. The main reason for the economic downturn was associated with a decrease in aggregate demand due to the quarantine measures introduced.

It is worth noting that today the country is one of the most energy-intensive countries in the world. In particular, our economy is

3 times energy intensive compared to the OECD countries. This characterizes the low material and technical base for the qualitative development of companies in the real sector of the economy. According to Magazzino et al. (2021) Information Technology (IT) is an important driver of economic growth. At the same time, digital technologies really increase energy consumption.

In Kazakhstan, about 7-8 years ago, there was a surplus of electricity. That is, the country produced more than it consumed. True, due to economic growth, there is a shortage of energy capacity. For example, in 2021, consumption growth increased to 8% on average. And on average, over the past 6-7 years, consumption growth has been within 3%.

Today, the process of agricultural production depends on the generation of electricity. In Kazakhstan, there is an acute shortage of wireless and fixed networks, power lines, power plants, especially in rural areas. It should be noted that the population of rural areas is small. Therefore, the use of smart technologies in the power industry does not always cover costs quickly. In this regard, note Klaniecki et al. (2020) - government support is needed for the energy sector in the development of digitalization and ICT at the rural level.

Currently, the agro-industrial complex is one of the priority sectors, because. directly contributes to food security. More than 40% of the republic's citizens live in rural areas. Over the past three years, agriculture provides about 5% of GDP. In particular, the volume of agricultural production has risen 1.6 times over the past 3 years. And according to the results of 2020. the volume of agricultural products has already amounted to 14.7 billion US dollars. At the same time, we note that the average annual rate of increase in labor productivity reached 18%. More than 15% of all labor resources work in this industry.

It should be noted that there is a serious problem - this is that the power transmission networks are worn out. So, in some regions, the wear factor is in the range of 60-80%. In addition, the main power generating facilities were built on coal more than 50 years ago.

We emphasize that the increase in agricultural production and land degradation processes have led to a decrease in soil fertility and salinity. At the same time, this affected the decrease in the productivity of agricultural plants and the environment. Here, a significant share of greenhouse gas emissions - more than 9% - is associated with agricultural activities.

The current lack of development of IT infrastructure and power plants in rural areas leads to a decrease in the potential of the agro-industrial complex. Benedek et al. (2018) showed the significant role of renewable energy in rural development.

Therefore, we believe that the production of agricultural products and electricity generation, especially in the context of COVID, will depend on the quality of the introduction of new digital technologies in both the energy sector and the agro-industrial complex.

2. LITERATURE REVIEW

From the point of view of Lange, Pohl, Santarius (2020), digitalization has a direct impact on the optimal use of energy. In particular, the use of ICT methods can improve energy efficiency and energy production, which stimulate economic growth.

The application of new information technologies (Dameto, Chaves-Ávila & San Román, 2020) stimulates the optimization of tariffs in the distribution of electricity network volumes.

Bansal (2019) notes that smart grids optimize the generation and transformation of electricity to create a safe technology for its consumption.

A few years ago, studies were carried out on the impact of ICT and the Internet on the environment. It has been substantiated that ICT and innovative technologies do not have a negative impact on climate and carbon emissions (Salahuddin et al., 2016).

Smagulova et al. (2015) substantiates the role of the electric power industry as an important sector of the national economy. At the same time, the lack of energy capacities is emphasized due to the significant wear and tear of equipment at power plants. A fairly high energy intensity in the production of industrial products was noted. This characterizes the need to introduce new energy-saving technologies. At the same time, there are problems of greenhouse gas emissions, including through food production (Smagulova et al., 2017).

The use of an intelligent power grid process has improved the output and energy efficiency of power plants. Smart grids, according to Mbungu et al. (2019), should use renewable energy sources. In turn, RES due to the implementation of the smart grid methodology have almost zero emissions into the atmosphere and protect the country's ecology.

Electronic and digital data can increase security and performance in the energy system, argue Rosetto and Reif (2021) in their article. They write that the digitalization of energy infrastructure has a positive effect on decarbonization and growth in the capacity of generating assets.

Evagelos and Chrysanthi (2020) believe that smart agriculture contributes to the production of healthy food commodities for the population. At the same time, important attention is paid to the issues of maintaining the environment and reducing harmful emissions from the use of land and arable land. The results of the study proved that intelligent agricultural technologies have a positive impact on the environment.

Digital agriculture is based on the use of blockchain, artificial intelligence, vertical farming. Klerkx and Rose (2020) argue that the future development of the agro-industrial complex is related to Agriculture 4.0 technologies.

State support plays an important role in the development of smart technologies in the energy sector. This increases energy production and reduces losses during its transportation. This is especially important for stimulating production in rural areas (Hlavacek and Skalník, 2021). Intelligent energy solutions contribute to the creation of Smart Villages.

According to Eastwood et al. (2019) the use of smart farming methodology provides farmers with opportunities to increase agricultural production based on increased labor productivity. Here, the role of the farm administration in improving the development of information skills is substantiated.

Rolandi et al. (2021) conduct a study on the basics of digitalization of the agro-industrial complex in rural areas. It provides for an analysis of the prospects and risks of introducing innovations and digital methods used in the agro-industrial complex.

In recent years, in the developed countries of Europe and the United States, great emphasis has been placed on the use of renewable energy sources. Here, too, special attention is paid to the use of geographic information systems. In particular, de Livio et al. (2019), Denarié et al. (2021) say that such systems evaluate the management and planning of renewable energy projects.

Wind, water and solar energy are natural fuels. They provide increased power generation (Sarkodie et al., 2020). Such sources are of particular importance for the growth of energy consumption.

To organize a low-carbon economy, it is necessary to attract large investments in the republic. According to Naumann and Rudolph (2020), renewable energy should be developed more widely.

There are many rural areas in Kazakhstan that have problems with lack of electricity. This is due to the large territory of the republic and remoteness from the electrical infrastructure. Shorabeh et al. (2021) consider that fossil fuels are therefore emerging as a potential solution for increasing electricity supply. In addition, the use of geographic information systems in rural areas makes it possible to quickly process big data.

3. ANALYSIS OF THE ENERGY OF KAZAKHSTAN

The energy sector of the republic consists of such priority areas: electric power industry and oil and gas industry. The nuclear industry today is at the stage of formation and active development.

If you look at the sectors of the economy, then the main consumer of electricity is industry, about 60%.

At the same time, agriculture accounts for <10% of energy consumption. This is due to the fact that in rural areas there is not enough production capacity. There is also a shortage of power lines in remote rural areas.

In the agro-industrial complex, the issues of updating agricultural equipment continue to be acute. For some types of equipment, wear from 40-70% is observed. From the standpoint of yield growth, about 10-15% of agricultural machinery should be updated annually. Thus, an old tractor loses more than 15% of the crop, while new equipment loses no more than 3-5%.

In our country, as well as around the world, there has been a sharp rise in food prices. Thus, in the fall of 2021, there was an increase in prices for food products at the level of 10-11% (sugar, vegetable oil, vegetables, cereals).

Kazakhstan is affected by such factors: the increase in the cost of production, the introduction of a lockdown due to the pandemic and the growth of the global market. In addition, a serious reason for the rise in prices is the increase in the cost of fuel and lubricants.

Let's consider the general economic indicators of the development of the electric power sector and the agro-industrial complex of the republic (Table 1).

There is an absolute positive increase in the amount of electricity generation in 2017 and 2018. In general, the growth rate in 2020 compared to 2014 is 92%, and the growth rate - is minus 7.92. Almost the same picture is presented at the level of electricity consumption. Here, the growth rate is −97.1%, and the growth rate is minus 2.8%.

Serious reasons for such a negative situation can be noted the presence of energy losses in the networks, which constitute a negative value of the growth rate - minus 16.86%.

The state of the growth rate of the level of depreciation of fixed assets in the electric power industry - 225% - causes serious concern. This characterizes a rather critical situation in the renewal of the material and technical fleet of power plants.

These energy losses are associated with high wear and tear of electrical engineering. In addition, a significant part of energy losses is associated with transmission over overhead power lines. At the same time, positive average growth rates of agriculture are visible, which amount to 4.6%. At the same time, the increasing growth rate of investment inflow into the agro-industrial complex - 52.7% - indicates significant prospects for increasing activity in this area. While the growth rate of electricity generation is much less than in the agricultural sector.

From this we can conclude that in the coming years, the production energy capacity may not be enough to maintain higher rates of agricultural production.

We emphasize that electricity consumption has been growing in recent years. According to Table 2, it can be seen that only three regions are energy surplus - Pavlodar, Atyrau and North Kazakhstan regions. Other regions are energy deficient, where consumption is higher than production.

The growth in consumption can be associated not only with an increase in the production of agricultural products, manufacturing industry, but also with the introduction of digital technologies.

Table 1: Main indicators of the state of the Electricity and agro-industrial complex

Indicators	2014	2015	2016	2017	2018	2019	2020	Growth rate 2020/2014 (%)	Rate of increase (%)
GDP, billion US dollars	227,44	184,36	137,28	159,4	170,54	181,67	169,8	74,6	−25,34
Share of Electric Power Industry in GDP, %	1,8	1,4	1,6	1,7	1,9	2,3	3	166	66,6
Electricity production, billion kWh	94,6	91,6	94,1	102,4	106,8	86,0	87,1	92	−7,92
Electricity consumption, billion kWh	89,2	90,5	92, 3	97, 8	103,2	85,3	86,7	97,1	−2,8
Network losses, %	8,3	6,38	6,47	7,79	7,65	6,5	6,9	83,1	−16,86
Electricity export, billion kWh	1,6	1,5	2,9	5,8	4,9	−4,2	−1,7	−106,3	−206,3
Electricity imports, billion kWh	3,1	0,9	1,1	1,2	1,3	1,1	1,2	38,7	−61,3
Depreciation rate of fixed assets, %	40	52	57	65	70	82	90	225	125
Final energy consumption by Industry, thousand tons of oil equivalent	18 108,6	16 178,1	16 498,9	16 615,4	15 013,6	13 101	12 200	67,3	−32,7
Final energy consumption in Agriculture, thousand tons of oil equivalent	893,6	721,9	732,2	860,1	1 650,3	869	1 730,2	193,6	93,6
agriculture in the structure of GDP, %	4,3	4,8	4,6	4,5	4,5	4,4	5,1	118,6	18,6
attraction of investments in agriculture, US dollars	967,0	739,2	741,4	1 068,4	1 119,6	1 435,9	1 477,1	152,7	52,7
the level of depreciation of fixed assets in agriculture	38	34	40	42,4	43	43,3	40	105,2	5,2

Source: Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan. (2021), Main socio-economic indicators of the Republic of Kazakhstan. Accessed from https://stat.gov.kz/for_users/dynamic

Table 2: Change in electricity consumption, 2020-2021

Electrical balance. January-September (billion kwh)					
Republic of Kazakhstan	Production		Consumption		Balance, %
	2021	2020	2021	2020	
	83,62	77,64	82,8	77,43	100.9
Pavlodar region	36,57	30,85	15,91	15,00	229,8
North-Kazakhstan region	2,06	2,38	1,31	1,24	157,2
Atyrau region	5,06	4,53	4,80	4,59	105,4
East-Kazakhstan region	6,87	6,98	6,89	6,74	99,8
Mangistau region	3,72	3,73	3,91	3,73	95,2
West-Kazakhstan region	1,76	1,66	1,87	1,64	94,1
Karaganda region	11,51	12,22	13,88	13,41	82,9
Almaty region	5,07	5,21	8,87	7,97	57,2
Aktobe region	2,73	2,91	5,07	4,87	53,8
Akmolinsk region	3,84	3,29	7,31	6,40	52,5
Zhambyl region	1,95	1,66	3,90	3,57	49,9
Kyzylorda region	0,46	,37	1,43	1,23	31,9
Turkestan region	1,29	1,08	4,21	3,73	30,7
Kostanay region	0,74	0,77	3,52	3,32	20,9

Source: Azattyq-ruhy. (2021), Electricity shortage threatens Kazakhstanis in winter – analysts. Accessed from https://rus.azattyq-ruhy.kz/economics/29866-defitsit-elektroenergii-grozit-kazakhstantsam-zimoi

This is especially true at the level of occurrence of COVID 19 over the past 2 years!

If such consumption growth rates continue, then already in 2022 there will be a shortage of energy production in the country.

Currently, there are 155 power plants in Kazakhstan. In terms of the structure as a whole, a large share of the distribution of electricity production falls on thermal and gas turbine power plants (up to 88.5%). At hydroelectric power plants and renewable energy facilities - 8.3% and 3.2%, respectively.

We highlight that 48% of energy generation is produced by state-owned companies. Therefore, the main problem here is that such a large percentage of state participation in the energy sector leads to non-competitiveness.

A large number of hydro power plants are located in East Kazakhstan. But their hydro potential is also limited.

The largest region is the Pavlodar region, where more than 40% of the share of electricity generation in the country is concentrated. This region supplies energy to the southern and northern zones of the Unified Electric Power System of our republic. In particular, an increase in the capacity of the power units of Ekibastuz GRES-1, GRES-2, a turbine unit at Aksuskaya GRES and the construction of innovative power lines will lead to an increase in electricity by 650 MW in the total volume of the National Electric Grid. In addition, after the repair of the power unit at the Ekibastuz GRES-2, an additional 500 MW of energy will be received by the beginning of 2022. All these activities will be carried out by attracting budgetary funds and foreign investors.

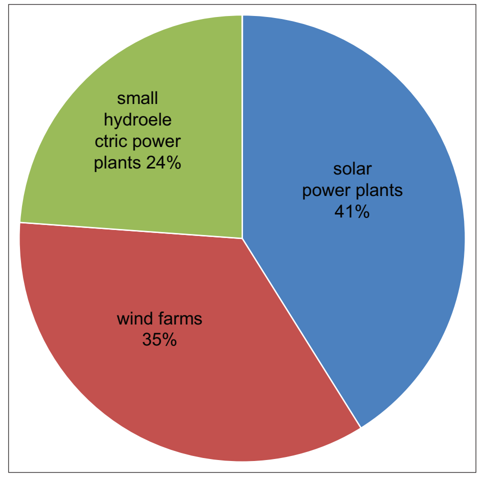
The most energy-deficient region in the country is the Southern zone of the Unified Electricity System (UES) of Kazakhstan. So, in 2021, consumption here increased by 12%. This leads to an imbalance in generation and an overload of electricity transit by 500 kV in the North-South direction. Therefore, the load on the work of Zhambyl GRES named after A. T.I. Baturov. In this regard, it is necessary to start restoring the 4th and 5th blocks of this state district power station in the Southern region. This will make it possible to increase the generation of electricity in the future. Due to the wear and tear of electrical networks and equipment, repairs at block power plants have become more frequent here. Until now, the issues of fuel supply have not been fully resolved. As a result, this increases the energy deficit and the supply of electricity.

The southern and eastern zones are provided with electricity by a large station - the Moinak hydroelectric power station. There are also certain problems here. In particular, one can highlight the lack of water resources, most of the power plants at power plants are in disrepair and require unscheduled repairs. This leads to restrictions and uneven supply of electricity in the marked areas.

So, in 2022, the project will begin to be implemented and the launch of new generating capacities to transfer the Almaty Thermal power plants (TPP)-2 to gas. This thermal power plant provides the entire large southern region of the republic. This project is of strategic importance for providing electricity to enterprises and the population of the largest city of Kazakhstan - Almaty. In addition, the modernization of the Almaty TPP-2 will seriously affect the solution of environmental problems and the decarbonization of the industrial sector.

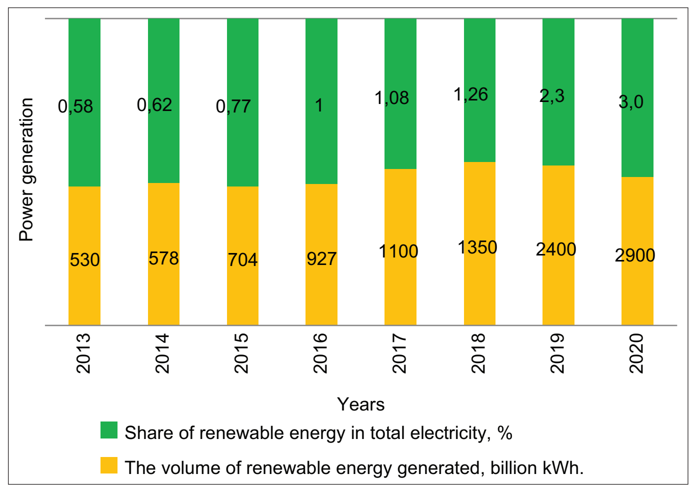
In terms of structure, electricity generation from renewable energy sources (RES) is mostly produced by solar power plants (41%). Least of all is produced at small hydroelectric power plants - 24% (Figure 1). The share of RES in total accounts for the generation of electricity only 3%. Thus, the production capacity of energy generation through the use of renewable energy sources has increased over the past 5 years - from 927 MW in 2016 to up to 2900 MW in 2020 (more than 3 times). In 2021, there will be a further increase in RES capacity over 3000 MW (Figure 2).

Figure 1: Electricity generation from renewable sources



Source: Ministry of Energy of the Republic of Kazakhstan. (2021), The investment headquarters reviewed the progress of projects in the fields of renewable energy and healthcare. Accessed from https://www.gov.kz/memleket/entities/energo/press/news/details/282045?lang=ru

Figure 2: The volume of electricity generation from renewable energy sources (RES), 2013-2020



Source: Uchet. (2020), Development of the energy sector of Kazakhstan in 2020. Accessed from: https://uchet.kz/news/razvitie-energeticheskoy-otrasli-kazakhstana-v-2020-godu

Obviously, this is still very little for a country where a lot of electricity is needed for the activity of the real sector of the economy and, especially, for the agro-industrial complex.

Today, the fuel and energy basket of our country consists of 54% coal, 24% oil and 22% gas. However, already in 20 years, the share of fossil energy resources will decrease by at least 3 times, and the share of renewable energy sources will increase by 20 times.

Over the past 8 years, more than 3.5 billion US dollars have been attracted to renewable energy projects. At the same time, incl. $350 million for 9M 2021. 126 renewable energy facilities were put into operation with a total power generation capacity of 1975 MW.

An important factor in the growth of energy consumption is the increase in digital projects against the background of the pandemic. Electronic and digital technologies contribute to the growth of energy consumption in 2020 and 2021, which has led to its shortage.

4. DATA AND METHODOLOGY

4.1. Data

During the simulation, the methodology for compiling questionnaires was used. All questions were measured on a seven-point Likert scale from 1 to 7. Questions ranged from "strongly disagree" (1) to "strongly agree" (7). After the survey was completed, all collected data was specially coded.

Statistical data on small and medium-sized enterprises in the agro-industrial complex were taken from the Agency for Strategic planning and reforms of the Republic of Kazakhstan Bureau of National statistics and National Bank of Kazakhstan.

4.2. Methods

In order to evaluate the data obtained, the software with a graphical interface "SmartPLS" was used. The software uses Partial Least Squares (PLS) to perform latent variable path (LVP) estimation. "SmartPLS" calculates standard criteria for analyzing significance results using statistical methods.

The general basic model for multidimensional PLS is as follows:

$$X = TPT + E \quad (1)$$

$$Y = UQT + F \quad (2)$$

Where X is $n * m$ - matrix of predictors, Y is $n * p$ - matrix of responses, T and U are located at the level of $n * l$ matrices, which are projections of X and Y; n and Q are the $m * l$ and $p * l$ of the orthogonal matrix loading.

And matrices E and F are erroneous independent terms.

The X and Y values are designed to maximize the covariance between T and U.

The data obtained after coding are entered into the "SmartPLS" program and testing is carried out to build a model and obtain final results.

5. MODEL RESULTS

In the republic in 2021, 1,610,496 small and medium-sized businesses were registered. If you look at the regions, the leaders are Turkestan, Almaty and Akmola regions.

As of the end of 2021, the size of small and medium-sized enterprises (SMEs), including farms, increased by about 2% compared to the previous period. In the structure of SMEs, the share of peasant/farm enterprises in the Almaty region was about 34%. The volume of gross value added (GVA) for the Almaty region amounted to 35%, which is 1% higher than the general republican level (Table 3).

In Kazakhstan, investments in agriculture in 2021 compared to 2020 increased by more than 70%. A significant place is given to measures of state support. First of all, this is due to the coronavirus pandemic and food security. Over the past 5 years, it can be seen that the inflow of investment has been uneven in agriculture. In general, we believe that this happened due to a change in the financing of state programs for the agro-industrial complex (Table 4).

Almaty region has great opportunities in the development of the agro-industrial complex. More than 143,248 food, light industry, agricultural engineering and other enterprises operate in the region.

In this southern region, there are favorable soil and climatic conditions for growing crops and breeding livestock. For example, by 2027, it is planned to increase the production of poultry meat by over 700 thousand tons per year. There will also be a modernization of the poultry farm, the construction of new smart greenhouses, dairy farms, processing plants in the Almaty region.

In the Almaty region, a total of 48,943 farms are registered in 2021, which are engaged in livestock and crop production. In general, the noted small enterprises do not have a complex organizational structure; basically, all decisions are made by one person in the person of the manager.

Among these small agribusinesses are smart farms. In many of these smart farms, new technologies are used - phones, computers. In some cases, GPS navigators for agricultural machinery, tracking sensors for animals, drones, elements of precision farming are used. There is an acute shortage of personnel who have the skills and knowledge in the field of information technology.

In our study, we took the farms of the Almaty region as an object, where a small number of employees, mainly a family business. At the same time, the head of such a small farm is a family member.

The hypothesis of building the model is as follows: information, communication and digital factors have a positive impact on the growth of agricultural production of farms in the Almaty region.

Based on our own research, we have identified the main factors influencing the introduction of information, communication and digital technologies in small farms in the Almaty region.

Based on the 11 factors below, the questions of the questionnaire were compiled.

Factor 1 - Relative advantage. It is assumed here that smart farms will increase productivity, improve product quality. At the same time, professional competencies for human resources in the field of ICT are needed.

Factor 2 - Difficulty in using information technology. The content of the "Technology acceptance model" is based on how companies use new technologies and information systems in their activities. Indeed, some companies have great advantages when using

Table 3: Socio-economic data on farms in Kazakhstan and Almaty region, 2021, units

Indicators	Total	Peasant or farm enterprises	Number of employed in small and medium-sized enterprises (SMEs)	Number of men and women employed in small and medium-sized enterprises (SMEs)		Share in GRP %)	Investment in fixed capital (%)
				Men	Women		
The Republic of Kazakhstan	1610496	225 435	3 408 985	1806762	1602222	34	102,7
Alma-Ata's region	143 248	48 943	268 634	142 376	126 257	35	100,5

Source: Agency for Strategic planning and reforms of the RK Bureau of National statistics. (2021), Small and medium enterprises. Accessed from https://stat.gov.kz/official/industry/139/statistic/6.

Table 4: Investments in industry and agriculture

Years	Investments in fixed assets of industry	Investments in agriculture
	in % to the previous period	in % to the previous period
2016	102,0	147,1
2017	105,8	127,8
2018	117,5	105,4
2019	108,8	139,2
2020	96,1	113,4

Source: Agency for Strategic planning and reforms of the RK Bureau of National statistics. (2021), Investment's statistics. Dynamic tables. Accessed from https://stat.gov.kz/official/industry/161/statistic/8

innovative technologies and this leads to increased productivity. But the other part of the companies has certain difficulties in implementing new information systems. For example, there is a lack of investment and financial resources to acquire new digital technologies.

Factor 3 - Compatibility. In the event that smart farming technology is compatible, therefore, most likely, it will be implemented in this farm. This technology will have a positive impact on the future performance of the smart farm.

Factor 4 - Innovativeness of the CEO/manager/owner. This implies that innovativeness has a positive effect on the adoption of new digital decisions.

Factor 5 - The knowledge of the CEO/manager/owner in the field of IT stimulates the introduction of new technologies in the management of a smart farm.

Factor 6 - Financial costs. Lack of finance negatively affects the use of IT in smart farms.

Factor 7 - The lack of digital skills of workers reduces the use of new technologies in smart farms.

Factor 8 - Lack of agricultural personnel in the field of IT has a negative impact on the use of information and electronic technologies.

Factor 9 - Competition among agricultural companies contributes to the introduction of new digital technologies.

Factor 10 - State support is the main factor in the acquisition of ICT in smart farms.

Factor 11 - The digital environment has a positive impact on the introduction of a large array of data and electronic technologies in smart farms.

Questionnaire - A survey was conducted to collect data. The survey process involved 250 small farms in the Almaty region. The survey was conducted offline and online (Table 5).

After we conducted the survey, all the collected data was sorted and data analysis was carried out using the Smart PLS program.

Based on the Cronbach alpha, we tested the reliability of all elements. In Table 6, we show the results of the analysis. As can be seen, the Cronbach alpha of all independent variables exceeded 0.70. That is, the results show the reliability and validity of all variables. Of all the indicators, it can be noted - latent variable 4, which shows a value of - 0.998 (Table 6).

The statistical significance of our results (p value) is shown in Table 7. As we can see, only Latent variable 4 shows a positive result. That is, the innovativeness of the CEO/manager/owner has a positive effect on the introduction of new information and electronic technologies in smart farms in the region.

If we look at the summary of respondents' responses, here's what we can see. Approximately 44-50% of respondents agree with the relative advantage of the smart farm.

Regarding the difficulty of using new technologies in the work of smart farms. Thus, 26-32% of respondents indicated that the use of a smart farm is too complicated for business operations. Here, the skills required to implement a smart farm are too complex for employees. In addition, 60% of farmers answered that using a smart farm requires a lot of mental and intellectual effort.

The compatibility of using new technologies with existing farm business operations varies. Also, at the level of corporate culture and the equipment already available, farms are not the same. Basically, in many smart farms, they are not compatible.

Table 5: Descriptive statistics

Indicators	Ranging	Number	Percentage
Sex of a person	Total	250	100
	Male	132	53
	Female	118	47
Age	Total	250	100
	20-29	11	5
	30-39	56	22
	40-49	48	19
	over 50	135	54
Enterprise type	Total	250	100
	Average	44	18
	Small	206	82
The number of employees	1-3	35	70
	4-6	8	16
	7-10	4	8
	10-15	2	4
	15-20	1	2
	More than 20	-	-

Table 6: Reliability cronbach alpha

	Cronbach's alpha	rho_A	Composite reliability	Average variance
Latent Variable 1	0.983	0.988	0.986	0.935
Latent Variable 10	0.937	1.186	0.958	0.884
Latent Variable 11	0.888	0.891	0.931	0.818
Latent Variable 12	0.995	0.995	0.997	0.995
Latent Variable 2	0.868	0.914	0.937	0.882
Latent Variable 3	0.928	0.968	0.950	0.827
Latent Variable 4	0.998	0.998	0.999	0.998
Latent Variable 5	0.865	0.895	0.919	0.791
Latent Variable 6	0.863	0.863	0.917	0.787
Latent Variable 7	0.843	0.891	0.926	0.862
Latent Variable 8	0.878	0.885	0.942	0.891
Latent Variable 9	0.984	1.015	0.990	0.970

Source: Compiled by the authors based on the "Smart PLS" program

Table 7: Statistical significance of the model

P values	
0.050	Latent Variable 4>Latent Variable 12
0.142	Latent Variable 6>Latent Variable 12
0.151	Latent Variable 8>Latent Variable 12
0.208	Latent Variable 9>Latent Variable 12
0.397	Latent Variable 2>Latent Variable 12
0.441	Latent Variable 11>Latent Variable 12
0.598	Latent Variable 5>Latent Variable 12
0.655	Latent Variable 3>Latent Variable 12
0.792	Latent Variable 1>Latent Variable 12
0.831	Latent Variable 7>Latent Variable 12
0.956	Latent Variable 10>Latent Variable 12

Source: Compiled by the authors based on the "Smart PLS" program

52% of respondents indicated that farm managers are willing to receive information technology training. But this is the case when financial opportunities are available.

Also, almost 75% believe that the introduction of smart technologies involves large financial costs.

In the survey, 60% of respondents noted that the state weakly encourages smart farms. In particular, the state promotes successful agro-industrial research and technical training to a low degree. It supports at a weak level various projects on the informatization of agriculture for farms.

80% of respondents agree that smart farms are a necessary trend of the times.

Through the survey, it can be seen that many farmers lack knowledge and skills in the field of IT. In many farms, the number of employees is 3-5 people. Although many farmers understand the importance of introducing ICT, there is a lack of investment and engineering knowledge. There is an underdeveloped infrastructure, lack of necessary innovative equipment.

Therefore, practically the obtained data are consistent with the hypothesis of the model. We see in Figure 3 that the latent variable 4 factor has a significant impact on the level of information and digital skills of the smart farm manager. In other words, it depends on the level of management how much a smart company can develop further, taking into account the introduction of the achievements of science, technology and the use of Big Data in the agricultural sector of the region. In addition, it should be added that new digital technologies have a positive impact on labor productivity and the growth of agricultural output.

Also, almost all respondents pointed to the lack of support from business and the state. True, in recent years, the state has begun to actively promote digitalization in all sectors through state programs and national projects. That is, we see the problem of ignorance of the population about existing programs and measures of support from the state.

At the same time, in our opinion, the state should expand financial support for small and medium-sized farms in order to promote the spread of smart farms.

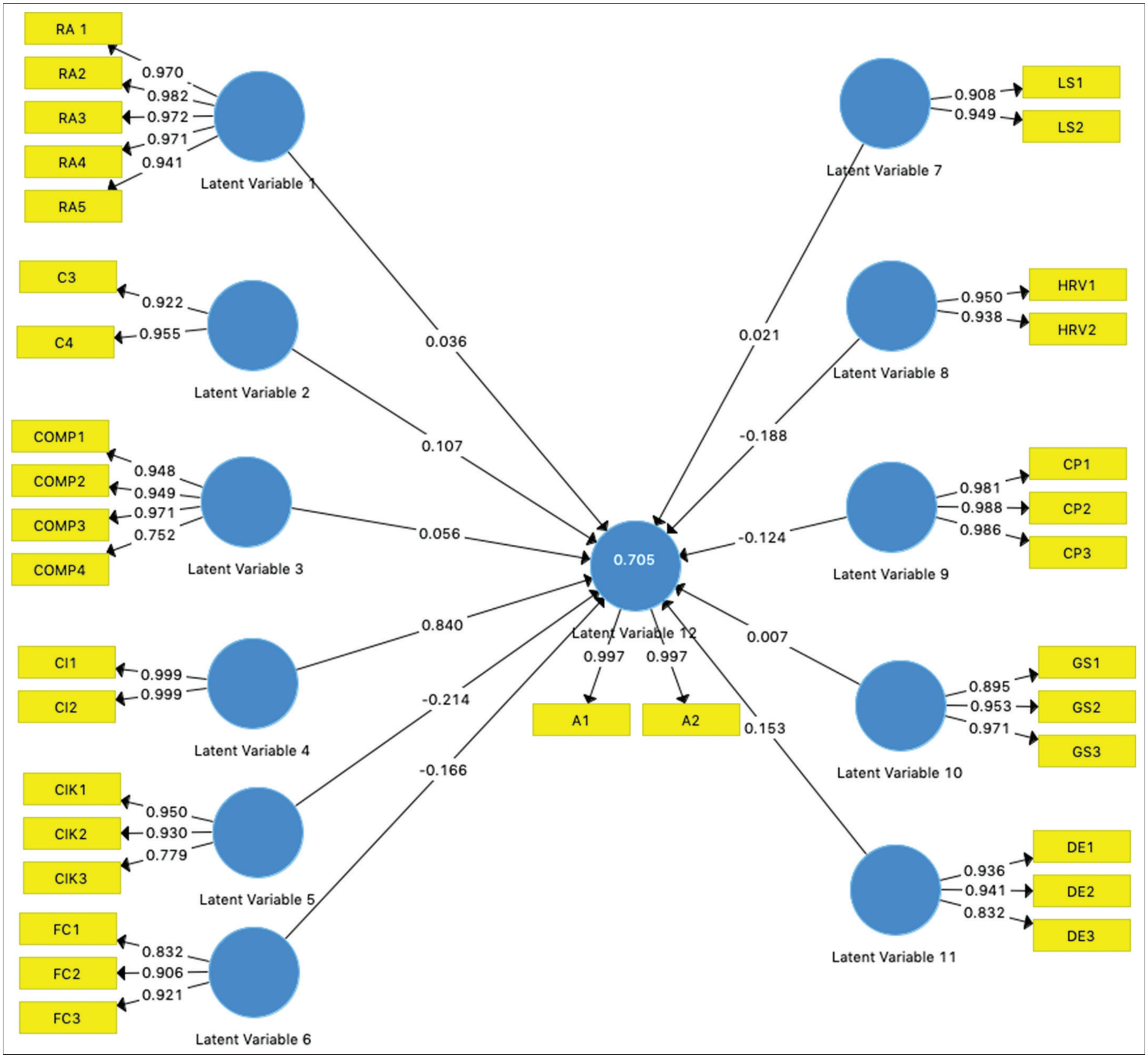
So, the use of big data analytics in smart farms stimulates great prospects in the management of innovative information. The demand for new technologies has increased significantly and many farms need to implement ICT to remain competitive.

6. DISCUSSION

It is necessary to continue developing projects in the field of digital energy (Digital Power) in the republic. For example, areas of digital energy are leading to energy storage based on the development and implementation of lithium batteries with a capacity of over 5 GWh. Such batteries can be actively used in rural areas. So, to work at solar power plants for energy supply in farms. The Digital Power mechanism is based on the digitalization of the energy industry, taking into account the organization of an intelligent society. Also note that the use of lithium batteries saves the environment on the basis of zero carbon emissions.

It is necessary to focus on increasing investment projects for the introduction of new capacities through the implementation of renewable energy sources. The implementation of such investment projects will reduce greenhouse gas emissions and produce an additional several billion kWh of green energy. At the same time,

Figure 3: Study model



Source: Compiled by the authors based on the "Smart PLS" program

there is an acute shortage of electricity in Kazakhstan in rural areas and remote areas. The implementation of renewable energy projects will increase the level of digitalization and the volume of agricultural production.

It is possible to cite the experience of digitalization of the electric power industry on the practical example of the Aksu power plant of the Eurasian Energy Corporation JSC. It should be noted that today the Aksu power plant generates up to 18% of electricity in the republic.

In particular, an automated process control system has been introduced at this station. Here, automation monitors not only Big Data, it processes and analyzes them. So, at the 2nd power unit, an automatic control and vibration diagnostics system - "Vibrobit" was installed. This allows you to track deviations of parameters, diagnose defects in equipment during power generation.

In accordance with the adopted new national project for the development of the agro-industrial complex of the Republic of Kazakhstan for 2021 - 2025. it is planned to allocate about 46 billion tenge for the digitalization of agriculture within 5 years. According to forecasts, by 2025, about 95% of the land will be included in the online database of the national data infrastructure. At the same time, digital topographic maps and remote sensing will be developed.

Digital monitoring of arable and agricultural land remains at a low level today. For the effective organization of state control over the use of agricultural land, a staff of professional land inspectors is needed. We believe that the introduction of control automation based on space monitoring will provide significant assistance here. We point out that the methods of space monitoring of agricultural lands are based on digitalization approaches. A very important condition is that space monitoring can objectively investigate the state of farmland and crops in areas with different natural and climatic conditions and specialization.

A certain new direction in animal husbandry is the use of the "artificial intelligence" method. This method is based on video tracking and video surveillance of movements in pastures and the birth of animals. In addition, drones are used here to count the animals. Video cameras on a round-the-clock basis monitor the health of animals.

In crop production, artificial intelligence is actively used in agricultural fields. Here, with the help of drones and neural networks, it is possible to recognize diseases, the condition of the fetus and leaves of agricultural plants from photographs. In particular, neural networks can be used to increase plant yields based on digital control. Also, the system of "neural networks" can select the required amount of water and fertilizers at a certain stage of plant development. In addition, smart management can automate harvesting dates and predict crop volumes.

However, so far, such measures for the digitalization of power units of Kazakhstani power plants are carried out at a single level.

Therefore, at present, a state project is needed to build and modernize a common national energy sector. To prevent current tariffs from becoming more expensive than the cost of producing clean energy from renewable sources, it is necessary to introduce digital energy technologies. Yes, to a certain extent, the cost of new innovations in the energy sector is quite expensive. But a quick payback, building up energy potential, cost optimization, innovation and environmental friendliness are the keys to success.

From our point of view, in order to solve the shortage of electricity in the republic, it is necessary to build and put into operation flexible electric capacities in the amount of 1-1.5 thousand megawatts. We emphasize that such maneuverable capacities help cover surges during peak hours of consumption. At the same time, maneuverability provides a balance for the supply of unstable electricity. This is especially true at the level of growth in the introduction of digitalization in the agro-industrial complex, and in general in the industry of the country.

The digitalization of mines, refineries, greenhouses, elevators, agricultural farms make it possible to exclude direct contact between entrepreneurs and officials. In addition, it can provide prompt placement of information and results about electronic auctions. As a result, this will reduce the shadow turnover of oil and food, and increase the collection of taxes.

7. CONCLUSION

On the basis of the conducted scientific and practical research and statistical modeling, we identified such problems in the development of the energy industry and the agro-industrial complex.

There is a seasonal shortage of fuel and lubricants and a speculative change in prices, which leads to destabilization of sowing and harvesting agricultural crops. unscheduled repairs, frequent accidents at refineries and pipelines have a negative impact on the volume of fuel and lubricants.

In the energy sector and the agro-industrial sector, the critical importance of the availability of qualified engineering and agro-technical personnel has begun to emerge. Here the average age of the staff is over 50-55 years. In addition, there are serious shortcomings in the level of wages.

The main barrier is represented by serious losses of electricity, which reach up to 13-15%. This is due to significant wear of electrical equipment. In turn, depreciation of power plants increases greenhouse gas emissions. This means that it seriously worsens the environment and climate change.

Let us single out that for a number of agricultural crops there is a certain dependence on imports and planting material of agricultural plants. In addition, there is an acute shortage of investment in the agro-industrial complex. This is especially reflected in the lack of investment in the digitalization of agricultural machinery and new agricultural technologies.

We found that the agro-industrial complex annually loses $1.5-4 billion due to low productivity. Currently, about 30% of agricultural land has already been degraded. More than 10 million hectares of arable land are abandoned, resulting in financial and environmental losses.

In the agro-industrial complex and the energy sector, in practice, there is a low degree of use of scientific, innovative and digital approaches to managing the economy.

To solve the identified problems, we offer the following recommendations.

It is necessary to plan the formation of diesel fuel stocks for the implementation of measures by agricultural producers.

A ban should be imposed on the export of petroleum products outside the republic in spring and autumn during agricultural work

It is necessary to establish a schedule taking into account the predetermined deadlines for refinery repairs.

Today, against the backdrop of advances in science and technology, there is a significant breakthrough in the development of hydrogen energy.

Soon (from 2023) in the EU countries will be introduced "carbon tax", which will make it difficult to export our products. The implementation of this tax will require changes in technical standards and increased requirements for the quality of export agricultural products.

The introduction of an information system for accounting for gas condensate and crude oil should be accelerated through state support.

In our opinion, the transition to electronic trading will provide prospects for investors, will allow for the modernization of the energy sector and the establishment of market pricing. At the same time, the sale of raw materials on the electronic exchange will ensure transparency and exclude transactions in the field of shadow exports of hydrocarbon raw materials and liquefied gas. All this will help to reduce the costs and prime cost of hydrocarbon production, taking into account the implementation of digital monitoring in the energy sector.

It is necessary to actively develop renewable energy projects using solar panels and micro stations.

Thus, for the purpose of sustainable development and prospects for the digital transformation of the agro-industrial complex, it is necessary to organize a common seed market, conduct a full analysis of the state and development of breeding and seed production of agricultural plants.

Innovative technologies both in the energy sector and in agriculture are quite expensive. And in a pandemic, there is a certain outflow and lack of investment resources. In this regard, it is necessary to rationally use energy resources, develop new renewable energy sources and gas-fired power plants, optimize costs for outdated energy equipment and promote the introduction of new digital technologies in the agro-industrial complex.

The transition to a resource-saving and high-tech level of development of the electric power industry and the agro-industrial complex on a digital basis is a vector for the future development of the economy and the growth of national competitiveness. This is the optimization of all existing assets and high productivity of work processes of the entire industrial sector of Kazakhstan.

The ICT work process is not so much the application of engineering technologies themselves, but also the creation of an organizational culture, taking into account the introduction of human professional skills with new digital technologies.

The use of modern digital technologies reduces risks, reduces energy intensity and provides a competitive advantage. This is due to the fact that Big Data, the Internet of things and artificial intelligence can significantly increase the efficiency of all business processes of energy and agricultural companies - from production, processing, storage and marketing of manufactured products to the end consumer.

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