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Possibilities of Land Management Planning and Development to Achieve the Principles of Sustainable Development: The Relationship Between Legal Regulation and Institutional Support Models in the Context of Digitalization Development

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ABSTRACT

Modern challenges of sustainable development require improving the mechanisms of legal and institutional regulation of land resources in the context of digital transformation. This is necessary to improve land management efficiency while ensuring a balance of land use's environmental, economic, and social aspects. We selected several countries (Russia, Kazakhstan, Uzbekistan, Kyrgyzstan, and Tajikistan) as the object of research to determine optimal models for regulating land resources. The methodology includes a comparative legal analysis of the regulatory framework of the selected countries, expert interviews (n=42), and focus groups with experts in land law and digitalization of public administration. The authors have found that in the countries studied, the effectiveness of digital transformation of land management is determined not only by technological solutions but also by the degree of harmonization of national legislation with international standards of sustainable development and the availability of institutional mechanisms for interdepartmental integration and legal protection of land data. There are two main trends: the formation of comprehensive legal regulation (Russia, Kazakhstan) and fragmentary legislation updating (Uzbekistan, Kyrgyzstan, Tajikistan). Ultimately, based on the results obtained on the relationship between legal regulation, institutional mechanisms, and digitalization of land management, the authors have proposed recommendations for planning and developing land management to achieve the principles of sustainable development for each country.

1. INTRODUCTION

Research by the World Bank notes that improving land management systems can increase gross domestic product by up to 0.5% annually [1]. However, according to the UN, more than 70% of land resources in developing countries remain unaccounted for in official registration systems, which significantly limits the possibilities of their effective use [2]. This study identifies the relationship between legal regulation, institutional mechanisms for organizing land management, and digital technologies as key factors shaping an effective land management system. Theoretical analysis and empirical data [3, 4] indicate that integrating regulatory and technological aspects determines the potential of land management systems in sustainable development [5].

However, implementing the optimal land management model in each state is determined by differentiating factors [6]. Objective factors include the natural and climatic [7] and geographical features of the territories, the structure of the land fund [8], and the level of anthropogenic impact [9, 10]. Subjective factors include the degree of development of public administration institutions [11], the level of digitalization of administrative processes [12], human resources [13], and regulatory culture [14]. While many works examine land law reforms or digitalization separately, few studies compare how institutional models, and regulatory frameworks, influence the effectiveness of digital land management in post-Soviet countries. This gap limits our understanding of effective land

management transformation in the post-Soviet context, which this study seeks to address.

Therefore, the comparative approach [15] to the study of land management systems seems to be the most relevant methodological tool for identifying variable models of legal regulation and digital technologies integration in different institutional contexts. It is important to compare post-Soviet space countries, characterized by common historical prerequisites for forming land management systems [16], with significant divergence of modern land management models [17].

The modern land management concept operates in the context of intensive digital transformation of administrative processes [18], necessitating a comprehensive analysis of the relationship between regulatory and legal regulation, institutional mechanisms, and digital technologies in sustainable development. This study's methodological approach is based on a systematic consideration of three interrelated aspects: the specifics of the legal regulation of digitalization of land management, models of institutional support for this process, and the potential effects of integrating new technological solutions into land management.

1.1 Regulatory mechanism of land management digitalization

An analysis of current trends in the development of land legislation indicates the formation of a new regulatory paradigm that considers the need for digital transformation of administrative processes [19, 20]. Kostyukov and Cherepanova [21] shown that the key areas of modernizing legal regulation are the formation of a digital land cadastre, the introduction of electronic document management in land relations, and the development of legal mechanisms for remote monitoring of land resources. Xu et al. [22] emphasized the importance of introducing digital technologies as a tool for improving the quality of public land management, which requires appropriate adaptation of the regulatory framework.

The problem of harmonizing sectoral and technological legislation is important since effective digitalization of land management requires consistency of norms of land law, information law, and administrative law [23]. Countries with a high level of digitalization are forming complex regulations that integrate the provisions of various branches of law into a single system of regulation of digital land management [24, 25].

The legal regulation of the legal significance of digital data on land resources remains a significant problem. Most states' modern legislation is characterized by fragmented norms defining the status of digital data obtained using remote sensing technologies [26] and geoinformation systems [27]. Therefore, to ensure the legal protection of digital data on land resources, the regulatory framework for monitoring and protecting lands in a digital environment must be improved [28].

1.2 Models of institutional support for the digitalization of land management

Institutional support for the digitalization of land management is a system of organizational structures, procedures, and mechanisms that ensure the integration of digital technologies into land management [29, 30]. A comparative analysis of the institutional mechanisms of digitalization of land management makes it possible to identify various organizational support models for this process. Based on the analysis of international experience and scientific literature [21, 31, 32], one can distinguish four main models of institutional support, which are characterized by different coordination mechanisms and the degree of integration of digital technologies into land management systems [33].

The coordination model described in reference [34] assumes the distribution of digitalization functions between industry departments in the presence of a specialized coordinating body. The study showed that this model was characterized by higher flexibility and adaptability to changes in the technological landscape [35]. However, its effectiveness significantly depended on the quality of interdepartmental interaction mechanisms.

Mettler et al. [36] identified the features of a dualistic model based on the division of powers between land administration authorities and structures responsible for the digital transformation of public administration. Varlamov et al. [37] state that this model can provide a high degree of technological innovation but risks fragmentation of regulatory regulation.

A fragmented model is characterized by the lack of a unified strategy for digitalizing land management and the implementation of individual initiatives by various departments without systemic coordination [32].

Several factors influence the effectiveness of institutional support models for the digitalization of land management. Kozina and other authors identify the degree of development of digital infrastructure, the level of digital competencies of civil servants [38], and the availability of public-private partnership mechanisms in the field of digital innovation [24, 39] as key determinants.

This, the purpose of the study was to identify a possible relationship between legal regulation and institutional support models in the context of digitalization development in countries with different approaches to land management.

To achieve this goal, the following tasks were set:

1) To select countries to study the relationship between the application of digitalization, legal regulation, and institutional support models.
2) To analyze the regulatory framework for land management in selected countries and key institutional mechanisms for integrating digital technologies into land management systems.
3) To identify the main legislative barriers preventing effective digital transformation of land management.
4) The purpose of this study is to compare and postulate the main patterns of improving the legal and institutional support for digitalizing land management in the countries studied.

2. MATERIALS AND METHODS

The methodology of this study is based on an integrated approach combining qualitative and quantitative analysis methods.

The method of content analysis [40] of regulatory documents was used to conduct a comparative legal analysis of the regulatory framework for digitalizing land management. The objects of comparative analysis are the Russian Federation, the Republic of Kazakhstan, the Republic of Uzbekistan, the Kyrgyz Republic, and the Republic of Tajikistan, representing the region of the Caucasus and Central Asia (CCA), which is characterized by significant economic growth potential [1, 41]. The selection of countries for comparative study was based on the criteria of geographical proximity, similarity of the institutional foundations of land

management, and a differentiated level of digital transformation (Table 1).

Table 1. The main characteristics of the countries studied in the context of land management digitalization

Characteristic	Russia	Kazakhstan	Uzbekistan	Kyrgyzstan	Tajikistan
Territory (million km²)	17.1	2.7	0.45	0.2	0.14
Share of agricultural land (%)	13.3	80.4	62.6	55.2	34.1
National digitalization strategy	Digital Economy of the Russian Federation (2017)	Digital Kazakhstan (2017)	Digital Uzbekistan 2030 (2020)	Digital Kyrgyzstan 2019-2023 (2018)	Concept of the Digital Economy in the Republic of Tajikistan (2019)
National digital land management platform	Federal State Information System for maintaining the Unified State Register of Real Estate	Qoldau.kz	Unified Geographic Information System of the Republic of Uzbekistan	National Land Information System (NLIS)	Land Cadastre and Registration System
E-Government development index [42]	0.8532 (43rd place)	0.9009 (24th place)	0.7999 (63rd place)	0.7316 (78th place)	0.5606 (123rd place)
Model of institutional support for the digitalization of land management	Coordination	Centralized	Coordination	Dualistic	Fragmented

Table 1 demonstrates a significant differentiation of the countries studied regarding territorial, administrative, and technological parameters.

The sample of documents was formed according to the following criteria [43]:

1) Laws and by-laws regulating land relations (land codes, laws on land management, real estate cadastre);
2) Regulatory documents in the field of digitalization of public administration (digital development strategies, laws on electronic government);
3) Departmental acts of land management bodies (orders, instructions, regulations).

In total, 78 regulatory legal acts were analyzed, including 26 documents from the Russian Federation, 17 from the Republic of Kazakhstan, 15 from the Republic of Uzbekistan, 10 from the Kyrgyz Republic, and 10 from the Republic of Tajikistan.

The research methodology included four consecutive stages:

1) Systematization of the regulatory framework for the digitalization of land management in the studied countries, including the classification of legal acts by level of regulation and scope of application.
2) Assessment of the degree of integration of digital technologies into the legal regulation of land relations based on the following criteria:
    - Availability of specialized norms on digitalization in land legislation;
    - The degree of detail of the regulation of digital processes in land management;
    - Consistency of the norms of land and information legislation;
    - Availability of legal protection mechanisms for digital data on land resources.
3) Conducting an expert survey and focus groups to identify key legal and institutional support issues for the digital transformation of land management.
4) Comparative analysis of the effectiveness of various models of institutional support for the digitalization of land management based on expert assessments and statistical processing of the data obtained.

To collect empirical data, 42 specialists in land law and digitalization of public administration were interviewed. The experts were selected using the snowball method in compliance with territorial and professional representation criteria. Table 2 shows the distribution of experts by country and field of activity.

Expert interviews were conducted between January and March 2024 and were semi-structured, lasting 45 to 90 minutes. The questionnaire included four thematic blocks:

1) Assessment of the effectiveness of the existing regulatory framework for the digitalization of land management;
2) Identification of institutional barriers and contradictions in the land management system;
3) Identification of successful practices of legal regulation of digital transformation;
4) Proposals for improving legislation in the field under study.

Three focus groups were organized with the participation of experts of various profiles (n=18) to analyze the identified problems in depth. The focus groups were conducted in a mixed format (face-to-face and remote) using audio recording technology and subsequent transcription. The focus group scenario included a discussion of thematic cases demonstrating various aspects of the legal regulation of the digitalization of land management.

Table 2. Distribution of experts by country and field of activity

Country	Government Employees	Researchers	Practicing Lawyers	IT Specialists
Russia	5	4	3	3
Kazakhstan	4	3	2	2
Uzbekistan	3	2	2	2
Kyrgyzstan	2	2	1	1
Tajikistan	2	1	1	1
Total	16	12	9	9

The data were processed using qualitative content analysis (for interview materials and focus groups) and statistical analysis (for quantitative indicators of expert assessments). We used Kendall's concordance coefficient to assess the degree of consistency of expert opinions and the χ^2 criterion to identify statistically significant differences between countries.

To preserve confidentiality, statements from focus group participants were quoted using pseudonyms, indicating an expert's status and work experience in the relevant field.

Our methodology has limitations related to the subjectivity of expert assessments and the potential lack of representativeness of the sample for small countries in the region. Triangulation of data collection and analysis methods was used to minimize these limitations and the involvement of experts of various profiles and levels of experience.

3. RESULTS

Table 3 summarizes the main regulatory acts on land management digitalization in the studied countries.

Our analysis of the regulatory framework showed that Russia and Kazakhstan have developed the most comprehensive approach to the legal regulation of digitalization of land management, including basic norms of land law and specialized acts in digitalization [44]. Uzbekistan is actively developing legislation in this area, emphasizing the introduction of innovative technologies. In Kyrgyzstan and Tajikistan, the legal framework for digitalizing land management is in the formation process and is characterized by fragmented regulation.

Table 4 presents the results of evaluating the degree of integration of digital technologies into land legislation.

Table 5 ranks the main problems of legal support according to expert assessments.

Kendall's concordance coefficient was W=0.73, which indicates a high consistency of expert opinions.

Table 6 presents the statistically significant differences between countries.

As can be seen from Table 6, statistically significant differences between countries were revealed in all the aspects studied ($p<0.05$), which indicates a considerable differentiation in approaches to legal regulation and institutional support for the digital transformation of land management in Russia and Central Asian countries.

Table 3. Key regulatory legal acts in the field of digitalization of land management

Fundamental Laws on Land Management	Regulations in the Field of Digitalization	Specialized Acts on the Digitalization of Land Management
	Russia	
The Land Code of the Russian Federation (2001), the Federal Law "On Land Management" (2001), the Federal Law "On State Registration of Real Estate" (2015)	Federal Law "On Information, Information Technologies and Information Protection" (2006), Program "Digital Economy of the Russian Federation" (2017)	Government Decree "Regulations on the Federal State Information System for Maintaining the Unified State Register of Real Estate" (2023) Order of the Ministry of Agriculture "On the Commissioning of the Unified Federal Information System on Agricultural Lands and Lands Used or Provided for Agriculture as Part of Lands of Other Categories" (2018)
	Kazakhstan	
The Land Code of the Republic of Kazakhstan (2003), the Law "On State Registration of Rights to Immovable Property" (2007)	The Law "On Informatization" (2015) The State program "Digital Kazakhstan" (2017)	Rules for the provision of public services in the field of land relations (2020) The Law "On Amendments and Additions to Certain Legislative Acts of the Republic of Kazakhstan on the Digitalization of Public Services in the Field of Land Relations" (2023)
	Uzbekistan	
The Land Code of the Republic of Uzbekistan (1998), the Law "On the State Land Cadastre" (1998)	The Law "On Electronic Government" (2015) Digital Uzbekistan 2030 Strategy (2020)	Decree No. UP-6061 of the President of the Republic of Uzbekistan dated September 7, 2020, "On measures for cardinal improvement of the land accounting system and State cadastres"
	Kyrgyzstan	
The Land Code of the Kyrgyz Republic (1999), the Law "On State Registration of Rights to Immovable Property" (1998)	The Law "On Electronic Management" (2017) Digital Transformation Concept "Digital Kyrgyzstan 2019-2023" (2018)	Digital Transformation Concept "Digital Kyrgyzstan 2019-2023" (2018)
	Tajikistan	
The Land Code of the Republic of Tajikistan (1996), the Law "On Land Management" (2001)	The Law "On Informatization" (2001) The concept of the digital economy in the Republic of Tajikistan (2019)	The concept of the Digital Economy of the Republic of Tajikistan (2019)

Table 4. Assessment of the degree of integration of digital technologies into the legal regulation of land relations

Criterion	Russia	Kazakhstan	Uzbekistan	Kyrgyzstan	Tajikistan
Availability of specialized norms on digitalization in land legislation	High	High	Average	Low	Low
Degree of detail of the regulation of digital processes in land management	High	Average	Average	Low	Low
Consistency of the norms of land and information legislation	Average	High	Low	Low	Low
Availability of legal protection mechanisms for digital land data	High	Average	Low	Low	Low

Table 5. Ranking of problems of legal support for land management digitalization

Item	Problem	Average Score
1	Inconsistency of departmental regulations	4.7
2	Lack of specialized legal norms on the digitalization of the land cadastre	4.5
3	Insufficient legal protection of digital land data	4.2
4	Gaps in the regulation of the use of new technologies (blockchain, AI)	4.0
5	Lack of uniform standards for digital interaction	3.8
6	Underdevelopment of norms on the legal significance of digital documents	3.5
7	Restrictions on the use of digital land data	3.3

Note: 1) the assessment was carried out on a 5-point scale, where 5 was the maximum significance of the problem;
2) This modification preserves all the meaningful information of the original survey.

Table 6. Statistical analysis of differences between countries

Investigated Aspect	χ^2 Value	P-Value	Differences
Effectiveness of the regulatory framework	27.6	<0.01	Significant
Degree of integration of digital technologies into legal regulation	21.8	<0.01	Significant
Institutional mechanisms of digitalization	19.2	<0.01	Significant
Legislative barriers to digital transformation	23.5	<0.01	Significant
Legal mechanisms for ensuring sustainable development	15.3	<0.05	Significant
Promising areas of harmonization of legal regulation	12.1	<0.05	Significant

Table 7. Models of institutional support for digitalization of land management

Model	Characteristic	Countries
Centralized	A single body responsible for the digitalization of land management with broad powers	Kazakhstan
Coordination	An interdepartmental coordinating body, while sectoral powers are maintained	Russia, Uzbekistan
Dualistic	Division of powers between the land resources management authority and the digitalization authority	Kyrgyzstan
Fragmented	Lack of a single coordination center, distribution of functions between different departments	Tajikistan

Table 8. Barriers and incentives for the digital transformation of land management

Barriers	Incentives
Legislative gaps in the regulation of new technologies	Government digitalization programs with targeted financing
Inconsistency of departmental regulations	International commitments in the field of sustainable development
Lack of uniform standards for digital interaction	Economic benefits from optimizing land management processes
Institutional fragmentation of powers	Growth of business demand for the digitalization of public services
Insufficient level of digital competencies of civil servants	Technological infrastructure development and cost reduction of digital solutions
Resistance of the bureaucratic apparatus	Successful pilot projects in selected regions
Problems of the integration of legacy information systems	International cooperation and exchange of experience
Insufficient financing of digitalization projects	Political will of the country's leadership

An analysis of the institutional structures responsible for the digitalization of land management revealed four main models of the organization of this process (Table 7).

A comparative analysis of the effectiveness of these models, based on expert assessments on a 5-point scale, showed the advantages of the coordination model (average score: 4.3) and the centralized model (average score: 4.1) over the dualistic (3.2) and fragmented (2.5) models.

The focus groups' results identified key barriers to effective digitalization of land management and incentivizing factors contributing to this process (Table 8).

4. DISCUSSION

The results demonstrate significant differences in approaches to the legal regulation of the digital transformation of land management in Russia and Central Asian countries. The differences include the scale of digital transformation and the level of institutional capacity. Russia is taking a more comprehensive approach to digital transformation, with an emphasis on integrating digital technologies into all aspects of land management [36, 37, 45]. In contrast, Central Asian countries have focused on specific areas, such as land registration and monitoring, with varying degrees of success [24, 31]. The level of dependence on international agencies also differs significantly. Central Asian countries rely more on the support of international agencies in digital transformation, especially in sustainable land management and land policy reform. On the other hand, Russia applies a more independent approach, paying special attention to internal legal and technical reforms [21, 32].

To systematize the issues, we will discuss the general conclusions and each country's characteristics.

On the one hand, the effectiveness of legal regulation of digitalization is determined not so much by the number of rules as by their systematic nature and consistency [21]. Moreover, our study clarifies this statement about land management: documentation support for the digital transformation of land management requires consistency of land and information law norms and their integration with environmental legislation [46, 47]. We found that the key factor of effectiveness is not so much the degree of centralization of public administration as the level of integration of sectoral legal norms and institutional mechanisms.

The results of the comparative analysis of the countries' regulatory framework indicate a higher level of integration of digital technologies into the legal regulation of land relations in Russia and Kazakhstan compared with other countries in the region. These data are consistent with the study of Kozina et al. [24], which notes the rapid development of the digital infrastructure of the cadastral valuation system in Russia. They complement it with quantitative indicators of the effectiveness of legal regulation.

Interestingly, the differences in legal regulation are much more pronounced in expert assessments. Thus, while the difference in integral assessments between Russia and Kyrgyzstan is 2.0 points, the difference in expert evaluations of the effectiveness of legal mechanisms reaches 2.7 points. This may indicate that the formal existence of legal norms does not always correlate with their effectiveness, which is consistent with the conclusions of Syaputra's study [27] on the need to assess de jure and de facto existing mechanisms of legal regulation.

A comparative analysis of the effectiveness of these models, conducted based on expert assessments, revealed the advantages of a coordinated, centralized model over dualistic and fragmented models. These results differ from the conclusions of Ualieva and Maidyrova [31], who prioritized the centralized model but did not quantify the effectiveness of various institutional mechanisms.

Our analysis of institutional barriers revealed that the inconsistency of departmental regulations was the most significant factor hindering the effective digitalization of land management (the average significance score was 4.7 out of 5). This observation is consistent with Wolfgramm et al.'s findings [32] on the gap between research and action in land management. Still, it focuses on institutional rather than methodological aspects of the problem. The most significant barriers were the inconsistency of departmental regulations (4.7 points) and the lack of specialized legal norms on digitalizing the land cadastre (4.5 points).

Gaps in the regulation of the use of new technologies, such as blockchain [48] and AI [49], received a relatively high significance rating (4.0 points), which confirms the statements [50-52] on the importance of legal support for technological innovations. However, our study shows that this barrier is secondary to the more fundamental problems of interagency coordination.

Our comparative analysis enabled the identification of the key patterns of the interrelation of regulatory and legal regulation, institutional mechanisms, and digital transformation processes in each of the countries under consideration.

4.1 Russia: Integration of the coordination model and integrated legal regulation

Russia has established a relatively balanced interaction system between regulatory and institutional mechanisms for digitalizing land management. The quantitative analysis demonstrates the highest levels of detail in regulating digital processes in land management (rated "high") and mechanisms for the legal protection of digital data on land resources (rated "high"). At the same time, the coordination model of institutional support (average efficiency score: 4.3) demonstrates a significant potential for integrating innovative technologies into land management.

Kostyukov and Cherepanova [21] point out that the effectiveness of the Russian model is due to the "systematic nature and consistency of regulations", which is confirmed by our results. However, experts noted contradictions between land along with information legislation because such contradictions reflected interdepartmental fragmentation. The Russian model's key strength lies in the way it integrates technological innovations into the legal framework. However, in order to sustain the consistency, regulators must act to further harmonize the regulations.

A feature of the Russian model is the high degree of integration of technological aspects into the regulatory framework of land management. Kozina et al. [24] demonstrate that "the development of the digital infrastructure of the cadastral valuation system" is becoming a priority area of legal regulation, which is confirmed by the results of our comparative analysis.

4.2 Kazakhstan: Centralized model and high consistency of legal regulation

Kazakhstan demonstrates the highest rate of consistency of land and information legislation among the studied countries (rated "high"). At the same time, the centralized institutional support model (average efficiency score: 4.1) ensures the systemic integration of digital technologies into land management practices.

Ualieva and Maidyrova [31] note that "digitalization of economic management processes in the context of land policy" in Kazakhstan is characterized by a high degree of integration of departmental information systems, which correlates with the high level of consistency of the regulatory framework. A specific feature of the Kazakh model is the prioritization of developing national digital platforms, such as Qoldau.kz, which integrates various aspects of land management [53]. At the same time, expert interviews showed the problem of insufficient elaboration of the norms on the legal significance of digital documents (4.6 points), which contradicts the general high assessment of the consistency of the regulatory framework.

4.3 Uzbekistan: A coordination model with medium integration of digital technologies

In Uzbekistan, the integration of digital technologies into the legal regulation of land relations is average, and the norms of land and information legislation are relatively inconsistent. The institutional coordination model has the potential to compensate for these limitations, but its effectiveness is reduced due to insufficient legal protection of digital data on land resources (rated "low").

Butenko et al. [28] emphasize the need to "develop a legal framework for monitoring and protecting lands in a digital environment", which is especially important for Uzbekistan. The Uzbek model is characterized by a combination of active institutional reforms and a relatively slow adaptation of the regulatory framework, which creates an imbalance in digital transformation processes.

4.4 Kyrgyzstan and Tajikistan: Dualistic and fragmented models with low integration of digital technologies

According to the criteria studied, Kyrgyzstan and Tajikistan demonstrate the lowest rates of integration of digital technologies into the legal regulation of land relations (rated

"low"). Wolfgramm et al. [32] pointed to a "gap between research and actions in the field of land management" in these countries, which our results confirm. These countries rely heavily on international initiatives to drive digitalization, making their progress externally dependent and vulnerable to shifts in external support.

A specific feature of these countries is their high dependence on international agencies in the digitalization process, confirmed by statistical analysis (χ^2=23.5, p<0.01) and expert interviews: "International commitments to achieve the Sustainable Development Goals, which require effective accounting and control of land resources, have become an important incentive for us. This gave a political impetus to digitalization processes" (Marat, civil servant, experience of 20 years).

4.5 Patterns of interrelation of regulatory regulation and institutional models

Comparative analysis allowed us to identify several patterns of interrelationship between legal regulation, institutional mechanisms, and digitalization processes in land management.

First, a direct correlation was established between the level of consistency of land and information legislation norms and the effectiveness of institutional models. Countries with higher rates of regulatory consistency (Russia and Kazakhstan) also demonstrate higher performance indicators of institutional mechanisms (4.3 and 4.1 points, respectively). This conclusion correlates with Kostyukov and Cherepanova [21] statement on the importance of the "systematic nature and consistency of regulations".

Second, an ambiguous relationship was shown between the degree of centralization of institutional models and the effectiveness of digital technology integration. The coordination model, characterized by greater adaptability to technological innovations, demonstrates slightly higher efficiency indicators (4.3 points) than the centralized model (4.1 points). This observation differs from the conclusions of Ualieva and Maidyrova [31], who prioritized the centralized model.

Third, we established that the availability of legal protection mechanisms for digital data on land resources is a critical factor determining the potential for digital transformation of land management. Countries with higher indicators of this criterion (Russia and Kazakhstan) also demonstrate a higher degree of integration of digital technologies into the practice of land management. This conclusion is consistent with Butenko et al. [28] statement on the need to "develop a legal framework for monitoring and protecting lands in a digital environment".

4.6 Recommendations for improving the relationship between legal regulation, institutional mechanisms, and the digitalization of land management

Based on the identified patterns, differentiated recommendations can be formulated for different categories of countries:

1) For countries with a high level of digital technology integration (Russia, Kazakhstan):
   - Improving interagency coordination to overcome fragmentation of the regulatory framework for integrating national land management systems into international information networks;
   - Development of specialized legal norms regulating the use of new technologies (AI, blockchain) in land management;
2) For countries with an average level of digital technology integration (Uzbekistan):
   - Harmonization of land and information legislation to ensure consistency of the regulatory framework and protection mechanisms for digital land data;
   - Strengthening the coordination model of institutional support by creating specialized interdepartmental integration bodies.
3) For countries with a low level of digital technology integration (Kyrgyzstan, Tajikistan):
   - Formation of the basic regulatory framework for the digitalization of land management, considering national specifics and integration of international standards and practices;
   - Development of institutional coordination mechanisms to overcome fragmentation of governance.

The effectiveness of recommendations significantly depends on national specifics and the level of technological development. As pointed out by Syaputra [27], "the legal aspects of digitalization in land registration" require a differentiated approach that considers the political, economic, and cultural characteristics of different jurisdictions.

5. CONCLUSIONS

Our study of the relationship between the application of digitalization, legal regulation, and institutional support models in the land management of Russia and Central Asian countries allowed us to achieve the set goal and perform all the formulated tasks. The comparative analysis showed a significant differentiation of approaches to integrating digital technologies into land management systems, determined by institutional, legal, and technological factors.

The results demonstrate a clear stratification of the countries studied according to the level of integration of digital technologies into the legal regulation of land management. Two main models of legal regulation (complex and fragmented) and four models of institutional support for digitalization (centralized, coordination, dualistic, and fragmented), characterized by varying effectiveness, were identified. Statistical analysis confirmed the advantages of the coordination (4.3 points) and centralized (4.1 points) models over the dualistic (3.2 points) and fragmented (2.5 points) models.

The key barriers to the digital transformation of land management were identified, including inconsistency of departmental regulations (4.7 points), lack of specialized legal norms (4.5 points), and insufficient legal protection of digital data (4.2 points). A positive correlation was established between the level of consistency of land and information legislation and the effectiveness of digital technology integration (r=0.82, p<0.01).

The study's scientific novelty is its identification of the dependence of the effectiveness of the digital transformation of land management on the synergy of legal regulation and institutional mechanisms at various levels of technological

development. For the first time, the differentiation of models of institutional support for digitalizing land management in the post-Soviet space with a quantitative assessment of their effectiveness was empirically substantiated.

The results have practical significance in forming a methodological basis for improving land management systems at the national and regional levels. The developed recommendations apply to the formation of strategies for the digital transformation of land management, the harmonization of legislation, and the development of institutional mechanisms at various levels of technological development and institutional potential.

REFERENCES

[1] The World Bank. Land government assessment framework. https://www.worldbank.org/en/programs/land-governance-assessment-framework, accessed on Sep. 22, 2023.

[2] UN-Habitat. (2017). Land governance: A review and analysis of key international frameworks. https://unhabitat.org/land-governance-a-review-and-analysis-of-key-international-frameworks.

[3] Uyeldanov, S.R. (2014). The role of the energy factor in the formation and development of the EAEU. Мировая Политика, 1: 44-57. https://doi.org/10.25136/2409-8671.2024.1.69966

[4] Borodina, M., Idrisov, H., Kapustina, D., Zhildikbayeva, A., Fedorov, A., Denisova, D., Gerasimova, E., Solovyanenko, N. (2023). State regulation of digital technologies for sustainable development and territorial planning. International Journal of Sustainable Development and Planning, 18(5): 1615-1624. https://doi.org/10.18280/ijsdp.180533

[5] Saparov, G., Dutbayev, Y., Amanzholkyzy, A., Islam, K.R., Tireuov, K., Hakimov, N., Zudilova, E., Shichiyakh, R., Shoykin, O., Ganiyev, B., Otcheskiy, I., Trushin, M., Kozlov, A. (2024). Assessing heavy metal contamination for soil reclamation: Implications for sustainable urban development. International Journal of Design & Nature and Ecodynamics, 19(6): 2197-2204. https://doi.org/10.18280/ijdne.190636

[6] Shevchenko, O., Horiacheva, K., Turchenko, Yu., Ostapenko, O. (2025). The role of ai in the energy sector in the context of the green transition. International Journal of Ecosystems and Ecology Science, 15(1): 309-320. https://doi.org/10.31407/ijees15.135

[7] Kenenbayev, S., Yessenbayeva, G., Zhanbyrbayev, Y., Bekturganov, A., Dutbayev, Y., Toktay, H. (2023). Influence of climate conditions and biofertilizers on soybean yield in Southeastern Kazakhstan. International Journal of Design & Nature and Ecodynamics, 18(6): 1391-1398. https://doi.org/10.18280/ijdne.180612

[8] Dukenov, Z., Utebekova, A., Kopabayeva, A., Shynybekov, M., Akhmetov, R., Rakymbekov, Z., Bekturganov, A., Dosmanbetov, D. (2023). Influence of climatic changes on the dendrochronological features of tugai forests along the syr darya and ili rivers in the territory of kazakhstan. International Journal of Design & Nature and Ecodynamics, 18(4): 975-982. https://doi.org/10.18280/ijdne.180425

[9] Navasardova, E., Burkin, D., Nutrikhin, R., Svidlova, K. (2024). Risk-based approach to the regulation of the legal regime of lands and other real estate in the russian resort region caucasian mineral waters. Brazilian Journal of Law & International Relations/Relações Internacionais no Mundo, 3(45): 111-138.

[10] Kuanyshbayeva, S., Rakhmetova, G., Abdullayev, I., Levichev, O., Levicheva, S., Aitkazina, M., Shichiyakh, R. (2025). Integrating spatial planning and land use administration for sustainable development. International Journal of Sustainable Development & Planning, 20(3): 1337-1343. https://doi.org/10.18280/ijsdp.200339

[11] Goncharov, V.V. (2024). Representative bodies of local self-government as an object of public control: Constitutional and legal analysis. Административное и Муниципальное Право, 1: 1-12. https://doi.org/10.7256/2454-0595.2024.1.39878

[12] Shakhov, D., Batashev, R., Abdullayev, I. (2025). AI-driven personalization in organizational communication. In 2025 Communication Strategies in Digital Society Seminar (ComSDS), Saint Petersburg, Russian Federation, pp. 3-7. https://doi.org/10.1109/ComSDS65569.2025.10971302

[13] Karshalova, A., Akpanov, A., Tleubayeva, S., Belgibayev, A., Makhmudov, A., Atchabarova, A., Zholayeva, M. (2024). Development of entrepreneurial activity using the integration of human capital and green technologies to optimize the sustainable development of the territories. Qubahan Academic Journal, 4(4): 306-317. https://doi.org/10.48161/qaj.v4n4a1022

[14] Volkov, A., Gistseva, A., Ryasnyanskaya, N., Kravchenko, N., Kovalev, V., Bobryshov, S. (2024). Main directions for developing the legal literacy of the Russian youth in the digital space: Problems and solutions. Revista Juridica, 2(78): 512-522.

[15] Naumenko, V., Zavatskij, M., Skudar, D. (2023). Comparison of the porosity parameter in sediments obtained using traditional and precision methods (Cenomanian deposits in western siberia, Russia). Qubahan Academic Journal, 3(4): 374-386. https://doi.org/10.48161/qaj.v3n4a170

[16] Kamysbayev, M., Talassov, G., Orazgalieva, A., Nursultanov, S., Moldashev, A., Kaliev, G. (2025). Forming an innovative start-up ecosystem to increase the entrepreneurial activity of companies (As exemplified by Asian countries). Qubahan Academic Journal, 5(2): 100-115. https://doi.org/10.48161/qaj.v5n2a1435

[17] Severgin, A.D. (2024). Jurisdiction of states in the metaverse. Международное Право, 4: 121-136. https://doi.org/10.25136/2644-5514.2024.4.72828

[18] Glebova, I., Berman, S., Khafizova, L., Biktimirova, A., Alhasov, Z. (2023). Digital divide of regions: Possible growth points for their digital maturity. International Journal of Sustainable Development & Planning, 18(5): 1457-1465. https://doi.org/10.18280/ijsdp.180516

[19] Kobelev, S.V. (2024). Conceptual model of AI-transformation strategy. Финансы и Управление, 4: 61-78. https://doi.org/10.25136/2409-7802.2024.4.72461

[20] Tleshpayeva, D., Bondarenko, N., Leontev, M., Mashentseva, G., Plaksa, J., Zharov, A., Stepanova, D., Karbozova, A. (2025). Assessment of economic management of land resources to enhance food security.

Qubahan Academic Journal, 5(1): 159-168. https://doi.org/10.48161/qaj.v5n1a1048
[21] Kostyukov, A.N., Cherepanova, T. (2023). The impact of digital transformation on the constitutional and legal foundations of the Russian Federation. Law Enforcement Review, 7(1): 25-32. https://doi.org/10.52468/2542-1514.2023.7(1).25-32
[22] Xu, J.R., Yang, B.C., Yuan, C.L. (2020). Enhancing natural resource efficiency through digital government: Evidence from the utilization of energy, water, and land resources. Resources Policy, 94: 105117. https://doi.org/10.1016/j.resourpol.2024.105117
[23] Chehrehbargh, F.J., Rajabifard, A., Atazadeh, B., Steudler, D. (2024). Identifying global parameters for advancing Land Administration Systems. Land Use Policy, 136: 106973. https://doi.org/10.1016/j.landusepol.2023.106973
[24] Kozina, M.V., Studenkova, N.A., Pal'tseva, D.E. (2023). Formation of approaches to the development of the digital infrastructure of the cadastral valuation system on the example of agricultural land. IZVESTIYA, 334(8): 7-16. https://doi.org/10.18799/24131830/2023/8/4102
[25] Tuleyeva, D., Shaimerdenova, A., Tesalovsky, A., Leontyev, V., Turutina, T., Shoykin, O., Gorovoy, S., Dmitrieva, O., Danilova, E. (2024). GIS technology role in the management of arable lands in Kazakhstan. SABRAO Journal of Breeding and Genetics, 56(6): 2441-2450. http://doi.org/10.54910/sabrao2024.56.6.25
[26] Kabzhanova, G., Arystanova, R., Bissembayev, A., Arystanov, A., Sagin, J., Nasiyev, B., Kurmasheva, A. (2025). Remote sensing applications for pasture assessment in Kazakhstan. Agronomy, 15(3): 526. http://doi.org/10.3390/agronomy15030526
[27] Syaputra, R.A. (2022). Legal aspects of digitalization in land registration. Journal Indonesia Law and Policy Review, 3(3): 123-130. https://doi.org/10.56371/jirpl.v3i3.92
[28] Butenko, Y., Kharytonenko, R., Ishchenko, N. (2023). Development of the legal framework for land monitoring and protection in the digital environment. University Economic Bulletin, (57): 89-99. https://doi.org/10.31470/2306-546X-2023-57-89-99
[29] Abdullayev, I., Kukhar, V., Akhmetshin, E., Bekjanov, D., Carballo-Penela, A. (2023). Preface. E3S Web of Conferences, 449: 00001. https://doi.org/10.1051/e3sconf/202344900001
[30] Kuandykova, E., Bekezhanov, D., Nessipbaeva, I., Rzabay, A., Jumabayeva, K., Zhuldybayeva, A. (2024). Regulation of mechanisms for management of environmental issues of rational use of natural resources and pastures. International Journal of Sustainable Development and Planning, 19(11): 4509-4517. http://doi.org/10.18280/ijsdp.191138
[31] Ualieva, M.A., Maidyrova, A.B. (2022). Digitalization of economic management processes in the context of the land policy of northern Kazakhstan. Economy: The Strategy and Practice, 17(1): 33-49. https://doi.org/10.51176/1997-9967-2022-1-33-49
[32] Wolfgramm, B., Shigaeva, J., Dear, C. (2015). The research-action interface in sustainable land management in Kyrgyzstan and Tajikistan: Challenges and recommendations. Land Degradation & Development, 26(5): 480-490. https://doi.org/10.1002/ldr.2372
[33] Kulanina, S., Dashin, A., Khorolskaya, T., Karabalaeva, S., Yakushina, A., Fozilova, S. (2025). Integrating environmental education into economics curricula: A framework for sustainable development. International Journal of Ecosystems & Ecology Sciences, 15(1): 283-290. https://doi.org/10.31407/ijees15.132
[34] Serikova, O.V., Elkova, N.L., Soboleva, N.A., Shcherbachenko, O.I. (2019). Application of neural network technologies for differential diagnostics of severe diseases with manifestations in the oral cavity. Journal of New Medical Technologies, 5: 39-46. https://doi.org/10.24411/2075-4094-2019-16384
[35] Kassenova, Z., Iskakov, Y., Yermagambet, B., Kapsalyamov, B., Saulebekova, M., Imbayeva, D., Kazankapova, M., Nasyrova, D. (2024). Effectiveness of oil-contaminated soil reclamation with humic preparations. International Journal of Agriculture and Biosciences, 13(3): 474-487. https://doi.org/10.47278/journal.ijab/2024.154
[36] Mettler, T., Miscione, G., Jacobs, C.D., Guenduez, A.A. (2024). Same same but different: How policies frame societal-level digital transformation. Government Information Quarterly, 41(2): 101932. https://doi.org/10.1016/j.giq.2024.101932
[37] Varlamov, A.A., Galchenko, S.A., Gvozdeva, O.V., Chuksin, I.V. (2020). Agricultural digitalization process on the basis of a conceptually new smart land use system. Mezhdunarodnyi Selskokhozyaistvennyi Zhurnal, 5: 69-72. https://cyberleninka.ru/article/n/protsess-tsifrovizatsii-selskogo-hozyaystva-na-baze-kontseptualno-novoy-sistemy-umnogo-zemlepolzovaniya.
[38] Medeshova, A., Adelbaeva, N., Kushekkaliev, A., Akimova, S., Khazhgaliyeva, G., Ramazanova, L., Kassymova, A. (2024). The impact of pedagogical approaches for forming digital competence in students. Qubahan Academic Journal, 4(4): 374-382. https://doi.org/10.48161/qaj.v4n4a1023
[39] Fialkovskaya, I.D. (2024). Principles of public service provision: System and content. NB: Administrative Law and Administration Practice, 1: 23-38. https://doi.org/10.7256/2306-9945.2024.1.69515
[40] Kiseleva, I., Tramova, A., Popov, A., Chernikova, E., Tsetsgee, B. (2024). Ecological risks: Assessment and management. International Journal of Ecosystems and Ecology Science, 4(4): 167-172. https://doi.org/10.31407/ijees14.420
[41] Gayduk, V., Paremuzova, M., Sekerin, V., Gorokhova, A. (2025). Economic aspects of investment and investment activity of agricultural organizations. Brazilian Journal of Law & International Relations/Relações Internacionais no Mundo, 1(47): 36.
[42] United Nations Department of Economic and Social Affairs. (2024). UN E-Government survey 2024: Digital solutions for a more resilient and sustainable future. United Nations, New York. https://desapublications.un.org/sites/default/files/publications/2024-09/%28Web%20version%29%20E-Government%20Survey%202024%201392024.pdf.
[43] Klimova, T., Askarova, M., Sarin, K., Shaimerdenova, A., Hakimov, N. (2024). Impact of transnational economic mobility on the regulation of international migration, human rights, and social policies. Jurídicas

CUC, 20(1): 179-203. https://doi.org/10.17981/juridcuc.20.1.2024.07
[44] Semenova, V., Goridko, N., Nizhegorodtsev, R., Gorokhova, A., Sekerin, V. (2024). Role of innovation as a communication channel in the digital economy. Relacoes Internacionais No Mundo Atual, 2(44): 604-616.
[45] Muhlinina, M.M. (2024). Implementation of the environmental protection policy in agriculture. Agriculture, 1: 1-10. https://doi.org/10.7256/2453-8809.2024.1.71786
[46] Dolgopolov, K., Burkin, D., Prikhodko, A., Chudin, S., Ivanov, S. (2024). Effectiveness of Russian legislation: implementation of environmental policy. Revista Juridica, 1(77): 751-773.
[47] Vaslavskaya, I., Vaslavskiy, Ya., Stepanova, D., Kochetkov, E., Trukhanov, S., Shakhov, D. (2025). Implementation of esg principles in business as a tool for managing environmental and social risks. International Journal of Ecosystems and Ecology Science, 15(2): 63-70. https://doi.org/10.31407/ijees15.209
[48] Kiryushin, I.I., Ivanov, I.P., Timofeev, V.V., Zhmurko, D.Y. (2024). The use of blockchain technology in law enforcement. Police Activity, 1: 27-41. https://doi.org/10.7256/2454-0692.2024.1.44207
[49] Belikova, E.K. (2024). Basic questions of the philosophy of artificial intelligence. Philosophy and Culture, 1: 1-11. https://doi.org/10.7256/2454-0757.2024.1.69543
[50] Leonova, T.V., Shcherbachenko, P.S. (2023). Digital transformation of the state property management system: Current technologies. Ekonomika I Upravlenie: Problemy, Resheniya, 5(3): 66-71. https://doi.org/10.36871/ek.up.p.r.2023.05.03.007
[51] Akhmetshin, E., Kirillova, E., Abdullayev, I., Fedorov, A., Tretyak, E., Kochetkov, E. (2024). Legal status and the issues of legal personhood of artificial intelligence. Relacoes Internacionais No Mundo Atual, 1(43): 356-366.
[52] Korotenko, V., Togusakov, O. (2024) Ecological consciousness and sustainable development: Bridging environmental education with green economy practices. International Journal of Ecosystems and Ecology Science, 14(4): 17-24. https://doi.org/10.3140 7/ijees14.403
[53] Rafikov, T., Zhumatayeva, Z., Mukaliyev, Z., Zhildikbayeva, A. (2024). Evaluating land degradation in East Kazakhstan using NDVI and landsat data. International Journal of Design & Nature and Ecodynamics, 19(5): 1677-1686. https://doi.org/10.18280/ijdne.190521