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Article

Analyzing the impact of cultural accessibility and ICT infrastructure on economic growth in Kazakhstan

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Abstract: For this, the primary aim of this study was to analyze of the impact of cultural accessibility and ICT (information and communication technology) infrastructure on economic growth in Kazakhstan, employing regression models to asses a single country data from 2008 to 2022. The research focuses on two sets of variables: cultural development variables (e.g., number of theaters, museums, and others) and ICT infrastructure variables (e.g., number of fixed Internet subscribers, total costs of ICT, and others). Principal component analysis (PCA) as employed to reduce the dimensionality of the data and identify the most significant predictors for the regression models. The findings indicate that in the cultural development model (Model 1), the number of recreational parks and students are significant positive predictors of GDP per capita. In the ICT infrastructure model (Model 2), ICT costs are found to have a significant positive impact on GDP per capita. Conversely, traditional connectivity indicators, such as the number of fixed telephone lines, show a low dependence on economic growth, suggesting diminishing returns on investment in these outdated forms of ICT. These results suggest that investments in cultural and ICT infrastructure are crucial for economic development. The study provides valuable insights for policymakers, emphasizing the need for quality improvements in education and strategic modernization of communication technologies.

Keywords: culture; policy; cultural institutions, information and communication technology, digital transformation; economic growth

1. Introduction

In an era of rapid digital transformations, institutions and organizations around the world have been compelled to revisit their development strategies. These changes have caused profound alterations in organizational culture and required a recalibration of both functional and strategic aspects of operations. Central to these transformations is the integration of digital technologies, which has significantly influenced the accessibility and effectiveness of cultural institutions. As a result, cultural institutions such as education, theaters, and cultural parks are undergoing a process of internalization. This global integration has fostered enhanced economic and informational exchanges, intensifying intercultural communication. One of the prominent manifestations of globalization is the widespread adoption of digital technologies and culture. This integration has not only reshaped the structural and functional aspects of cultural institutions but has also altered the way they interact with and influence societies globally. By examining these transformations, it is necessary to explore the profound impact of globalization on cultural dynamics, emphasizing the pivotal role of digital technology in redefining cultural landscapes worldwide.

The works of Bilan et al. (2019) and Jaya Aziz (2019) are particularly important in the current study. They noted that culture in the digital context is under-researched, as scholars tend to focus more on e-commerce, the “Internet of Things,” or blockchain technologies. In another study, Khanani et al. (2021) argued that for economic development, it is more important to develop road infrastructure projects that provide access to cultural facilities. Kim et al. (2022), as well as Mihu et al. (2023), discussed in their works that states invest in the ICT sector following shocks such as the 2008 crisis and the COVID-19 pandemic, which serves merely as a mitigating measure.

Kazakhstan, a pivotal Central Asian nation, has experienced significant transformations over the past decades. As a resource-rich country, it has historically relied on extracting and exporting natural resources. However, diversifying its economy has become a pivotal government policy to ensure economic growth. The development of ICT infrastructure is vital, enabling efficient communication, enhancing access to information, and facilitating the delivery of public services. In Kazakhstan, significant investments have been made in expanding internet and telecommunications networks. In addition, cultural accessibility represents a crucial aspect of quality of life and social cohesion. It encompasses the availability of cultural institutions such as theatres, museums, and educational facilities, which enhance cultural diversity and contribute to the local economy.

Despite these advancements, there remains a significant gap in the literature concerning the specific impacts of cultural and ICT development on Kazakhstan’s broader economic landscape. While many studies have explored these themes in isolation, few have integrated them into an analysis that accounts for their interdependencies and combined effects on economic growth. This study aims to fill this gap by providing a detailed analysis of how cultural accessibility and ICT infrastructure development contribute to economic growth in Kazakhstan. For this, this study aims to employ regression models to investigate how cultural elements and ICT infrastructure influence economic growth. The current study consists of an introduction, a literature review, a methodology that includes substantiation and verification of hypotheses, and a discussion of the results and conclusions.

2. Literature review

Research on economic growth since the early 1990s has highlighted the importance of technological development, scientific advancement, and productivity improvement (Goel and Ram, 1994). The role of entrepreneurship in stable political and economic conditions has also been emphasized (Chen and Feng, 1996). Scholars have argued that stimulating economic growth involves job creation, innovation development, and enhancing population competitiveness (Wennekers and Thurik, 1999). Additionally, studies have shown that economic growth can potentially reduce poverty by creating resources for policies to improve population welfare (Midgley and Tang, 2001).

One of the critical factors in long-term economic growth is the quality of education (Gylfason, 2001). Researchers noted that both school and higher education are causally linked to income levels in adulthood. Therefore, economic growth depends on the quality of human capital (Krueger and Lindahl, 2001). Investments in education, research, and development at the micro, meso, and macro levels are crucial for ensuring sustainable societal development (Boeren, 2019; Izmaylov, 2017; Turkebayeva et al., 2022). However, due to legislative inconsistencies, universities and private investors sometimes need higher returns on investments in youth education (Iatagan and Ionita, 2009).

Despite these challenges, higher education plays a crucial role in shaping and developing the intellectual potential of society, thereby contributing to economic growth and innovation. The research analyzes the experiences of various countries and universities in effectively integrating education, science, and the economy (Dhaqane and Afrah, 2016; Moshtari and Safarpour, 2024; Shifrina, 2013). It is precisely the cognitive skills of graduates, rather than merely the level of education, that significantly impact long-term economic growth (Yu et al., 2014). Studies indicate that the rise in education levels should be accompanied by an improvement in the quality of education and its alignment with current market needs, such as digitalization (Holmes, 2013; Martyakova and Gorchakova, 2019).

Information and communication technologies (further-ICT) play a crucial role in stimulating economic growth. Research shows that ICT usage, measured by the number of internet users, broadband subscribers, and mobile subscribers, is positively correlated with GDP per capita growth rates (Farhadi et al., 2012). Scholars also noted that targeted policy measures are necessary for greater ICT dissemination, as broader technology coverage leads to higher economic growth in countries.

The implementation and use of ICT enhance productivity, improve decision-making quality, and create new opportunities for economic development, especially in highly developed and middle-income countries (Erumban and Das, 2016; Jorgenson and Vu, 2016). Nevertheless, the digital divide continues to affect the industry, and the digitalization of production remained a secondary factor in economic development until 2019 (Hawash and Lang, 2020). Interestingly, the impact of ICT on economic growth varies significantly depending on countries' income levels. ICT plays a vital role in economic growth in highly developed and middle-income countries, whereas this effect is less pronounced in less developed countries (Appiah-Otoo and Song, 2021; Das et al., 2018; Dzobelova et al., 2019; 2021; Yousefi, 2011). Governments in less developed countries face various challenges in implementing ICT, including technical peculiarities, high financial costs, and significant time required for staff training. Therefore, ICT development strategies must be carefully planned (Kozma and Vota, 2014; Verma et al., 2023). One undeniable advantage of ICT applications is e-government and social media, which promote transparency and reduce corruption. Such technologies can change societal cultural attitudes by enhancing the value of openness and transparency (Bertot et al., 2010; Lee et al., 2018; Usmani et al., 2021).

Studies on the interaction between ICT and culture demonstrate the existence of specific practices in the perception of digital products characteristic of different countries' populations, as well as the presence of intercultural interaction. Cultural traits like individualism can explain differences in ICT adoption between countries. Some studies prove that culture influences the level and speed of digital application adoption in various countries (Erumban and Jong, 2006; Kireyeva et al., 2019; Lee et al., 2013; Mihu et al., 2023; Rubino et al., 2020).

Digital platforms are also used to promote cultural heritage. Public libraries equipped with digitized literature can contribute to developing information literacy and eliminating gender disparities in technology use (Silva and Olinto, 2016). Technologies allow users to interact with cultural heritage objects virtually, which is particularly important for educational purposes and the accessibility of exhibits that may be unavailable in real life (Aiello et al., 2019).

The COVID-19 pandemic forced museums to seek new forms of public engagement through digitization, underscoring the importance of technology for maintaining cultural resources under changed conditions (Hepburn et al., 2020; Lerario, 2021; Kim et al., 2022). Using ICT to create smart infrastructure for cultural sites helps improve user interaction and enrich their experience when visiting museums. Integrating wireless sensor networks with Bluetooth allows for more precise identification, localization, and support of users at cultural sites (Chianese and Piccialli, 2017; Khanani et al., 2021; Nurbatsin and Vasa, 2021; Samiyeva, 2023). In society, five new components play a unique role: information and communication, culture and art, education, planning and design, and games and entertainment (Abdel-Aziz et al., 2016).

The use of ICT in urban culture has numerous benefits. For example, interactive maps can significantly enhance inclusion in cultural sites, providing information and services that allow all visitors to organize their visits better and utilize available opportunities (Marconcini, 2018). Digitalization in urban landscapes creates hybrid spaces where nature, society, and technology converge to create new forms of interaction and improve the quality of urban life (Costa et al., 2019; Thornton et al., 2011). Recent research indicates that using the latest ICT advancements, such as artificial intelligence, in urban planning contributes to achieving economic and environmental success (Rieder et al., 2022).

Supportive policies, adequate funding, and stable governance are crucial for ICT-driven development (Alimi and Adediran, 2020; Neto and Pereira, 2005; Sepehrdoust and Ghorbanseresht, 2019). Public and private investments in ICT infrastructure are necessary to ensure widespread access to digital technologies (Brito et al., 2018; Falch and Henten, 2015). Policies to reduce inequality include improving internet access, developing e-commerce, and ensuring access to cultural heritage (Bilan et al., 2019; Muscarà and Sani, 2019).

Based on the literature review, the following key conclusions can be drawn. ICTs play a crucial role in increasing productivity, improving decision-making quality, and creating new economic development opportunities. However, the impact of ICT varies significantly across countries with different income levels, and digital inequality remains a significant issue. Many studies do not fully explore the approaches through which ICT and the accessibility of cultural institutions influence economic development in various contexts. Thus, despite extensive research on the interrelationship between ICT, education, and economic growth, there is a clear gap in the analysis concerning countries with transition economies, such as Kazakhstan. Given the identified gaps, it is necessary to focus the study on analyzing the current state of the ICT infrastructure in Kazakhstan and its impact on cultural accessibility and economic growth. This will make it possible to develop effective measures to improve the digital infrastructure further and integrate it into the cultural and economic processes of the country. Such research will provide specific data and recommendations necessary for making informed decisions aimed at enhancing digital infrastructure and its integration into Kazakhstan's cultural and economic processes.

3. Materials and methods

A broad literature review is a standard method for investigating the relationships between culture and ICT. Most authors employ a qualitative literature review (Aboiron and Aboiron, 2022; El-Said and Aziz, 2021; Hanelt et al., 2020). Others use qualitative analysis and review case studies within the context of the digital economy (Demir et al., 2023). Some researchers apply correlational-regression analysis techniques in their studies (Basten and Cuaresma, 2014). For example, Bilan et al. (2019) used regression models based on data from EU countries. The current research will utilize the construction of several regression models based on available factors. However, after certain checks and calculations, some factors will be excluded. Those factors that ultimately are included in the models are of particular interest. The methodology of the conducted research is illustrated in **Figure 1**.

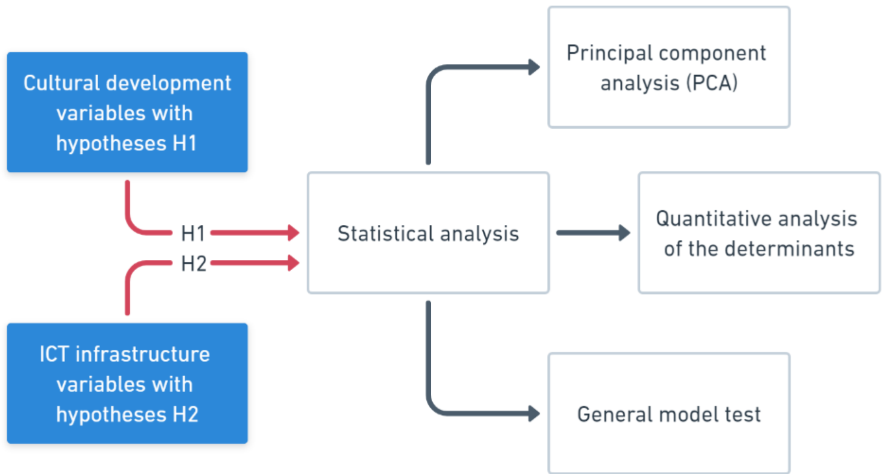

Figure 1. Research framework.

The research methodology flowchart includes two main models: "Cultural development variables" with hypotheses H1 and "ICT infrastructure variables" with hypotheses H2. The following hypotheses were put forward:

H1: There is a significant relationship between cultural development variables (e.g., number of theaters, museums, and others) and GDP per capita.

H2: There is a significant relationship between ICT infrastructure variables (e.g., number of fixed Internet subscribers, total costs of ICT, and others) and GDP per capita.

These models undergo statistical analysis, which consists of four key stages:

a) Principal component analysis (PCA) is used to measure the degree of correlation between ranked variables and variables of economic growth. The method allows the transformation of a set of related variables into a smaller set of unrelated variables;

b) Overall model test—assesses the adequacy of the model as a whole to evaluate how well the collected data fit the developed hypotheses;

c) Quantitative analysis of determinants—identifies the contribution of each variable in explaining the observed variation in the data, which can help reveal critical drivers or predictors in the data.

Each of the two models features groups of variables, and each hypothesis (H1–H2) reflects the assumed impact of a specific indicator on the analyzed area (presented in **Table 1**).

Table 1. Definitions of the used variables (Note: compiled by source Bureau of National Statistics (2022)).

Model	Description	Definition
Cultural development variables (Model 1)	Theaters	Theaters, units
	Leisure	Cultural and leisure institutions, units
	Concert	Concert organizations, units
	Recreation parks	Number of amusement and recreation parks, units
	Museums	Museums, units
	Enrollment in higher education	Gross enrollment in higher education, percentage
	Universities	Number of higher education organizations, units
	Teaching staff	Number of teaching staff of higher education organizations, person
	Students	Number of students in higher education organizations, person
	Master's students	Number of master's students, person
ICT infrastructure variables (Model 2)	Internet subscribers	Number of fixed Internet subscribers, thousand units
	Telephone lines	Number of fixed telephone lines, thousand units
	Costs ICT	Total costs ICT, million KZT
	Computer users	Share of computer users aged 16–74 years, percentage
	Internet users	Share of Internet users aged 16–74 years, percentage

3.1. Moderating variables

Each hypothesis reflects the presumed impact of a specific indicator on the area being analyzed.

The first model includes variables of cultural development, encompassing both traditional cultural variables and higher education metrics, as they collectively reflect the comprehensive level of cultural infrastructure. Traditional cultural variables, such as the number of theaters, museums, and cultural institutions, demonstrate the activity and accessibility of the cultural environment. Higher education metrics indicate intellectual potential, including the number of students, faculty, and educational organizations. Overall, cultural infrastructure development requires the government to develop and implement cultural policies to support cultural and educational institutions. Thus, including cultural development variables in the model allows for assessing their combined impact on economic well-being and political stability.

The second model includes variables such as the number of fixed telephone lines, total ICT expenditures, the number of fixed internet subscribers, and the proportion of internet and computer users, as they collectively demonstrate the level of digital infrastructure. The number of telephone lines primarily reflects the usage of outdated analog connections. Total ICT variables represent the strategy for investment and expenditure policies in implementing digitalization. The number of fixed internet subscribers, the proportion of internet users, and the proportion of computer users characterize the intensity of modern ICT usage. Therefore, including ICT infrastructure variables in the model allows for assessing their combined impact on economic well-being and political stability.

3.2. Sample selection and data collection

The data underpinning this study were obtained from open sources, specifically, the National Statistics Bureau of Kazakhstan, covering the period from 2008 to 2022. The collected data are categorized into three distinct groups, each corresponding to specific sectors (Model 1 and Model 2) hypothesized to influence economic growth (forecast). Each model is tailored to understand and predict the impact of different factors on overall economic growth.

4. Results

4.1. Results of correlation analysis

According to the steps mentioned above, the first stage of the analysis involves examining the collected data for relationships between variables using PCA. There are two groups of factors; each factor's impact on GDP per capita will be tested in sequence. The data indicate varying effects of these two groups of factors on a country's economic condition. The degrees of freedom for all indicators are the same (df = 13). In the PCA biplot, two important aspects to note are the length of the arrows and the angle between the arrows. The length of each arrow represents the variance explained by that particular variable in the principal component space. Longer arrows indicate that the variable has a stronger influence on the principal components, meaning it explains more of the variation in the data. The statistical analysis of the relationships between various cultural and ICT variables and GDP per capita is illustrated in **Figures 2** and **3**.

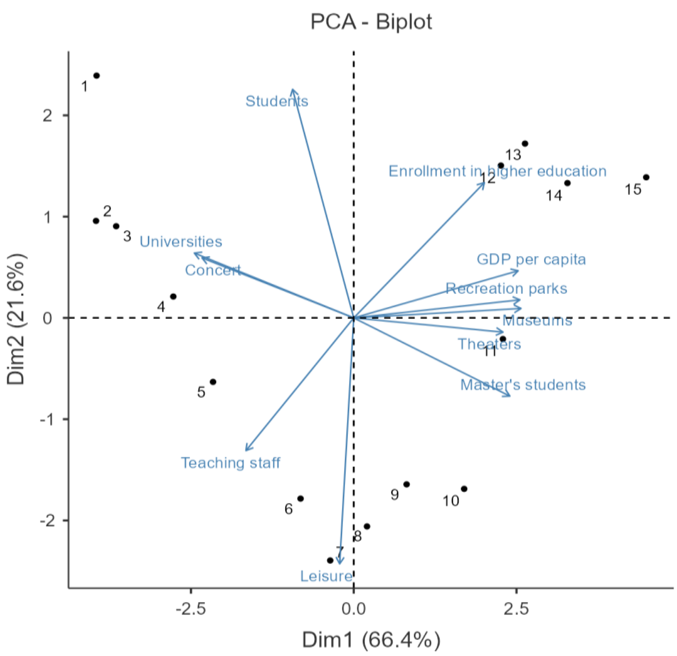

Figure 2. PCA biplot analysis of Model 1.

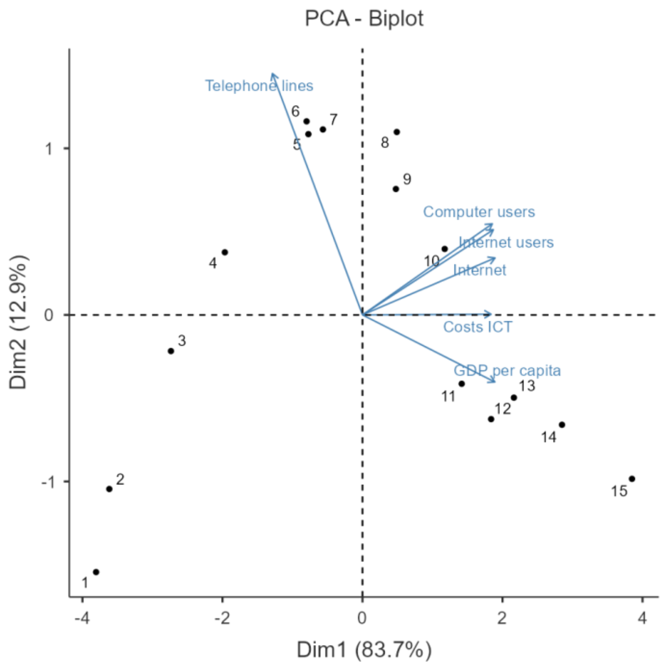

Figure 3. Bi-plot analysis of the primary component Model 2.

4.1.1. Model 1 (cultural development)

The PCA biplot for Model 1, which includes cultural development variables, illustrates the relationships and contributions of these variables to the first two principal components, Dim1 and Dim2. Dim1 explains 66.4% of the total variance, while Dim2 accounts for 21.6%, together capturing 88% of the total variance. The variables GDP per capita and recreation parks are closely aligned with each other and have long arrows, indicating a strong positive correlation and significant influence on the principal components. Enrollment in higher education also shows a positive correlation with GDP per capita and recreation parks, underscoring the importance of higher education for economic development. Museums and theaters, although positively correlated with GDP per capita, contribute less to the total variance compared to recreation parks. Similarly, Concerts and universities exhibit a high positive correlation, as evidenced by the small angle between their vectors. Conversely, Leisure is oriented in the opposite direction of GDP per capita, Recreation parks, and Enrollment in higher education, indicating a negative correlation with these variables.

Based on the obtained results, the formula for Model 1 of the linear multiple regression is as follows Equation (1):

$$\text{GDP per carita} = \beta_0 + \beta_1 \times \text{Recreation parks} + \beta_2 \times \text{Museums} + \beta_3 \times \text{Theatres} + \beta_4 \times \text{Master's students} + \beta_5 \times \text{Enrollment in higher education} + \beta_6 \times \text{Students} + \beta_7 \times \text{Leisures} + \beta_8 \times \text{Teaching staff} + \beta_9 \times \text{Universities} + \beta_{10} \times \text{Concerts} + \varepsilon \quad (1)$$

where:

GDP per capita—the main independent variable;

Recreation parks—the main independent variable;

All variables—indicators that minimize estimation bias in the model;

β_0—the constant;

β_1–β_{10}—free coefficients of the model;

ε—is the error.

4.1.2. Model 2 (ICT infrastructure)

The PCA biplane for Model 2 includes ICT infrastructure variables and illustrates the relationship and contribution of these variables to the first two principal components, Dim1 and Dim2. Thus, Dim1 explains 83.7% of the total variance, and Dim2 explains 12.9%, which accounts for 96.6%. The telephone lines variable has a long arrow pointing to the left, indicating a significant contribution to the first principal component of GDP per capita but a negative correlation with other variables. Other indicators, such as computer users, internet subscribers, computer users, costs ICT, telephone lines, on the contrary, have arrows pointing to the right, which indicates their high positive correlation with each other and a significant contribution to GDP per capita.

Based on the results obtained, the model 2 linear multiple regression formula looks as follows:

$$\text{GDP per carita} = \beta_0 + \beta_1 \times \text{Cost ICT} + \beta_2 \times \text{Telephon lines} + \beta_3 \times \text{Computer users} + \beta_4 \times \text{Internet users} + \beta_5 \times \text{Internet subscribers} + \varepsilon \quad (2)$$

where:

GDP per capita—the main independent variable;

Recreation parks—the main independent variable;

All variables—indicators that minimize estimation bias in the model;

β_0—the constant;

β_1–β_{10}—free coefficients of the model;

ε—is the error.

The next stage involved indicators with high correlation. Further validation of the models revealed fit indicators such as the Pearson correlation coefficient (R), the coefficient of determination (R^2), the adjusted R^2, the standard error of estimation (SEE), F-statistic, and corresponding significance levels (p-values), which are used to evaluate the quality and adequacy of statistical models. Each indicator and an overall conclusion for each model are presented in **Table 2**.

Table 2. General model test.

Model fit indicators						**Comprehensive model test**			
R	***R*²**	**Adjusted *R*²**	**AIC**	**BIC**	**Std. Dev.**	***F***	**df1**	**df2**	***p***
Model 1									
1.000	0.999	0.999	779	10	4	210	9	5	<0.001
Model 2									
0.985	0.971	0.955	60.5	5	9	214	1	13	<0.001

Model 1 exhibits a very strong correlation (R = 1.000) and explains a large portion of the data variation (R^2 = 0.999). However, the adjusted R^2 is slightly lower, which may indicate that some variables in the model do not contribute significantly. The AIC and BIC are relatively high (534 and 542, respectively), suggesting a greater complexity of the model.

Model 2 shows a less strong correlation (R = 0.985) but also a high R^2 (0.971).

This model has lower AIC and BIC compared to Model 1, indicating a more effective balance between accuracy and simplicity.

All models demonstrate statistical significance ($p < 0.001$), indicating that their predictions are statistically reliable. The most important aspects in choosing a model are the balance between prediction accuracy, model complexity, and its ability to explain the data, which is best achieved by Model 1.

4.2. Results of building models

The subsequent phase of the research presents the results of a regression analysis, which allows for the assessment of the impact of specific predictors on GDP per capita. The weights of the predictors indicate the direction and magnitude of their impact. At the same time, standard errors (SE), confidence intervals, *t*-statistics, *p*-values, and standardized scores provide a further understanding of these effects' statistical significance and reliability (**Table 3**).

Table 3. Quantitative analysis of the determinants of economic growth (Model coefficients—GDP_*p_p*).

Predictor	Weighting factor	SE	95% confidence interval		*t*	*p*	Standard rating
			Lower	Upper			
Model 1							
Constant	-7.29×10^{-7}	3.31×10^{8}	-9.92×10^{-8}	8.46×10^{8}	−0.22013	0.837	-
Recreation parks	1.66×10^{6}	420,376	495,110.83	2.83×10^{6}	3.95423	0.017	0.5155
Museums	2.33×10^{6}	874,185	−96,048.57	4.76×10^{6}	2.66657	0.056	0.4047
Theaters	1.48×10^{6}	1.52×10^{6}	-2.74×10^{-6}	5.71×10^{6}	0.97625	0.384	0.0512
Master's students	1044.2	1505	−3135.76	5224	0.69358	0.526	0.0699
Enrollment in higher education	-2.14×10^{-6}	1.28×10^{6}	-5.70×10^{-6}	1.43×10^{6}	−1.66535	0.171	−0.1105
Students	461.3	164	4.56	918	2.80416	0.049	0.2161
Leisures	−162,524.8	176,473	−652,493.10	327,444	−0.92096	0.409	−0.0551
Teaching staff	−31.5	3639	−10,135.48	10,072	−0.00867	0.993	-4.25×10^{-4}
Universities	-1.24×10^{-6}	961,376	-3.91×10^{-6}	1.43×10^{6}	−1.29052	0.266	−0.1067
Concerts	−119,140.1	395,566	-1.22×10^{-6}	979,127	−0.30119	0.778	−0.0150
Model 2							
Constant	3.56×10^{8}	8.19×10^{7}	1.71×10^{8}	5.41×10^{8}	4.345	0.002	-
Costs ICT	337	124	55.7	618	2.711	0.024	0.352
Telephone lines	−84,296	17,834	−124,639.5	−43,953	−4.727	0.001	−0.373
Computer users	−698,459	2.51×10^{6}	-6.38×10^{-6}	4.98×10^{6}	−0.278	0.787	−0.131
Internet users	1.20×10^{6}	2.64×10^{6}	-4.78×10^{-6}	7.18×10^{6}	0.453	0.661	0.251
Internet subscribers	46,221	54,043	−76,032.8	168,475	0.855	0.415	0.278

The obtained data describes the statistical analysis results for two regression models. These results can be used to assess the influence of various variables on the dependent variable within the two models.

4.2.1. Model 1 (Cultural development variables)

In the first model, the constant is not statistically significant ($p > 0.05$), indicating that the intercept does not have a primary effect on GDP per capita when all predictor values are zero. Among the cultural variables, recreation parks and students showed a positive and statistically significant effect on GDP per capita ($p < 0.05$). Specifically, a one-unit increase in the number of holiday parks is associated with a 1.66-unit increase in GDP per capita. Similarly, an increase in university students per person will increase GDP by 461.3 units. Museums were nearly statistically significant ($p = 0.056$), suggesting a potential positive impact on economic development, though this result is not conclusive. The remaining variables, including theaters, master's students, enrollment in higher education, leisures, teaching staff, universities, and concerts, did not show statistically significant effects ($p > 0.05$) on GDP per capita.

4.2.2. Model 2 (ICT infrastructure)

In the second model, the constant term is also not statistically significant ($p > 0.05$), indicating the absence of a primary effect on GDP per capita when all predictor values are zero. Among the ICT variables, ICT costs showed a positive and statistically significant effect on GDP per capita ($p < 0.05$). Specifically, a one-unit increase in ICT spending is associated with a 337-unit increase in GDP per capita. Conversely, the number of telephone lines negatively and statistically significantly affected GDP per capita ($p < 0.05$). The remaining three indicators (computer users, internet users, and internet subscribers), did not have statistically significant effects ($p > 0.05$) on GDP per capita.

In the cultural development model, recreation parks and the number of students were found to be significant predictors of GDP per capita. Similarly, in the ICT infrastructure model, ICT costs were identified as a significant predictor. These findings highlight that both cultural and ICT investments play crucial roles in economic development.

The high levels of GDP in developed regions enable greater investment in cultural infrastructure, such as recreational parks, suggesting a bidirectional relationship: not only do parks influence GDP, but GDP also impacts the number of parks. This reverse causation underscores the complex interplay between economic growth and cultural infrastructure.

The negative impact of the number of telephone lines reflects the decline in landline usage due to the rise of digital communication methods. This finding indicates the diminishing relevance of traditional telecommunications technologies in the modern digital economy. Consequently, it highlights the need to reconsider their role and to develop strategies and policies that support the transition to more advanced digital communication infrastructures, ultimately fostering economic growth.

5. Discussion

This study explored the impact of cultural and ICT infrastructure factors on economic growth indicators using regression models. The results regarding variables the influence of cultural and ICT variables on the economic growth of Kazakhstan were ambiguous.

Among the ten cultural indicators variables, two factors demonstrated a significant positive impact on GDP per capita. The first factor, the number of recreational and leisure parks, underscores the importance of such facilities for enhancing quality of life. Parks attract tourists and contribute to local business revenue, supporting the preservation of cultural heritage and the hosting of community events (Thornton et al., 2011). The second factor, number of students in higher education organizations as an indicator of workforce quality and is a key factor. Highly educated professionals contribute to innovation and actively utilize digital resources, fostering technological growth and increasing labor productivity. These findings are supported by research such as that by Bilan et al. (2019) and Moshtari and Safarpour (2024). The inclusion of both cultural and educational variables in the model offers a comprehensive view of their concurrent impact.

Conversely, the number of higher education institutions displayed a negative correlation with GDP per capita. This result indicates that it is not the quantity of higher educational institutions but their quality that determines their contribution to economic development. This result challenges the prevailing notion that the mere presence of higher education institutions automatically contributes to economic growth, highlighting the need for a focus on educational quality rather than expansion (Hepburn et al., 2020).

In the second model, the total expenditures on ICT technologies demonstrated a positive impact on GDP. This supports theories that advancements in ICT infrastructure not only facilitate cultural and economic opportunities but also play a pivotal role in a country's overall economic development (Dzobelova et al., 2019; Kim et al., 2022; Usmani et al., 2021).

Conversely, a negative correlation was noted with the number of fixed telephone lines. This indicates that investments in new fixed telephone infrastructure may not be economically viable. However, without alternatives to wired internet, and considering the higher costs associated with installing cellular towers in small villages, the ongoing installation of telephone lines in Kazakhstan remains justified until alternative solutions, such as satellite internet, are developed.

H1: There is a significant relationship between cultural development variables (e.g., number of theaters, museums, and others) and GDP per capita—partially confirmed.

The analysis revealed that certain cultural development variables, such as the number of recreation parks and students, have a statistically significant positive effect on GDP per capita. However, other cultural variables, including the number of theaters, museums, and others, did not demonstrate a statistically significant relationship. Thus, the hypothesis is partially confirmed.

H2: There is a significant relationship between ICT infrastructure variables (e.g., number of fixed Internet subscribers, total costs of ICT, and others) and GDP per capita—partially confirmed.

The results indicated that the total costs of ICT are positively and significantly related to GDP per capita, whereas the number of telephone lines showed a statistically significant negative relationship. However, other ICT infrastructure variables, such as the number of fixed Internet subscribers, computer users, and internet users, did not show a statistically significant effect. Therefore, this hypothesis is also partially confirmed.

6. Conclusion

The findings from this study offer significant insights for policy-making in the domains of cultural and ICT infrastructure development, particularly in the context of enhancing economic growth in Kazakhstan. To do this, it is necessary to pay attention to the monitoring of universities and the reorientation of educational programs towards the development of digital skills. Ultimately, this study not only contributes to the empirical literature but also serves as a foundational resource for policymakers seeking to harness cultural and technological levers for economic development.

Policy recommendations:

1) The negative correlation between the sheer number of higher education institutions and GDP per capita underscores the need for policy initiatives focused on improving the quality of education rather than merely increasing the number of institutions. This could involve enhancing accreditation standards, increasing funding for research, and promoting faculty development programs. Such initiatives could help cultivate a highly skilled workforce capable of driving economic innovation and growth. Policies should prioritize the quality over the quantity of educational institutions to maximize their economic contribution.

2) The positive impact of amusement and recreation parks on GDP per capita highlights the economic value of cultural and recreational infrastructure. Policy-makers should consider investing in these areas to boost recreation parks and local economies. This could include grants for park development, maintenance of cultural heritage sites, and support for community cultural events.

3) The significant positive effect of total expenditures on ICT on economic growth indicates that strategic investments in ICT infrastructure can yield substantial economic benefits. Policies aimed at expanding digital access and improving ICT literacy among the population can facilitate wider technology usage and spur economic activities.

4) The negative correlation with the number of fixed telephone lines suggests that investments in traditional telecommunication infrastructure might not be economically beneficial in the current digital age. Instead, policy efforts could be better directed towards more modern and cost-effective communication technologies, such as expanding broadband internet access or exploring new technologies like satellite internet, especially in rural or underserved areas.

This study offers significant insights for policy development in the areas of cultural and ICT infrastructure, particularly in the context of Kazakhstan's economic growth. To achieve this goal, it is essential to focus on monitoring universities and reorienting educational programs towards the development of digital skills. Ultimately, this study not only contributes to the empirical literature but also serves as a foundational resource for policymakers seeking to harness cultural and technological levers for economic development.

Future research could focus on the long-term impact of investments in culture and ICT, comparative analyses with other regions, and the assessment of new technologies and global trends on economic development. Additional attention should be given to the study of policy implementation and qualitative research, which can provide deeper insights into the perceptions and experiences of stakeholders. This approach will help develop sustainable strategies for further economic growth.

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