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Dynamic Modeling of the Development of Communication and Information Services for the Population in the Kashkadaryo Region

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Abstract: This article analyzes the dynamics of the development of communication and information services provided to the population in the Kashkadarya region based on an econometric approach. In the course of the research, the trends in the volume of communication and information services over time in the region were studied based on statistical data, and their future development prospects were assessed. The research used the ARIMA model based on time series analysis, and the calculations were carried out using the EViews software package. The modeling results show a stable growth trend in the volume of communication and information services, allowing us to identify important factors for the development of digital infrastructure and information services in the region. The results obtained are of significant scientific and practical importance in developing a strategy for the development of information and communication services at the regional level and in making economic decisions in the sector.

Keywords: Econometric Modeling, Dynamic Modeling, Time Series Analysis, ARIMA Model, Stationarity Test, Autoregressive Process, Moving Average Model, Forecasting Model

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1. Introduction

In the context of the rapid development of the digital economy, information and communication technologies (ICT) are becoming one of the most important factors in the development of society and the economy. In the modern economic system, communication and informatization services are emerging not only as an infrastructure that provides information exchange, but also as a strategic sector that stimulates economic growth, increases production efficiency, and serves to expand the services market. In particular, the widespread introduction of Internet technologies, the development of mobile communication services, the proliferation of digital platforms and electronic services are further accelerating the exchange of information between the population and economic entities. In recent years, our country has been implementing important reforms to develop information and communication technologies, modernize telecommunications infrastructure, expand Internet coverage, and improve the quality of communication services provided to the population. Digital transformation processes are being widely implemented in public administration, economic sectors, and social sectors. In this regard, it is of great scientific and practical importance to analyze the level of development of

communication and information services in the regions, determine their place in economic growth, and assess future development trends[1].

The growth of the service sector in the regional economy, in particular, the volume of communication and information services, has a positive impact on the development of other sectors of economic activity. Because telecommunication services are an important factor in increasing the efficiency of production processes, developing e-commerce, introducing remote services, and forming the infrastructure of the digital economy. Therefore, studying the dynamics of the development of this sector based on statistical and econometric methods is one of the urgent scientific issues[2].

Kashkadarya region is considered one of the important economic regions of our country, and in recent years, important work has been carried out in this region to develop information and communication services. Measures are being taken in the region to develop telecommunication infrastructure, expand Internet services, and increase the volume of digital services. However, one of the important research directions is the scientific assessment of how these services change over time, their development trends and future forecast indicators.

The purpose of this article is to analyze the dynamics of the development of communication and information services provided to the population in the Kashkadarya region based on econometric modeling and to determine their future development prospects. In the course of the research, trends in the volume of services based on time series are studied, and statistical analysis methods are used. Also, the ARIMA model, one of the time series models, is used to forecast the future development of the volume of services[3].

Econometric calculations are performed using the EViews software package. During the model building process, the stationarity of the time series is checked, the optimal ARIMA model is determined, and the diagnostic indicators of the model are evaluated. Based on the results obtained, the main trends in the development of communication and information services are identified and the future development directions of this industry are forecasted.

Literature Review

The development of information and communication technologies and communication services is one of the important areas that has been widely studied in economic research in recent years. In the scientific literature, special attention is paid to the impact of this sector on economic growth, its role in the services market, and the modeling of its development dynamics.

The ARIMA model based on time series analysis, developed by foreign economists J. Box and G. Jenkins, is one of the widely used methods for forecasting economic processes. Their scientific developments substantiate the possibility of determining changes in economic indicators over time and forecasting future trends [2].

Also, econometric approaches developed by R. Engle and C. Granger play an important role in time series analysis. Their research covers the theoretical foundations of determining long-term relationships between economic indicators and building dynamic models. This approach allows for in-depth analysis and forecasting of economic processes [3].

In addition, the issues of dynamic modeling of economic processes have been widely studied by C. W. J. Granger and J. D. Hamilton. J. D. Hamilton, in his scientific works on time series econometrics, emphasizes the importance of using modern econometric models in analyzing the dynamic changes in economic indicators and forecasting them. These approaches allow for a deep analysis of changes in economic systems and the identification of their future development directions [4].

Domestic economists have also widely studied the issues of the development of the digital economy and information and communication services. In particular, a number of scientific studies have been conducted on the introduction of digital technologies in the economy, the expansion of the services market, and the impact of telecommunications infrastructure on economic development. These studies examined the territorial development of information and communication services, trends in the growth of the volume of services, and their assessment through econometric modeling[5].

The analysis of the above scientific studies shows that the use of econometric modeling methods, in particular time series models, is of significant scientific and practical importance in studying the development processes of communication and information services. Therefore, in this article, the dynamics of the development of communication and information services provided to the population in the Kashkadarya region are analyzed based on the ARIMA model, and their future development trends are assessed through econometric modeling.

2. Material and Methods

This study used econometric analysis methods to study the dynamics of the development of communication and information services provided to the population in the Kashkadarya region and to forecast their future development trends. The methodological basis of the study is dynamic modeling methods based on time series analysis. In the course of the study, statistical data on the volume of communication and information services in the Kashkadarya region were initially collected and systematized. Based on this data, the trends in the volume of services over time were analyzed using economic and statistical methods. At the stage of statistical analysis, the dynamics of indicators, growth rates, and general development trends were determined [6]. At the next stage, the characteristics of the time series of the volume of services were studied and the stationarity of the series was checked. For this, the Augmented Dickey–Fuller (ADF) test was used. If the time series was non-stationary, the differentiation method was used to bring it to a stationary state. After that, the autoregressive (AR) and moving average (MA) components of the time series were determined, and the optimal ARIMA model was selected. The process of estimating model parameters and diagnostic analysis was carried out using the EViews software package. As a result of modeling, the randomness of residual values, model adequacy, and forecast accuracy were assessed based on statistical criteria. Also, the most optimal model was selected using the Akaike Information Criterion (AIC) and Schwarz Criterion (SC) [7]. Based on the selected ARIMA model, a forecast for the future development of the volume of communication and information services provided to the population in the Kashkadarya region was developed. The results obtained serve as a scientific basis for identifying future development trends in the services sector and making effective economic decisions in this area.

3. Results and Discussion

To analyze the dynamics of the development of the volume of communication services in the Kashkadarya region, statistical data for 2000–2025 were studied. The results of the analysis show that during this period, the volume of communication services in the region had a steady growth trend, and the rapid development of information and communication technologies and the expansion of telecommunications infrastructure had a significant impact on this process.

According to statistics, in 2000, the volume of communication services in the region amounted to 38.6 billion soums, while by 2005 this figure had reached 48.8 billion soums. During this period, a relatively slow but steady growth in the volume of services was observed. In 2006–2010, the volume of services increased from 49.6 billion soums to 64.9 billion soums, indicating the expansion of telecommunications services in the region [8].

Since 2011, there has been a significant increase in the volume of communication services. In particular, in 2011, the volume of services amounted to 116.7 billion soums, in 2012 it reached 168.2 billion soums, and in 2013 it reached 206.4 billion soums. In subsequent years, this indicator has been steadily increasing, reaching 431.7 billion soums in 2017. This indicates the widespread introduction of mobile communication services, Internet technologies, and digital services in the region.

The growth rate of communication services in 2018–2023 will further accelerate. For example, in 2018, the volume of services amounted to 500.5 billion soums, while in 2020 it reached 574.6 billion soums, in 2021 it reached 703.1 billion soums, and in 2022 it reached 902.0 billion soums. In 2023, this figure amounted to 1083.5 billion soums, indicating that high growth rates in the sector are maintained. By 2024–2025, the volume of services reached 1364.9 billion soums and 1802.7 billion soums, respectively (table 1).

For a deeper analysis of dynamic series, basic and chain-like growth indicators were used. According to the results of the baseline analysis, the volume of communication services in 2025 increased by almost 46.7 times compared to 2000 ($1802.7 / 38.6$). This indicates that there is a long-term stable growth process in the sector. The baseline growth indicators confirm that the communication services sector is taking an increasingly important place in the regional economy [9] (Table 1).

Table 1. Development indicators of the volume of information and communication services in the region in 2000-2025 (billion soums)

Yillar	Viloyatda aloqa sohasidagi xizmatlar hajmi (mlrd.so'm)	Yillar	Viloyatda aloqa sohasidagi xizmatlar hajmi (mlrd.so'm)	Yillar	Viloyatda aloqa sohasidagi xizmatlar hajmi (mlrd.so'm)	Yillar	Viloyatda aloqa sohasidagi xizmatlar hajmi (mlrd.so'm)	Yillar	Viloyatda aloqa sohasidagi xizmatlar hajmi (mlrd.so'm)
2000	38,6	2006	49,6	2012	168,2	2018	500,5	2024	1364,9
2001	40,7	2007	52,1	2013	206,4	2019	510,2	2025	1802,7
2002	40,8	2008	54,8	2014	241,2	2020	574,6		
2003	41,9	2009	56,7	2015	279,4	2021	703,1		
2004	43,9	2010	64,9	2016	331,5	2022	902,0		
2005	48,8	2011	116,7	2017	431,7	2023	1083,5		

Chain analysis allows us to determine the dynamics of year-on-year growth. The results of the analysis show that in some years there was a sharp increase in the volume of services. For example, in 2011, the volume of services increased by almost 1.8 times compared to 2010 ($116.7 / 64.9$). Also, significant growth was observed in 2024–2025, and in 2025 the volume of services increased by 1.32 times compared to 2024. This is explained by the expansion of internet coverage in the region, the increase in the volume of digital services, and the development of telecommunications infrastructure [10].

This study used statistical data for the period 2000–2025 to model the dynamics of the development of the volume of communication services in the Kashkadarya region. The process of building an econometric model based on time series was carried out using the EViews software package. The ARIMA model was used in the model evaluation process, and the following specification was introduced in the program:

$$d(y) \text{ ar}(1) \text{ ma}(1)$$

As a result of this command, the AR(1) and MA(1) components are calculated based on the first-order differentiated series of the model. Here, $d(y)$ is the first-order differential

of the resulting indicator, AR(1) is the first order of the autoregressive component, and MA(1) represents the first order of the moving average component [11].

The Least Squares (NLS and ARMA) method was used to estimate the model parameters, and observations for the period 2000–2030 were selected for analysis. This approach allows us to determine the dynamics of the volume of communication services, taking into account the trend and random fluctuations in the time series, and to estimate future forecast values [12].

As a result, it was possible to estimate the parameters of the ARIMA model in the EViews program, check the adequacy of the model, and determine the forecast results.

The results of the econometric evaluation carried out in the EViews program allow us to statistically analyze the dynamics of the volume of communication services. According to the evaluation results, most of the indicators included in the model are statistically significant [13].

According to the results of the table, the AR(1) coefficient is 0.938019, its t-statistic is 5.8179, and the probability level is $p = 0.0000$. This indicator is considered to be statistically highly significant. This result indicates that the change in the volume of communication services in the current period has a strong correlation with the indicators of the previous period. In other words, there is a high level of dynamic stability in the time series, which means that the growth trend in the volume of services continues consistently (table 2).

Table 2. Results of econometric assessment of the dynamics of the volume of communication services in the Kashkadarya region based on the ARIMA model

Dependent Variable: D(Y)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 03/16/26 Time: 13:55
Sample: 2001 2025
Included observations: 25
Convergence achieved after 70 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	166.8500	186.8301	0.893057	0.3819
AR(1)	0.938019	0.161228	5.817948	0.0000
MA(1)	0.600751	0.121377	4.949467	0.0001
SIGMASQ	1746.634	441.1913	3.958903	0.0007
R-squared	0.836275	Mean dependent var		70.56400
Adjusted R-squared	0.812885	S.D. dependent var		105.4162
S.E. of regression	45.59962	Akaike info criterion		10.76176
Sum squared resid	43665.84	Schwarz criterion		10.95678
Log likelihood	-130.5219	Hannan-Quinn criter.		10.81585
F-statistic	35.75450	Durbin-Watson stat		1.721721
Prob(F-statistic)	0.000000			

Also, the MA(1) coefficient is 0.600751, its t-statistic is 4.9494, and the probability level is $p = 0.0001$. This result is also statistically significant. This indicator indicates that short-term random factors also play an important role in the volume of communication services. Such factors include the expansion of telecommunications infrastructure, the introduction of new technologies, and the development of digital services.

Although the coefficient C (constant) in the model is 166.85, its probability level is $p = 0.3819$, which indicates that it is not statistically significant. This indicates that the main explanatory role in the model is played by dynamic components.

The qualitative indicators of the model also confirm that it is sufficiently reliable. In particular, the coefficient of determination (R^2) is 0.836275, which indicates that 83.6 percent of the variation in the outcome is explained by this model. The value of Adjusted $R^2 = 0.812885$ also indicates that the model has high explanatory power.

The F-statistic, which assesses the overall significance of the model, is 35.75, with a probability of 0.000000. This result confirms that the model is generally statistically significant.

Also, the Durbin–Watson statistic is 1.72, which indicates that there is no significant autocorrelation between the residual values. The values of the Akaike information criterion ($AIC = 10.76$) and the Schwarz criterion ($SC = 10.95$) indicate that the model is statistically acceptable [14].

The results of the econometric assessment indicate that there is a stable and consistent dynamic process in the change in the volume of communication services over time in the Kashkadarya region. This is explained by the development of telecommunications infrastructure in the region, the widespread introduction of digital technologies, and the increasing demand for information services by the population.

According to the assessment results, the following econometric model was developed to characterize the volume of communication services:

$$\Delta Y_t = 166.85 + 0.938 \Delta Y_{t-1} + 0.601 \varepsilon_{t-1} + \varepsilon_t \quad (1)$$

here:

Y_t – volume of communication services in period t (billion soums);

ΔY_t – first-order differentiation of the indicator;

0.938 – autoregressive component coefficient;

0.601 – moving average component coefficient;

ε_t – is a random error.

This model has the form ARIMA(1,1,1) and reflects the influence of previous period values and random fluctuations in the time series on the current period indicator (Fig 1).

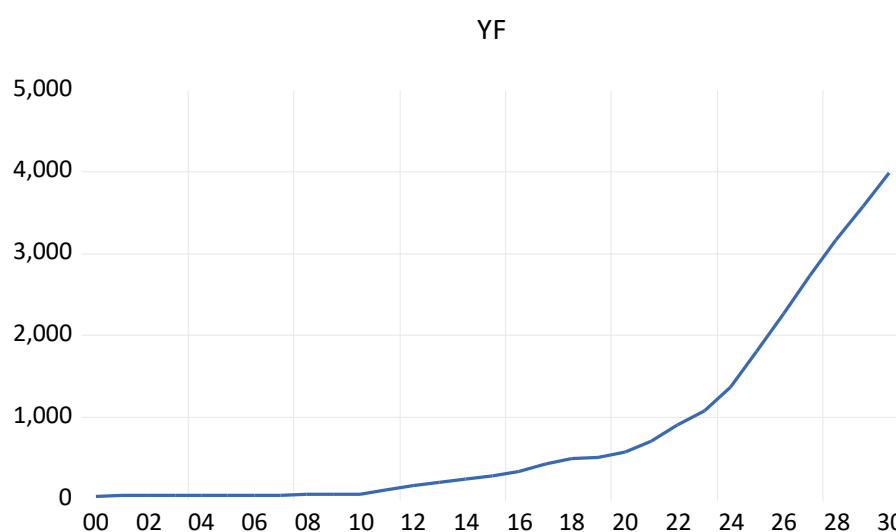


Figure 1. Forecast dynamics of the volume of communication services in the Kashkadarya region (based on the ARIMA model)

Based on the constructed econometric model, the forecast values of the volume of communication services in the Kashkadarya region for the coming periods were calculated and their graphical representation was formed. The graph clearly shows the trend of change of the forecasted indicators over time.

According to the results of the graphical analysis, the volume of communication services was relatively low in the initial periods and had a gradual growth trend. This process is explained by the development of telecommunications infrastructure in the region, the widespread introduction of mobile communication services and Internet technologies, and the formation of the digital services market [15].

The forecast graph shows that the volume of communication services is expected to grow consistently in the coming years. The upward direction of the graphic line indicates that this sector will maintain its development trend in the future. Especially in the last years of the forecast period, a sharp increase in the volume of services is observed. This is due to the development of the digital economy in the region, the expansion of Internet coverage, and the rapid introduction of information and communication technologies into various sectors of the economy.

The graphical results show that the volume of communication services will continue to have a steady growth trend in the future, and by the end of the forecast period, the indicators are expected to increase significantly. In general, the results of the graphical analysis confirm the logical validity of the forecast values obtained on the basis of the constructed econometric model and indicate that the communication and information services sector in the Kashkadarya region has the potential for rapid development in the future.

In this study, the dynamics of the development of communication and information services provided to the population in the Kashkadarya region were analyzed based on statistical data for 2000–2025, and econometric modeling was carried out using time series methods. The results of the analysis showed that the volume of communication services in the region has a consistent and stable growth trend during the analyzed period, and the importance of this sector in the regional economy is increasing (table 3).

Table 3. Results of econometric forecast of the volume of communication services in the Kashkadarya region (2026–2030)

Years	Forecast values
2025 (real)	1802,7
2026	2274.89
2027	2728.16
2028	3163.68
2029	3582.55
2030	3985.79

According to the results of the statistical analysis, in 2000 the volume of communication services amounted to 38.6 billion soums, while by 2025 this figure had reached 1802.7 billion soums. This indicates a tenfold increase in the volume of services during the analyzed period. This process is explained by the expansion of telecommunications infrastructure in the region, an increase in the coverage of Internet services, and the widespread introduction of digital technologies.

According to the results of econometric modeling, the growth trend in the volume of communication services is projected to continue in the coming years. According to the calculations, the volume of communication services in 2026 is expected to be 2274.89 billion soums, in 2027 - 2728.16 billion soums, in 2028 - 3163.68 billion soums, in 2029 - 3582.55 billion soums, and by 2030 - 3985.79 billion soums. This indicates that the communication services sector in the region has the potential to develop at high rates in the future.

Based on the results of the study, the following conclusions were drawn:

The results of the study showed that the volume of communication and information services in the Kashkadarya region has a stable growth trend for 2000–2025, and the volume of services has increased several dozen times during this period. This process is explained by the development of telecommunications infrastructure in the region and the widespread introduction of information and communication technologies.

According to the results of statistical analysis, the growth of the volume of communication services indicates the increasing importance of the service sector in the regional economy. In particular, the introduction of mobile communications, Internet services and digital technologies has a significant impact on the rapid development of this sector.

The results of econometric modeling showed that there is a dynamic relationship in the change in the volume of communication services over time. This confirms that the growth process of this indicator has a stable trend and is inextricably linked with the indicators of the previous period.

The results of the forecast based on the constructed econometric model showed that the volume of communication services will continue to grow steadily in the coming years. In particular, by 2030, this figure is projected to reach approximately 3985.79 billion soums. The forecast results show that the development of digital infrastructure, the expansion of Internet services coverage, and the formation of a digital services market in the Kashkadarya region will contribute to the sustainable development of the communications services sector.

The results of the study show that the development of communication and information services is one of the important factors stimulating regional economic growth. Therefore, the introduction of modern telecommunications technologies in this area and the expansion of the digital services infrastructure are of great importance in ensuring regional development.

4. Conclusion

The results of the study showed that the development of the communication and information services sector in the Kashkadarya region is one of the important factors of the regional economy. The results of the conducted statistical analysis and econometric modeling confirmed the existence of a stable growth trend in this area. Also, forecast calculations showed that the volume of communication services will continue to grow consistently in the coming years.

The results of this study substantiate the need to develop digital infrastructure in the region, expand the scope of telecommunications services, and widely introduce information and communication technologies into economic sectors. At the same time, the use of scientifically based approaches to the development of the communication and information services sector is of great importance in ensuring regional economic growth.

In general, the results of the study show that the communication services market in the Kashkadarya region has the potential for rapid development in the future and serve as an important scientific and practical basis for further improving the economic reforms being carried out in this area.

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