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THE ROLE OF DIGITAL TECHNOLOGIES IN THE STATISTICAL SYSTEM OF DEVELOPED COUNTRIES

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Abstract: *The article examines the role of digital technologies in the statistical system of developed countries, the collection, processing, and transmission of statistical data using digital technologies. In the statistical system, proposals are made for increasing work efficiency using Big data and artificial intelligence. Scientific works of young and experienced as well as foreign scientists were analyzed. The advantages of using remote sensing and aerial photography, portable GPS devices, CAPI, CAWI technologies in the statistical system are taken into consideration. In the collection of statistical data, the use of information technologies and Internet work of the CIS countries was analyzed, and each country's use of CAPI, CAWI technologies was studied as an example of population registration processes. Statistical systems of Canada, South Korea, Brazil, New Zealand, Estonia, Russia and other developed countries were studied and analyzed. Modern digital technologies enable effective acquisition, storage, processing, analysis, distribution and understanding of newly available and complex official statistical data for the state and society.*

Keywords: *statistics, digital technologies, remote sensing, aerial photography, big data, artificial intelligence, platform, information system, metadata, geospatial data, CAPI, GPS, web scraping, cloud technologies.*

INTRODUCTION

The rapid development and wide spread of digital technologies are leading to truly revolutionary changes in the economy and society. The large-scale digitization of the economy and various aspects of daily life is changing the way government organizations operate and how people interact. Innovation in government organizations has been encouraged and the revolution of digital technologies has begun. Increased consumer choice for quality digital services. In addition, digital technologies serve to increase the efficiency and transparency of public services, as well as the trust and participation of citizens. This is encouraging citizens to digitize the economy and society, and government organizations to move from analog to digital transformation.

Today, official statistics play an important role in providing the state and society with objective information on all issues that are of primary importance in making certain decisions.

In the context of the acceleration and complexity of global processes, the role of statistics has changed significantly, and the requirements for the effectiveness of statistical data and its quality are also increasing. As a result, the need for digitalization of statistical



activities has increased, and great attention is being paid to the issues of modernization and integration of statistical information systems used today.

ANALYSIS OF LITERATURE ON THE SUBJECT

A number of studies have been conducted on the role of information technology in the statistical system of developed countries, among which young Uzbek researchers D. E. Safarova, M. R. Akbarova, A. B. Radjiyev's scientific works, as well as B. A. Begalov, O. S. Umarov, S. S. The scientific research works of Gulyamov, AA Musaliyev and P. F. Oliver, N. S. Karpova, A. E. Surinov, I. S. Ulyanov, S. Kenneth, P. Jane, K. S. Laudon, N. Wiener, J. P. Laudon, J. F. Neumann, M. Hammer, K. Shannon, B. S. McNurlin, E. A. Terentev, A. M. Mavletova, M. S. Foreign scientists like Kosolapov contributed to the development of the statistics system with their scientific research.

Basic doctoral student M. R. Akbarova's article on "The role of digital technologies in the statistical system" was studied. The article is dedicated to the use of digital technologies in statistical activities, specific aspects of statistical data, quantitative statistical indicators, development trends of the field of national statistics and digital economy in our country, as well as projects implemented and implemented in the statistical system based on the strategy "Digital Uzbekistan-2030", digital economy Issues such as Big Data, artificial intelligence, neurotechnologies, quantum technologies, cloud and mobile technologies, virtual and augmented reality technologies, crowdsourcing, blockchain technologies, which are considered the main technologies, are highlighted. Also, the status of indicators reflecting the state of digital economy development in Uzbekistan and other developed countries was compared and analyzed.

D. E. Safarova's article on the topic "Using information technologies in the field of digital economy and statistics in the Republic" presents the main directions of improving the methodology of using advanced information and communication technologies in the field of statistics of the Republic of Uzbekistan in the context of the digitization of the economy. In particular, it has been shown that modern information and communication technologies have a huge potential for global competitiveness and serve the growth of our country's economy. Currently, in the field of statistics of the Republic of Uzbekistan, many statistical calculations and forecasts are carried out based on the use of advanced ICT, the State Statistics Committee of the Republic of Uzbekistan has decided to develop a new methodical mechanism for the development of innovative work mechanisms in preparation for the implementation of the national program "Digital Uzbekistan - 2030" by the State Statistics Committee of the Republic of Uzbekistan. solutions, technologies, software products, the need for data collection, the need for data processing and reporting for different categories of users based on the use of advanced ICT.[6]

K. S. Laudon, J. P. From their research, the Laudons proposed a methodology for the development of information systems and their effective application in economic sectors. In their scientific works, issues such as infrastructure of information systems, network technologies, design and development of information systems, infrastructure of information technologies were considered.



S. Kenneth, P. In their research, the Janes conducted research in such areas as the use of information systems in management processes, optimal design of their subsystems, effective use of information systems in solving various functional issues. In addition, they gave their suggestions on the optimal functioning of information systems in the context of network technologies.

N. S. Karpova, A. E. Surinov, I. S. Ulyanov's article "Problems and opportunities of using big data in Russian statistics" reveals the content of the concept of big data, presents its features, discusses the possibilities of using big data for the preparation of official statistics, and describes the problems and difficulties associated with it. The international experience of working on big data projects in official statistics and the prospects of their use in Russian statistics are presented.[5]

RESEARCH METHODOLOGY

In the period of active development of digital technologies, all statistical services of the world are realizing the need to move to new technologies of data collection and dissemination.

Statistics are generated everywhere, from industrial facilities, household appliances, spaceships, organizations and households, to social networks. And the content of the information is becoming more and more diverse and is constantly being updated. The range of data sources is expanding, along with types of data that include general quantitative and qualitative characteristics of various objects, processes or events, text, audio-visual and other "technological" formats. New data can supplement or improve the results of previous observations, or even fundamentally change them.[1]

The international standard for data and metadata exchange (SDMX) is being introduced by the Eurasian Economic Union in order to increase the value of statistical data and metadata for users, reduce the burden of data providers and ensure high quality of statistical information.[2] Information exchange of statistical data and metadata using the international SDMX standard is a complex process that requires constant improvement of existing mechanisms at the national and international level with their constant interaction.

New promising sources of information, large volumes of data, which can be used in the creation of official statistics, are emerging through the increasing use of information and communication technologies, which allow obtaining high-quality and timely digital data at a lower cost and reducing the burden of respondents. Administrative data is another source of information that allows to increase the accuracy and information content of official statistics quickly and at low cost. [6]

Digital transformation refers to the adoption of digital tools and methods by an organization, whether it is a business, government, or any other type of organization. Such a transformation integrates technology and data into all areas and functions, increasing the efficiency of organizations and fundamentally changing the way they work.

Our research shows that the wide implementation of digital technologies in the statistical activities will help to increase the country's statistical potential index. This index reflects the results of the country's statistical potential, achievements and reforms in the development of the national statistics system. For information, it can be said that the



Republic of Uzbekistan was first evaluated according to this index in 2016 and took the 133rd place with a score of 48.9 , and in 2020 it rose to the 67th place.[8]

ANALYSIS AND RESULTS

Our research shows that in developed countries, conducting statistical observations using digital technologies was the first time that CAPI technology was used in the agricultural registration process in Brazil in 2006, and later it was implemented in other South American countries, European and Asian countries (Table 1) [9].

Table 1.

Countries using digital technologies in agricultural registration⁴⁷

T/r	Name of States	Year	A type of digital technology
1	Estonia	2010	CAPI, CASI
2	France	2010	CAPI
3	Latvia	2010	CAPI, CATI, CASI
4	Poland	2010	CAPI, CATI, CASI
5	Austria	2010	CASI
6	Finland	2010	CASI
7	Sweden	2010	CASI, CATI
8	Argentina	2008	CAPI
9	Brazil	2006	CAPI
10	Mexico	2007	CAPI
11	Canada	2011	CASI
12	USA	2012	CASI
13	Australia	2011	CASI
14	Thailand	2013	CAPI
15	Iran	2014	CAPI

As citizens in developed countries are more concerned about information security and privacy and the confidentiality of information provided to the government, statistical organizations are facing a decline in participation in censuses, which are critical to the collection of statistical data.

Censuses provide a wide range of statistical data on the population—individuals, households, and residential units—and allow detailed distribution of data by small geographic areas and small population groups. However, it is widely recognized that conducting a census is one of the most expensive and complex data collection operations involving many interrelated activities. Additionally, logistical and time-limited challenges in reaching and gathering information from the entire population add to the complexity.[14]

These problems force statistical organizations to study alternative methods of conducting population censuses and ultimately to modernize and change the traditional method of population censuses. Advances in digital technology provide statistical organizations with unprecedented opportunities to innovate and transform census operations, significantly improving performance and census results while reducing costs. In addition, they can improve the quality and accessibility of census results. Proper planning

⁴⁷Developed during the author's research.



of census processes based on modern technologies helps to increase efficiency (cost and time savings, increase productivity, increase accuracy).

Our research shows that data collection using the Statistical Observation Methodology (CAPI) on tablets or laptops is replacing the use of paper questionnaires (PAPI) in most parts of the world. The ability of CAPI systems to transmit data instantaneously over mobile data networks provides a significant advantage over traditional procedures and allows data to be captured, verified and validated shortly after collection. CAPI systems integrated with digital mapping and operational management applications can improve the monitoring of census data collection operations and the coordination of field operations, logistics, and communications, so many countries today use CAPI effectively in census activities. [11] In particular, in the CIS countries, -in 2010, the population census was conducted entirely on the basis of paper questionnaires, and by 2020, CAPI and CAWI (via the Internet) systems are being used in all countries except Azerbaijan. Table 2.

Table 2.

The level of use of digital technologies in census activities of the CIS countries (in %)⁴⁸

CIS countries	2010 year	2020 year		
	Paper technology	Registration technology		
		Paper	Digital technology (CAPI)	Via Internet (CAWI)
Azerbaijan	100	100	-	-
Armenia		-	100/25*	-
Belarus		-	76/2*	22
Kazakhstan		-	60	40
Kyrgyzstan		-	100	-
Moldova**		-	81	19
Russia		-	77/5*	18
Tajikistan		60	25	15
Turkmenistan		-	100	-
Uzbekistan**		-	-	90

* Population register and administrative data.

** Transfer is planned.

Digital technologies are bringing great changes in the activities of statistical organizations, not only in data collection, but also in the distribution of official statistical data.

refers to the websites, databases and related information technology infrastructure used to collect, store, protect and ultimately disseminate the data (and related metadata, as well as documents).

The process of disseminating official statistics begins with external or end-user interfaces (eg, websites) and then ends with downstream internal networks, hardware, and software. In addition, statistics organizations are starting to collect data from the Internet

⁴⁸Developed during the author's research.



and private producers using web scraping technology. The use of mobile phone data to generate official statistics on population, tourism and even employment is becoming commonplace today.

Our research shows that as statistical organizations are responsible for collecting, processing, analyzing and disseminating the necessary quality data, the growing variety of statistical data sources (remote sensing, big data, administrative data, Internet of Things, web scraping, etc.) they need to develop long-term digitization strategies of the organization that meet the diversity and complexity and user requirements (speed, quality, precision, etc.). This requires the integration of statistical information systems with the systems of other ministries and agencies. For example, population statistics are obtained from administrative sources belonging to other state bodies.

Statistical services in developed countries are moving forward with digital transformation at different paces and with different approaches. For example, Statistics Denmark -in 2015 aimed to be more user-friendly and data-provider-friendly by incorporating a digital-enabled vision into its business process management strategy.

As Statistics New Zealand's national data steward, it has developed policy, infrastructure, strategy and planning for the wider adoption of digital technologies, helping other agencies to increase their ability to disseminate and use data through digital approaches.

In Estonia, Statistics Norway is the national data manager, playing a central role in the country's overall national digital transformation and coordinating the overall data management in the country, and significantly contributing to reducing data duplication.

Our research shows that statistical organizations need well-designed digitization strategies to prepare their business models for digital. The digitization strategies of statistical organizations should take into account the environment, including the legal framework, financial resources and stakeholders. In particular, it will be necessary to systematically identify and properly address the specific problems and emerging opportunities that the subjects of statistical organizations face in the digital age.

The experience of the South Korean state in developing a strategy for the digitization of statistical activities should be highlighted. The State Statistics Agency of South Korea has carried out effective work on the widespread introduction of digital technologies in all processes of its activities. Digital transformation requires significant investment from statistical organizations not only in terms of purchasing technologies (hardware, software, network infrastructure, etc.), but also primarily in terms of revising their capabilities, core processes and management model. Below are examples of some countries and the opportunities created by successful digital transformation:

1. User-centricity. A fully digitized statistical production chain can facilitate the distribution of various statistical outputs (statistical tables, data services, etc.) to meet the various needs of external users. Researchers, the general public and policy makers will have access to real-time interactive data services. For example, the National Institute of Statistics in Cambodia has stated that it is ready to adapt to the requirements of its



(external) users, and is guided by the requirements of its users when developing the concept and design of platforms for the dissemination of official statistics.

2. Improve efficiency and quality. Modern digital technologies enable statistical organizations to process unprecedented amounts of data in a fraction of the time required to code, input, clean, process and analyze survey and census data. The overall data quality is also increased due to the reduction of the human factor and the quality control of automated systems. For example, the Department of National Administrative Statistics in Colombia has found that online surveys based on very robust and scalable technologies can achieve high response rates.

3. More opportunities are created for innovation. A robust and secure information technology infrastructure, combined with clear and agile data access policies and management models, enables statistical organizations to rapidly test, evaluate and implement new digital technologies and approaches. In Colombia, the creation of an informal Innovation and Development Laboratory by the National Administrative Statistics Department provides an opportunity to flexibly test and evaluate promising technologies in the field of statistics. [4]

4. Competitive advantage. Although the production of official statistics is the competence of the statistical services, today the private sector also plays a major role in the preparation of statistics. From creating satellite images to processing big data sources (eg through web scraping and artificial intelligence), private companies are now able to provide statistics directly.

5. Data management. Digital transformation will help statistical organizations control data management at the government level and all processes related to the collection, management and dissemination of their data.

Our research shows that Statistics Canada's digitization goals are to make statistical data quickly discoverable, accessible, re-usable and open, and these goals are achieved through the following key principles:

- People will have the knowledge and tools to access, use and share official statistics.
- Information is effectively and strategically managed through horizontal management.
- Data is accessible and secure.
- Data will be stored and accessible in an integrated environment with modern digital infrastructure.
- Data literacy, attention to modern scientific methods and analytical capabilities remain core competencies of Statistics Canada.[13]

The following strategic actions outline Statistics Canada's key areas for digitization:

- introduction of an organizational business model consisting of modern digital technologies to further develop the agency's strategic direction and ensure stable operations;
- regular monitoring of the effectiveness of information systems for continuous improvement and reduction of maintenance costs;



- Information systems, platforms, containers, and microservices in technology areas such as information systems security, open source, data science, cloud-based science, agile development, user experience design, and AI and machine learning, smart machines, analytics, and the digital workplace. development;
- introduce bimodal management to further support innovation and eliminate unnecessary bureaucracy, while digitizing agency management;
- Develop a digital strategy consistent with Statistics Canada's modernization and digitization policy; [12]
- Modernize information systems to support new technologies and approaches such as cloud deployment and software-defined infrastructure;
- develop a cloud-first technology strategy and information security policy to support data access and a mobile workforce;
- create a digital workplace so that all employees can work from anywhere, anytime using modern security tools;
- provide researchers, policymakers and other stakeholders with convenient virtual access to statistical information enriched with new dissemination tools such as data visualization dashboards and portals;
- offering powerful data analytics services with key components such as data management center, data ingestion services and data analysis using artificial intelligence, machine learning techniques and high performance data processing.

CONCLUSIONS AND SUGGESTIONS

In conclusion, the power of data is increasingly being used to help nations make informed decisions to address the world's most pressing challenges—climate change, the Sustainable Development Goals, systemic poverty, and global pandemics. Therefore, traditional and non-fully digital statistical methods combined with outdated technological environments hinder the ability to produce the quality statistical data requested by decision makers. Modern digital technologies enable effective acquisition, storage, processing, analysis, dissemination and understanding of newly available and complex official statistical data for the state and society. [3]

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