DOI: 10.52363/passa-2026.1-8
UDC: 629.78:339.13:355(477)

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THE IMPACT OF SATELLITE INFRASTRUCTURE MARKETS ON NATIONAL SECURITY AND ECONOMIC DEVELOPMENT OF UKRAINE

ВПЛИВ РИНКІВ СУПУТНИКОВОЇ ІНФРАСТРУКТУРИ НА НАЦІОНАЛЬНУ БЕЗПЕКУ ТА ЕКОНОМІЧНИЙ РОЗВИТОК УКРАЇНИ

This article examines the impact of satellite infrastructure markets on the national security and economic development of Ukraine. The study systematizes the essence and classification of satellite technologies, distinguishing six key segments: satellite communications, telemetry, geospatial services, Earth remote sensing, satellite navigation, and meteorological observation. Such classification

provides a structured basis for analyzing technological capabilities, identifying market segments, and determining commercialization opportunities.

The paper substantiates a comprehensive methodological approach to analyzing the satellite infrastructure market, combining PEST, SWOT, Porter's Five Forces, market sizing, segmentation, and statistical forecasting methods.

Special attention is paid to the role of satellite technologies in public administration, national security, and social welfare. It is demonstrated that satellite-based solutions enhance decision-making transparency, improve environmental monitoring, strengthen emergency response systems, and ensure reliable communications under crisis conditions.

The study concludes that satellite infrastructure should be considered not only as a high-tech market but also as a strategic asset for state resilience and sustainable development.

Keywords: *Satellite Infrastructure Markets, Satellite Technologies, Geospatial Services, Methodologies of Market Analysis, Public Sector Impact, Economic Development Impact, Ukraine.*

У статті розглядається вплив ринків супутникової інфраструктури на національну безпеку та економічний розвиток України. У дослідженні систематизовано сутність та класифікацію супутникових технологій, виокремлюючи шість ключових сегментів: супутниковий зв'язок, телеметрію, геопросторові послуги, дистанційне зондування Землі, супутникову навігацію та метеорологічні спостереження. Така класифікація забезпечує структуровану основу для аналізу технологічних можливостей, визначення сегментів ринку та визначення можливостей комерціалізації.

У статті обґрунтовано комплексний методологічний підхід до аналізу ринку супутникової інфраструктури, що поєднує PEST, SWOT, п'ять сил Портера, визначення розміру ринку, сегментацію та методи статистичного прогнозування.

Особлива увага приділяється ролі супутникових технологій у державному управлінні, національній безпеці та соціальному забезпеченні. Показано, що супутникові рішення підвищують прозорість

прийняття рішень, покращують моніторинг навколишнього середовища, зміцнюють системи реагування на надзвичайні ситуації та забезпечують надійний зв'язок у кризових умовах.

Зроблено висновок, що супутникову інфраструктуру слід розглядати не лише як високотехнологічний ринок, але й як стратегічний актив для стійкості держави та сталого розвитку.

Ключові слова: *ринки супутникової інфраструктури, супутникові технології, геопросторові послуги, методології аналізу ринку, вплив на державний сектор, вплив на економічний розвиток, Україна.*

Problem statement. The rapid development of satellite technologies has transformed them from specialized tools of aerospace and defense into a cornerstone of global digital infrastructure. In the twenty-first century, satellite communications, navigation, remote sensing, telemetry, and geospatial services have become essential components of economic activity, public administration, and social welfare. Their growing role is linked not only to technological progress but also to the increasing demand for real-time data, secure communications, and spatial intelligence across both private and public sectors. That is why it is extremely important to systematize the main areas of satellite technologies, propose methodological approaches for analyzing the satellite infrastructure market, and assess their impact on public administration, security, and welfare.

Analysis of recent research and publications. Such scientists as Galagan N., Blazhennyi N., Ulyanytsky D., Didenko S., Polyakov M. as well as analytical and research institutions including the Ukrainian State Centre of Radio Frequencies, EOS Data Analytics, Pro-Consulting have devoted their publications to the study of satellite technologies, geospatial data, and the development of satellite communications markets [1; 2; 4; 6; 8; 11]. At the same time, a number of studies address the institutional and market aspects of the sector, including global trends, commercialization opportunities, and the integration of satellite services into public administration and security systems [3; 7; 9; 10]. However, the role of satellite technologies in the conditions of digital transformation and modern security threats requires further research, which requires a

comprehensive scientific understanding of their economic and strategic significance.

Research objectives. This article aims to systematize the main areas of satellite technologies, propose methodological approaches for analyzing the satellite infrastructure market, and assess their impact on public administration, security, and welfare. By linking technological classification with market dynamics and societal outcomes, the study contributes to understanding how satellite infrastructure can serve as both an economic driver and a strategic asset for states and societies.

Presentation of the main material. First of all, it is necessary to consider the essence and classification of satellite technologies, geospatial and telemetry services. The development of satellite technologies has become one of the defining trends of the global high-tech sector, reflecting the growing demand for reliable communications, spatial data, and monitoring solutions in virtually all spheres of human activity.

The classification of satellite technologies should be based not only on their technical characteristics but also on the nature of the services they enable. The versatility of satellite systems makes them applicable to telecommunications, remote sensing, meteorology, navigation, and security, with each of these areas serving multiple industries and public needs. Consequently, systematizing them into functional groups enables researchers and practitioners to approach the market comprehensively, ensuring a balance between technical analysis and socio-economic implications.

Satellite technologies cover a wide range of solutions related to data transmission, remote sensing, navigation, meteorology, telemetry, and geospatial services. Based on their functional purpose and the type of services provided, they can be classified into six main groups: satellite communications, telemetry, geospatial services, Earth remote sensing, satellite navigation, and meteorological observation.

1. Satellite communications. This is a type of space radio communications based on the use of artificial satellite repeaters to transmit signals between ground stations [1].

2. Telemetry. Telemetry is defined as a set of technologies and means for

remote measurement and transmission of data about various objects or processes [2].

3. Geospatial services. Geospatial services are services related to the acquisition, processing, and analysis of data about objects on Earth linked to specific geographic coordinates [3].

4. Remote sensing of the Earth (RSE). RSE is the observation of the Earth's surface from space or aircraft equipped with various imaging equipment [4]. Remote sensing satellites are equipped with optical cameras, radar, multispectral scanners, and other sensors to obtain images and measurements of the Earth's surface.

5. Satellite navigation. Satellite navigation systems are a complex of ground and space equipment designed to determine the location of objects on Earth, their coordinates in geographical space and time, as well as movement parameters (speed, direction).

6. Meteorological observations (weather satellites). Meteorological satellites are artificial satellites designed to observe the atmosphere and weather processes. Their program includes regular photography of cloud cover and measurement of atmospheric parameters (temperature, humidity, etc.) in order to collect data for weather forecasting [5].

Each of these areas has its own system of spacecraft, ground infrastructure, and end-user interfaces. For example, telemetry solutions are based on satellite data transmission channels as part of M2M or IoT solutions and are particularly important for the industrial sector. Geospatial services often integrate Earth observation and GNSS data for accurate mapping and spatial analytics. Meteorological satellites, in turn, provide critical data for national climate monitoring and hazard forecasting systems.

Thus, the classification of satellite technologies allows structuring the subject of research and outlining potential directions for the development and commercialization of the company's products. All of the above areas of satellite infrastructure can serve as a basis for the production of both hardware solutions (antennas, receivers, terminals) and services (monitoring, data transmission, spatial analysis) relevant to public administration, civil, and security sectors.

e-ISSN 2786-5533

Next, we should consider methodological approaches to analyzing the satellite infrastructure market. The analysis of the satellite infrastructure market requires a clear methodological foundation, as this sector is characterized by rapid technological change, a wide variety of applications, and strong dependence on institutional and geopolitical factors. Unlike traditional industries, the satellite market operates at the intersection of high technology, state regulation, and global competition, which makes its study both complex and interdisciplinary. Understanding its dynamics is not limited to evaluating financial indicators or production volumes; it also involves assessing technological readiness, innovation potential, regulatory frameworks, consumer behavior, and long-term strategic trends. A properly designed methodological framework ensures that the study is not fragmented but rather systematic, allowing for the integration of economic, technical, and social dimensions of development.

The importance of methodological rigor is also explained by the dual nature of satellite technologies, which combine commercial potential with strategic value for states and societies. Therefore, the application of diverse research methods – from classical market sizing techniques to scenario-based forecasting and institutional analysis – allows researchers to obtain a comprehensive and multidimensional picture of the satellite infrastructure market. In this context, methodological pluralism is not a theoretical luxury but a practical necessity that enables the discovery of both quantitative trends and qualitative transformations within the sector.

1. PEST analysis.

Political (P), economic (E), social (S), and technological (T) factors reveal the macro conditions of the market. This approach allows you to identify government regulations, the investment climate, the level of technological readiness, and social trends that may affect the prospects for the development of satellite technologies. Its application is appropriate at the initial stage of analysis to determine external influences on the market environment.

2. Market sizing and forecasting.

This approach involves determining the current market volume, its development dynamics, assessing the level of supply and demand, and building

forecast scenarios. The application of forecasting methods is based on the extrapolation of time series, the use of growth rates, trend and regression models.

3. Porter's Five Forces.

This strategic analysis tool allows you to characterize the competitive environment of the satellite services market. It covers the analysis of threats from new players, pressure from suppliers and buyers, the risk of substitute products, and the level of competition among existing market participants. Porter's analysis allows you to identify barriers to entry, competitive advantages, and critical success factors in target segments.

4. SWOT analysis.

The SWOT method (strengths, weaknesses, opportunities, threats) is used for a comprehensive internal and external analysis of a company's position in the market. Combined with PEST and Porter's five forces analysis, it allows you to form strategic directions for development based on the company's potential and market opportunities.

5. Segment analysis and survey methods.

To identify target consumers of satellite infrastructure products and services, the market is segmented according to the following criteria: industry, form of ownership, scale of operations, and territorial affiliation. An in-depth study of demand is carried out using surveys, in-depth interviews, and focus groups, which makes it possible to identify specific needs in equipment, data transmission channels, and geospatial solutions.

6. Content analysis of regulatory acts and strategies.

This method is used to analyze the content of government programs, strategic documents, and legislative initiatives related to satellite infrastructure, digitalization, communications, and geoinformation technologies. The results of the analysis allow for institutional constraints and market development incentives to be taken into account.

7. Statistical analysis and regression forecasting.

Statistical analysis methods are used to process quantitative market indicators: production volumes, sales, number of users, tariffs, and technology penetration levels. Regression models are used to identify dependencies

between key indicators, as well as to construct scenarios for market growth or decline depending on given conditions.

The scope and expected results of the main methods of researching the satellite infrastructure market are shown in Table 1.

Table 1.

Main methods of researching the satellite infrastructure market

Method	Scope of application	Expected result
PEST analysis	Macro market factors	Map of influences, drivers, risks
Market sizing & forecasting	Assessment of market dynamics and potential	Forecasted market volume indicators
Porter's five forces	Competitive environment	Determining the intensity of competition and market threats
SWOT analysis	Internal and external context of activities	Identifying strategic directions for the company's development
Segment and survey analysis	Behavioral and industry characteristics of consumers	Identification of target groups and analysis of their needs
Content analysis of standards	Legislative and program framework	Identification of regulatory factors influencing the market
Statistical and regression methods	Quantitative market data	Growth models, factor analysis, trend assessments

Source: Compiled by the authors

The selection of research methods in accordance with the tasks set in the research project will ensure a comprehensive study of the satellite infrastructure market. The combination of qualitative and quantitative approaches will allow us to obtain a multidimensional analytical model of the market environment, which will serve as the basis for further calculations and justifications regarding the prospects for the development of the products and services.

Finally, we will consider the impact of the development of satellite technology on public administration, security and welfare. The rapid expansion of satellite technologies has moved them far beyond the realm of technical innovation and positioned them as a strategic resource for states, societies, and businesses alike. Modern governments, municipalities, and international organizations increasingly rely on satellite-based solutions not only for

specialized tasks in aerospace or defense but also for everyday functions of administration, communication, and service delivery. The ability to obtain timely, objective, and spatially accurate information makes satellite technologies a unique tool for addressing complex challenges of governance, security, and socio-economic development. As digital transformation accelerates across the globe, satellites serve as both enablers of innovation and guarantors of resilience in times of crisis.

In this context, assessing the impact of satellite technologies requires attention to multiple dimensions: governance efficiency, national and civil security, environmental sustainability, and the welfare of citizens. Their influence extends from operational improvements in decision-making processes to long-term contributions to resilience, transparency, and quality of life. Thus, satellites have become a strategic instrument of public policy, directly shaping how states manage resources, protect citizens, and foster social development in the digital age.

Modern satellite systems are increasingly being used by government agencies, municipalities, and specialized services to ensure effective management of natural resources, monitoring of territories, management of transport infrastructure, health care, education, energy, etc. [6]. Geospatial data and services based on remote sensing of the Earth (RSE) provide objective and timely information on the state of land, water resources, forests, buildings, and risk areas. In combination with geographic information systems (GIS), this allows authorities to make informed decisions, improve management efficiency, and increase planning transparency [7]. For example, rapid analysis of satellite images can detect illegal logging, unauthorized land use, or flooding. This significantly improves the quality of monitoring by environmental services, municipalities, and regulatory authorities.

In the field of security, satellite technologies play a crucial role in ensuring communications in emergency situations, coordinating rescue operations, monitoring border areas, tracking the movement of objects, and in early warning systems for natural disasters. For example, satellite communications are critical when ground infrastructure is disrupted, especially during periods of military conflict or natural disasters [2; 9]. Telemetry and monitoring systems

that use satellite channels are also actively used in the protection of strategic facilities and transport control. For example, telemetry solutions make it possible to track the movement of military equipment, monitor the status of critical infrastructure (oil pipelines, hydroelectric power plants, nuclear power plants), and provide real-time feedback from sensor systems across large areas.

The social impact of the introduction of satellite technologies is also significant. Thanks to the development of satellite internet and data transmission services, the digital divide between cities and rural areas, remote communities and urban centers is narrowing. This creates conditions for distance learning, telemedicine, and e-government, which directly affects the quality of life of the population and access to services [8; 11]. The deployment of satellite solutions in rural schools, medical centers, administrative service centers, and libraries provides a new level of social inclusion. Such infrastructure projects can be implemented within the framework of public-private partnerships or targeted regional digital transformation programs.

In the economic sphere, satellite technologies contribute to the digitalization of the agricultural sector, increased agricultural productivity, accurate yield forecasting, and land accounting, which is particularly relevant for state land cadasters and budget subsidy accounting [10]. Remote sensing data is widely used in agriculture to create field productivity maps, identify moisture zones, and detect crop stress. In urban planning, satellite data helps optimize zoning, plan development and infrastructure, and control illegal construction. For example, cities can automatically track changes in development through periodic analysis of high-resolution images.

In addition, satellite navigation supports the development of intelligent transport systems, GPS monitoring of public transport and freight routes, and analysis of population mobility, which is an important component of urban mobility and road safety planning. Furthermore, GNSS systems are used for accurate geodetic positioning in construction, land management, and the laying of engineering communications.

The impact of satellite technology development on public administration, security, and well-being is summarized in Table 2.

Table 2.

Areas of influence of satellite technologies on public and state processes

Area of impact	Examples of application	Expected effect
Public administration	Geographic information systems (GIS), land monitoring, urban planning	Transparency and soundness of management decisions
Environmental control	Detection of illegal logging, pollution, changes in terrain	Rapid response, sustainable use of natural resources
Emergencies	Coordination of rescue operations, backup communications in crisis situations	Improving disaster response efficiency
Defense and security	Border monitoring, infrastructure control, telemetry of strategic facilities	Strengthening national security
Social services	Satellite internet in villages, support for telemedicine, distance learning	Reducing digital inequality, improving access to services
Agriculture	Yield maps, precision farming, subsidy accounting	Increased agricultural production efficiency, cost optimization
Urban planning	Control of construction, detection of unauthorized construction	Balanced territorial development, preservation of architectural integrity
Transport and mobility	GPS monitoring, movement analytics, route management	Improving transport efficiency, reducing congestion
Geodesy and cadasters	GNSS land surveying, precise positioning	Updating of public cadastral maps, legalization of land use

Source: Compiled by the authors

Therefore, the introduction of satellite technologies is becoming a key factor in improving the quality of public administration, ensuring national security, and improving the well-being of the population. In this context, products and services in the field of satellite communications, telemetry, navigation, and geospatial data processing have not only market value but also strategic social value.

Conclusions. The conducted study has demonstrated that satellite technologies constitute a multifaceted system of communications, telemetry,

geospatial services, remote sensing, navigation, and meteorological observations. Their classification provides a structured framework for analyzing both technological capabilities and areas of practical application. Such systematization is essential for identifying target market segments and determining opportunities for commercialization.

Methodological approaches to analyzing the satellite infrastructure market – ranging from PEST and SWOT to Porter's Five Forces, regression modeling, and survey-based segmentation – make it possible to obtain a comprehensive view of market dynamics. The combination of qualitative and quantitative methods ensures the reliability of results, highlights drivers and risks, and supports the formation of well-grounded strategies for industry development.

The impact of satellite technologies extends beyond the market dimension. Their integration into public administration processes strengthens transparency and efficiency of decision-making, supports environmental monitoring, and enhances territorial planning. In the sphere of national security, satellite-based solutions provide stable communications, real-time monitoring of critical infrastructure, and early warning capabilities. Socially, they contribute to overcoming the digital divide, fostering telemedicine, distance education, and inclusion of remote communities.

Therefore, satellite infrastructure should be considered not only as a technological and economic sector but also as a strategic asset for governance and socio-economic development. The results underline the necessity of coordinated policies, government support, and public-private partnerships aimed at scaling up satellite solutions. This will maximize their potential to contribute simultaneously to market growth, state resilience, and the welfare of society.

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Funding. This research received no external funding.

Use of AI. AI was not used in the preparation of this manuscript. The author bears full responsibility for the content of the article.

Acknowledgments. The author declares no acknowledgments.

Received: 24.03.26

Accepted: 27.05.26

Published: 26.06.26